Oracle® Database

Oracle Clusterware and Oracle Real Application Clusters Administration and Deployment Guide

10*g* Release 2 (10.2)

B14197-15

July 2010

ORACLE®

Oracle Database Oracle Clusterware and Oracle Real Application Clusters Administration and Deployment Guide, 10*g* Release 2 (10.2)

B14197-15

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Preface

The *Oracle Database Oracle Clusterware and Oracle Real Application Clusters Administration and Deployment Guide* describes the Oracle Clusterware and Oracle Real Application Clusters (Oracle RAC) architectures and provides an overview of these products. This book also describes administrative and deployment topics for Oracle Clusterware and Oracle RAC.

Information in this manual applies to Oracle RAC as it runs on all platforms unless otherwise noted. In addition, the content of this manual supplements administrative and deployment topics for Oracle single-instance databases that appear in other Oracle documentation. Where necessary, this manual refers to platform-specific documentation. This Preface contains these topics:

Audience

The *Oracle Database Oracle Clusterware and Oracle Real Application Clusters Administration and Deployment Guide* is intended for database administrators, network administrators, and system administrators who perform the following tasks:

- Install and configure Oracle RAC databases
- Administer and manage Oracle RAC databases
- Manage and troubleshoot clusters and networks that use Oracle RAC

To use this document, you should be familiar with the administrative procedures described in *Oracle Database 2 Day DBA* and the *Oracle Database Administrator's Guide*. You should also read *Oracle Database Concepts* to become familiar with Oracle database concepts. You should also be familiar with installing and configuring Oracle RAC as described in the platform-specific Oracle RAC installation guides.

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Related Documents

For more information, refer to the Oracle resources listed in this section.

- Platform-specific Oracle Clusterware and Oracle RAC installation guides
- *Oracle Database 2 Day DBA*
- *Oracle Database Administrator's Guide*
- *Oracle Database Net Services Administrator's Guide*
- *Oracle Database Platform Guide for Microsoft Windows (32-Bit)*
- *Oracle Database 10g Administrator's Reference Release 1 (10.2) for UNIX Systems: AIX-Based Systems, HP-UX, Tru64 UNIX, Linux, and the Solaris Operating System (SPARC)*

Database error messages descriptions are available online or by way of a Tahiti documentation search. Oracle Clusterware messages and Oracle RAC-specific java tool messages appear in Appendix C and Appendix F of this document respectively.

Conventions

The following text conventions are used in this document:

Convention	Meaning
boldface	Boldface type indicates graphical user interface elements associated with an action, or terms defined in text or the glossary.
italic	Italic type indicates book titles, emphasis, or placeholder variables for which you supply particular values.

Convention	Meaning
`monospace`	Monospace type indicates commands within a paragraph, URLs, code in examples, text that appears on the screen, or text that you enter.

What's New in Oracle Real Application Clusters Administration and Deployment?

This section describes the new administration and deployment features for Oracle Real Application Clusters (Oracle RAC) for the following releases:

- Oracle Database 10g Release 2 (10.2) New Features for Oracle RAC Administration
- Oracle Database 10g Release 1 (10.1) New Features for Oracle RAC Administration

> **See Also:** *Oracle Database New Features* for a complete description of the new features in Oracle Database 10*g* release 2 (10.2) and *Oracle Database 2 Day DBA* for an introduction to Oracle RAC administration

Oracle Database 10*g* Release 2 (10.2) New Features for Oracle RAC Administration

This section describes the Oracle Database 10*g* release 2 (10.2) features for Oracle RAC administration.

- Oracle Clusterware

  Oracle Clusterware, formerly known as Cluster Ready Services (CRS) is an integrated **cluster** management solution that enables you to link multiple servers so that they function as a single system or cluster. The Oracle Clusterware simplifies the infrastructure required for Oracle RAC because it is integrated with the Oracle Database. In addition, Oracle Clusterware is also available for use with single-instance databases and applications that you deploy on clusters.

  See Also:

  - Chapter 1, "Introduction to Oracle Clusterware and Oracle Real Application Clusters", Chapter 14, "Making Applications Highly Available Using Oracle Clusterware", and Appendix B, "High Availability Oracle Clusterware Command-Line Reference and C API" for more information about Oracle Clusterware, the Oracle Clusterware API, and the Oracle Clusterware API commands
  - Your platform-specific Oracle Clusterware and Oracle RAC installation guide for more information about installing Oracle Clusterware

Note: You can install the Oracle Clusterware high availability Application Programming Interface (API) from the Oracle Database 10*g* release 10.2 client installation media.

- The Oracle Real Application Clusters Deployment Book Merged into the Administration Book and Oracle Clusterware designated as a separate component

  Information that was previously in the *Oracle Real Application Clusters Deployment and Performance Guide* and the *Oracle Database Oracle Clusterware and Oracle Real Application Clusters Administration and Deployment Guide* is combined into one book. The title of this book is *Oracle Database Oracle Clusterware and Oracle Real Application Clusters Administration and Deployment Guide*. In addition, because you can now use Oracle Clusterware for single-instance Oracle databases within clustered environments, Oracle Clusterware is presented as a separate, portable Oracle component.

  See Also: Your platform-specific Oracle Clusterware and Oracle RAC installation guide for more information about installing Oracle Clusterware

- Oracle Clusterware High Availability Application Programming Interface Support

  You can now use the Oracle Clusterware high availability components to make your customized applications highly available. You can configure high availability features for applications that are inside or outside of the Oracle database environment. In addition, the functionality provided by some of the command-line interfaces is available through the application programming interfaces (API).

  See Also: Chapter 14, "Making Applications Highly Available Using Oracle Clusterware", and Appendix B, "High Availability Oracle Clusterware Command-Line Reference and C API" for more information about Oracle Clusterware, the Oracle Clusterware API, and Oracle Clusterware API commands

- Cluster Verification Utility

  The Cluster Verification Utility (CVU) verifies a wide range of cluster and Oracle RAC-specific components such as shared storage devices, networking configurations, system requirements, Oracle Clusterware, groups, and users. You can use CVU for pre- and post-installation checks of your cluster environment. You can also use CVU to verify your environment when performing administrative operations such as installation, storage management, node addition, and troubleshooting. The OUI runs CVU immediately after you successfully install Oracle Clusterware.

  See Also: "Using the Cluster Verification Utility" on page A-10 for more information about CVU

- Extending Oracle RAC Databases by Cloning Oracle Clusterware and Oracle Real Application Clusters nodes and instances

  The preferred method to extend Oracle RAC databases is to use Enterprise Manager Grid Control to clone nodes and instances as described in *Oracle Universal Installer and OPatch User's Guide*. Cloning enables you to copy base images of Oracle Clusterware and Oracle RAC software onto other nodes that

have identical hardware and base software. You can also use cloning to create new clusters.

> **See Also:** Chapter 10, "Adding and Deleting Nodes and Instances on UNIX-Based Systems" and Chapter 11, "Adding and Deleting Nodes and Instances on Windows-Based Systems" for more information about adding or deleting nodes

- Oracle Load Balancing Advisory

  Applications using an Oracle RAC database need to balance the workload across the cluster. The Oracle Database 10*g* release 2 load balancing advisory assists in the balancing of application workloads across designated resources. The load balancing advisory monitors workload activity across the cluster for each instance on which a service is active. The advisory provides a percentage value to indicate how much of the workload should be sent to a particular instance. The advisory also provides a service quality flag to indicate how well an instance is responding to service requests. Oracle provides this feedback as an entry in the automatic workload repository and Oracle publishes a Fast Application Notification (FAN) event. To take advantage of the load balancing advisory, applications can use integrated clients or clients that use the **Runtime Connection Load Balancing** feature, or applications can directly subscribe to the FAN events.

- Oracle RAC Runtime Connection Load Balancing using JDBC and Oracle Data Provider for .NET (ODP.NET)

  Oracle supports Runtime Connection Load Balancing to balance work requests across all of the instances of an Oracle RAC database using service level information to select connections from a connection pool. The Oracle Database 10*g* client enables you to use Runtime Connection Load Balancing when using Java Database Connectivity (JDBC) or ODP.NET connection pools.

  Runtime Connection Load Balancing balances work requests across instances based on a service's real-time information. The connection cache manager uses Oracle RAC workload metrics and the load balancing policies to select the optimal instance to process a connection request. This results in efficient database resource usage with a balanced and dynamic distribution of the workload among Oracle RAC instances based on workload metrics and distribution policy.

  > **Note:** ODP.NET and OCI do not process `UP` events.

  > **See Also:** Chapter 6, "Introduction to Workload Management" for more information about services and the Oracle application development documentation set for more information about this feature

- Oracle Fast Connection Failover (FCF)

  You can use FCF with JDBC, OCI, and ODP.NET to recover sessions when UP or DOWN events are published from clients. In the case of a DOWN event, Oracle cleans up any sessions in the connection pool that go to the instance that stops. For UP events, Oracle creates new connections to the recently-started instance. Clients can use any of the three connection protocols to accept event information that Runtime Connection Load Balancing publishes to re-create sessions and initiate failover. In addition, your chosen connection protocol, JDBC, OCI, or ODP.NET,

reacts to throughput information that Runtime Connection Load Balancing publishes to choose the most appropriate connection.

- Transparent Data Encryption and Oracle Real Application Clusters

  Transparent Data Encryption protects data that is stored in Oracle datafiles by preventing access to the data using means other than the normal database access mechanisms. This feature also provides secure storage and management of the encryption keys using a module that is external to the database. Thus, you can encrypt database column access and also more effectively manage encryption key access.

  Using Transparent Data Encryption in an Oracle RAC environment requires that all of the database instances have access to the same encryption keys. For this release, the only key storage mechanism that is supported is the Oracle Wallet. All of the Oracle RAC nodes must be able to access the wallet either through a shared disk or by way of a local copy. All other Transparent Data Encryption administration and usage requirements are the same as those for single-instance Oracle database deployments.

  See Also: "Data Security Considerations in Oracle Real Application Clusters" on page 15-3 and *Oracle Database Advanced Security Administrator's Guide* for additional information about transparent data encryption

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- Oracle RAC Configuration Assistant Enhancements

  The Database Configuration Assistant (DBCA), the Database Upgrade Assistant (DBUA) have been enhanced for this release as follows:

  – DBCA Enhancements for Standalone ASM Configuration

    When you create an Oracle RAC database that uses ASM, DBCA creates the database in the same Oracle home that the ASM instance uses. If you create the database using a different home than the Oracle home that has ASM and if the ASM version is 10.2, then DBCA automatically extends ASM from whichever Oracle home ASM is running in. However, if the ASM version is 10.1 and if ASM instances do not yet exist on all of the selected nodes, then DBCA displays an error, prompting you to either run the add node script or to upgrade ASM using the Database Upgrade Assistant (DBUA).

    See Also: "Automatic Storage Management in Oracle Real Application Clusters" on page 4-2 for more information about ASM in Oracle RAC

  – DBCA Enhancements for Standalone ASM Disk Group Management

    You can use DBCA to create and manage an ASM instance and its disk groups independent of the database creation process. You can use DBCA to create, add, and mount an ASM disk group on any node in the cluster database. If an ASM instance does not yet exist on a node, then DBCA automatically extends ASM.

    See Also: *Oracle Database Administrator's Guide* for more information about ASM

  – Database Configuration Assistant, General Enhancements

When you use DBCA to create a database in version 10.1, you configure the database control agent and OMS on all of the hosts. For version 10.2, DBCA by default configures an agent on all of the hosts where the Oracle RAC database has an instance, but only configures OMS on the node where you invoked DBCA. However, you can always run EMCA to change this configuration and set up multiple database console OMS configurations on other hosts. If the central agent (also called the Grid Control agent) is configured on the cluster, you can optionally register the database to the central agent.

See Also: Your platform-specific Oracle Clusterware and Oracle RAC installation guide for more information about DBCA

– Database Upgrade Assistant Enhancements

You can also upgrade ASM independently or upgrade both the database and ASM at the same time. During an upgrade, the Oracle Database Upgrade Assistant (DBUA) automatically locates the Oracle Database 10*g* release 1 (10.1) Listener, and migrates it to Oracle Database 10*g* release 2. The Listener migration process stops the Listener in the existing Oracle home and restarts the Listener from the new Oracle home. During migration, client applications may not be able to connect to any databases that are registered to the Listener that is being migrated.

If you are upgrading a database from Oracle Database 10*g* release 1.0 to Oracle Database 10*g* release 2.0, then the Database Control configuration in the 10*g*R1 Oracle home is upgraded to Oracle Database 10*g* release 2.0 as well. If you are upgrading a pre-Oracle Database 10*g* release 1.0 database to Oracle Database 10*g* release 2.0, then a new release 2.0 Database Control configuration will be performed. If the Listener was migrated as part of an upgrade operation, then the Enterprise Manager configurations will be updated with new information.

See Also: *Oracle Database Upgrade Guide* for more information about database upgrades

- ASM Storage Consolidation

One ASM instance on a node can support both single-instance Oracle database instances and Oracle RAC instances running on that node.

See Also: "Automatic Storage Management in Oracle Real Application Clusters" on page 4-2 for more information about ASM in Oracle RAC

- Dynamic RMAN Channel Allocation for Oracle RAC Environments

In previous releases, to use RMAN's parallelism in Oracle RAC, you had to manually allocate an RMAN channel for each instance. You can now use the syntax `CONFIGURE DEVICE TYPE` *`device`* `PARALLELISM` *`n`* in Oracle RAC in the same way as in single-instance Oracle database environments. Dynamic channel allocation is only applicable where each node can access all of the datafiles, archived logs, and so on, in an Oracle RAC environment.

See Also: "Configuring Channels for RMAN in Oracle Real Application Clusters" on page 7-2 for more information about dynamic RMAN channel allocation in Oracle RAC

- Archived Log Redo Thread Parameter Requirements

You must use all three archived log redo thread identifier parameters, `%r` or `%R`, `%s` or `%S`, and `%t` or `%T`, when identifying archived redo log threads. This enables Oracle to create unique names for the archive logs across the incarnation.

> **See Also:** "Archived Redo Log File Conventions in Oracle RAC" on page 7-4 for more information about changing the archived redo log thread

- Changing the Archiving Mode

  You no longer need to modify the `CLUSTER_DATABASE` parameter setting to change the archiving mode in Oracle RAC. You can change archive log mode as long as the database is mounted in the local instance and not open in any instances.

  > **See Also:** "Changing the Archiving Mode in Oracle Real Application Clusters" on page 7-8 for more information about changing the archiving mode in Oracle RAC

- Failover Improvements for Distributed Transaction Processing (DTP) in Oracle RAC

  Oracle DTP transaction environments should now use services to simplify management in an Oracle RAC environment. This feature automates the implementation of workarounds for using distributed transactions in Oracle RAC. This feature leverages the Oracle services framework so that failure detection, failover, and fail back are transparent to DBAs.

  In this release, DTP services automate the steps that are required to configure an Oracle RAC database to support distributed transactions in DTP environments. A DTP service will only be active on one instance in the cluster at a time. By creating multiple DTP services, with one or more DTP services enabled on each Oracle RAC instance, all tightly coupled branches of a global distributed transaction go to the same instance. In this way, you can leverage all of the instances of an Oracle RAC database to balance the distributed transaction load and thereby maximize application throughput.

  For current and future client implementations, such as those for JDBC, you do not need the invocation to the `SYS.DBMS_SYSTEM.DIST_TXN_SYNC` procedure because the `OPS_FAILOVER` flag is deprecated. Instead, the server manages the synchronization of in-doubt transaction information across the Oracle RAC instances for transaction recovery.

  > **See Also:** "Services and Distributed Transaction Processing in Oracle RAC" on page 6-16 for information about how to configure DTP services to support distributed transactions

- Multiple Oracle Clusterware Files

  When you install Oracle Clusterware, you can select the option of using multiple voting disks that reside on independent shared physical disks. This removes the requirement that the voting disk use redundant storage; now Oracle provides the redundancy and you do not need to use third party storage solutions to duplicate the voting disk. You can also select the option of mirroring your Oracle Cluster Registry (OCR). In addition, you can replace, repair, or remove an OCR if it fails, and you can perform these operation while the OCR is online. If you do not select the OCR mirroring option during the Oracle Clusterware installation, then you can mirror the OCR later.

See Also: Chapter 3, "Administering Oracle Clusterware Components" and your platform-specific Oracle RAC installation guide for more information about multiplexing the voting disk and the OCR

- Fast-Start Failover and Data Guard Environments

  Fast-start failover, which is provided with the Oracle Data Guard broker, enables failovers to occur automatically when an Oracle RAC primary database becomes unavailable. This occurs without DBA intervention and with no loss of data. When fast-start failover is enabled, the broker determines if a failover is necessary and automatically initiates the failover to a pre-specified target Oracle RAC standby database instance.

  Fast-start failover will not occur in an Oracle RAC environment until all instances comprising an Oracle RAC primary database have failed. Moreover, after a failover completes, the broker can automatically reinstate the former primary database as a standby database in the new configuration.

  See Also: *Oracle Data Guard Broker* for more information about Data Guard

- Expanded Enterprise Manager Monitoring Features

  You can use expanded Enterprise Manager monitoring features to:

  - Monitor cluster interconnects to see all of the configured interfaces and interfaces that individual **cluster database** instances use. A single page provides information such as the transfer rates achieved on these interfaces, and whether the interface is private or public. You can see historical data for interconnects from drilldowns across the cluster or for a specific database.
  - Improve scalability when monitoring clusters with a higher number of nodes. For example, the Performance page displays the maximum, minimum, and average loads across the cluster hosts, not just average load of each node. This enables you to quickly assess whether the load is evenly distributed. You only need to drill down to detailed information if a problem appears at the higher level Performance page.
  - View backup reports for a group of databases.
  - Global Cache Block Access Latency drilldowns. You can View the Global Cache Block Access Latency summary chart to see the end-to-end elapsed time or latency for a block request. You can drill down from there to the Cluster Cache Coherency page to see the cluster cache coherency metrics for the entire cluster database. This enables you to identify processing trends and optimize performance for your Oracle RAC environment.

- Expanded Enterprise Manager Instance Addition

  You can use Enterprise Manager to add instances to an Oracle RAC database.

- Expanded Enterprise Manager Service Administration

  You can use expanded Enterprise Manager service features for either Database Control or Grid Control to perform the following services tasks:

  - Create
  - Delete
  - Update

  - Test connections

- Server Control Utility (SRVCTL) Enhancements

  If you create additional Listeners with non-default names, in other words, with names other than the name `listener_nodename` where *nodename* is the name of the node on which the Listener resides, then you must start and stop these Listeners with SRVCTL commands.

  > **See Also:** Appendix E, "Server Control Utility Reference" for more information about SRVCTL

- `MAX_COMMIT_PROPAGATION_DELAY`: The `MAX_COMMIT_PROPAGATION_DELAY` parameter is deprecated. By default, commits on one instance are immediately visible on all of the other instances.

  > **See Also:** *Oracle Database Reference* for more information about parameters and deprecated parameters

- Deprecated Views

  Several views were deprecated in Oracle Database 10*g* release 1 (10.1). The information in these deprecated views is either obsolete or the information was incorporated into the `GV$INSTANCE_CACHE_TRANSFER`, `V$INSTANCE_CACHE_TRANSFER`, `GV$SEGMENT_STATISTICS` and `V$SEGMENT_STATISTICS` views. The deprecated views are:

  - `GV$CLASS_CACHE_TRANSFER` and `V$CLASS_CACHE_TRANSFER`
  - `GV$CACHE_LOCK` and `V$CACHE_LOCK`
  - `GV$FALSE_PING` and `V$FALSE_PING`
  - `GV$FILE_CACHE_TRANSFER` and `V$FILE_CACHE_TRANSFER`
  - `GV$GC_ELEMENTS_WITH_COLLISIONS` and `V$GC_ELEMENTS_WITH_COLLISIONS`
  - `GV$TEMP_CACHE_TRANSFER` and `V$TEMP_CACHE_TRANSFER`
  - `GV$LOCK_ACTIVITY` and `V$LOCK_ACTIVITY`

- Windows Firewall Usage on Windows Server 2003

  Depending on which Oracle products you install and how they are used, you may need to perform additional Windows post-installation configuration tasks so that the Firewall products are functional on Windows Server 2003.

  > **See Also:** Windows Firewall Considerations on page 15-3 for more information about Windows Firewall post-installation requirements

Oracle Database 10*g* Release 1 (10.1) New Features for Oracle RAC Administration

This section describes the Oracle Database 10*g* release 1 (10.1) features for Oracle RAC administration.

- High Availability, Workload Management, and Services

  Oracle Real Application Clusters introduces integrated clusterware known as Cluster Ready Services (CRS). You install CRS on all platforms on which you can run Oracle Real Application Clusters software. CRS manages cluster database

functions including node membership, group services, global resource management, and high availability.

> **See Also:** *Oracle Real Application Clusters Quick Installation Guide for Oracle Database Standard Edition for Microsoft Windows* to install the Oracle Database 10*g* Standard Edition with Oracle RAC on Windows systems

In Oracle Real Application Clusters, you can use services to define application workloads by creating a service for each application, group of applications, or for major components within complex applications. You can then define where and when the service runs and thus use services to control your workload.

In both cluster and non-cluster environments, the **Automatic Workload Repository (AWR)** tracks performance metrics using services. You can also set thresholds on performance metrics to automatically generate alerts if these thresholds are exceeded.

> **See Also:** *Oracle Database PL/SQL Packages and Types Reference* for more information about the `DBMS_SERVICE` PL/SQL and `DBMS_MONITOR` packages and for more information about setting thresholds.

- Enhanced Cluster Management Implementation

  In earlier releases of the Oracle Database, cluster manager implementations on some platforms were referred to as "Cluster Manager". In Oracle Database 10*g* release (10.1), Cluster Ready Services (CRS) serves as the clusterware software, and Cluster Synchronization Services (CSS) is the cluster manager software for all platforms. The Oracle Cluster Synchronization Service Daemon (OCSSD) performs some of the clusterware functions on UNIX-based systems. On Windows-based systems, OracleCSService, OracleCRService, and OracleEVMService replace the Oracle Database OracleCMService9*i*.

  Oracle Enterprise Manager, the Database Configuration Assistant (DBCA), and the Server Control (SRVCTL) Utility provide tools to administer clusters, Oracle RAC databases, and services.

- Enterprise Manager Enhancements for Oracle RAC

  This release includes the new Web-based Enterprise Manager Database Control with which you can manage an Oracle RAC database, and Enterprise Manager Grid Control for administering multiple Oracle RAC databases. Administration of Oracle RAC databases is greatly simplified because of more simplified drill-down tasks and because Enterprise Manager displays cluster-wide performance information. This is available for both single-instance Oracle and Oracle RAC databases.

  Enterprise Manager has several summary pages that show cluster database performance information at a glance; you no longer have to log in to each cluster database or display instance-specific pages to obtain a global view of cluster database performance.

- Expanded Enterprise Manager Service Administration

  You can use expanded Enterprise Manager service features for either Enterprise Manager Database Control or Grid Control to perform the following services tasks:

  – Edit

  - Enable
  - Disable
  - Start
  - Stop
- Enhancements for Flash Recovery Area and Automatic Disk-Based Backup and Recovery
- A flash recovery area is an Automatic Storage Management (ASM) disk group, a file system, or a directory that serves as a default storage area for recovery files. Oracle RAC supports the Automatic Disk-Based Backup and Recovery feature that simplifies managing disk space and backup and recovery files.
- Database Configuration Assistant (DBCA) Enhancements
- Use DBCA to perform instance addition and deletion as well as database deletion.
- Database Upgrade Assistant (DBUA) Enhancements

  Use DBUA to upgrade from an earlier Oracle RAC version to Oracle Database 10*g* with Oracle RAC. When you upgrade from a Primary/Secondary environment, DBUA creates one service and assigns it to one instance as a preferred instance, and to the other instance as its available instance.
- Server Control (SRVCTL) Enhancements

  Enhancements to SRVCTL support the management of services and Automatic Storage Management (ASM) instances within Oracle RAC.
- Enhanced Recovery Parallelism on Multiple CPU Systems

  The default for instance, crash, and media recovery is to operate in parallel mode on multiple-CPU systems.
- Revised Error Messages for High Availability and Management Tools in Oracle Real Application Clusters
- The high availability error messages have been enhanced for this release.
- Oracle Cluster Registry (OCR) Enhancements

  The OCR contains configuration details for the cluster database and for high availability resources such as services, Virtual Interconnect Protocol (VIP) addresses, and so on.
- `GCS_SERVER_PROCESSES` Parameter

  There is a new, static parameter to specify the number of server processes for an instance's Global Cache Service (GCS) for routing inter-instance traffic among Oracle RAC instances. The default number of GCS server processes is calculated based on system resources with a minimum of 2. You can set this parameter to different values on different instances.

1

Introduction to Oracle Clusterware and Oracle Real Application Clusters

This chapter introduces Oracle Clusterware and Oracle Real Application Clusters (Oracle RAC) by describing these products as well as how to install, administer, and deploy them. This chapter describes Oracle Clusterware and Oracle RAC architectures as well as the software and hardware components for both of these products. This chapter also briefly describes workload management, services, and high availability for both single-instance Oracle databases and Oracle RAC environments. This chapter includes the following topics:

Oracle Clusterware and Oracle Real Application Clusters

A **cluster** comprises multiple interconnected computers or servers that appear as if they are one server to end users and applications. Oracle Database 10*g* Real Application Clusters (Oracle RAC) enables the clustering of the Oracle Database. Oracle RAC uses Oracle Clusterware for the infrastructure to bind multiple servers so that they operate as a single system.

Oracle Clusterware is a portable cluster management solution that is integrated with the Oracle database. The Oracle Clusterware is also a required component for using Oracle RAC. In addition, Oracle Clusterware enables both single-instance Oracle databases and Oracle RAC databases to use the Oracle high availability infrastructure. The Oracle Clusterware enables you to create a clustered pool of storage to be used by any combination of single-instance and Oracle RAC databases.

Oracle Clusterware is the only clusterware that you need for most platforms on which Oracle RAC operates. You can also use clusterware from other vendors if the clusterware is certified for Oracle RAC.

Single-instance Oracle databases have a one-to-one relationship between the Oracle database and the instance. Oracle RAC environments, however, have a one-to-many relationship between the database and instances. In Oracle RAC environments, the cluster database instances access one database. The combined processing power of the multiple servers can provide greater throughput and scalability than is available from a single server. Oracle RAC is the Oracle Database option that provides a single system image for multiple servers to access one Oracle database. In Oracle RAC, each Oracle instance usually runs on a separate server.

Oracle RAC is a unique technology that provides high availability and scalability for all application types. The Oracle RAC infrastructure is also a key component for implementing the Oracle enterprise grid computing architecture. Having multiple instances access a single database prevents the server from being a single point of failure. Oracle RAC enables you to combine smaller commodity servers into a cluster to create scalable environments that support mission critical business applications. Applications that you deploy on Oracle RAC databases can operate without code changes.

The Oracle Clusterware Architecture and Oracle Clusterware Processing

The Oracle Clusterware is software that when installed on servers running the same operating system, enables the servers to be bound together to operate as if they were one server. The Oracle Clusterware requires two clusterware components: a voting disk to record node membership information and the Oracle Cluster Registry (OCR) to record cluster configuration information. The voting disk and the OCR must reside on shared storage. The Oracle Clusterware requires that each node be connected to a private network by way of a private interconnect.

The private interconnect that Oracle Clusterware requires is a separate network that you configure between the cluster nodes. This interconnect, which is required by Oracle RAC, can be the same network that the clusterware uses, but the interconnect should not be accessible by nodes that are not part of the cluster.

Oracle recommends that you configure a redundant interconnect to prevent the interconnect from being a single point of failure. Oracle also recommends that you use User Datagram Protocol (UDP) on a Gigabit Ethernet for your cluster interconnect. Crossover cables are not supported for use with Oracle Clusterware or Oracle RAC databases.

The Oracle Clusterware manages node membership and prevents **split brain syndrome** in which two or more instances attempt to control the database. This can occur in cases where there is a break in communication between nodes through the interconnect.

The Oracle Clusterware architecture supports high availability by automatically restarting stopped components. The Oracle Clusterware can automatically re-start a node to prevent problems with that node from affecting the availability of the rest of the Oracle RAC environment. In an Oracle RAC environment, all Oracle processes are under the control of the Oracle clusterware. The Oracle Clusterware also provides an application programming interface (API) that enables you to control other Oracle processes with Oracle Clusterware.

Oracle Clusterware Software Component Processing Details

The Oracle Clusterware comprises several background processes that facilitate cluster operations. The Cluster Synchronization Service (CSS), Event Management (EVM), and Oracle Cluster components communicate with other cluster component layers in

the other instances within the same cluster database environment. These components are also the main communication links between the Oracle Clusterware high availability components and the Oracle Database. In addition, these components monitor and manage database operations.

> **See Also:** Chapter 14, "Making Applications Highly Available Using Oracle Clusterware" for more detailed information about the Oracle Clusterware API

The following list describes the functions of some of the major Oracle Clusterware components. This list includes these components which are processes on Unix and Linux operating systems or services on Windows.

> **Note:** On Windows-based operating systems, many of the components are threads of the Oracle process instead of separate processes.

- **Cluster Synchronization Services (CSS)—**Manages the cluster configuration by controlling which nodes are members of the cluster and by notifying members when a node joins or leaves the cluster. If you are using third-party clusterware, then the `css` process interfaces with your clusterware to manage node membership information.
- **Cluster Ready Services (CRS)—**The primary program for managing high availability operations within a cluster. Anything that the `crs` process manages is known as a cluster resource which could be a database, an instance, a service, a Listener, a virtual IP (VIP) address, an application process, and so on. The `crs` process manages cluster resources based on the resource's configuration information that is stored in the OCR. This includes start, stop, monitor and failover operations. The `crs` process generates events when a resource status changes. When you have installed Oracle RAC, `crs` monitors the Oracle instance, Listener, and so on, and automatically restarts these components when a failure occurs. By default, the `crs` process makes five attempts to restart a resource and then does not make further restart attempts if the resource does not restart.
- **Event Management (EVM)**: A background process that publishes events that `crs` creates.
- **Oracle Notification Service (ONS)**: A publish and subscribe service for communicating Fast Application Notification (FAN) events.
- **RACG—**Extends clusterware to support Oracle-specific requirements and complex resources. Runs server callout scripts when FAN events occur.
- **Process Monitor Daemon (OPROCD)**: This process is locked in memory to monitor the cluster and provide I/O fencing. OPROCD performs its check, stops running, and if the wake up is beyond the expected time, then OPROCD resets the processor and reboots the node. An OPROCD failure results in Oracle Clusterware restarting the node. OPROCD uses the hangcheck timer on Linux platforms.

In the following table, if a process has a (`r`) beside it, then the process runs as the `root` user. Otherwise the process runs as the `oracle` user.

Table 1–1 List of Processes and Windows Services associated with Oracle Clusterware

Oracle Clusterware Component	Linux/Unix Process	Windows Services	Windows Processes
Process Monitor Daemon	`oprocd` (r)	`OraFenceService`	
RACG	`racgmain`, `racgimon`		`racgmain.exe` `racgimon.exe`
Oracle Notification Service (ONS)	`ons`		`ons.exe`
Event Manager	`evmd` (r), `evmd.bin`, `evmlogger`	`OracleEVMService`	`evmlogger.exe`, `evmd.exe`
Cluster Ready	`crsd.bin` (r)	`OracleCRSService`	`crsd.exe`
Cluster Synchronization Services	`init.cssd` (r), `ocssd` (r), `ocssd.bin`	`OracleCSService`	`ocssd.exe`

The Oracle Clusterware Software Components

When Oracle Clusterware operates, several platform-specific processes or services will also be running on each node in the cluster to support Oracle Clusterware. The Oracle Clusterware platform-specific UNIX-based processes and Windows-based services are described under the following headings:

- Oracle Clusterware Processes on UNIX-Based Systems
- Oracle Clusterware Services on Windows-Based Systems

Oracle Clusterware Processes on UNIX-Based Systems

The Oracle Clusterware processes on UNIX-based systems are:

- `crsd`: Performs high availability recovery and management operations such as maintaining the OCR and managing application resources. This process runs as the `root` user, or by a user in the `admin` group on Mac OS X-based systems. This process restarts automatically upon failure.
- `evmd`: Event manager daemon. This process also starts the `racgevt` process to manage FAN server callouts.
- `ocssd`: Manages cluster node membership and runs as the `oracle` user; failure of this process results in cluster restart.
- `oprocd`: Process monitor for the cluster. Note that this process only appears on platforms that do not use vendor clusterware with Oracle Clusterware.

> **Note:** Oracle RAC on Linux platforms can have multiple threads that appear as separate processes with separate process identifiers.

Oracle Clusterware Services on Windows-Based Systems

The Oracle Clusterware services on Windows-based systems are:

- `OracleCRService`: Performs high availability recovery and management operations such as maintaining the OCR and managing application resources. This process runs as the `root` user, or by a user in the `admin` group on Mac OS X-based systems. This process restarts automatically upon failure.

- `OracleCSService`: Manages cluster node membership and runs as `oracle` user; failure of this process results in cluster restart.
- `OracleEVMService`: Event manager daemon. This process also starts the `racgevt` process to manage FAN server callouts.
- `OraFenceService`: Process monitor for the cluster. Note that this process only appears on platforms that do not use vendor clusterware with Oracle Clusterware.

The Oracle Real Application Clusters Architecture and Oracle Real Application Clusters Processing

An Oracle RAC database is a logically or physically **shared everything** database. All datafiles, control files, PFILEs, and redo log files in Oracle RAC environments must reside on cluster-aware shared disks so that all of the cluster database instances can access them. All of the instances must also share the same interconnect. In addition, Oracle RAC databases can share the same interconnect that Oracle Clusterware uses.

Because an Oracle RAC database uses a shared everything architecture, Oracle RAC requires cluster-aware storage for all database files. It is your choice as to how to configure your disk, but you must use a supported cluster-aware storage solution. Oracle Database 10*g* provides Automatic Storage Management (ASM), which is the recommended solution to manage your disk. However you may also use a cluster-aware volume manager or a cluster file system (not required). In Oracle RAC, the Oracle Database software manages disk access and the Oracle software is certified for use on a variety of storage architectures. An Oracle RAC database can have up to 100 instances. Depending on your platform, you can use the following file storage options for Oracle RAC:

- ASM, which Oracle recommends
- Oracle Cluster File System (OCFS), which is available for Linux and Windows platforms, or a third-party cluster file system that is certified for Oracle RAC
- A network file system
- Raw devices

Oracle RAC databases differ architecturally from Oracle RACsingle-instance Oracle databases in that each Oracle RAC database instance also has:

- At least one additional thread of redo for each instance
- An instance-specific undo tablespace

All nodes in an Oracle RAC environment must connect to a Local Area Network (LAN) to enable users and applications to access the database. Applications should use the Oracle Database services feature to connect to an Oracle database. Services enable you to define rules and characteristics to control how users and applications connect to database instances. These characteristics include a unique name, workload balancing and failover options, and high availability characteristics. Oracle Net Services enables the load balancing of application connections across all of the instances in an Oracle RAC database.

Users can access an Oracle RAC database using a client-server configuration or through one or more middle tiers, with or without connection pooling. Users can be DBAs, developers, application users, power users, such as data miners who create their own searches, and so on.

Most public networks typically use TCP/IP, but you can use any supported hardware and software combination. Oracle RAC database instances can be accessed through a database's defined, default IP address and through VIP addresses.

> **Note:** Do not to use the interconnect or the private network for user communication because **Cache Fusion** uses the private interconnect for inter-instance communications.

In addition to the node's host name and IP address, you must also assign a virtual host name and an IP address to each node. The virtual host name or VIP should be used to connect to the database instance. For example, you might enter the virtual host name `CRM` in the address list of the `tnsnames.ora` file.

A virtual IP address is an alternate public address that client connections use instead of the standard public IP address. To configure VIP addresses, you need to reserve a spare IP address for each node that uses the same subnet as the public network.

If a node fails, then the node's VIP fails over to another node on which the VIP cannot accept connections. Generally, VIPs fail over when the node on which a VIP runs fails or if all interfaces for the VIP fail or are disconnected from the network. Clients that attempt to connect to the VIP receive a rapid `connection refused` error instead of waiting for TCP connect timeout messages. You configure VIP addresses in the address list for your database connection definition to enable connectivity. The following section describes the Oracle RAC software components in more detail.

The Oracle Real Application Clusters Software Components

Oracle RAC databases have two or more database instances that each contain memory structures and background processes. An Oracle RAC database has the same processes and memory structures as a single-instance Oracle database as well as additional process and memory structures that are specific to Oracle RAC. Any one instance's database view is nearly identical to any other instance's view within the same Oracle RAC database; the view is a single system image of the environment.

Each instance has a buffer cache in its System Global Area (SGA). Using Cache Fusion, Oracle RAC environments logically combine each instance's buffer cache to enable the instances to process data as if the data resided on a logically combined, single cache.

> **Note:** The SGA size requirements for Oracle RAC are greater than the SGA requirements for single-instance Oracle databases due to Cache Fusion.

To ensure that each Oracle RAC database instance obtains the block that it needs to satisfy a query or transaction, Oracle RAC instances use two processes, the Global Cache Service (GCS) and the Global Enqueue Service (GES). The GCS and GES maintain records of the statuses of each data file and each cached block using a Global Resource Directory (GRD). The GRD contents are distributed across all of the active instances, which effectively increases the size of the System Global Area for an Oracle RAC instance.

After one instance caches data, any other instance within the same cluster database can acquire a block image from another instance in the same database faster than by reading the block from disk. Therefore, Cache Fusion moves current blocks between instances rather than re-reading the blocks from disk. When a consistent block is needed or a changed block is required on another instance, Cache Fusion transfers the

block image directly between the affected instances. Oracle RAC uses the private interconnect for inter-instance communication and block transfers. The Global Enqueue Service Monitor and the Instance Enqueue Process manages access to Cache Fusion resources as well as enqueue recovery processing.

These Oracle RAC processes and the GRD collaborate to enable Cache Fusion. The Oracle RAC processes and their identifiers are as follows:

- `LMS`: Global Cache Service Process
- `LMD`: Global Enqueue Service Daemon
- `LMON`: Global Enqueue Service Monitor
- `LCK0`: Instance Enqueue Process

If you use Network Attached Storage (NAS), then you are required to configure a second private network. Access to this network is typically controlled by the vendor's software. The private network uses static IP addresses.

Note: Many of the Oracle components that this section describes are in addition to the components that are described for single-instance Oracle databases in *Oracle Database Concepts*.

Oracle Clusterware Components and High Availability

When you combine Oracle Clusterware and Oracle RAC, you can achieve excellent scalability and high availability. The Oracle Clusterware achieves this using the components that this section describes under the following topics:

- The Oracle Clusterware Voting Disk and Oracle Cluster Registry
- Oracle Clusterware High Availability and the Application Programming Interface
- The Oracle Clusterware Software Components

The Oracle Clusterware Voting Disk and Oracle Cluster Registry

The Oracle Clusterware requires the following two critical files:

- **Voting Disk**: Manages cluster membership by way of a health check and arbitrates cluster ownership among the instances in case of network failures. Oracle RAC uses the voting disk to determine which instances are members of a cluster. The voting disk must reside on shared disk. For high availability, Oracle recommends that you have multiple voting disks. The Oracle Clusterware enables multiple voting disks but you must have an odd number of voting disks, such as three, five, and so on. If you define a single voting disk, then you should use external mirroring to provide redundancy.
- **Oracle Cluster Registry (OCR)**: Maintains cluster configuration information as well as configuration information about any cluster database within the cluster. The OCR also manages information about processes that Oracle Clusterware controls. The OCR stores configuration information in a series of key-value pairs within a directory tree structure. The OCR must reside on shared disk that is accessible by all of the nodes in your cluster. The Oracle Clusterware can multiplex the OCR and Oracle recommends that you use this feature to ensure cluster high availability. You can replace a failed OCR online, and you can update the OCR through supported APIs such as Enterprise Manager, the Server Control Utility (SRVCTL), or the Database Configuration Assistant (DBCA).

Note: Both the voting disks and the OCRs must reside on either **cluster file system** files or on shared raw devices that you configure before you install Oracle Clusterware and Oracle RAC.

Oracle Clusterware High Availability and the Application Programming Interface

Oracle Clusterware provides a high availability application programming interface (API) that you can use to enable Oracle Clusterware to manage applications or processes that run a cluster. This enables you to provide high availability for all of your applications. The Oracle Clusterware with ASM enables you to create a consolidated pool of storage to support both the single-instance Oracle databases and the Oracle RAC databases that are running on your cluster.

To maintain high availability, Oracle Clusterware components can respond to status changes to restart applications and processes according to defined high availability rules. In addition, you can use the Oracle Clusterware high availability framework by registering your applications with Oracle Clusterware and configuring the clusterware to start, stop, or relocate your application processes. That is, you can make custom applications highly available by using Oracle Clusterware to create profiles that monitor, relocate, and restart your applications. The Oracle Clusterware responds to FAN events that are created by an Oracle RAC database. Oracle broadcasts FAN events when cluster servers may become unreachable and network interfaces are slow or non-functional.

See Also: Chapter 14, "Making Applications Highly Available Using Oracle Clusterware" for more detailed information about the Oracle Clusterware API

Workload Management with Oracle Real Application Clusters

Workload Management enables you to manage the distribution of workloads to provide optimal performance for users and applications. This includes providing the highest availability for database connections, rapid failure recovery, and balancing workloads optimally across the active configuration. Oracle Database 10*g* with Oracle RAC includes many features that can enhance workload management such as connection load balancing, fast connection failover (FCF), the load balancing advisory, and Runtime Connection Load Balancing. Workload management provides the greatest benefits to Oracle RAC environments. You can, however, take advantage of workload management by using Oracle services in single-instance Oracle Databases, especially those that use Data Guard or Streams. Workload management comprises the following components:

- **High Availability Framework**: The Oracle RAC high availability framework enables the Oracle Database to maintain components in a running state at all times. Oracle high availability implies that Oracle Clusterware monitors and restarts critical components if they stop, unless you override the restart processing. The Oracle Clusterware and Oracle RAC also provide alerts to clients when configurations change. This enables clients to immediately react to the changes, enabling application developers to hide outages and reconfigurations from end users. The scope of Oracle high availability spans from the restarting of stopped Oracle processes in an Oracle database instance to failing over the processing of an entire instance to other available instances.
- **Load Balancing Advisory**: This is the ability of the database to provide information to applications about the current service levels being provided by the database and its instances. Applications can take advantage of this information to

direct connection requests to the instance that will provide the application request with the best service quality to complete the application's processing. Oracle has integrated its Java Database Connectivity (JDBC) and Oracle Data Provider for .NET (ODP.NET) connection pools to work with the load balancing information. Applications can use the integrated connection pools without programmatic changes.

- **Services**: Oracle Database 10*g* introduces a powerful automatic workload management facility, called services, to enable the enterprise grid vision. Services are entities that you can define in Oracle RAC databases. Services enable you to group database workloads and route the work to the optimal instances that are assigned to process the service. Furthermore, you can use services to define the resources that Oracle assigns to process workloads and to monitor workload resources. Applications that you assign to services transparently acquire the defined workload management characteristics, including high availability and load balancing rules. Many Oracle database features are integrated with services, such as Resource Manager, which enables you to restrict the resources that a service can use within an instance. Some database features are also integrated with Oracle Streams, Advanced Queuing, to achieve queue location transparency, and the Oracle Scheduler, to map services to specific job classes.

  In Oracle RAC databases, the service performance rules that you configure control the amount of work that Oracle allocates to each available instance for that service. As you extend your database by adding nodes, applications, components of applications, and so on, you can add more services.

- **Connection Load Balancing**: Oracle Net Services provides connection load balancing for database connections. Connection load balancing occurs when the connection is created. Connections for a given service are balanced across all of the running instances that offer the service. You should define how you want connections to be balanced in the service definition. However, you must still configure Oracle Net Services. When you enable the load balancing advisory, the Listener uses the load balancing advisory for connection load balancing.

  See Also: Chapter 6, "Introduction to Workload Management" for more information about workload management and services

Introduction to Installing Oracle Clusterware and Oracle Real Application Clusters

This section introduces the storage options for Oracle RAC and the installation processes for both Oracle Clusterware and Oracle RAC under the following topics:

- Oracle Clusterware Installation Process Description
- Oracle Real Application Clusters Installation and Database Creation Process Description
- Cloning Oracle Clusterware and Oracle RAC Software in Grid Environments

Oracle Clusterware Installation Process Description

The Oracle Clusterware is distributed on the Oracle Database 10*g* installation media. The Oracle Universal Installer (OUI) installs Oracle Clusterware into a directory structure, which can be referred to as `CRS_home`, that is separate from other Oracle software running on the machine. 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 system

administrator, which is generally the `root` user on Unix and Linux systems and the `System Administrator` user on Windows systems.

Before you install Oracle Clusterware, Oracle recommends that you run the Cluster Verification Utility (CVU) to ensure that your environment meets the Oracle Clusterware installation requirements. The OUI also automatically runs CVU at the end of the clusterware installation to verify various clusterware components. The CVU simplifies the installation, configuration, and overall management of the Oracle Clusterware installation process by identifying problems in **cluster** environments.

During the Oracle Clusterware installation, you must identify three IP addresses for each node that is going to be part of your installation. One IP address is for the private interconnect and the other is for the public interconnect. The third IP address is the virtual IP address that clients will use to connect to each instance.

The Oracle Clusterware installation process creates the voting disk and OCR on cluster-aware 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 Oracle Cluster Registry (OCR) file and three copies of the Voting Disk file.

Note: If you choose external redundancy for the OCR and voting disk, then to enable redundancy, your disk subsystem must be configurable for RAID mirroring. Otherwise, your system may be vulnerable because the OCR and voting disk are single points of failure.

Oracle Real Application Clusters Installation and Database Creation Process Description

The Oracle RAC software is distributed as part of the Oracle Database 10*g* installation media. By default, the standard Oracle Database 10*g* software installation process installs the Oracle RAC option when it recognizes that you are performing the installation on a cluster. The OUI installs Oracle RAC into a directory structure, which can be referred to as *`Oracle_home`*, that is separate from other Oracle software running on the machine. Because OUI is cluster-aware, it installs the Oracle RAC software on all of the nodes that you defined to be part of the cluster. If you are using a certified cluster file system for the Oracle home, then only select the node that you are connected to for the installation.

You must first install Oracle Clusterware before installing Oracle RAC. After Oracle Clusterware is operational, you can use OUI to install the Oracle database software with the Oracle RAC components. During the installation, OUI runs DBCA to create your Oracle RAC database according to the options that you select. The DBCA also runs the Net Configuration Assistant (NETCA) to configure the network for your Oracle RAC environment.

> **See Also:** *Oracle Database Net Services Administrator's Guide* for more information about NETCA

Oracle recommends that you select ASM during the installation to simplify storage management; ASM automatically manages the storage of all database files within disk groups. You can also configure services during installation, depending on your

processing requirements. If you are using the Oracle Database 10*g* Standard Edition, then you *must* use ASM for storing all of the database files.

By default, DBCA creates one service for your environment and this service is for the database. The default service is available on all instances in an Oracle RAC environment, unless the database is in restricted mode.

Cloning Oracle Clusterware and Oracle RAC Software in Grid Environments

This section briefly summarizes the procedures for deploying Oracle RAC in grid environments that have large numbers of nodes using cloned images for Oracle Clusterware and Oracle RAC. Oracle cloning is the preferred method of extending your Oracle RAC environment by adding nodes and instances. To perform the cloning procedures that are summarized in this section, refer to the *Oracle Universal Installer and OPatch User's Guide*.You can also use Enterprise Manager Grid Control to perform cloning.

The cloning process assumes that you successfully installed an Oracle Clusterware home and an Oracle home with Oracle RAC on at least one node. In addition, all root scripts must have run successfully on the node from which you are extending your cluster database. To use Oracle cloning, first clone the Oracle Clusterware home and then clone the Oracle home with the Oracle RAC software.

To clone the Oracle Clusterware home, on UNIX-based systems create a tar file of the Oracle Clusterware home and copy the file to the new node's Oracle Clusterware home. On Windows-based systems you must create zip files. Then on UNIX-based systems create the required users and groups on the new nodes. On Windows-based systems, you do not need to create users and groups, but the user that performs the cloning should be the same user that performed the installation.

Extract the tar file, or unzip the zip file, and run the Oracle Universal Installer (OUI) in clone mode as described in the *Oracle Universal Installer and OPatch User's Guide*. Then run the installation scripts and repeat these steps on each node that you are adding. The process for cloning the Oracle home onto new nodes is similar to the process for cloning the Oracle Clusterware home. In addition, you must run the Oracle Net Configuration Assistant (NETCA) on each new node to create a Listener.

> **See Also:** *Oracle Database Net Services Administrator's Guide* for more information about NETCA

If you have not already created a database, then you can run the Database Configuration Assistant (DBCA) to create one. Finally, follow the post-cloning procedures to complete the extension of your Oracle RAC environment onto the new nodes.

> **See Also:** *Oracle Universal Installer and OPatch User's Guide* for details about the Oracle cloning procedures

Additional Considerations and Features for Oracle Real Application Clusters

In addition to configuring services to manage your workloads, also consider using the following features when you deploy Oracle RAC:

- Scaling Your Oracle RAC Database: As mentioned, you can add nodes and instances to your Oracle RAC environment using Oracle cloning. If you choose to

not use cloning, then you can extend your database by using the manual procedures that are described in Chapter 10, "Adding and Deleting Nodes and Instances on UNIX-Based Systems" or Chapter 11, "Adding and Deleting Nodes and Instances on Windows-Based Systems".

- Enterprise Manager: Use Enterprise Manager to administer your entire Oracle RAC environment, not just the Oracle RAC database. Use Enterprise Manager to create and modify services, and to start and stop the cluster database instances and the cluster database. Enterprise Manager has additional features as detailed in the section "Overview of Using Enterprise Manager with Oracle Real Application Clusters" on page 2-4.
- Recovery Manager (RMAN): RMAN backs up, restores, and recovers datafiles, control files, server parameter files (SPFILEs) and archived redo logs. You can use RMAN with a media manager to back up files to external storage. You can also configure parallelism when backing up or recovering Oracle RAC databases. In Oracle RAC, RMAN channels can be dynamically allocated across all of the Oracle RAC instances. Channel failover enables failed operations on one node to continue on another node. You can use RMAN in Oracle RAC from the Oracle Enterprise Manager Backup Manager or from a command line.
- Automatic undo management: Automatically manages undo processing.
- Automatic segment space management (ASSM): Automatically manages segment freelists and freelist groups.
- Locally managed tablespaces: Enhances space management performance.
- Cluster Verification Utility (CVU): Use CVU to verify the status of your clusterware if you experience problems or use it whenever you reconfigure your cluster.
- Sequences: If you use sequence numbers, then always use `CACHE` with the `NOORDER` option for optimal sequence number generation performance. With the `CACHE` option, however, you may have gaps in the sequence numbers. If your environment cannot tolerate sequence number gaps, then use the `NOCACHE` option or consider pre-generating the sequence numbers. If your application requires sequence number ordering but can tolerate gaps, then use `CACHE` and `ORDER` to cache and order sequence numbers in Oracle RAC. If your application requires ordered sequence numbers without gaps, then use `NOCACHE` and `ORDER`. This combination has the most negative effect on performance compared to other caching and ordering combinations.
- Indexes: If you use indexes, consider alternatives, such as reverse key indexes, to optimize index performance. Reverse key indexes are especially helpful if you have frequent inserts to one side of an index, such as indexes that are based on insert date.

> **See Also:** Chapter 7, "Configuring Recovery Manager and Archiving" for more information about RMAN

Managing Oracle Real Application Clusters Environments

This section describes the following Oracle RAC environment management topics:

- Designing Oracle Real Application Clusters Environments
- Administrative Tools for Oracle Real Application Clusters Environments
- Monitoring Oracle Real Application Clusters Environments

- Evaluating Performance in Oracle Real Application Clusters Environments

Designing Oracle Real Application Clusters Environments

Consider performing the following steps during the design and development of applications that you are deploying on an Oracle RAC database. Consider tuning:

1. The design and the application
2. The memory and I/O
3. Contention
4. The operating system

> **Note:** If an application does not scale on an SMP machine, then moving the application to an Oracle RAC database cannot improve performance.

Consider using hash partitioning for insert-intensive online transaction processing (OLTP) applications. Hash partitioning:

- Reduces contention on concurrent inserts into a single database structure
- Affects sequence-based indexes when indexes are locally partitioned with a table and tables are partitioned on sequence-based keys
- Is transparent to the application

If you hash partitioned tables and indexes for OLTP environments, then you can greatly improve performance in your Oracle RAC database. Note that you cannot use index range scans on an index with hash partitioning.

If you are using sequence numbers, then always use the `CACHE` option. If you use sequence numbers with the `CACHE` option, then:

- Your system may lose sequence numbers
- There is no guarantee of the ordering of the sequence numbers

> **Note:** If your environment cannot tolerate sequence number gaps, then consider pre-generating the sequence numbers or use the `ORDER` and `CACHE` options.

Administrative Tools for Oracle Real Application Clusters Environments

Oracle enables you to administer a cluster database as a single system image through Enterprise Manager, SQL*Plus, or through Oracle RAC command-line interfaces such as Server Control (SRVCTL). You can also use several tools and utilities to manage your Oracle RAC environment and its components as follows:

- Enterprise Manager: Enterprise Manager has both the Database Control and Grid Control GUI interfaces for managing both single instance and Oracle RAC environments.

  See Also: Chapter 9 and Chapter 13 for more information about Enterprise Manager

- Cluster Verification Utility (CVU): CVU is a command-line tool that you can use to verify a range of cluster and Oracle RAC-specific components such as shared storage devices, networking configurations, system requirements, and Oracle Clusterware, as well as operating system groups and users. You can use CVU for pre-installation checks as well as for post-installation checks of your cluster environment. CVU is especially useful during pre-installation and during installation of Oracle Clusterware and Oracle RAC components. The OUI runs CVU after Oracle Clusterware and the Oracle installation to verify your environment.

  See Also: "Using the Cluster Verification Utility" on page A-10 for more information about CVU

- Server Control (SRVCTL): SRVCTL is a command-line interface that you can use to manage an Oracle RAC database from a single point. You can use SRVCTL to start and stop the database and instances and to delete or move instances and services. You can also use SRVCTL to manage configuration information.

  See Also: Appendix E for more information about SRVCTL

- Cluster Ready Services Control (CRSCTL): CRSCTL is a command-line tool that you can use to manage Oracle Clusterware. You can use CRSCTL to start and stop Oracle Clusterware. CRSCTL has many options such as enabling online debugging,

  See Also: "Diagnosing Oracle Clusterware High Availability Components" on page A-1 for more information about CRSCTL

- Oracle Interface Configuration Tool (OIFCFG): OIFCFG is a command-line tool for both single-instance Oracle databases and Oracle RAC environments that you can use to allocate and de-allocate network interfaces to components. You can also use OIFCFG to direct components to use specific network interfaces and to retrieve component configuration information.

  See Also: "Administering System and Network Interfaces with OIFCFG" on page 9-7 for more information about OIFCFG

- OCR Configuration Tool (OCRCONFIG): OCRCONFIG is a command-line tool for OCR administration. You can also use the OCRCHECK and OCRDUMP utilities to troubleshoot configuration problems that affect the OCR.

  See Also: Chapter 3 and Appendix D for more information about managing the OCR

Monitoring Oracle Real Application Clusters Environments

Web-based Enterprise Manager Database Control and Grid Control enable you to monitor an Oracle RAC database. The Enterprise Manager Console is a central point of control for the Oracle environment that you access by way of a graphical user interface (GUI). Use the Enterprise Manager Console to initiate cluster database management tasks. Use Enterprise Manager Grid Control to administer multiple Oracle RAC databases. Also note the following points about monitoring Oracle RAC environments:

- The global views, or GV$ views, are based on V$ views. The `catclustdb.sql` script creates the GV$ views. Run this script if you do not create your database with DBCA. Otherwise, DBCA runs this script for you.

- Statspack is Oracle RAC-aware.

> **Note:** Instead of using Statspak, Oracle recommends that you use the more sophisticated management and monitoring features of the Oracle Database 10*g* Diagnostic and Tuning packs which include the Automatic Database Diagnostic Monitor (ADDM).

Evaluating Performance in Oracle Real Application Clusters Environments

You do not need to perform special tuning for Oracle RAC; Oracle RAC scales without special configuration changes. If your application performed well on a single-instance Oracle database, then it will perform well in an Oracle RAC environment. Many of the tuning tasks that you would perform on a single-instance Oracle database can also improve Oracle RAC database performance. This is especially true if your environment required scalability across a greater number of CPUs.

Some of the Oracle RAC performance features are:

- Dynamic Resource Allocation
  - Oracle dynamically allocates Cache Fusion resources as needed
  - The dynamic mastering of resources improves performance by keeping resources local to data blocks
- Cache Fusion Enables A Simplified Tuning Methodology
  - You do not have to tune any parameters for Cache Fusion
  - No application-level tuning is necessary
  - You can use a bottom-up tuning approach with virtually no effect on your existing applications
- More Detailed Performance Statistics
  - More views for Oracle RAC performance monitoring
  - Enterprise Manager Database Control and Grid Control are Integrated with Oracle RAC

2

Introduction to Oracle Clusterware and Oracle RAC Administration and Deployment

This chapter provides an overview of administering Oracle Clusterware and Oracle Real Application Clusters (Oracle RAC) environments. This chapter includes the following topics:

Oracle Real Application Clusters Documentation Overview

This section describes the Oracle RAC documentation set. This book, the *Oracle Database Oracle Clusterware and Oracle Real Application Clusters Administration and Deployment Guide*, provides Oracle RAC-specific administration and application deployment information.

This book describes how to administer the Oracle Clusterware components such as the voting disks and the Oracle Cluster Registry (OCR). This book also explains how to administer storage and how to use Oracle RAC scalability features to add and delete instances and nodes. This book also discusses how to use Recovery Manager (RMAN), and how to perform backup and recovery in Oracle RAC.

The *Oracle Database Oracle Clusterware and Oracle Real Application Clusters Administration and Deployment Guide* describes Oracle RAC deployment topics by explaining how to deploy automatic workload management and take advantage of high availability by using **services**. This book describes how the **Automatic Workload Repository (AWR)** tracks and reports service levels and how you can use service level thresholds and alerts to improve high availability in your Oracle RAC environment. This book also explains how to make your applications highly available by using Oracle Clusterware.

The *Oracle Database Oracle Clusterware and Oracle Real Application Clusters Administration and Deployment Guide* explains how to monitor and tune performance in Oracle RAC environments by using Oracle Enterprise Manager and by using information in AWR and Oracle performance views. This book also highlights application-specific deployment techniques for online transaction processing and data warehousing environments.

The appendices in this book describe:

- Troubleshooting tips such as debugging and log file use and general information about installing and using the Cluster Verification Utility (CVU)
- The Oracle Clusterware command-line reference
- The Oracle Cluster Registry command syntax
- How to use the Server Control (SRVCTL) utility to start and stop the database and instances, to manage configuration information, and to delete or move instances and services
- Oracle RAC tools error messages

In addition to this book, refer to the platform-specific Oracle Real Application Clusters installation and configuration guide on your product installation media as described under the following heading.

Platform-Specific Oracle Real Application Clusters Installation and Configuration Guides

Each platform-specific Oracle Database 10*g* installation media contains a copy of an Oracle Real Application Clusters platform-specific installation and configuration guide in HTML and PDF formats. These Oracle RAC installation books contain the pre-installation, installation, and post-installation information for the various UNIX- and Windows-based platforms on which Oracle RAC operates.

Note: Additional information for this release may be available in the Oracle Database 10*g* README or Release Notes. If these documents are available for this release, then they are on your Oracle product installation media.

Introduction to Administering Oracle Real Application Clusters

Install Oracle Clusterware and your Oracle Database 10*g* software with the Oracle Universal Installer (OUI) and create your database with the Database Configuration Assistant (DBCA). This ensures that your Oracle RAC environment has the optimal network configuration, database structure, and parameter settings for the environment that you selected. As a DBA, after installation your tasks are to administer your Oracle RAC environment at three levels:

- Instance Administration
- Database Administration
- Cluster Administration

Administering Oracle Real Application Clusters

Use the following tools to perform administrative tasks in Oracle RAC:

- Cluster Verification Utility (CVU): Install and use CVU before you install Oracle RAC to ensure that your configuration meets the minimum Oracle RAC installation requirements. Also use the CVU for on-going administrative tasks, such as node addition and node deletion.

  See Also: Your platform-specific Oracle Clusterware and Oracle RAC installation guide for information about how to manually install CVU

- Enterprise Manager: Oracle recommends that you use Enterprise Manager to perform administrative tasks whenever feasible
- Task-specific GUIs such as the Database Configuration Assistant (DBCA) and the Virtual Internet Protocol Configuration Assistant (VIPCA)
- Command-line tools such as SQL*Plus, Server Control (SRVCTL), the Oracle Clusterware command-line interface, and the Oracle Interface Configuration tool (OIFCFG)

Voting Disk and Oracle Cluster Registry Device Administration

You can use multiple disks for both the voting disk and the Oracle Cluster Registry (OCR) disk to prevent them from becoming single points of failure. Administer these components as described in Chapter 3, "Administering Oracle Clusterware Components".

Database Instance Management and Database Administration in Oracle RAC

Use Enterprise Manager, SQL*Plus, or SRVCTL to administer database instances and Oracle RAC databases as described in Chapter 5, "Administering Database Instances and Cluster Databases".

Storage Management in Oracle Real Application Clusters

When you create your database, you can create Automatic Storage Management (ASM) disk groups and configure mirroring for ASM disk groups using DBCA. After your Oracle RAC database is operational, you can administer ASM disk groups with Enterprise Manager or the SRVCTL utility as described in Chapter 4, "Administering Storage".

You can configure ASM in a separate standalone ASM-only home. This enables instances for single-instance Oracle and Oracle RAC databases to share a single ASM instance on a node. You also have the option to upgrade ASM independently of your database upgrades.

The Oracle tools that you use to manage ASM, including DBCA, Database Upgrade Assistant (DBUA), Enterprise Manager, and the silent mode install and upgrade commands, include options to manage ASM instances and disk groups. For example, you can run DBCA to create a new ASM instance or ASM disk group independently of creating a database.

When you perform ASM-related options during installs, upgrades, or other operations, the tool you are using may automatically extend ASM to other nodes in your **cluster**. This can include installing ASM software into the same home as on the current node and starting the ASM instance. For example, if you use DBCA to create a database using a new Oracle home, then DBCA will attempt to extend ASM to the new Oracle home on all of the nodes you select.

In some cases, your current configuration may not be compatible with an ASM activity that you are trying to perform, either explicitly or with an automatic ASM extension to other nodes. Should you be using DBCA, as described earlier, to build a database using a new Oracle home, and if the ASM version is from an earlier release of the Oracle software but does not exist on all of the nodes you selected for the database, then ASM cannot be extended. Instead, the DBCA session displays an error, prompting

you either to run the add node script or to upgrade ASM using the Database Upgrade Assistant (DBUA).

Oracle Clusterware for Oracle Real Application Clusters

When you create an Oracle RAC database, you can also use DBCA to create services and assign them to instances. After your Oracle RAC database is operational, you can use Enterprise Manager, DBCA, or SRVCTL to create and administer services and high availability components as described in Chapter 6, "Introduction to Workload Management".

Other high availability components include node resources such as the Virtual Internet Protocol (VIP) address, the Global Services Daemon, the Oracle Notification Service, and the Oracle Net Listeners. These resources are automatically started when Oracle Clusterware starts the node and then automatically restarts them if they stop. The application level resources are the instances and the Oracle Clusterware background processes that run on each instance.

You can use the VIPCA to administer VIP addresses and you can use SRVCTL to administer other node resources. The information that describes the configuration of these components is stored in the Oracle Cluster Registry (OCR) that you can administer as described in Chapter 3, "Administering Oracle Clusterware Components".

Additional Oracle Real Application Clusters Administrative Topics

This book contains the following additional Oracle RAC administrative topics:

- Scalability: Adding instances and nodes to an Oracle RAC database as described in Chapter 10, "Adding and Deleting Nodes and Instances on UNIX-Based Systems" and Chapter 11, "Adding and Deleting Nodes and Instances on Windows-Based Systems"
- Backup and Recovery: Configuring Recovery Manager (RMAN) and performing backup and recovery processing as described in Chapter 7, "Configuring Recovery Manager and Archiving" and Chapter 8, "Managing Backup and Recovery"
- Making Applications Highly Available: Wrapping your custom applications with the Oracle Clusterware commands to use the Oracle Clusterware infrastructure to keep your applications highly available as described in Chapter 14, "Making Applications Highly Available Using Oracle Clusterware" and Appendix B, "High Availability Oracle Clusterware Command-Line Reference and C API"
- Log Files: Administering information that Oracle records in log files as described in Appendix A, "Troubleshooting"
- Using SRVCTL: Using SRVCTL to administer Oracle RAC instances, databases, services, and so on, as described in Appendix E, "Server Control Utility Reference"
- Error Messages: Interpreting error messages for Oracle RAC high availability and management tools as described in Appendix F, "Oracle Real Application Clusters Tools Messages"

Overview of Using Enterprise Manager with Oracle Real Application Clusters

Enterprise Manager is a Web-based tool with Oracle RAC-specific administration and performance-related features. If you create your Oracle RAC database with the

Database Configuration Assistant (DBCA), then the Enterprise Manager Database Control tool is automatically configured for your Oracle RAC environment. This means that all instances that were part of your installation have an Enterprise Manager Agent running on them. Enterprise Manager Database Control enables you to manage a single Oracle RAC database with its instance targets, Oracle Net Services Listener targets, host targets, and a cluster target.

You can configure Enterprise Manager Grid Control on additional hosts, which were not part of your initial Oracle RAC installation, either inside or outside your cluster environment. Enterprise Manager Grid Control enables you to manage multiple cluster databases, cluster database instances, and the hosts on which **cluster database** components operate.

Grid Control enables you to monitor and administer your entire computing environment from one network location. Use Grid Control to manage all of your enterprise services, including hosts, databases, Listeners, application servers, HTTP Servers, and Web applications, as one cohesive unit. Enterprise Manager Grid Control only requires one Agent on one host in your cluster environment to perform cluster database and instance discovery. Install Enterprise Manager Grid Control from a your Oracle Database 10*g* installation media.

> **See Also:** *Oracle Enterprise Manager Concepts* for more information about using Enterprise Manager

You can also use both Enterprise Manager Database Control and the Enterprise Manager Grid Control to:

- Administer database services: Create, configure, start, stop, relocate, obtain status, and so on
- Create and assign resource plans: Assign resource plans to cluster database instances
- Administer storage: Assign undo tablespaces and re-assign them from one instance to another, administer redo log assignments among cluster database instances, and switch archive log modes
- Administer Automatic Storage Management: Administer ASM instances and ASM disk groups if the database uses ASM
- Perform general database activities: Start up and shut down Oracle RAC databases and instances, perform backup and recovery operations, edit server parameter file (spfile) settings for instances or for entire cluster databases, and so on
- Display host configurations: Memory, CPU, device I/O, network interfaces, the operating system and installed patches

The following sections introduce Oracle Real Application Clusters (Oracle RAC) application deployment and performance by explaining the main points that you need to remember when you deploy applications on Oracle RAC:

Overview of Deploying Applications on Oracle Real Application Clusters

To optimally deploy applications on Oracle RAC, remember the following points:

- Storage for Oracle RAC datafiles must be shared storage: When you install Oracle RAC, use Automatic Storage Management (ASM) or a Cluster File System for datafile storage when available.
- Create your database with the Database Configuration Assistant (DBCA).
- Define services for your environment with DBCA or Enterprise Manager and administer them with Oracle Enterprise Manager or the Server Control (SRVCTL) Utility.
- Use the Server Parameter File (SPFILE): The SPFILE should be located on either a **cluster file system** file or on a shared raw device.
- Use Automatic Undo Management.
- Use Automatic Segment-Space Management.
- Use the Automatic Database Diagnostic Monitor (ADDM) to reduce the effort required to tune Oracle systems.

> **See Also:** Your platform-specific Oracle Real Application Clusters installation guide for more information about configuring these features for Oracle Database 10*g* Oracle Real Application Clusters

Code Changes are Not Required for Applications

Applications that perform well on single-instance Oracle databases do not require code changes to perform well on Oracle RAC databases. The same compatibility guidelines that apply to Oracle single-instance databases also apply to Oracle RAC. For example, if an application scales well in an SMP environment, then the application will scale well with Oracle RAC.

The primary feature of Oracle RAC that enables applications to scale across multiple instances is **Cache Fusion**. Cache Fusion enable each instance to locate the most useful version of a block of data for its needs, whether that block resides on disk or in the memory of another instance. The cluster interconnect provides a fast pathway for Cache Fusion to transfer required blocks of data between instances when necessary.

Implementing Oracle Features with Oracle Real Application Clusters

The Oracle features described in this section enhance the performance and simplify the administration of your Oracle RAC environment. The features discussed in this section are:

- Automatic Storage Management
- Cluster File Systems in Oracle Real Application Clusters
- Storage Management Features and Oracle Real Application Clusters
- Services in Oracle Database 10g
- The Oracle Clusterware and High Availability in Oracle Real Application Clusters
- Additional Oracle High Availability Features and Solutions

Automatic Storage Management

Automatic Storage Management (ASM) simplifies database administration by eliminating the need for you to manage Oracle database files. Instead, ASM enables you to create disk groups that comprise disks and the files that reside on them.

Cluster File Systems in Oracle Real Application Clusters

Depending on your hardware platform, you can store Oracle homes and Oracle datafiles on a cluster file system. Cluster file systems are simpler to configure and manage than raw device storage. Cluster file systems also offer scalable, low latency, highly resilient storage that significantly reduces costs.

Storage Management Features and Oracle Real Application Clusters

The advanced storage features of Oracle Automatic Storage Management greatly enhance manageability for Oracle RAC just as with single instance Oracle. Other storage features include Oracle-managed files, automatic segment-space management, and automatic undo management. Refer to the Oracle database documentation for more information about using storage management features.

See Also:

- *Oracle Database 2 Day DBA*
- *Oracle Database Administrator's Guide*
- *Oracle Database Application Developer's Guide - Object-Relational Features*

Services in Oracle Database 10*g*

With Oracle Database 10*g*, you can define application workloads as services so that you can individually manage and control them. You can create a service for each application or for major components within a complex application. Once created, you can define where and when a service runs. Your entire database workload can be separated into a few services, each of which can be managed independently, reducing the need to manage individual users or sessions for many tasks.

In an Oracle RAC database, you can use services to maximize the use of your cluster's processing resources. You can assign each service to one or more instances for normal startup (preferred), depending on its processing requirements. Additionally, you can define one or more alternate (available) instances that a service can use if one of the service's assigned (preferred) instances becomes unavailable.

In both cluster and non-cluster environments, you can track performance metrics by service using the Automatic Workload Repository (AWR). You can set thresholds on performance metrics so that your system automatically generates alerts if the thresholds are exceeded. You can also map services to Resource Manager consumer groups to provide more fine-grained resource allocation controls such as placing limits on CPU consumption. Other Oracle tools and facilities such as Oracle Scheduler, Parallel Query, and Oracle Streams Advanced Queuing can also use services to manage their workloads.

The settings for Resource Manager are instance specific, that is, you can have different Resource Manager settings on different instances. Therefore, ensure that your Resource Manager settings are appropriate for the instances on which you are using it. The Automatic Workload Management features of Oracle Database 10*g* are integrated with the resource manager. The only difference in the way you use Resource Manager with Oracle RAC is that Resource Manager has instance specific settings.

Note: An example that shows how to manage a complex environment with database services is available on the Oracle Technology Network at the URL http://www.oracle.com/index.html. The example includes entries from the related files, such as listener, database, and Net Services parameter files, as well as the commands to create and use the services for application management.

Runtime Connection Load Balancing is used when selecting connections from a connection pool. For connection pools that support services at one instance only, the first available connection in the pool is used. When connection pools support services that span multiple instances using a policy such as service metrics, Runtime Connection Load Balancing distributes work requests across instances that are adequately serving a service. This avoids sending work to slow, hung, failed or restricted instances.

For connection load balancing, the method for balancing connections across a service uses four metrics: session count by instance, run queue length of the node, goodness by service, and weighted session count by service. The metrics used depend on what goals have been defined for the service and how Oracle Net Services has been configured.

Fast Connection Failover is used to prevent connections being directed to failed nodes or instances. Integrated connection pools will clean up connections when a failure occurs or add additional connections when new instances become available. This allows the application to be immediately aware of cluster configuration changes and react to them without any programming or configuration changes at the application tier.

See Also: Chapter 6, "Introduction to Workload Management" for more detailed information about these features

The Oracle Clusterware and High Availability in Oracle Real Application Clusters

This section introduces the following high availability features:

- High Availability with Oracle Clusterware
- The Oracle Clusterware and High Availability

High Availability with Oracle Clusterware

Oracle Real Application Clusters 10*g* introduces a complete, integrated clusterware management solution on all Oracle Database 10*g* platforms. This clusterware functionality provides all of the features required to manage your cluster database including node membership, group services, global resource management, and high availability functions.

You install Oracle Clusterware as a separate install that you can complete independently or as a pre-requisite to the Oracle RAC installation process. Oracle database features such as Oracle 10*g* services use the underlying Oracle Clusterware mechanisms to provide their capabilities. Oracle also continues to support select third-party clusterware products on specified platforms.

See Also: Chapter 14, "Making Applications Highly Available Using Oracle Clusterware" for more information about Oracle Clusterware

The Oracle Clusterware and High Availability

High availability configurations have redundant hardware and software that maintain operations by avoiding single points-of-failure. During outages, Oracle Clusterware relocates the processing performed by the inoperative component to a backup component. The Oracle recovery processes quickly re-master resources, recover partial or failed transactions, and rapidly restore the system.

You can combine many Oracle products and features to create highly reliable computing environments. Doing this requires capacity and redundancy planning. In addition, consider your overall system costs and your return on investment. There are also other practical considerations such as selecting the appropriate hardware and deciding whether to use idle machines that are part of your high availability configuration.

Additional Oracle High Availability Features and Solutions

This section describes the following additional high availability solutions:

- Connection Load Balancing with Oracle Real Application Clusters
- Recovery Manager (RMAN) in Oracle Real Application Clusters
- Data Guard
- Primary/Secondary Instance Configurations in Earlier Releases

Connection Load Balancing with Oracle Real Application Clusters

The connection load balancing feature of Oracle Net Services automatically distributes connections among active instances. Connection load balancing does this based on the workload of each node and instance in a cluster.

Recovery Manager (RMAN) in Oracle Real Application Clusters

Recovery Manager (RMAN) is an Oracle tool that you can use to backup, copy, restore, and recover datafiles, control files, SPFILEs, and archived redo logs. You can invoke RMAN as a command-line utility or use Oracle Enterprise Manager.

A best practice is to configure RMAN so that all instances can access all of the archive log threads throughout your cluster database. In the event of media recovery, the recovering instance requires access to all of the archived redo log threads. You can simplify media recovery administration by ensuring that a recovering instance can access a local copy of the archive log threads from all of the instances in your cluster database.

> **See Also:** *Chapter 7, "Configuring Recovery Manager and Archiving"* for details about configuring RMAN for use with Oracle RAC and *Oracle Database Backup and Recovery Advanced User's Guide* for detailed information about RMAN

Data Guard

Oracle Data Guard works with standby databases to protect your data against errors, failures, and corruptions that might otherwise destroy your database. Data Guard protects critical data by automating the creation, management, and monitoring aspects of standby database environments. Oracle Data Guard automates the otherwise manual process of maintaining a transactional consistent copy of an Oracle database to recover from the loss of or damage to the production database.

Primary/Secondary Instance Configurations in Earlier Releases

If you are upgrading from a pre-Oracle 10*g* Primary/Secondary configuration, then the Database Upgrade Assistant (DBUA) creates a service on your database with one preferred instance and one available instance.

3

Administering Oracle Clusterware Components

The Oracle Clusterware includes two important components: the voting disk and the Oracle Cluster Registry (OCR). The voting disk is a file that manages information about node membership and the OCR is a file that manages **cluster** and Oracle Real Application Clusters (Oracle RAC) database configuration information. This chapter describes how to administer the voting disks and the Oracle Cluster Registry (OCR) under the following topics:

- Administering Voting Disks in Oracle Real Application Clusters
- Administering the Oracle Cluster Registry in Oracle Real Application Clusters
- Administering Multiple Cluster Interconnects on UINIX-Based Platforms

Administering Voting Disks in Oracle Real Application Clusters

Oracle recommends that you select the option to configure multiple voting disks during Oracle Clusterware installation to improve availability. After installation, use the following procedures to regularly backup your voting disks and to recover them as needed:

- Backing up Voting Disks
- Recovering Voting Disks

> **See Also:** "Administering the Oracle Cluster Registry in Oracle Real Application Clusters" on page 3-2 for more information about administering the OCR

Backing up Voting Disks

Run the following command to back up a voting disk. Perform this operation on every voting disk as needed 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
```

> **Note:** You can use the `ocopy` command in Windows environments or use the `crsctl` commands described in the following note.

Recovering Voting Disks

Run the following command to recover a voting disk 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
```

Note: If you have multiple voting disks, then you can remove the voting disks and add them back into your environment using the `crsctl delete css votedisk` *path* and `crsctl add css votedisk` *path* commands respectively, where *path* is the complete path of the location on which the voting disk resides.

Changing the Voting Disk Configuration after Installing Oracle Real Application Clusters

You can add and remove voting disks after installing Oracle Real Application Clusters. Do this using the following commands where *path* is the fully qualified path for the additional voting disk. Run the following command as the `root` user to add a voting disk:

```
crsctl add css votedisk path
```

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

```
crsctl delete css votedisk path
```

Note: Bring down `ocssd` using the `-force` option prior to modifying the voting disk configuration with either of these commands to avoid interacting with active Oracle Clusterware daemons. Note also that using the `-force` option while any cluster node is active may corrupt your configuration.

Administering the Oracle Cluster Registry in Oracle Real Application Clusters

This section describes how to administer the OCR. The OCR contains information about the cluster node list, instance-to-node mapping information, and information about Oracle Clusterware resource profiles for applications that you have customized as described in Chapter 14, "Making Applications Highly Available Using Oracle Clusterware". The procedures discussed in this section are:

- Adding, Replacing, Repairing, and Removing the OCR
- Managing Backups and Recovering the OCR Using OCR Backup Files
- Diagnosing OCR Problems with the OCRDUMP and OCRCHECK Utilities
- Overriding the Oracle Cluster Registry Data Loss Protection Mechanism
- Administering the Oracle Cluster Registry with OCR Exports
- Implementing the Oracle Hardware Assisted Resilient Data Initiative for the OCR
- Upgrading and Downgrading the OCR Configuration in Oracle RAC

See Also: Appendix A, "Troubleshooting" for information about the ocrdump utility

Adding, Replacing, Repairing, and Removing the OCR

The Oracle installation process for Oracle RAC gives you the option of automatically mirroring the OCR. This creates a second OCR to duplicate the original OCR. You can put the mirrored OCR on an Oracle **cluster file system** disk, on a shared raw device, or on a shared raw logical volume.

You can also manually mirror the OCR if you:

- Upgraded to release 10.2 but did not choose to mirror the OCR during the upgrade
- Created only one OCR during the Oracle Clusterware installation

Note: Oracle *strongly* recommends that you use mirrored OCRs if the underlying storage is not RAID. This prevents the OCR from becoming a single point of failure.

In addition to mirroring the OCR, you can also replace the OCR if Oracle displays an OCR failure alert in Enterprise Manager or in the Oracle Clusterware alert log file. You can also repair an OCR location if there is a mis-configuration or other type of OCR error. In addition, you can remove an OCR location if, for example, your system experiences a performance degradation due to OCR processing or if you transfer your OCR to RAID storage devices and chose to no longer use multiple OCRs. Use the following procedures to perform these tasks:

- Adding an Oracle Cluster Registry
- Replacing an Oracle Cluster Registry
- Repairing an Oracle Cluster Registry Configuration on a Local Node
- Removing an Oracle Cluster Registry

Note: The operations in this section affect the OCR cluster-wide: they change the OCR configuration information in the `ocr.loc` file on UNIX-based systems and the Registry keys on Windows-based systems. 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.

Adding an Oracle Cluster Registry

You can add an OCR location after an upgrade or after completing the Oracle RAC installation. If you already mirror the OCR, then you do not need to add an OCR location; Oracle automatically manages two OCRs when it mirrors the OCR. Oracle RAC environments do not support more than two OCRs, a primary OCR and a second OCR.

Note: If your OCR resides on a cluster file system file or if the OCR is on an network file system, then create the target OCR file before performing the procedures in this section.

Run the following command to add an OCR location using either *destination_file* or *disk* to designate the target location of the additional OCR:

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

Run the following command to add an OCR mirror location using either *destination_file* or *disk* to designate the target location of the additional OCR:

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

Note: You must be `root` user to run `ocrconfig` commands.

Replacing an Oracle Cluster Registry

You can replace a mirrored OCR using the following procedure as long as one OCR-designated file remains online:

1. Verify that the OCR that you are *not* going to replace is *online*.
2. Verify that Oracle Clusterware is running on the node on which the you are going to perform the replace operation.

   Note: The OCR that you are replacing can be either online or offline. In addition, if your OCR resides on a cluster file system file or if the OCR is on an network file system, then create the target OCR file before continuing with this procedure.

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

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

   Run the following command to replace an OCR mirror location using either *destination_file* or *disk* to indicate the target OCR:

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

4. If any node that is part of your current Oracle RAC environment is shut down, then run the command `ocrconfig -repair` on any node that is stopped to enable that node to rejoin the cluster after you restart the stopped node.

Repairing an Oracle Cluster Registry 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 not up while you were adding, replacing, or removing an OCR. Use the following procedure to repair an OCR configuration:

1. Run the following command to stop Oracle Clusterware on all nodes:

   ```
   crsctl stop crs
   ```

2. Run the following command on one node to take a backup of the OCR configuration:

   ```
   ocrconfig -export export_filename
   ```

In the preceding command, *export_filename* is the name of the of the file to which you backed up OCR. You import this file after you repair the OCR configuration.

3. Run the following command on all nodes to repair the OCR configuration:

```
ocrconfig -repair
```

4. Run the following command to import the backup to the repaired OCR configuration:

```
ocrconfig -import export_filename
```

5. Run the following command on one node to overwrite the OCR configuration on disk:

```
ocrconfig -overwrite
```

6. Run the following command on one node to verify the OCR configuration:

```
ocrcheck
```

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

Removing an Oracle Cluster Registry

To remove an OCR location, at least one other OCR must be online. You can remove an OCR location to reduce OCR-related overhead or to stop mirroring your OCR because you moved your the OCR to redundant storage such as RAID. Perform the following procedure to remove an OCR location from your Oracle RAC environment:

1. Ensure that *at least one* OCR other than the OCR that you are removing is online.

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

---

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

```
ocrconfig -replace ocr
```

Run the following command on any node in the cluster to remove the mirrored OCR:

```
ocrconfig -replace ocrmirror
```

These commands update the OCR configuration on all of the nodes on which Oracle Clusterware is running.

See Also: You can also use the `-backuploc` option to move the OCR to another location as described in Appendix D, "Oracle Cluster Registry Configuration Tool Command Syntax"

Note: When removing an OCR location, the remaining OCR must be online. If you remove a primary OCR, then the mirrored OCR becomes the primary OCR.

Managing Backups and Recovering the OCR Using OCR Backup Files

This section describes two methods for copying OCR content and using it for recovery. The first method uses automatically generated OCR file copies and the second method uses manually created OCR export files.

The Oracle Clusterware automatically creates OCR backups every four hours. At any one time, Oracle always retains the last three backup copies of the OCR. The CRSD process that creates the backups also creates and retains an OCR backup for each *full day* and *at the end of each week*.

You cannot customize the backup frequencies or the number of files that Oracle 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 resides.

The default location for generating backups on UNIX-based systems is *CRS_home*`/cdata/`*cluster_name* where *cluster_name* is the name of your cluster. The Windows-based default location for generating backups uses the same path structure.

Note: You must be `root` user to run `ocrconfig` commands.

Restoring the Oracle Cluster Registry from Automatically Generated OCR Backups

If an application fails, then before attempting to restore the OCR, restart the application. As a definitive verification that the OCR failed, run an `ocrcheck` and if the command returns a failure message, then both the primary OCR and the OCR mirror have failed. Attempt to correct the problem using one of the following platform-specific OCR restoration procedures.

Note: You *cannot* restore your configuration from an automatically created OCR backup file using the `-import` option, which is explained in "Administering the Oracle Cluster Registry with OCR Exports" on page 3-9. You *must instead* use the `-restore` option as described in the following sections.

- Restoring the Oracle Cluster Registry on UNIX-Based Systems
- Restoring the Oracle Cluster Registry on Windows-Based Systems

Restoring the Oracle Cluster Registry on UNIX-Based Systems Use the following procedure to restore the OCR on UNIX-based systems:

1. Identify the OCR backups using the `ocrconfig -showbackup` command. Review the contents of the backup using `ocrdump -backupfile` *file_name* where *file_name* is the name of the backup file.
2. Stop Oracle Clusterware on all the nodes in your Oracle RAC cluster by running the following command as `root`:

   ```
   # crsctl stop crs
   ```

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

Note: Prior to running the `crsctl start crs` command in step 4, run the following command to verify that all processes *except* `init.cssd fatal` are inactive:

```
ps -ef|grep cssd
```

---

3. Perform the restore 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.

   ```
   ocrconfig -restore file_name
   ```

4. Start Oracle Clusterware on all the nodes in your Oracle RAC cluster by running the following command as `root`:

   ```
   # crsctl start crs
   ```

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

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

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

   See Also: Appendix A, "Troubleshooting" for more information about enabling and using CVU

Restoring the Oracle Cluster Registry on Windows-Based Systems Use the following procedure to restore the OCR on Windows-based systems:

1. Identify the OCR backups using the `ocrconfig -showbackup` command. Review the contents of the backup using `ocrdump -backupfile` *`file_name`* where *`file_name`* is the name of the backup file.
2. On all of the remaining nodes, disable the following OCR clients and stop them using the Service Control Panel: `OracleClusterVolumeService`, `OracleCSService`, `OracleCRService`, and the `OracleEVMService`.
3. Execute the restore by applying an OCR backup file that you identified in Step 1 with the `ocrconfig -restore` *`file name`* command. Make sure that the OCR devices that you specify in the OCR configuration exist and that these OCR devices are valid.
4. Start all of the services that were stopped in step 2. Restart all of the nodes and resume operations in cluster mode.
5. Run the following command to verify the OCR integrity where the `-n all` argument retrieves a listing of all of the cluster nodes that are configured as part of your cluster:

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

   See Also: "Cluster Verification Utility Oracle Clusterware Component Verifications" on page A-17 for more information about enabling and using CVU

Diagnosing OCR Problems with the OCRDUMP and OCRCHECK Utilities

You can use the OCRDUMP and OCRCHECK utilities to diagnose OCR problems as described under the following topics:

- Using the OCRDUMP Utility
- Using the OCRCHECK Utility

Using the OCRDUMP Utility

Use the OCRDUMP utility to write the OCR contents to a file so that you can examine the OCR content.

> **See Also:** "OCRDUMP Utility Syntax and Options" on page A-6 for more information about the OCRDUMP utility

Using the OCRCHECK Utility

Use the OCRCHECK utility to verify the OCR integrity.

> **See Also:** Using the OCRCHECK Utility on page A-7 for more information about the OCRCHECK utility

Overriding the Oracle Cluster Registry Data Loss Protection Mechanism

The OCR has a mechanism that prevents data loss due to accidental overwrites. If you configure a mirrored OCR and if the OCR cannot access the two mirrored OCR locations and also cannot verify that the available OCR contains the most recent configuration, then the OCR prevents further modification to the available OCR. The OCR prevents overwriting by prohibiting Oracle Clusterware from starting on the node on which the OCR resides. In such cases, Oracle displays an alert message in either Enterprise Manager, the Oracle Clusterware alert log files, or both.

Sometimes this problem is local to only one node and you can use other nodes to start your **cluster database**. In such cases, Oracle displays an alert message in Enterprise Manager, the Oracle Clusterware alert log, or both.

However, if you are unable to start *any* cluster nodes in your environment and if you cannot repair the OCR, then you can override the protection mechanism. This procedure enables you to start the cluster using the available OCR, thus enabling you to use the updated OCR file to start your cluster. However, this can result in the loss of data that was not available at the time that the previous known good state was created.

> **Note:** Overriding the OCR using this procedure can result in the loss of OCR updates that were made between the time of the last known good OCR update made to the currently-accessible OCR and the time at which you performed this procedure. In other words, running the `ocrconfig -overwrite` command can result in data loss if the OCR that you are using to perform the overwrite does not contain the *latest* configuration updates for your cluster environment.

Perform the following procedure to overwrite the OCR if a node cannot start up *and* if the alert log contains a a CLSD-1009 or CLSD-1011 message.

1. Attempt to resolve the cause of the a CLSD-1009 or CLSD-1011 message. Do this by comparing the node's OCR configuration (`ocr.loc` on Unix-based systems

and the Registry on Windows-based systems) with other nodes on which Oracle Clusterware is running. If the configurations do not match, then run `ocrconfig -repair`. If the configurations match, then ensure that the node can access all of the configured OCRs by running an `ls` command on Unix-based systems or a `dir` command on Windows-based systems. Oracle issues a warning when one of the configured OCR locations is not available or if the configuration is incorrect.

2. Ensure that the most recent OCR contains the latest OCR updates. Do this by taking output from the `ocrdump` command and determine whether it has your latest updates.
3. If you cannot resolve the CLSD message, then run the command `ocrconfig -overwrite` to bring up the node.

Administering the Oracle Cluster Registry with OCR Exports

In addition to using the automatically created OCR backup files, you should also export the OCR contents before and after making significant configuration changes, such as adding or deleting nodes from your environment, modifying Oracle Clusterware resources, or creating a database. Do this by using the `ocrconfig -export` command. This exports the OCR content to a file format.

Using the `ocrconfig -export` command enables you to restore the OCR using the `-import` option if your configuration changes cause errors. For example, if you have unresolvable configuration problems, or if you are unable to restart your clusterware after such changed, then restore your configuration using one of the following platform-specific procedures:

- Importing Oracle Cluster Registry Content on UNIX-Based Systems
- Importing Oracle Cluster Registry Content on Windows-Based Systems

> **Note:** Most configuration changes that you make not only change the OCR contents, configuration changes also cause file and database object creation. Some of these changes are often not restored when you restore the OCR. Do not perform an OCR restore as a correction to revert to previous configurations if some of these configuration changes should fail. This may result in an OCR that has contents that do not match the state of the rest of your system.

Importing Oracle Cluster Registry Content on UNIX-Based Systems

Use the following procedure to import the OCR on UNIX-based systems:

1. Identify the OCR export file that you want to import by identifying the OCR export file that you previously created using the `ocrconfig -export file_name` command.
2. Stop Oracle Clusterware on all of the nodes in your Oracle RAC database by executing the `init.crs stop` command on all of the nodes.
3. Perform the import by applying an OCR export file that you identified in Step 1 using the following command where *`file_name`* is the name of the OCR file from which you want to import OCR information:

   ```
   ocrconfig -import file_name
   ```

4. Restart Oracle Clusterware on all of the nodes in your cluster by restarting each node.

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

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

Note: You *cannot* import an exported OCR backup file, which is described in "Managing Backups and Recovering the OCR Using OCR Backup Files" on page 3-6. You must instead use the `-import` option as described in the following sections.

See Also: Appendix A, "Troubleshooting" for more information about enabling and using CVU

Importing Oracle Cluster Registry Content on Windows-Based Systems

Use the following procedure to import the OCR on Windows-based systems:

1. Identify the OCR export file that you want to import by running the `ocrconfig -showbackup` command. .
2. Stop the following OCR clients *on each node* in your Oracle RAC environment using the Service Control Panel: OracleClusterVolumeService, OracleCMService, OracleEVMService, OracleCSService, and the OracleCRService.
3. Import an OCR export file using the `ocrconfig -import` command from one node.
4. Restart all of the affected services on all nodes.
5. Run the following Cluster Verification Utility (CVU) command to verify the OCR integrity where *`node_list`* is a list of all of the nodes in your cluster database:

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

See Also: Appendix A, "Troubleshooting" for more information about enabling and using CVU

Implementing the Oracle Hardware Assisted Resilient Data Initiative for the OCR

The Oracle Hardware Assisted Resilient Data (HARD) initiative prevents data corruptions from being written to permanent storage. If you enable HARD, then the OCR writes HARD-compatible blocks. To determine whether the device used by the OCR supports HARD and then enable it, review the Oracle HARD white paper at:

`http://www.oracle.com/technology/deploy/availability/htdocs/HARD.html`

Upgrading and Downgrading the OCR Configuration in Oracle RAC

When you install Oracle Clusterware, Oracle automatically runs the `ocrconfig -upgrade` command. To downgrade, follow the downgrade instructions for each component and also downgrade the OCR using the `ocrconfig -downgrade` command. If you are upgrading the OCR to Oracle Database 10*g* release 10.2, then you can use the `cluvfy` command to verify the integrity of the OCR. If you are downgrading, you cannot use the Cluster Verification Utility (CVU) commands to verify the OCR for pre-10.2 release formats.

HARD-Compatible OCR Blocks in Oracle9*i*

In Oracle9*i*, the OCR did not write HARD-compatible blocks. If the device used by OCR is enabled for HARD, then use the method described in the HARD white paper to *disable* HARD for the OCR before downgrading your OCR. If you do not disable HARD, then the downgrade operation fails.

Administering Multiple Cluster Interconnects on UINIX-Based Platforms

In Oracle RAC environments that run on UNIX-based platforms, you can use the CLUSTER_INTERCONNECTS initialization parameter to specify an alternative interconnect for the private network.

The CLUSTER_INTERCONNECTS initialization parameter requires the IP address of the interconnect instead of the device name. It enables you to specify multiple IP addresses, separated by colons. Oracle RAC network traffic is distributed between the specified IP addresses.

The CLUSTER_INTERCONNECTS initialization parameter is useful only in a UNIX-based environments where UDP IPC is enabled. The CLUSTER_ INTERCONNECTS parameter enables you to specify an interconnect for all IPC traffic to include Oracle Global Cache Service (GCS), Global Enqueue Service (GES), and Interprocessor Parallel Query (IPQ).

Overall cluster stability and performance may improve when you force Oracle GCS, GES, and IPQ over a different interconnect by setting the CLUSTER_INTERCONNECTS initialization parameter. For example, to use the network interface whose IP address is 129.34.137.212 for all GCS, GES, and IPQ IPC traffic, set the CLUSTER_ INTERCONNECTS parameter as follows:

```
CLUSTER_INTERCONNECTS=129.34.137.212
```

Use the ifconfig or netstat command to display the IP address of a device. This command provides a map between device names and IP addresses. For example, to determine the IP address of a device, run the following command as the root user:

```
# /usr/sbin/ifconfig -a
fta0: flags=c63<UP,BROADCAST,NOTRAILERS,RUNNING,MULTICAST,SIMPLEX>
      inet 129.34.137.212 netmask fffffc00 broadcast 129.34.139.255 ipmtu 1500

lo0:  flags=100c89<UP,LOOPBACK,NOARP,MULTICAST,SIMPLEX,NOCHECKSUM>
      inet 127.0.0.1 netmask ff000000 ipmtu 4096

ics0:  flags=1100063<UP,BROADCAST,NOTRAILERS,RUNNING,NOCHECKSUM,CLUIF>
      inet 10.0.0.1 netmask ffffff00 broadcast 10.0.0.255 ipmtu 7000

sl0:  flags=10<POINTOPOINT>

tun0: flags=80<NOARP>
```

In the preceding example, the interface fta0: has an IP address of 129.34.137.212 and the interface ics0: has an IP address of 10.0.0.1.

Bear in mind the following important points when using the CLUSTER_ INTERCONNECTS initialization parameter:

- The IP addresses specified for the different instances of the same database on different nodes must belong to network adapters that connect to the same network. If you do not follow this rule, then inter-node traffic may pass through bridges and routers or there may not be a path between the two nodes at all.

- Specify the CLUSTER_INTERCONNECTS initialization parameter in the parameter file, setting a different value for each database instance.
- If you specify multiple IP addresses for this parameter, then list them in the same order for all instances of the same database. For example, if the parameter for instance 1 on node 1 lists the IP addresses of the alt0:, fta0:, and ics0: devices in that order, then the parameter for instance 2 on node 2 must list the IP addresses of the equivalent network adapters in the same order.
- If the interconnect IP address specified is incorrect or does not exist on the system, then Oracle Database uses the default cluster interconnect device. On Tru64 UNIX for example, the default device is ics0:.

Failover and Failback and CLUSTER_INTERCONNECTS

Some operating systems support run-time failover and failback. However, if you use the CLUSTER_INTERCONNECTS initialization parameter, then failover and failback are disabled.

Note: Failover and failback and CLUSTER_INTERCONNECTS are not supported on AIX systems.

4

Administering Storage

This chapter describes storage topics such as Automatic Storage Management (ASM). The topics in this chapter are:

- Overview of Storage in Oracle Real Application Clusters
- Automatic Storage Management in Oracle Real Application Clusters

Overview of Storage in Oracle Real Application Clusters

Storage for Oracle Real Application Clusters (Oracle RAC) databases must be shared. In other words, datafiles must reside in an Automatic Storage Management (ASM) disk group, on a **cluster file system**, or on shared raw devices. This must include space for an undo tablespace for each instance if you are using automatic undo management. Additionally, for each instance you must create at least two redo log files that reside on shared storage. In addition, as Oracle recommends, you can use one shared server parameter file (SPFILE) with instance-specific entries. Or you can use a local file system to store client-side parameter files (PFILEs).

Unless otherwise noted, Oracle storage features such as ASM, Oracle Managed Files (OMF), automatic segment-space management, and so on, function the same in Oracle RAC environments as they do in single-instance Oracle database environments. Refer to *Oracle Database 2 Day DBA* and the *Oracle Database Administrator's Guide* for additional information about these storage features.

If you do not use ASM, if your platform does not support a cluster file system, or if you do not want to use a cluster file system to store datafiles, then create additional raw devices as described in your platform-specific Oracle Real Application Clusters installation and configuration guide. However, Oracle recommends that you use ASM for datafile storage which is described later in this chapter in the section titled "Automatic Storage Management in Oracle Real Application Clusters" on page 4-2. The remainder of this section describes the following topics:

- Datafile Access in Oracle Real Application Clusters
- Redo Log File Storage in Oracle Real Application Clusters
- Automatic Undo Management in Oracle Real Application Clusters

> **Note:** To create an Oracle RAC database using the Oracle Database 10*g* Standard Edition, you *must* use ASM for your datafile storage.

Datafile Access in Oracle Real Application Clusters

All Oracle RAC instances must be able to access all datafiles. If a datafile needs to be recovered when the database is opened, then the first Oracle RAC instance to start is the instance that performs the recovery and verifies access to the file. As other instances start, they also verify their access to the datafiles. Similarly, when you add a tablespace or datafile or bring a tablespace or datafile online, all instances verify access to the file or files.

If you add a datafile to a disk that other instances cannot access, then verification fails. Verification also fails if instances access different copies of the same datafile. If verification fails for any instance, then diagnose and fix the problem. Then run the `ALTER SYSTEM CHECK DATAFILES` statement on each instance to verify datafile access.

Redo Log File Storage in Oracle Real Application Clusters

Each instance has its own online redo log groups which are referred to as an instance's thread of online redo. Create these online redo log groups and establish group members as described in the *Oracle Database Administrator's Guide.*

Each instance must have at least two groups of online redo log files in its thread. When the current group fills, an instance begins writing to the next log file group. If your database is in `ARCHIVELOG` mode, then each instance must save filled log files into its own archive log thread and update the control file with the status of its thread.

Note: `MAXLOGHISTORY` is useful for sites with demanding availability requirements. This option can help you administer recovery, especially when there are many instances and many log files.

Automatic Undo Management in Oracle Real Application Clusters

Oracle 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, all instances can always read all undo blocks throughout the **cluster** environment for consistent read purposes. Also, any instance can update any undo tablespace during transaction recovery, as long as that undo tablespace is not currently 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 Administrator's Guide* for detailed information about creating and managing undo tablespaces

Automatic Storage Management in Oracle Real Application Clusters

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 of the available storage within your **cluster database** environment. ASM partitions your total disk space requirements into

uniformly sized units across all 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.

To use ASM in Oracle RAC, select ASM as your storage option when you create your database with the Database Configuration Assistant (DBCA). 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 as follows:

- Automatic Storage Management Components in Oracle RAC
- Modifying Disk Group Configurations for ASM in Oracle RAC
- Standalone ASM Disk Group Management
- Administering ASM Instances and Disk Groups with Enterprise Manager in Oracle RAC
- Administering ASM Instances with SRVCTL in Oracle RAC

Automatic Storage Management Components in Oracle RAC

When you create your database, Oracle 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. You may need to back up the parameter files and the TNS entries for nondefault Oracle Net Listeners.

Modifying 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 only need to prepare 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 re-balances the storage load after you add or delete a disk or disk group.

In a cluster, each ASM instance manages its node's metadata updates to the disk groups. 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, DBCA, SQL*Plus, and the Server Control Utility (SRVCTL) to administer disk groups for ASM in Oracle RAC. The *Oracle Database Administrator's Guide* explains how to use SQL*Plus to administer ASM instances. The following sections describe how to use the other tools.

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. However, you can also use the standalone ASM disk group management feature to create and manage an ASM instance and its associated disk groups independently of creating a new database. You can use Enterprise Manager or DBCA to add disks to a disk group, to mount a disk group or to mount all of the disk groups, or to create ASM instances. Additionally, you can use Enterprise Manager to dismount and drop disk groups or to delete ASM instances.

To create an ASM instance without creating a database with DBCA, select the **Configure Automatic Storage Management** option on the DBCA Database Options page. You can also use this option to add or mount one or more ASM disk groups. The DBCA then displays the Node Selection page on which you can identify the nodes on

which you want to create the ASM instance or on which you want to manage disk groups. If necessary, the next page you must complete is the DCBA Create Instance Page on which you add the information about the ASM instance parameter file and `SYS` password and, for Windows-based systems, the owner of the ASM-related service.

The DBCA session provides the same ASM Disk Groups page for standalone ASM management as it does for database creation using ASM storage. Use this page to create new disk groups, to add disks to existing disk groups, or to mount disk groups that are not currently mounted. You can also use the standalone ASM feature, where you have the ability to manage ASM instances independent of the database, in DBCA silent mode to create an ASM instance or to manage ASM disk groups. The syntax for the DBCA silent mode command is:

```
dbca -silent -nodeList nodelist -configureASM -asmPassword asm_pwd [-diskList
disk_list] [-redundancy redundancy_option] [-diskGroupName dgname]  [-diskString
disk_discovery_string] [-recoveryGroupName recovery_dgname] [-recoveryRedundancy
redundancy_option]
```

Where:

- *`nodelist`* is a comma-delimited list of nodes and these are the nodes on which you want to perform the ASM activities
- *`asm_pwd`* is the password for the SYS account in the ASM instance
- *`disk_list`* is a comma-delimited list of disks to be added to disk group
- *`redundancy_option`* is `NORMAL`, `HIGH`, or `EXTERNAL`
- *`dgname`* is either the name of an existing disk group, in which case the disk group is mounted on all of the selected nodes, or *`dgname`* is the name of a new disk group, in which case the disk group is created and started on all of the selected nodes
- `disk_recovery_string` identifies the location or identifier for the ASM-ready disks
- *`recovery_dgname`* is the name for a recovery disk group

Administering ASM Instances and Disk Groups with Enterprise Manager in Oracle RAC

You can perform administrative operations on ASM disk groups with 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 ASM-related Enterprise Manager tasks that you can perform are:

- When you add a disk group, the disk group definition includes a checkbox to indicate whether the disk group is automatically mounted to all of 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 checkbox to indicate which instances should mount or dismount a particular ASM Disk Group.

> **See Also:** *Oracle Database Administrator's Guide* and *Oracle Database 2 Day DBA* for detailed information about using Enterprise Manager

Administering ASM Instances with SRVCTL in Oracle RAC

You can use the Server Control Utility (SRVCTL) to add, remove, enable, and disable an ASM instance as described in the following procedures:

Use the following syntax to add configuration information about an existing ASM instance:

```
srvctl add asm -n node_name -i asm_instance_name -o oracle_home
```

> **Note:** For all of the SRVCTL commands in this section for which the `-i` option is not required, if you do not specify an instance name, then the command applies to all of the ASM instances on the node.

Use the following syntax to remove an ASM instance:

```
srvctl remove asm -n node_name [-i asm_instance_name]
```

Use the following syntax to enable an ASM instance:

```
srvctl enable asm -n node_name [-i ] asm_instance_name
```

Use the following syntax to disable an ASM instance:

```
srvctl disable asm -n node_name [-i asm_instance_name]
```

You can also use SRVCTL to start, stop, and obtain the status of an ASM instance as in the following examples.

Use the following syntax to start an ASM instance:

```
srvctl start asm -n node_name [-i asm_instance_name] [-o start_options] [-c
<connect_str> | -q]
```

Use the following syntax to stop an ASM instance:

```
srvctl stop asm -n node_name [-i asm_instance_name] [-o stop_options] [-c
<connect_str> | -q]
```

Use the following syntax to show the configuration of an ASM instance:

```
srvctl config asm -n node_name
```

Use the following syntax to obtain the status of an ASM instance:

```
srvctl status asm -n node_name
```

5

Administering Database Instances and Cluster Databases

This chapter describes how to administer Oracle Real Application Clusters (Oracle RAC) database instances and Oracle RAC databases. This chapter explains the startup and shutdown tasks for database components and well as how to administer parameters and parameter files in Oracle RAC. The topics in this chapter are:

- Overview of Oracle Real Application Clusters Management Tools
- Starting and Stopping Instances and Oracle Real Application Clusters Databases
- Overview of Initialization Parameter Files in Oracle Real Application Clusters
- Initialization Parameter Use in Oracle Real Application Clusters
- Summary of Parameter Use in Oracle Real Application Clusters Databases
- Backing Up the Server Parameter File

> **See Also:** Chapter 4, "Administering Storage" for information about managing Automatic Storage Management (ASM) instances

Overview of Oracle Real Application Clusters Management Tools

The following section introduces the three tools that you will most likely use to manage Oracle RAC databases and Oracle RAC instances, namely, Oracle Enterprise Manager, SQL*Plus, and the SRVCTL utility. In many cases, you use these tools the same way to manage Oracle RAC environments as you would use them manage single-instance Oracle databases. The following sections identify the differences when managing an Oracle RAC database:

- Overview of Administering Oracle Real Application Clusters with Enterprise Manager
- Overview of Administering Oracle Real Application Clusters with SQL*Plus
- Overview of Administering Oracle Real Application Clusters with SRVCTL

Overview of Administering Oracle Real Application Clusters with Enterprise Manager

Use the Web-based Enterprise Manager Database Control to manage a single Oracle RAC database. The Enterprise Manager Console provides a central point of control for the Oracle environment through a graphical user interface (GUI). You can use the Enterprise Manager Console to initiate a variety of **cluster database** management tasks. Use Enterprise Manager Grid Control to administer multiple Oracle RAC databases.

Enterprise Manager enables you to start, stop, and monitor databases, cluster database instances, and their Listeners, as well as to schedule jobs or set up alert thresholds for metrics. You can perform these tasks simultaneously on multiple cluster databases. You can also use the Console to manage schemas, security, and cluster database storage features.

> **See Also:** *Oracle Enterprise Manager Concepts* for more information about administering Oracle RAC with Enterprise Manager

Overview of Administering Oracle Real Application Clusters with SQL*Plus

SQL*Plus commands operate on the current instance. The current instance can be either the local default instance on which you initiated your SQL*Plus session, or it can be a remote instance to which you connect with Net Services.

Because, by default, the SQL*Plus prompt does not identify the current instance, you should direct your commands to the correct instance. Starting a SQL*Plus session and connecting to the database without specifying an instance directs all SQL*Plus commands to the local instance. In this case, the default instance is also the current instance.

To connect to a different instance in SQL*Plus, issue a new CONNECT command specify a remote instance net service name as in the following example:

```
CONNECT user name/password@net_service_name
```

Note: You may wish to change the SQL*Plus prompt so that it includes the name of the current instance. To do this you can issue a SQL*Plus command such as the following:

```
SET SQLPROMPT '_CONNECT_IDENTIFIER> '
```

This command replaces the "SQL" string in front of the greater than symbol (>) with the user variable `_CONNECT_IDENTIFIER` that will display the current instance name for the duration of your current session.

To change the prompt for all sessions automatically, add an entry similar to the following entry in your `glogin.sql` file, found in the SQL*Plus administrative directory:

```
SET SQLPROMPT '_CONNECT_IDENTIFIER> '
```

You may include any other required text or SQL*Plus user variable between the single quotes in the command.

Connecting as `SYSOPER` or `SYSDBA` enables you to perform privileged operations, such as instance startup and shutdown. Multiple SQL*Plus sessions can connect to the same instance at the same time. SQL*Plus automatically disconnects you from the first instance whenever you connect to another one.

See Also:

- *Oracle Database Net Services Administrator's Guide* for the proper specification of `net_service_name`
- The *Oracle Database Administrator's Guide* for information about connecting to the database using `SYSDBA` or `SYSOPER` privileges

Overview of Administering Oracle Real Application Clusters with SRVCTL

The SRVCTL tool manages configuration information that is used by several other Oracle tools. For example, Enterprise Manager uses the configuration information that SRVCTL generates to discover and monitor nodes in your **cluster**.

When you use SRVCTL to perform configuration operations on your cluster, SRVCTL stores configuration data in the Oracle Cluster Registry (OCR). SRVCTL performs other operations, such as starting and stopping instances, by calling SQL*Plus on each node.

Starting and Stopping Instances and Oracle Real Application Clusters Databases

You can start up and shut down instances with Enterprise Manager, SQL*Plus or SRVCTL as described in the following sections. Both Enterprise Manager and SRVCTL provide options to startup and shutdown all of the instances in an Oracle RAC database with a single step.

You can only perform certain operations when the database is in a NOMOUNT or MOUNT state. Performing other operations requires that the database be OPEN. In addition, some operations require that only one instance be in the required state, while other operations require that all of the instances be in an identical state.

The procedures in this section assume that you are using a server parameter file (SPFILE) and are described in the following topics:

- Starting Up and Shutting Down with Enterprise Manager
- Starting Up and Shutting Down with SQL*Plus
- Starting Up and Shutting Down with SRVCTL

Before you can start an Oracle RAC instance, your clusterware and any required operating system-specific processes must be running. For more information about these processes, see your operating system documentation.

The procedure for shutting down Oracle RAC instances is identical to shutting down instances in single-instance Oracle, with the exceptions described here. Refer to the *Oracle Database Administrator's Guide* for more information about shutting down Oracle databases.

- In Oracle RAC, shutting down one instance does not interfere with the operation of other running instances.
- To shut down an Oracle RAC database completely, shut down every instance that has the database open or mounted.
- After a `NORMAL` or `IMMEDIATE` shutdown, instance recovery is not required. Recovery is required, however, after you issue the `SHUTDOWN ABORT` command or after an instance terminates abnormally. The instance that is still running performs instance recovery for the instance that shut down. If no other instances are

running, the next instance to open the database performs instance recovery for any instances needing it.

- The `SHUTDOWN TRANSACTIONAL` command with the `LOCAL` option is useful to shutdown an instance after all active transactions on the instance have either committed or rolled back. This is in addition to what this command does for `SHUTDOWN IMMEDIATE`. Transactions on other instances do not block this operation. If you omit the `LOCAL` option, then this operation waits until transactions on all other instances that started before the shutdown was issued either commit or rollback.

Starting Up and Shutting Down with Enterprise Manager

You can shut down all instances or any identified instance from the Cluster Database Startup and Shutdown page. To start up or shut down a cluster database instance:

1. Go to the Cluster Database Home page.
2. Click the appropriate **Startup** or **Shutdown** button for your situation. If the system is down, a Startup button appears. If the system is up, a Shutdown button appears. A Specify Host and Target Database Credentials page appears.
3. Enter valid user names and passwords for host and database credentials to change the status of the database, then click **OK**. To change the status of the database, you must log in to the database as either SYSDBA or SYSOPER.

To start or shut down a cluster database, that is, all of the instances known to Enterprise Manager:

1. Go to the Cluster Database Home page.
2. Click **Startup/Shutdown**. The Specify Credentials page appears.
3. Enter a valid User Name and Password for the cluster that hosts the cluster database, then click **Continue**. You must be a member of the OSDBA group.

Starting Up and Shutting Down with SQL*Plus

If you want to start or stop just one instance and you are connected to your local node, you should first ensure that your current environment includes the SID for the local instance. Note that any subsequent commands in your session, whether inside or outside a SQL*Plus session, will be associated with that same SID.

To start or shutdown your local instance, initiate a SQL*Plus session and connect with the SYSDBA or SYSOPER privilege and then issue the required command. For example to start and mount an instance on your local node, run the following commands within your SQL*Plus session:

```
CONNECT / AS SYSDBA
STARTUP MOUNT
```

You can start more than one instance from a single SQL*Plus session on one node by way of Oracle Net Services. To achieve this, you must connect to each instance in turn by using a Net Services connection string, typically an instance-specific alias from your `TNSNAMES.ORA` file.

> **Note:** To ensure that you connect to the correct instance, you must use an alias in the connect string that is associated with just one instance. If you use an alias to a service or with multiple addresses, you may not be connected to your intended instance.

For example, you can use a SQL*Plus session on a local node to perform a transactional shutdown for two instances on remote nodes by connecting to each in turn using the instance's individual alias name. Assume the alias name for the first instance is `db1` and that the alias for the second instance is `db2`. Connect to the first instance and shut it down as follows:

```
CONNECT /@db1 AS SYSDBA
SHUTDOWN TRANSACTIONAL
```

Then connect to and shutdown the second instance by entering the following from you SQL*Plus session:

```
CONNECT /@db2 AS SYSDBA
SHUTDOWN TRANSACTIONAL
```

Other startup and shut down keywords, such as NOMOUNT, MOUNT, IMMEDIATE, and so on, are described in the *SQL*Plus User's Guide and Reference*

It is not possible to start up or shut down more than one instance at a time in SQL*Plus, so you cannot start or stop all of the instances for a cluster database with a single SQL*Plus command. You may wish to create a script that will connect to each instance in turn and start it up and shut it down. However, you will need to maintain this script manually if you add or drop instances.

Intermittent Windows Shutdown Issue in Oracle RAC Environments

In an Oracle Real Application Clusters release 10.1.0.2 environment on Windows, a normal Windows shutdown may cause errors that prevent the Windows shutdown from completing. As a result, you may need to perform a power reset. The following steps are recommended to avoid this during Windows shutdowns. Before shutting down or restarting any Oracle cluster node, perform a graceful shutdown of all registered Oracle Clusterware resources on the affected cluster node. Do this by using SRVCTL commands to shutdown:

- All services on the node.
- All database instances on the node.
- All ASM instances on the node.
- All node applications on the node.

Lengthy Startup of OracleDBConsole and OracleCRService on Windows

After a cluster node restart, the node may not be fully responsive for some period of time. During this time, Oracle is attempting to restart the process OracleDBConsole*sid* and the OracleCRService resource. Eventually, all of the resource startup operations will complete and the computer will operate normally.

Starting Up and Shutting Down with SRVCTL

Enter the following SRVCTL syntax from the command line, providing the required database name and instance name, or include more than one instance name to start more than one specific instance:

```
srvctl start instance -d db_name -i "inst_name_list" [-o start_options] [-c
connect_str | -q]
```

Note that this command will also start all enabled and non-running services that have the listed instances either as preferred or available instances.

To stop one or more instances, enter the following SRVCTL syntax from the command line:

```
srvctl stop instance -d name -i "inst_name_list" [-o stop_options] [-c connect_str
| -q]
```

This command will also stop the services related to the terminated instances on the nodes where the instances were running. As an example, the following command provides its own connection information to shut down the two instances, orcl3 and orcl4, using the IMMEDIATE option:

```
srvctl stop instance -d orcl -i "orcl3,orcl4" -o immediate -c "sysback/oracle as
sysoper"
```

To start or stop your entire cluster database, that is, all of the instances and its enabled services, enter the following SRVCTL commands:

```
srvctl start database -d name [-o start_options] [-c connect_str | -q]

srvctl stop database -d name [-o stop_options] [-c connect_str | -q]
```

The following SRVCTL command, for example, mounts all of the non-running instances of an Oracle RAC database using the default connection information:

```
srvctl start database -d orcl -o mount
```

> **See Also:** Appendix E, "Server Control Utility Reference" for information about SRVCTL options and information about other administrative tasks that you can perform with SRVCTL

Customizing How Oracle Clusterware Manages Oracle RAC Databases

By default, Oracle Clusterware controls database restarts in Oracle RAC environments. In some cases, you may need to minimize the level of control that Oracle Clusterware has over your Oracle RAC database. You may need to do this, for example, during database migration or maintenance.

To prevent Oracle Clusterware from restarting your Oracle RAC database when you restart your system, or to avoid restarting failed instances more than once, configure a policy to define the degree of control. There are two policies, automatic, which is the default, and manual.

To use this feature, configure one of the pre-defined policies to define the degree of control. There are two policy types: automatic, which is the default, and manual. The manual policy, which minimizes the database instance protection level, is an override of the automatic policy.

This procedure enables you to configure your system so that either Oracle Clusterware automatically restarts your Oracle RAC database when you restart your system, or you manually restart your Oracle RAC database. You can also use this procedure to configure your system to prevent Oracle Clusterware from auto-restarting failed database instances more than once.

Switching Between the Automatic and Manual Policies

Use SRVCTL commands to display and change these Oracle Clusterware policies. For example, use the following command syntax to display the current policy where *database_name* is the name of the database for which you want to change policies:

```
srvctl config database -d database_name -a
```

Use the following SRVCTL command syntax to change the current policy to another policy where *policy_name* is the name of the new policy for the database that is identified by database_name:

```
srvctl modify database d database_name -y policy_name
```

This command syntax changes the resource profile values for each applicable resource and sets the Current Policy OCR key to the new value. When you add a new database using the srvctl command, you can use the -y option to specify the policy as in the following example where database_name is the name of the database and *policy_name* is the name of the policy:

```
srvctl add database -d database_name -y policy_name
```

This command syntax places the new database under the control of Oracle Clusterware. If you do not provide a new option, then Oracle uses the default value of automatic. After you change the policy, the OCR records the new value for the affected database.

> **See Also:** Chapter 14, "Making Applications Highly Available Using Oracle Clusterware" for more information about using Oracle Clusterware and Appendix E, "Server Control Utility Reference" for more information about SRVCTL commands

Overview of Initialization Parameter Files in 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. If you manually create your database, then Oracle recommends that you create an SPFILE from an initialization parameter file (PFILE).

All instances in the cluster database use the same SPFILE at startup. Because the SPFILE is a binary file, do not directly edit the SPFILE with an editor. Instead, change SPFILE parameter settings using Enterprise Manager or ALTER SYSTEM SQL statements.

Oracle RAC uses a traditional PFILE only if an SPFILE does not exist or if you specify PFILE in your STARTUP command. Oracle recommends that you use SPFILE file 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.

Setting Server Parameter File Parameter Values for Oracle Real Application Clusters

You can alter SPFILE settings with Enterprise Manager or by using the SET clause of the ALTER SYSTEM statement. The examples in this section appear in ASCII text although the SPFILE is a binary file. Assume that you start an instance with an SPFILE containing the following entries:

```
*.OPEN_CURSORS=500
```

```
prod1.OPEN_CURSORS=1000
```

> **Note:** The value before the dot in an SPFILE entry identifies the instance to which the particular parameter value belongs. When an asterisk precedes the dot, the value is applied to all instances that do not have a subsequent, individual value listed in the SPFILE.

For the instance with the Oracle system identifier (sid) `prod1`, the `OPEN_CURSORS` parameter is set to `1000` even though it has a database-wide setting of `500`. Parameter file entries that have the asterisk (*) wildcard character only affect the instances without an instance-specific entry. This gives you control over parameter settings for instance *prod1*. These two types of settings can appear in any order in the parameter file.

If another DBA runs the following statement, then Oracle updates the setting on all instances except the instance with sid *prod1*:

```
ALTER SYSTEM SET OPEN_CURSORS=1500 sid='*' SCOPE=MEMORY;
```

Then if you run the following statement on another instance, the instance with sid *prod1* also assumes the new setting of `2000`:

```
ALTER SYSTEM SET OPEN_CURSORS=2000 sid='*' SCOPE=MEMORY;
```

In the following example, the server parameter file contains these entries:

```
prod1.OPEN_CURSORS=1000
*.OPEN_CURSORS=500
```

Running the following statement makes Oracle disregard the first entry from the server parameter file:

```
ALTER SYSTEM RESET SCOPE=SPFILE;
```

To reset a parameter to its default value throughout your cluster database, enter the statement:

```
alter system reset open_cursors scope=spfile sid='prod1';
```

> **Note:** Modifying SPFILEs with anything except Enterprise Manager or SQL*Plus can corrupt the file and prevent database startup. To repair the file, you might need to create the PFILE and regenerate the SPFILE.

Parameter File Search Order in Oracle Real Application Clusters

Oracle searches for your parameter file in a particular order depending on your platform. On UNIX-based platforms, Oracle examines directories in the following order:

1. `$ORACLE_HOME/dbs/spfilesid.ora`
2. `$ORACLE_HOME/dbs/spfile.ora`
3. `$ORACLE_HOME/dbs/initsid.ora`

The search order on Windows-based platforms is:

1. %ORACLE_HOME%\database\spfilesid.ora
2. %ORACLE_HOME%\database\spfile.ora
3. %ORACLE_HOME%\database\initsid.ora

Initialization Parameter Use in Oracle Real Application Clusters

By default, Oracle 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 the *Oracle Database Reference.* Other parameters *must* either be unique or identical as described in the following sections.

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 must be identical on every instance:

- ACTIVE_INSTANCE_COUNT
- ARCHIVE_LAG_TARGET
- CLUSTER_DATABASE
- CLUSTER_DATABASE_INSTANCES
- CONTROL_FILES
- DB_BLOCK_SIZE
- DB_DOMAIN
- DB_FILES
- DB_NAME
- DB_RECOVERY_FILE_DEST
- DB_RECOVERY_FILE_DEST_SIZE
- DB_UNIQUE_NAME
- 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

If you use the THREAD or ROLLBACK_SEGMENTS parameters, then Oracle recommends setting unique values for them by using the sid identifier in the SPFILE. However, you must set a unique value for INSTANCE_NUMBER for each instance and you cannot use a default value.

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

Specify the ORACLE_SID environment variable, which comprises the database name and the number of the THREAD assigned to the instance. When you specify UNDO_

TABLESPACE with automatic undo management enabled, then set this parameter to a unique undo tablespace name 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 Streams with your Oracle RAC database, the value should be greater than zero.

- LICENSE_MAX_USERS

  This parameter determines a database-wide limit on the number of users 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 cause additional warning messages to be generated during instance startup or cause commands related to database user management to fail on some instances.

- LOG_ARCHIVE_FORMAT

  If you do not use the same value for all your instances, then you unnecessarily 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 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 behave differently and unpredictably in fail over, load-balancing, as well as normal operations. Additionally, a change you make to the SPFILE with 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 SPFILEs.

  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.

- TRACE_ENABLED

  If you want diagnostic trace information to be always available for your Oracle RAC database, you must set TRACE_ENABLED to TRUE on all of your database instances. If you trace on only some of your instances, then diagnostic information might not be available when required should the only accessible instances be those with TRACE_ENABLED set to FALSE.

- UNDO_RETENTION

  By setting different values for UNDO_RETENTION in each instance, you are likely to reduce scalability and encounter unpredictable behavior following a fail over. Therefore, you should carefully consider whether you will accrue any benefits

before you assign different values for this parameter to the instances in your Oracle RAC database.

Summary of Parameter Use in Oracle Real Application Clusters Databases

This section summarizes considerations for using parameters in Oracle RAC databases.

- CLUSTER_DATABASE

  Enables a database to be started in cluster mode. Set this parameter to TRUE.

- CLUSTER_DATABASE_INSTANCES

  Sets the number of instances in your Oracle RAC environment. A proper setting for this parameter can improve memory use. Set the CLUSTER_DATABASE_INSTANCES parameter to the *same* value on all instances. Otherwise, instance startup can fail. Normally, set this parameter to be equal to the number of instances in your Oracle RAC database. Alternatively, you can set this parameter to a value that is *greater than* the current number of instances if you are planning to add instances.

  Note: The value for this parameter determines the maximum number of instances that you can have in your Oracle RAC database environment. If you add instances, then you may need to reset the value for this parameter to accommodate the increased number of instances.

- CLUSTER_INTERCONNECTS

  Specifies the cluster interconnect when there is more than one interconnect. Refer to your Oracle platform-specific documentation for the use, syntax, and behavior of this parameter.

  You typically do not need to set the CLUSTER_INTERCONNECTS parameter. For example, do not set this parameter for the following common configurations:

  - If you have only one cluster interconnect.
  - If the default cluster interconnect meets the bandwidth requirements of your Oracle RAC database, which is typically the case.
  - If your database is running on a Sun Solaris cluster. If you do set the parameter, its value must be the same on all instances.

  Oracle uses information from CLUSTER_INTERCONNECTS to distribute interconnect traffic among the various network interfaces if you specify more than one interconnect with this parameter. Note that the specified configuration inherits any limitations of the listed interconnects and the associated operating system IPC services, such as availability. Consider setting CLUSTER_INTERCONNECTS when a single cluster interconnect cannot meet your bandwidth requirements. You may need to set this parameter in data warehouse environments with high interconnect bandwidth demands from one or more databases as described here.

  For example, if you have two databases with high interconnect bandwidth requirements, then you can override the default interconnect provided by your operating system and nominate a different interconnect for each database using

the following syntax in each server parameter file where ip*n* is an IP address in standard dot-decimal format, for example: `144.25.16.214`:

```
Database One: CLUSTER_INTERCONNECTS = ip1
Database Two: CLUSTER_INTERCONNECTS = ip2
```

If you have one database with high bandwidth demands, then you can nominate multiple interconnects using the following syntax:

```
CLUSTER_INTERCONNECTS = ip1:ip2:...:ipn
```

If you set multiple values for `CLUSTER_INTERCONNECTS` as in the preceding example, then Oracle uses all of the interconnects that you specify. This provides load balancing as long as all of the listed interconnects remain operational. You must use identical values, including the order in which the interconnects are listed, on all instances of your database when defining multiple interconnects with this parameter.

If an operating system error occurs while Oracle is writing to the interconnect that you specify with `CLUSTER_INTERCONNECTS`, then Oracle returns an error even if some other interfaces are available. This is because the communication protocols between Oracle and the interconnect can vary greatly depending on your platform. Refer to your Oracle platform-specific documentation for more information.

Note: Setting this parameter does not provide interconnect failover. Because interconnect failover is operating-system dependent, refer to your operating system documentation for information about configuring interconnect failover.

- `DB_NAME`

  If you set a value for `DB_NAME` in instance-specific parameter files, the setting must be identical for all instances.

- `DISPATCHERS`

  Set the `DISPATCHERS` parameter to enable a shared server configuration, that is a server that is configured to enable many user processes to share very few server processes. With shared server configurations, many user processes connect to a dispatcher. The `DISPATCHERS` parameter may contain many attributes.

  Oracle recommends that you configure at least the `PROTOCOL` and `LISTENER` attributes. `PROTOCOL` specifies the network protocol for which the dispatcher process generates a listening end point. `LISTENER` specifies an alias name for the Oracle Net Services Listeners. Set the alias to a name that is resolved through a naming method such as a `tnsnames.ora` file. The `tnsnames.ora` file contains net service names. Clients, nodes, and the Oracle Performance Manager node need this file. Enterprise manager does not require `tnsnames.ora` entries on the client for Database Control or Grid Control. Refer to *Oracle Database Net Services Administrator's Guide* for complete information about configuring the `DISPATCHERS` parameter and its attributes and for configuring the shared server.

- `INSTANCE_NAME`

  This parameter is normally set to a different value for each instance to provide a simple method for clients to connect directly to a specific instance. However, you may use the same value for multiple instances. The value of the `INSTANCE_NAME` parameter is usually the same as the value of the SID for the instance, to which it

defaults, and this association of the two names may help reduce confusion when managing complex systems.

- PROCESSES

  PROCESSES specifies the maximum number of operating system user processes that can simultaneously connect to Oracle. Its value should allow for all background processes such as locks, job queue processes, and parallel execution processes. The default values of the SESSIONS and TRANSACTIONS parameters are derived from this parameter. Therefore, if you change the value of PROCESSES, you should evaluate whether to adjust the values of those derived parameters.

- SERVICE_NAMES

  When you use an SPFILE, all Oracle RAC database instances must use the SPFILE and the file must be on shared storage. Entries in the SERVICE_NAMES parameter may be used by client connections rather than the INSTANCE_NAME parameter value. The SERVICE_NAMES parameter may include one or more names and different instances may share one or more names with other instances. This enables a client to connect to either a specific instance or to any one of a set of instances, depending on the service name chosen in the connection string.

  Note: If you use services as described in Chapter 6, "Introduction to Workload Management", then do not set values for the SERVICE_NAMES parameter. The tools that create and manage services for workload management automatically set values this parameter.

- SESSIONS_PER_USER

  Each instance maintains its own SESSIONS_PER_USER count. If SESSIONS_PER_USER is set to 1 for a user, the user can log on to the database more than once as long as each connection is from a different instance.

- SPFILE

  When you use an SPFILE, all Oracle RAC database instances must use the SPFILE and the file must be on shared storage.

- THREAD

  If specified, this parameter must have unique values on all instances. The THREAD parameter specifies the number of the redo thread to be used by an instance. You can specify any available redo thread number as long as that thread number is enabled and is not used.

- TRANSACTIONS

  TRANSACTIONS specifies the maximum number of concurrent transactions. Greater values increase the size of the SGA and can increase the number of rollback segments allocated. The default value is greater than SESSIONS (and, in turn, PROCESSES) to allow for recursive transactions.

Backing Up the Server Parameter File

Oracle recommends that you regularly back up the server parameter file for recovery purposes. Do this using the CREATE PFILE statement. For example:

```
CREATE PFILE='?/dbs/initdbname.ora'
FROM SPFILE='/dev/vx/rdsk/oracle_dg/dbspfile'
```

You can use RMAN (Recovery Manager) to create backups of the server parameter file. You can also recover an SPFILE by starting an instance using a client-side initialization parameter file. Then re-create the server parameter file using the `CREATE SPFILE` statement. Note that if the parameter file that you use for this operation was for a single instance, then the parameter file will not contain instance-specific values, even those that must be unique in Oracle RAC instances. Therefore, ensure that your parameter file contains the appropriate settings as described earlier in this chapter.

To ensure that your SPFILE (and control files) are automatically backed up by RMAN during typical backup operations, use Enterprise Manager or the RMAN `CONTROLFILE AUTOBACKUP` statement to enable the RMAN autobackup feature

See Also:

- *Oracle Database Backup and Recovery Basics* for more information about RMAN
- *Oracle Database SQL Reference* for more information about the `CREATE SPFILE` statement

6

Introduction to Workload Management

This chapter describes how to manage workloads in Oracle Real Application Clusters (Oracle RAC) to provide high availability and scalability for your applications. This chapter contains the following topics:

Introduction to Workload Management and Application High Availability

Workload management enables you to manage workload distributions to provide optimal performance for users and applications. Workload management comprises the following:

- **Services**: Oracle Database 10*g* introduces a powerful automatic workload management facility, called services, to enable the enterprise grid vision. Services are entities that you can define in Oracle RAC databases that enable you to group database workloads and route work to the optimal instances that are assigned to offer the service.
- **Connection Load Balancing**: A feature of Oracle Net Services that balances incoming connections across all of the instances that provide the requested database service.
- **High Availability Framework**: An Oracle RAC component that enables the Oracle Database to maintain components in a running state at all times.
- **Fast Application Notification (FAN)**: The notification mechanism that Oracle RAC uses to quickly alert applications about configuration and workload service level changes.

- **Load Balancing Advisory**: Provides information to applications about the current service levels that the database and its instances are providing. The load balancing advisory makes recommendations to applications about where to direct application requests to obtain the best service based on the policy that you have defined for that service.
- **Fast Connection Failover**: This is the ability of Oracle Clients to provide rapid failover of connections by subscribing to FAN events.
- **Runtime Connection Load Balancing**: This is the ability of Oracle Clients to provide intelligent allocations of connections in the connection pool based on the current service level provided by the database instances when applications request a connection to complete some work.

When a user or application connects to a database, Oracle recommends that you specify a service in the connect data portion of the connect string. Oracle Database automatically creates one database service when the database is created. For many installations, this may be all you need. To enable more flexibility in the management of the workload using the database, Oracle Database 10*g* enables you to create multiple services and specify which instances offer the services. Continue reading this chapter to understand the added features that you can use with services if you are interested in greater workload management flexibility.

Note: The features discussed in this chapter do not work with the default database service. You must create cluster managed services to take advantage of these features. You can only manage services that you create. Any service created by the database server will be managed by the database server.

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 several considerations that this chapter describes. The following section describes the various service deployment options.

Service Deployment Options

This section describes the following service deployment topics:

- Using Oracle Services
- Default Service Connections
- Connection Load Balancing

Using Oracle Services

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 group work by type under services. For example, online users can be a service while batch processing can be another and reporting can be yet another service type.

Oracle recommends that all users who share a service have the same service level requirements. You can define specific characteristics for services and each service can be a separate unit of work. There are many options that you can take advantage of

when using services. Although you do not have to implement these options, using them helps optimize application performance.

When you define a service, you define which instances normally support that service. These are known as the PREFERRED instances. You can also define other instances to support a service if the service's preferred instance fails. These are known as AVAILABLE instances.

When you specify PREFERRED instances, you are specifying the number of instances on which a service will normally run. The Oracle Clusterware attempts to ensure that the service always runs on the number of nodes for which you have configured the service. Afterwards, due to either instance failure or planned service relocations, a service may be running on an AVAILABLE instance. When a service moves to an available instance, Oracle does not move the service back to the PREFERRED instance when the PREFERRED instance restarts because:

- The service is already running on the desired number of instances
- Maintaining the service on the current instance provides a higher level of service availability
- Not moving the service back to the initial PREFERRED instance prevents a second outage

You can, however, easily automate fail back by using FAN callouts.

Resource profiles are automatically created when you define a service. A resource profile describes how Oracle Clusterware should manage the service and which instance the service should failover to if the preferred instance stops. Resource profiles also define service dependencies for the instance and the database. Due to these dependencies, if you stop a database, then the instances and services are automatically stopped in the correct order.

Services are integrated with Resource Manager which enables you to restrict the resources that are used by a service within an instance. The Resource Manager enables you to map a consumer group to a service so that users who connect with the service are members of the specified consumer group. Also, the Automatic Workload Repository (AWR) enables you to monitor performance by service.

Oracle Net Services provides connection load balancing to enable you to spread user connections across all of the instances that are supporting a service. 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, CLB_GOAL. You can also specify a single TAF policy for all users of a service by defining the FAILOVER_METHOD, FAILOVER_TYPE, and so on. Oracle RAC uses FAN to notify applications about configuration changes and the current service level that is provided by each instance where the service is enabled.

FAN has two methods for publishing events to clients, the Oracle Notification Service (ONS), which is used by Java Database Connectivity (JDBC) clients including the Oracle Application Server 10*g*, and Oracle Streams, Advanced Queueing which is used by Oracle Call Interface (OCI) and Oracle Data Provider for .NET (ODP.NET) clients. When using Advanced Queueing, you must enable the service to use the queue by setting AQ_HA_NOTIFICATIONS to true.

With Runtime Connection Load Balancing, applications can use load balancing advisory events to provide better service to users. The Oracle JDBC and ODP.NET clients are automatically integrated to take advantage of load balancing advisory events. The load balancing advisory informs the client about the current service level that an instance is providing for a service. The load balancing advisory also recommends how much of the workload should be sent to that instance. In addition,

Oracle Net Services provides connection load balancing to enable you to spread user connections across all of the instances that support a service. To enable the load balancing advisory, set the GOAL parameter on the service.

Distributed transaction processing applications have unique requirements. To make it easier to use Oracle RAC with global transactions, set the distributed transaction processing parameter on the service so that all tightly coupled branches of a distributed transaction processing transaction are run on the same instance.

> **See Also:** "Services and Distributed Transaction Processing in Oracle RAC" on page 6-16 for more information about distributed transaction processing in Oracle RAC

Default Service Connections

As mentioned earlier, DBCA creates a default service for your Oracle RAC database and this service is a special Oracle database service. This default service is always available on all instances in an Oracle RAC environment, unless an instance is in restricted mode. You cannot alter this service or its properties. The database also supports the following two internal services:

- `SYS$BACKGROUND` is used by the background processes only
- `SYS$USERS` is the default service for user sessions that are not associated with any application service

Both of these internal services support all of the workload management features. You cannot stop or disable either of these internal services.

Connection Load Balancing

Oracle Net Services provides the ability to balance client connections across the instances in an Oracle RAC configuration. There are two types of load balancing that you can implement: client-side and server-side load balancing. Client-side load balancing balances the connection requests across the Listeners. With server-side load balancing, the Listener directs a connection request to the best instance currently providing the service by using the load balancing advisory. In an Oracle RAC database, client connections should use both types of connection load balancing.

FAN, FCF, and the load balancing advisory depend on an accurate connection load balancing configuration that includes setting the connection load balancing goal for the service. You can use a goal of either *long* or *short* for connection load balancing. These goals have the following characteristics:

- **Long**: Use the `LONG` connection load balancing method for applications that have long-lived connections. This is typical for connection pools and SQL*Forms sessions. Long is the default connection load balancing goal. The following is an example of modifying a service, `POSTMAN`, with the PL/SQL `DBMS_SERVICE` package and the `CLB_GOAL_LONG` package constant to define the connection load balancing goal for long-lived sessions:

```
EXECUTE DBMS_SERVICE.MODIFY_SERVICE (service_name => 'POSTMAN'
        , clb_goal => DBMS_SERVICE.CLB_GOAL_LONG);
```

- **Short**: Use the `SHORT` connection load balancing method for applications that have short-lived connections. The following example modifies the service known as `ORDER`, using the `DBMS_SERVICE.CLB_GOAL_SHORT` package constant to set the goal to short:

```
EXECUTE DBMS_SERVICE.MODIFY_SERVICE (service_name => 'ORDER'
```

```
, CLB_GOAL => DBMS_SERVICE.CLB_GOAL_SHORT);
```

When you create an Oracle RAC database with the Database Configuration Assistant (DBCA), DBCA configures and enables server-side load balancing by default. The DBCA also creates a sample client-side load balancing connection definition in the `tnsnames.ora` file on the server. Any services created through DBCA have the default setting of `CLB_GOAL=CLB_GOAL_LONG`.

When Oracle Net Services establishes a connection to an instance, the connection remains open until the client closes the connection, the instance is shutdown, or a failure occurs. If you configure transparent application failover (TAF) for the connection, then Oracle 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 rollback the failed transaction and resubmit the transaction. You must re-execute any session customizations, in other words, `ALTER SESSION` statements, after failover has occurred. However, with TAF, a connection is not moved during normal processing, even if the workload changes over time.

Services simplify the deployment of TAF. You can define a TAF policy for a service and all connections using this service will automatically have TAF enabled. This does not require any client-side changes. The TAF setting on a service overrides any TAF setting in the client connection definition. To define a TAF policy for a service, use the `DBMS_SERVICE` PL/SQL procedure as in the following example:

```
EXECUTE DBMS_SERVICE.MODIFY_SERVICE (service_name => 'gl.us.oracle.com'
, aq_ha_notifications => TRUE
, failover_method => DBMS_SERVICE.FAILOVER_METHOD_BASIC
, failover_type => DBMS_SERVICE.FAILOVER_TYPE_SELECT
, failover_retries => 180
, failover_delay => 5
, clb_goal => DBMS_SERVICE.CLB_GOAL_LONG);
```

Client-side load balancing is defined in your client connection definition by setting the parameter `LOAD_BALANCE=ON` (the default is `ON` for description lists). When you set this parameter to `ON`, Oracle randomly selects an address in the address list, and connects to that node's Listener. This balances client connections across the available Listeners in the cluster. When the Listener receives the connection request, the Listener connects the user to an instance that the Listener knows provides the requested service. To see what services a Listener supports, run the `lsnrctl services` command.

> **See Also:** *Oracle Database Net Services Administrator's Guide* for detailed information about both types of load balancing

Fast Application Notification

This section provides a detailed description of FAN under the following topics:

- Overview of Fast Application Notification
- Application High Availability with Services and FAN
- Managing Unplanned Outages
- Managing Planned Outages
- Fast Application Notification High Availability Events

- Using Fast Application Notification Callouts

See Also: "Oracle Clients that Are Integrated with Fast Application Notification" on page 6-11 for more information about specific client environments that you can use with FAN

Overview of Fast Application Notification

FAN is a notification mechanism that Oracle RAC uses to notify other processes about configuration and service level information such as includes service status changes, such as UP or DOWN events. Applications can respond to FAN events and take immediate action. FAN `UP` and `DOWN` events can apply to instances, services, and nodes.

For cluster configuration changes, the Oracle RAC high availability framework publishes a FAN event immediately when a state change occurs in the cluster. Instead of waiting for the application to poll the database and detect a problem, applications can receive FAN events and react immediately.

FAN also publishes load balancing advisory events. Applications can take advantage of the load balancing advisory FAN events to direct work requests to the instance in the cluster that is currently providing the best service quality. You can take advantage of FAN events in the following three ways:

1. Your application can use FAN without programmatic changes if you use an integrated Oracle client. The integrated clients for FAN events include Oracle Database 10*g* JDBC (Oracle Database 10*g* Release 2 is required for load balancing), Oracle Database 10*g* Release 2 ODP.NET, and Oracle Database 10*g* Release 2 OCI. This includes applications that use TAF.
2. Applications can use FAN programmatically by using the ONS Application Programming Interface (API) to subscribe to FAN events and to execute event handling actions upon the receipt of an event.
3. You can implement FAN with server-side callouts on your database tier.

For `DOWN` events, the disruption to the application can be minimized because sessions 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 available instances only. 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. Through server-side callouts, you can also use FAN to:

- Log status information
- Page DBAs or to open support tickets when resources fail to start
- Automatically start dependent external applications that need to be co-located with a service
- Change resource plans or to shut down services when the number of available instances decreases, for example, if nodes fail
- Automate the fail back of a service to `PREFERRED` instances if needed

FAN events are published using ONS and an Oracle Streams Advanced Queuing. The publication mechanisms are automatically configured as part of your Oracle RAC installation.

The Connection Manager (CMAN) and Oracle Net Services Listeners are integrated with FAN events. This enables the Listener and CMAN to immediately de-register

services provided by the failed instance and to avoid erroneously sending connection requests to failed instances.

If you use the service goal `CLB_GOAL_SHORT`, then the Listener uses the load balancing advisory when the Listener balances the connection loads. When load balancing advisory is enabled, the metrics used for the Listener are finer grained.

Application High Availability with Services and FAN

Oracle focuses on maintaining service availability. In Oracle RAC, Oracle services are designed to be continuously available with loads shared across one or more instances. The Oracle RAC high availability framework maintains service availability by using Oracle Clusterware and resource profiles.

The Oracle RAC high availability framework monitors the database and its services and sends event notifications using FAN. The Oracle Clusterware recovers and balances services according to business rules.

Managing Unplanned Outages

You can assign services in Oracle RAC to one or more instances. If Oracle RAC detects an outage, then Oracle Clusterware isolates the failed component and recovers the dependent components. For services, if the failed component is an instance, then Oracle Clusterware relocates the service to an available instance in the cluster. FAN events can occur at various levels within the Oracle Server architecture and the response can include notifying external entities by way of ONS, Advanced Queuing, or you can program notification using FAN callouts.

> **Note:** Oracle does not run Oracle RAC callouts with guaranteed ordering. Callouts are run asynchronously and they are subject to scheduling variabilities.

Notification occurs from a surviving node when the failed node is out of service. The location and number of instances in an Oracle RAC environment that provide a service are transparent to applications. Restart and recovery are automatic, including the restarting of the subsystems, such as the Listener and the Automatic Storage Management (ASM) processes, not just the database. You can use FAN callouts to report faults to your fault management system and to initiate repair jobs.

Managing Planned Outages

For repairs, upgrades, and changes that require you to isolate one or more instances, Oracle RAC provides interfaces that relocate, disable, and enable services to minimize service disruption to application users. Once you complete the operation, you can return the service to normal operation.

Due to dependencies, if you manually shutdown your database, then all of your services automatically stop. If you then manually restart the database, then you must also restart the database's services. Use FAN callouts to automate starting the services when the database starts.

Fast Application Notification High Availability Events

Table 6–1 describes the FAN event record parameters and the event types, followed by name-value pairs for the event properties. The event type is always the first entry and the timestamp is always the last entry as in the following example:

```
FAN event type: service_member
Properties: version=1.0 service=ERP database=FINPROD instance=FINPROD3 host=node3
status=up
```

Table 6–1 Event Record Parameters and Descriptions

Parameter	Description
VERSION	Version of the event record. Used to identify release changes.
EVENT TYPE	SERVICE, SERVICE_MEMBER, DATABASE, INSTANCE, NODE, ASM, SRV_PRECONNECT. Note that Database and Instance types provide the database service, such as DB_UNIQUE_NAME.DB_DOMAIN.
DATABASE UNIQUE NAME	The unique database supporting the service; matches the initialization parameter value for DB_UNIQUE_NAME, which defaults to the value of the initialization parameter DB_NAME.
INSTANCE	The name of the instance that supports the service; matches the ORACLE_SID value.
NODE NAME	The name of the node that supports the service or the node that has stopped; matches the node name known to Cluster Synchronization Services (CSS).
SERVICE	The service name; matches the service in DBA_SERVICES.
STATUS	Values are UP, DOWN, NOT_RESTARTING, PRECONN_UP, PRECONN_DOWN, and UNKNOWN.
REASON	Failure, Dependency, User, Autostart, Restart.
CARDINALITY	The number of service members that are currently active; included in all UP events.
INCARNATION	For node DOWN events; the new cluster incarnation.
TIMESTAMP	The local time zone to use when ordering notification events.

A FAN record matches the database signature of each session as shown in Table 6–2. The signature information is also available using OCI_ATTRIBUTES. These attributes are available in the OCI Connection Handle. Use this information to take actions on sessions that match the FAN event data.

Table 6–2 FAN Parameters and Matching Database Signatures

FAN Parameter	Matching Oracle Database Signature
SERVICE	sys_context('userenv', 'service_name')
DATABASE UNIQUE NAME	sys_context('userenv', 'db_unique_name')
INSTANCE	sys_context('userenv', 'instance_name')
CLUSTER NODE NAME	sys_context('userenv', 'server_host')

Using Fast Application Notification Callouts

FAN callouts are server-side executables that Oracle RAC executes immediately when high availability events occur. You can use FAN callouts to automate the following activities when events occur in a cluster configuration, such as:

- Opening fault tracking tickets
- Sending messages to pagers
- Sending e-mail
- Starting and stopping server-side applications
- Maintaining an uptime log by logging each event as it occurs

- Relocating low-priority services when high priority services come online

To use FAN callouts, place an executable in the directory *CRS_home*/racg/usrco on every node that runs Oracle Clusterware. If you are using scripts, then set the shell as the first line of the executable. The following is an example file for the *CRS_home*/racg/usrco/callout.sh callout:

```
#! /bin/ksh
FAN_LOGFILE= [your path name]/admin/log/`hostname`_uptime.log
echo $* "reported="`date` >> $FAN_LOGFILE &
```

The following output is from the previous example:

```
NODE VERSION=1.0 host=sun880-2 incarn=23 status=nodedown reason=
timestamp=08-Oct-2004 04:02:14 reported=Fri Oct 8 04:02:14 PDT 2004
```

> **See Also:** Table 6–1 for information about the callout and event details

A FAN record matches the database signature of each session, as shown in Table 6–2. The signature information is also available using OCI_ATTRIBUTES. These attributes are available in the OCI Connection Handle. Use this information to take actions on sessions that match the FAN event data.

Load Balancing Advisory

This section describes the load balancing advisory under the following topics:

- Overview of the Load Balancing Advisory
- Configuring Your Environment to Use the Load Balancing Advisory
- Load Balancing Advisory FAN Events

Overview of the Load Balancing Advisory

Load balancing distributes work across all of the available Oracle RAC database instances. Oracle recommends that applications use persistent connections that span the instances that offer a particular service. Connections are created infrequently and exist for a long duration. Work comes into the system with high frequency, borrows these connections, and exists for a relatively short duration. The load balancing advisory provides advice about how to direct incoming work to the instances that provide the optimal quality of service for that work. This minimizes the need to relocate the work later.

By using the THROUGHPUT or SERVICE_TIME goals, feedback is built in to the system. Work is routed to provide the best service times globally, and routing responds gracefully to changing system conditions. In a steady state, the system approaches equilibrium with improved throughput across all of the Oracle RAC instances.

Standard architectures that can use the load balancing advisory include connection load balancing, transaction processing monitors, application servers, connection concentrators, hardware and software load balancers, job schedulers, batch schedulers, and message queuing systems. All of these applications can allocate work.

The load balancing advisory is deployed with key Oracle clients, such as a Listener, the JDBC Implicit Connection Cache 10*g*, and the ODP.NET Connection Pool. The load balancing advisory is also open for third party subscription by way of ONS.

Configuring Your Environment to Use the Load Balancing Advisory

You can configure your environment to use the load balancing advisory by defining service-level goals for each service for which you want to enable load balancing. This enables the load balancing advisory for that service and FAN load balancing events are published. There are two types of service-level goals for runtime:

- SERVICE TIME: Attempts to direct work requests to instances according to response time. Load balancing advisory data is based on elapsed time for work done in the service plus available bandwidth to the service. An example for the use of SERVICE TIME is for workloads such as internet shopping where the rate of demand changes:

```
EXECUTE DBMS_SERVICE.MODIFY_SERVICE (service_name => 'OE'
, goal => DBMS_SERVICE.GOAL_SERVICE_TIME -
, clb_goal => DBMS_SERVICE.CLB_GOAL_SHORT);
```

- THROUGHPUT: Attempts to direct work requests according to throughput. The load balancing advisory is based on the rate that work is completed in the service plus available bandwidth to the service. An example for the use of THROUGHPUT is for workloads such as batch processes, where the next job starts when the last job completes:

```
EXECUTE DBMS_SERVICE.MODIFY_SERVICE (service_name => 'sjob' -
        , goal => DBMS_SERVICE.GOAL_SERVICE_TIME -
       , clb_goal => DBMS_SERVICE.CLB_GOAL_LONG);
```

Setting the goal to NONE disables load balancing for the service. You can see the goal settings for a service in the data dictionary and in the DBA_SERVICES, V$SERVICES, and V$ACTIVE_SERVICES views.

> **See Also:** "Administering Services" on page 6-18 for more information about administering services and adding goals to services

Load Balancing Advisory FAN Events

The load balancing advisory FAN events provide metrics for load balancing algorithms. The easiest way to take advantage of these events is to use the Runtime Connection Load Balancing feature of an Oracle integrated client such as JDBC, ODP.NET, or OCI. Client applications can subscribe to these events directly by way of the ONS API. Table 6–3 describes the load balancing advisory FAN event parameters.

Table 6–3 Load Balancing Advisory FAN Events

Parameter	Description
VERSION	Version of the event record. Used to identify release changes.
EVENT TYPE	SERVICE, SERVICE_MEMBER, DATABASE, INSTANCE, NODE, ASM, SRV_PRECONNECT. Note that Database and Instance types provide the database service, such as DB_UNIQUE_NAME.DB_DOMAIN.
SERVICE	The service name; matches the service in DBA_SERVICES.
DATABASE UNIQUE NAME	The unique database supporting the service; matches the initialization parameter value for DB_UNIQUE_NAME, which defaults to the value of the initialization parameter DB_NAME.
INSTANCE	The name of the instance that supports the service; matches the ORACLE_SID value.
PERCENT	The percentage of work requests to send to this database instance.
FLAG	Indication of the service quality relative to the service goal. Valid values are GOOD, VIOLATING, NO DATA, and BLOCKED.

Table 6–3 (Cont.) Load Balancing Advisory FAN Events

Parameter	Description
TIMESTAMP	The local time zone to use when ordering notification events.

Use the following example to monitor load balancing advisory events:

```
SET PAGES 60 COLSEP '|' LINES 132 NUM 8 VERIFY OFF FEEDBACK OFF
COLUMN user_data HEADING "AQ Service Metrics" FORMAT A60 WRAP
BREAK ON service_name SKIP 1
SELECT
 TO_CHAR(enq_time, 'HH:MI:SS') Enq_time
 , user_data
FROM sys.sys$service_metrics_tab
ORDER BY 1 ;
```

Oracle Clients that Are Integrated with Fast Application Notification

Oracle has integrated FAN with many of the common client application environments that are used to connect to Oracle RAC databases. Therefore, the easiest way to use FAN is to use an integrated Oracle Client.

You can use the OCI Session Pools, CMAN session pools, and JDBC and ODP.NET connection pools. OCI applications with TAF enabled should use FAN high availability events for fast failover. The overall goal is to enable applications to consistently obtain connections to available instances that provide the best service. Due to the integration with 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.

When instances start, Oracle RAC uses FAN to notify the 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. The use of connection pools and FAN requires that you have properly configured database connection load balancing across all of the instances that provide the service(s) that the connection pool is using. Oracle recommends that you configure both client-side and server-side load balancing with Oracle Net Services, which is the default when you use DBCA to create your database. Oracle connection pools that are integrated with FAN can:

- Balance connections across all of the Oracle RAC instances when a service starts; this is preferable to directing the sessions that are defined for the connection pool to the first Oracle RAC instance that supports the service
- Remove terminated connections immediately when a service is declared `DOWN` at an instance, and immediately when nodes are declared `DOWN`
- Report errors to clients immediately when Oracle detects the `NOT RESTARTING` state, instead of making the client wait while the service repeatedly attempts to restart
- Balance work requests at run time using load balancing advisory events

The next sections describe how to enable FAN events for the several specific client development environments:

- Enabling Java Database Connectivity Clients to Receive FAN Events
- Enabling Oracle Call Interface Clients to Receive FAN High Availability Events

Enabling Java Database Connectivity Clients to Receive FAN Events

Enabling FAN for the Oracle JDBC Implicit Connection Cache enables FAN high availability events in Oracle Database 10*g* release 1, and the load balancing advisory in Oracle Database 10*g* release 2. Your application can use the JDBC development environment for either thick or thin JDBC clients to use FAN. You must use the JDBC Implicit Connection Cache to enable the FAN features of Fast Connection Failover and Runtime Connection Load Balancing.

To configure the JDBC client, set the `FastConnectionFailoverEnabled` property before making the first `getConnection()` request to a data source. When you enable FCF, the failover applies to every connection in the connection cache. If your application explicitly creates a connection cache using the Connection Cache Manager, then you must first set `FastConnectionFailoverEnabled`.

> **See Also:** The *Oracle Database JDBC Developer's Guide and Reference* for information about configuring the JDBC implicit connection cache and ONS

Using FAN with Thick JDBC and Thin JDBC Clients

This procedure explains how to enable FAN events for JDBC. For thick JDBC clients, if you enable FCF, do not enable TAF, either on the client or for the service. The FAN events that you enable can be both high availability events and load balancing advisory events. When using thin or thick JDBC clients, you can use FAN by configuring the JDBC implicit connection cache as described in the following procedure:

1. On a cache enabled DataSource, set the DataSource property `FastConnectionFailoverEnabled` to `true` as in the following example to enable FAN for Oracle implicit JDBC connect cache:

```
OracleDataSource ods = new OracleDataSource()
ods.setUser("Scott");
...
ods.setPassword("tiger");
ods.setConnectionCachingEnabled(True);
ods.setFastConnectionFailoverEnabled(True);
ods.setConnectionCacheName("MyCache");
ods.setConnectionCacheProperties(cp);
ods.setURL("jdbc:oracle:thin:@(DESCRIPTION=
   (LOAD_BALANCE=on)
   (ADDRESS=(PROTOCOL=TCP)(HOST=VIP1)(PORT=1521))
   (ADDRESS=(PROTOCOL=TCP)(HOST=VIP2)(PORT=1521))
   (CONNECT_DATA=(service_name=service_name)))");
```

> **Note:** Use the following system property to enable FAN without making data source changes: `-D oracle.jdbc.FastConnectionFailover=true`.

2. Ensure that you have configured ONS on each node that is running Oracle Clusterware as in the following example using the *CRS_home*`/opmn/conf/ons.config` file.

Note: This should have been automatically completed during the Oracle RAC installation.

```
localport=6100 # This is the port ONS is writing to on this node
remoteport=6200 # This is the port ONS is listening on this node
loglevel=3
useocr=on
```

The information in the Oracle Cluster Registry (OCR) for ONS daemons is automatically configured by DBCA. If you are upgrading from a previous version of the database, then manually configure the OCR as follows. To add the middle tier nodes or to update the Oracle RAC nodes, use `racgons` from the Oracle Clusterware `bin` directory:

- To add the ONS daemon configuration:

  ```
  racgons add_config hostname:port [hostname:port] ...
  ```

- To remove the ONS daemon configuration:

  ```
  racgons remove_config hostname[:port] [hostname:port]..
  ```

3. Configure remote ONS subscription. Remote ONS subscription offers the following advantages:

   - Support for an All Java mid-tier software
   - An ONS daemon is not needed on the client machine; you do not need to manage this process
   - Simple configuration by way of a `DataSource` property

   When using remote ONS subscription for FCF, an application uses `setONSConfiguration`, using the string `remoteONSConfig`, on an Oracle DataSource instance as in the following example:

   ```
   ods.setONSConfiguration("nodes=racnode1:4200,racnode2:4200");
   ```

4. When you start the application, make sure that the `ons.jar` file is located on the application `CLASSPATH`. The `ons.jar` file is part of the Oracle client installation.

See Also: *Oracle Database JDBC Developer's Guide and Reference* for more information about JDBC

Enabling Oracle Call Interface Clients to Receive FAN High Availability Events

Oracle Call Interface (OCI) clients can register to receive notifications about Oracle RAC high availability events and respond when events occur. This improves the session failover response time in OCI and also removes terminated connections from connection and session pools. This feature works on OCI applications that use TAF, connection pools, or session pools.

First, you must enable a service for high availability events. If your application is using TAF, then enable the TAF settings for the service. Then configure client applications to enable them to connect to an Oracle RAC instance to enable event notification. Clients can register callbacks that are used whenever an event occurs. This reduces the time that it takes to detect a connection failure. During `DOWN` event processing, OCI:

- Terminates affected connections at the client

- Removes connections from the OCI connection pool and the OCI session pool—the session pool maps each session to a physical connection in the connection pool, and there can be multiple sessions for each connection
- Fails over the connection if you have configured TAF

If TAF is not configured, then the client only receives an error.

Note: OCI does not manage `UP` events.

Perform the following steps to configure Advanced Queueing notifications to an OCI client:

1. Ensure that the service that you are using has Advanced Queuing notifications enabled by setting the services' values of `AQ_HA_NOTIFICATIONS` to `TRUE`. For example:

```
EXECUTE DBMS_SERVICE.MODIFY_SERVICE (service_name => 'gl.us.oracle.com'
        , aq_ha_notifications => TRUE
        , failover_method  => DBMS_SERVICE.FAILOVER_METHOD_BASIC
        , failover_type    => DBMS_SERVICE.FAILOVER_TYPE_SELECT
        , failover_retries => 180
        , failover_delay   => 5
        , clb_goal => DBMS_SERVICE.CLB_GOAL_LONG);
```

2. Enable `OCI_EVENTS` at environment creation time on the client as follows:

```
( OCIEnvCreate(...) )
```

3. Client applications must link with the client thread or operating system library.

Clients on which you want to use this functionality that also require notifications, including TAF clients, must:

- Register for notifications
- Optionally register a client `EVENT` callback

An Advanced Queueing `ALERT_QUE` is populated automatically. To see the alert information, you can query the views `DBA_OUTSTANDING_ALERTS` and `DBA_ALERT_HISTORY`. OCI clients obtain a subscription to this queue if they meet the three criteria specified previously in this section.

See Also: *Oracle Call Interface Programmer's Guide* for more information about OCI

Enabling ODP.NET Clients to Receive FAN High Availability Events

Oracle Data Provider for .NET (ODP.NET) connection pools can subscribe to notifications that indicate when nodes, services, and service members are down. After a `DOWN` event, Oracle cleans up sessions in the connection pool that go to the instance that stops and ODP.NET proactively disposes connections that are no longer valid. ODP.NET establishes connections to existing Oracle RAC instances if the removal of severed connections brings the total number of connections below the value that is set for the `MIN POOL SIZE` parameter.

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. Perform the following steps to enable FAN:

1. Enable Advanced Queuing notifications by using the `DBMS.SERVICE` package as in the following example:

```
EXECUTE DBMS_SERVICE.MODIFY_SERVICE (service_name => 'gl.us.oracle.com'
        , aq_ha_notifications => TRUE
        , clb_goal => DBMS_SERVICE.CLB_GOAL_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`, which is the default. The following example shows this in more detail:

```
// 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=tiger;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();
  }
}
```

Enabling ODP.NET Clients to Receive FAN Load Balancing Advisory Events

Use the following procedures to enable ODP.NET to receive FAN load balancing advisory events:

1. Enable Advanced Queuing notifications by using the `DBMS.SERVICE` package as in the following example:

```
EXECUTE DBMS_SERVICE.MODIFY_SERVICE (service_name => 'gl.us.oracle.com'
        , aq_ha_notifications => TRUE
        , failover_method  => DBMS_SERVICE.FAILOVER_METHOD_BASIC
        , failover_type    => DBMS_SERVICE.FAILOVER_TYPE_SELECT
        , failover_retries => 180
        , failover_delay   => 5
        , clb_goal => DBMS_SERVICE.CLB_GOAL_LONG);
```

2. Set the `GOAL` and `CLB_GOAL` for the service and ensure that Oracle Net Service is configured for connection load balancing.

3. To take advantage of load balancing events with ODP.NET connection pools, set the load balancing string to `TRUE`; the default is `FALSE`. You can do this at connect

time. This only works if you are using connection pools, or when the pooling attribute is set to TRUE which is the default, as in the following example:

```
// C#
using System;
using Oracle.DataAccess.Client;

class LoadBalancingEnablingSample
{
  static void Main()
  {
    OracleConnection con = new OracleConnection();

    // Open a connection using ConnectionString attributes
    // Also, enable "load balancing"
    con.ConnectionString =
      "User Id=scott;Password=tiger;Data Source=oracle;" +
      "Min Pool Size=10;Connection Lifetime=120;Connection Timeout=60;" +
      "Load Balancing=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: *Oracle Data Provider for .NET Developer's Guide* for more information about ODP. NET and the *Oracle Database PL/SQL Packages and Types Reference* for more information about the DBMS_SERVICES PL/SQL package

Note: ODP.NET does not support connection re-distribution when a node starts. However, if you have enabled failover on the server-side, then ODP.NET can migrate connections to available instances.

Services and Distributed Transaction Processing in Oracle RAC

All tightly coupled branches of a distributed transaction running on an Oracle RAC database must run on the same instance. Between transactions and between services, transactions can be load balanced across all of the database instances. This is important when designing your application tier for a distributed transaction processing application that runs on an Oracle RAC database. To provide improved application performance and load balancing, it is better to have several groups of smaller application servers with each group directing its transactions to a single service, or set of services, than to have one or two larger application servers.

In addition, connection pools at the application server tier that load balance across multiple connections to an Oracle RAC database must ensure that all tightly-coupled branches of a global distributed transaction run on only one Oracle RAC instance. This is also true in distributed transaction environments using protocols such as X/Open Distributed Transaction Processing (DTP) or the Microsoft Distributed Transaction Coordinator (DTC).

To simplify the deployment of distributed transactions, you can use services to manage DTP environments. By defining the DTP property of a service, the service is guaranteed to run on one instance at a time in an Oracle RAC database. All global distributed transactions performed through the DTP service are ensured to have their tightly-coupled branches running on a single Oracle RAC instance. This preserves the integrity for distributed transactions and has the following benefits:

- The changes are available locally within one Oracle RAC instance when tightly coupled branches need information about changes made by each other
- Relocation and failover of services are fully supported for DTP
- By using more DTP services than there are Oracle RAC instances, Oracle can balance the load by services across all of the Oracle RAC database instances

To leverage all of the instances in a cluster, create one or more DTP services for each Oracle RAC instance that hosts distributed transactions. Choose one DTP service for one distributed transaction. Choose different DTP services for different distributed transactions to balance the workload among the Oracle RAC database instances. Because all of the branches of a distributed transaction are on one instance, you can leverage all of the instances to balance the load of many DTP transactions through multiple **singleton services**, thereby maximizing application throughput.

An external transaction manager, such as OraMTS, coordinates DTP/XA transactions. However, an internal Oracle transaction manager coordinates distributed SQL transactions. Both DTP/XA and distributed SQL transactions must use the DTP service in Oracle RAC.

For current and future client implementations, such as those for JDBC, you do not need the invocation to the SYS.DBMS_SYSTEM.DIST_TXN_SYNC procedure because the OPS_FAILOVER flag is deprecated. Instead, the server manages the synchronization of in-doubt transactions across the Oracle RAC instances for transaction recovery. However, for backward compatibility you should retain the invocation to the SYS.DBMS_SYSTEM.DIST_TXN_SYNC procedure. If you add or delete nodes from your cluster database, then you may need to identify and relocate services that you are using for DTP transactions to ensure that you maintain optimum performance levels.

Your transaction manager does not have to use the XA_RECOVER() call when the transaction manager has enough information about in-flight transactions. The transaction manager uses the XA_RECOVER() call only if the transaction manager needs to retrieve a list of prepared transactions from the database, in which case heuristically completed transaction information is also returned from the call.

> **See Also:** *Oracle Database Application Developer's Guide - Fundamentals* for more information about transaction branch management in Oracle RAC

Enabling Distributed Transaction Processing for Services

For services that you are going to use for distributed transaction processing, create the service using Enterprise Manager, DBCA, or SRVCTL and define only one instance as the preferred instance. You can have as many AVAILABLE instances as you want. For example, the following SRVCTL command creates a singleton service for database crm, xa_01.service.us.oracle.com, whose preferred instance is RAC01:

```
srvctl add service -d crm -s xa_01.service.us.oracle.com -r RAC01 -a RAC02, RAC03
```

Then mark the service for distributed transaction processing by setting the DTP parameter to TRUE; the default is FALSE. Enterprise Manager enables you to set this

parameter on the Cluster Managed Database Services: Create Service or Modify Service page. You can also use the DBMS_SERVICE package to modify the DTP property of the singleton service as follows:

```
EXECUTE DBMS_SERVICE.MODIFY_SERVICE(service_name =>'xa_01.service.us.oracle.com',
DTP=>TRUE);
```

If, for example, RAC01 which provides service XA_01 fails, then the singleton service that it provided fails over to one of the other instances, such as RAC02 or RAC03.

If services migrate to other instances after the cold-start of the Oracle RAC database, then you might need to force the relocation of the service to evenly re-balance the load on all of the available hardware. Use data from the GV$ACTIVE_SERVICES view to determine whether to do this.

> **See Also:** *Oracle Database Application Developer's Guide - Fundamentals* for more information about distributed transactions in Oracle RAC

Administering Services

When you create and administer services, you are dividing the work that your database performs into manageable units. The goal of using services is to achieve optimal utilization of your database infrastructure. You can create and deploy services based on business requirements and Oracle can measure the performance for each service. You can define both the application modules within a service as well as the individual actions for a module and monitor thresholds for these actions. This enables you to manage workloads to deliver capacity on demand.

When you create new services for your database, you should define each service's workload management characteristics. The characteristics of a service include:

- A unique global name to identify the service.
- A Net Service name that a client uses to connect to the service.
- The preferred instances where you want the service to be enabled in a normal running environment.
- The available instances where the service can be enabled if one of the preferred instances fails.
- A service goal that determines whether connections are made to the service based on best service quality (how efficiently a single transaction completes) or best throughput (how efficiently a complete job or long-running query completes), as determined by the load balancing advisory.
- An indicator that determines whether the service is used for distributed transactions.
- An indicator that determines whether Oracle RAC high availability events are sent to OCI and ODP.NET clients that have registered to receive them through Advanced Queuing.

  > **See Also:** "Enabling Oracle Call Interface Clients to Receive FAN High Availability Events" on page 6-13 for more details

- The characteristics of session failovers such as whether failovers occur, whether sessions can use pre-existing connections on the failover instance, and whether failed over sessions can continue to process interrupted queries. The service

definition can also define the number of times that a failed session attempts to reconnect to the service and how long it should wait between reconnection attempts. The service definition can also include a connection load balancing goal that informs the Listener how to balance connection requests across the instances that provide the service.

- The method for load balancing connections for each service. This method is used by the Listener when Oracle creates connections. Connections are classified as `LONG` (such as connection pools and SQL*FORMS) which tells the Listener to use session based, or `SHORT` which tells the Listener to use CPU based. If load balancing advisory is enabled, its information will be use to balance connections otherwise CPU utilization is used.

In addition to creating services, you may need to:

- Delete a service. You can delete services that you created. However, you cannot delete or modify the properties of the default database service that Oracle created.
- Check the status of a service. A service can be assigned different roles among the available instances. In a complex database with many services, you may not remember the details of every service. Therefore, you may need to check the status on an instance or service basis. For example, you may need to know the status of a service for a particular instance before you make modifications to that instance or to the Oracle home from which it runs.
- Start or stop a service for a database or an instance. A service must be started before it can be used for client connections to that instance. If you shutdown your database, for example, by running the Server Control (SRVCTL) command `srvctl stop database -d` *`database_name`* where *`database_name`* is the name of the database that you want to stop, then Oracle stops all services to that database. You must manually re-start the services when you start the database.
- Map a Service to a Consumer Group: Oracle can automatically map services to Resource Manager Consumer groups to limit the amount of resources that services can use in an instance. You must create the consumer group and then map the service to the consumer group.

  See Also: *Oracle Database PL/SQL Packages and Types Reference* for information about the `DBMS_RESOURCE_MANAGER.SET_CONSUMER_GROUP_MAPPING_PRI` procedure

- Enable or disable a service for a database or an instance. By default, Oracle Clusterware attempts to restart a service automatically after failures. You can prevent this behavior by disabling a service. Disabling a service is useful when you need to perform database or instance maintenance, for example, if you are performing an upgrade and you want to prevent connection requests.
- Relocate a service to a different instance. You can move a service from one instance to another instance to re-balance workloads, for example, after adding or deleting cluster nodes.

Notes:

- When you use services, do not set a value for the `SERVICE_NAMES` parameter; Oracle controls the setting for this parameter for the services that you create and for the default database service. The service features that this chapter describes are not directly related to the features that Oracle provides when you set `SERVICE_NAMES`. In addition, setting a value for this parameter may override some of the benefits of using services.
- You must still use `INSTANCE_GROUPS` and `PARALLEL_INSTANCE_GROUPS` to restrict parallel execution processing to a subset of instances in an Oracle RAC database.
- Using service names to access a queue provides location transparency for the queue within an Oracle RAC database.

Administering Services with Enterprise Manager, DBCA, PL/SQL, and SRVCTL

You can create and administer services with Enterprise Manager, DBCA, and the `DBMS_SERVICE` PL/SQL package, and you can perform most service administration tasks with the SRVCTL utility. The following sections describe how to perform service-related tasks using these tools:

- Administering Services with Enterprise Manager
- Administering Services with the Database Configuration Assistant
- Administering Services with the PL/SQL DBMS_SERVICE Package
- Administering Services with SRVCTL

Administering Services with 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 drilldowns from this page to:

- 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: *Oracle Enterprise Manager Concepts* for more information about administering services with Enterprise Manager

Service-Related Tasks that You Can Perform with Enterprise Manager

You can perform service-related tasks as described for the following Enterprise Manager pages:

- Cluster Managed Database Services Page
- Cluster Managed Database Services Detail Page
- Create Services Page

Cluster Managed Database Services Page

The Cluster Managed Database Services page enables you to:

- 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

Cluster Managed Database Services Detail Page

The Cluster Managed Database Services Detail page enables you to:

- 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 re-balance the services load

Create Services Page

The Create Services page enables you to:

- Create the service with name, high availability and performance attributes
- Select the desired service policy for each instance configured for the cluster database
- Select the desired service properties, such as the TAF policy. (This configures client-side TAF. To set the service TAF policy, use the `DBMS_SERVICE` package). You can also set the notification properties, load balancing goals, alert levels, and resource management properties

Accessing the Enterprise Manager Services Pages

To access the Cluster Managed Database Services page and detail pages for service instances:

1. From the Cluster Database Home page, click the **Maintenance** tab.
2. From the Cluster Database Maintenance page, under the Services heading in the High Availability options list, 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 cluster database and click **Continue**. The Cluster Managed Database Services page appears and displays services that are available on the cluster database instances. For

information about performing tasks on this page, refer to the online help for this page.

> **Note:** You must have SYSDBA credentials to access a cluster database. Cluster Managed Database Services does not permit you to connect as anything other than SYSDBA.

4. To manage a service at the instance level, either click a service name or select a service name, then select **Manage** from the Actions drop-down list and click **Go**. The Cluster Managed Database Services Detail page for the service appears. For information about performing tasks on this page, refer to the online help for this page.

To access the Relocate page:

1. Perform steps 1 - 3 from the previous procedure set.
2. From the Cluster Managed Database Services page, either click a Service name or select a service name, then select **Manage** from the Actions drop-down list and click **Go**. The Cluster Managed Database Services Detail page for the service appears.
3. Click **Relocate**. The Relocate Service from Instance page appears, where you can perform manual load balancing of services. For information about performing tasks on this page, refer to the online help for this page.

Administering Services with the Database Configuration Assistant

You can administer services in Oracle RAC with DBCA as described under the following topics:

- Using the Database Configuration Assistant to Add and Modify Services
- Using the Database Configuration Assistant to Administer Services

Using the Database Configuration Assistant to Add and Modify Services

You can use DBCA to create services and to perform administrative tasks on them. If you use the Database Upgrade Assistant (DBUA) to upgrade a Primary/Secondary configuration from an earlier release of the Oracle database, then the Database Upgrade Assistant (DBUA) creates one service and assigns it to one instance as a preferred instance and to the other instance as an available instance.

> **See Also:** *Oracle Database PL/SQL Packages and Types Reference* for more information about the `DBMS_SERVICE` PL/SQL and `DBMS_MONITOR` packages and for more information about setting thresholds

Using the Database Configuration Assistant to Administer Services

The DBCA Services Management feature enables you to manage service assignments and service preferences for instances and to configure TAF policies. You can perform these procedures while your Oracle RAC database is running. Even if your instances or the Oracle RAC database is not running, you can still use DBCA to configure services, but the services will not start automatically. To add, modify, or delete services using the DBCA Services Management feature:

1. On the DBCA Welcome page, select the Oracle Real Application Clusters option and click **Next**.

2. On the DBCA Operations page, select Services Management and click **Next**.
3. On the DBCA List of Databases page, select the cluster database for which you want to configure services and click **Next**. If the database that you selected already has services assigned to it, then DBCA displays these on this page.
4. Click **Add**, **Modify**, or **Delete**.
5. To add a service, enter the name of the service. Note that service names with the prefix `SYS$` are reserved for use by Oracle internal processes. To modify a service, edit the service and configure the service's instance preferences and TAF policies. Assign the service to instances for preferred (normal) and available (recovery) processing. The DBCA records your changes when you select another service or proceed to another page. To delete a service, select the service and click **Delete**.

> **Note:** Entries that you make in the Add a Service dialog are appended to the `SERVICE_NAMES` parameter entry which has a 4KB limit. Therefore, the total length of the names of all services assigned to an instance cannot exceed 4KB.

6. To remove a service, select the service and click **Remove**.
7. Click **Finish** and DBCA displays the Summary page. Click **OK** and DBCA displays a progress dialog while it configures your services.

When you click **Finish**, DBCA configures the Oracle Clusterware resources for the services that you added, modified, or removed. The DBCA also configures the net service entries for these services and starts them. When you use DBCA to remove services, DBCA stops the service, removes the Oracle Clusterware resource for the service, and removes the net service entries.

Administering Services with the PL/SQL DBMS_SERVICE Package

You can manage services with the PL/SQL `DBMS_SERVICE` package procedures. These procedures are described in the following sections:

- CREATE_SERVICE
- MODIFY_SERVICE
- DELETE_SERVICE
- START_SERVICE
- STOP_SERVICE
- DISCONNECT_SESSION

CREATE_SERVICE

The `CREATE_SERVICE` procedure adds a new service to the Oracle RAC database. In the `CREATE_SERVICE` syntax `service_name` is the unique, global service name, `network_name` is the TNS name for connections to the service, `goal` sets the workload management goal directive to service quality or throughput, `dtp` is the distributed transaction flag, `aq_ha_notification` is the flag to send Oracle RAC high availability events to registered OCI clients, `failover_method` is the TAF failover method for the service, `failover_type` is the TAF failover method for the service, `failover_retries` is the TAF connection retry count, `failover_delay` is the wait time between TAF connection retries, and `clb_goal` sets the connection load balancing goal. When using services with Oracle RAC, add the high availability

properties, such as the PREFERRED and AVAILABLE placement, using Enterprise Manager, DBCA or SRVCTL.

Note: Oracle recommends that you use Enterprise Manager or DBCA to create services for Oracle RAC environments.

See Also: *Oracle Database PL/SQL Packages and Types Reference* for more information about the CREATE_SERVICE procedure syntax and for information about other procedures mentioned in this section

MODIFY_SERVICE

The MODIFY_SERVICE procedure changes one or more service characteristics. In the MODIFY_SERVICE syntax the parameters are the same as those for the CREATE_SERVICE procedure.

DELETE_SERVICE

The DELETE_SERVICE procedure drops an existing service. In the DELETE_SERVICE syntax service_name is the name of the service to be dropped.

START_SERVICE

The START_SERVICE procedure starts a service on the connected instance, the named instance, or all instances. In the START_SERVICE syntax SERVICE_NAME is the name of the service to be started and INSTANCE_NAME can be NULL (to start the service on the connected instance), the name of an instance (to start the service on that instance), or the package constant DBMS_SERVICE.ALL_INSTANCES to start the service on all instances where it is defined.

STOP_SERVICE

The STOP_SERVICE procedure stops a service on the connected instance, the named instance, or all instances. In the STOP_SERVICE syntax the parameters are the same as those for the START_SERVICE procedure.

DISCONNECT_SESSION

The DISCONNECT_SESSION procedure terminates all sessions on the connected instance, or the instance where the PL/SQL procedure is run. In the DISCONNECT_SESSION syntax service_name is the name of the service for which connections are to be dropped.

Administering Services with SRVCTL

When you create a service with SRVCTL, you must start it with a separate SRVCTL command. However, you may later need to manually stop or restart the service. You may also need to disable the service to prevent automatic restarts, to manually relocate the service, or obtain status information about the service. The following sections explain how to use SRVCTL to perform the following administrative tasks:

- Creating Services with SRVCTL
- Starting and Stopping Services with SRVCTL
- Enabling and Disabling Services with SRVCTL
- Relocating Services with SRVCTL

- Obtaining the Statuses of Services with SRVCTL
- Obtaining the Configuration of Services with SRVCTL

> **See Also:** Appendix E, "Server Control Utility Reference" for more information about SRVCTL and the other SRVCTL commands that you can use to manage services

Creating Services with SRVCTL

To create a service with SRVCTL, enter a command from the command line using the following syntax:

```
srvctl add service -d database_unique_name -s service_name -r preferred_list[-a
available_list] [-P TAF_policy]
```

Starting and Stopping Services with SRVCTL

Enter the following SRVCTL syntax from the command line:

```
srvctl start service -d database_unique_name [-s service_name_list] [-i inst_name]
[-o start_options] [-c connect_str | -q]

srvctl stop service -d database_unique_name -s service_name_list [-i inst_name]
[-o start_options] [-c connect_str | -q]
```

Enabling and Disabling Services with SRVCTL

Use the following SRVCTL syntax from the command line to enable and disable services:

```
srvctl enable service -d database_unique_name -s service_name_list [-i inst_name]
srvctl disable service -d database_unique_name -s service_name_list [-i inst_name]
```

Relocating Services with SRVCTL

Run the `srvctl relocate service` command from the command line to relocate a service. For example, the following command relocates the `crm` service from instance apps1 to instance apps3:

```
srvctl relocate service -d apps -s crm -i apps1 -t apps3
```

Obtaining the Statuses of Services with SRVCTL

Run the `srvctl relocate service` command from the command line to obtain the status of a service. For example, the following command returns the status of the `crm` service that is running on the crm database:

```
srvctl status service -d apps -s crm
```

Obtaining the Configuration of Services with SRVCTL

Run the `srvctl relocate service` command from the command line to obtain the high availability configuration of a service. For example, the following command returns the configuration of the `crm` service that is running on the `crm` database:

```
srvctl config service -d apps -s crm -a
```

See Also: Appendix E, "Server Control Utility Reference" for information about other administrative tasks that you can perform with SRVCTL

Measuring Performance by Service Using the Automatic Workload Repository

Services add a new dimension for performance tuning. With services, workloads are visible and measurable and resource consumption and wait times are attributable by application. Tuning by using 'service and SQL' replaces tuning by 'session and SQL' in the majority of systems where all sessions are anonymous and shared.

The AWR maintains performance statistics that include information about response time, throughput, resource consumption, and wait events for all services and work that a database performs. Oracle also maintains metrics, statistics, wait events, wait classes, and SQL-level traces for services. You can optionally augment these statistics by defining modules within your application to monitor certain statistics. You can also define the actions within those modules that business critical transactions should execute in response to particular statistical values. Enable module and action monitoring using the DBMS_MONTIOR PL/SQL package as follows:

```
EXECUTE DBMS_MONITOR.SERV_MOD_ACT_STAT_ENABLE(SERVICE_NAME => 'ERP', MODULE_NAME=>
'PAYROLL', ACTION_NAME => 'EXCEPTIONS PAY');
EXECUTE DBMS_MONITOR.SERV_MOD_ACT_STAT_ENABLE(SERVICE_NAME => 'ERP', MODULE_
NAME=>'PAYROLL', ACTION_NAME => NULL);
```

Use the DBA_ENABLED_AGGREGATIONS view to verify that you have enabled monitoring.

Statistics aggregation and tracing by service are global in scope for Oracle RAC databases. In addition, they are persistent across instance restarts and service relocations for both Oracle RAC and single-instance Oracle databases.

The service, module, and action names are visible in V$SESSION, V$ACTIVE_SESSION_HISTORY, and V$SQL views. The call times and performance statistics are visible in V$SERVICE_STATS, V$SERVICE_EVENTS, V$SERVICE_WAIT_CLASSES, V$SERVICEMETRIC, and V$SERVICEMETRIC_HISTORY. When you enable statistics collection for an important transaction, you can see the call speed for each service, module, and action name at each database instance using the V$SERV_MOD_ACT_STATS view.

The following sample SQL*Plus script provides service quality statistics every five seconds. You can use these service quality statistics to monitor the quality of a service, to direct work, and to balance services across Oracle RAC instances:

```
SET PAGESIZE 60 COLSEP '|' NUMWIDTH 8 LINESIZE 132 VERIFY OFF FEEDBACK OFF
COLUMN service_name FORMAT A20 TRUNCATED HEADING 'Service'
COLUMN begin_time HEADING 'Begin Time' FORMAT A10
COLUMN end_time HEADING 'End Time' FORMAT A10
COLUMN instance_name HEADING 'Instance' FORMAT A10
COLUMN service_time HEADING 'Service Time|mSec/Call' FORMAT 999999999
COLUMN throughput HEADING 'Calls/sec'FORMAT 99.99
BREAK ON service_name SKIP 1
SELECT
    service_name
  , TO_CHAR(begin_time, 'HH:MI:SS') begin_time
  , TO_CHAR(end_time, 'HH:MI:SS') end_time
  , instance_name
  , elapsedpercall  service_time
```

```
  ,  callspersec  throughput
FROM
    gv$instance i
  , gv$active_services s
  , gv$servicemetric m
WHERE s.inst_id = m.inst_id
  AND s.name_hash = m.service_name_hash
  AND i.inst_id = m.inst_id
  AND m.group_id = 10
ORDER BY
   service_name
 , i.inst_id
 , begin_time ;
```

Service Thresholds and Alerts

Service level thresholds enable you to compare achieved service levels against accepted minimum required levels. This provides accountability with respect to the delivery or the failure to deliver an agreed service level. The end goal is a predictable system that achieves service levels. There is no requirement to perform as fast as possible with minimum resource consumption; the requirement is to meet the *quality* of service.

You can explicitly specify two performance thresholds for each service: the response time for calls, or `SERVICE_ELAPSED_TIME`, and the CPU time for calls, or `SERVICE_CPU_TIME`. The response time goal indicates that the elapsed time should not exceed a certain value, and the response time represents wall clock time. Response time is a fundamental measure that reflects all delays and faults that might be blocking the call from running on behalf of the user. Response time can also indicate differences in node power across the nodes of an Oracle RAC database.

The service time and CPU time are calculated as the moving average of the elapsed, server-side call time. The AWR monitors the service time and CPU time and publishes AWR alerts when the performance exceeds the thresholds. You can then respond to these alerts by changing the priority of a job, stopping overloaded processes, or by relocating, expanding, shrinking, starting or stopping a service. This permits you to maintain service availability despite changes in demand.

Services and Thresholds Alerts Example

To check the thresholds for the payroll service, use the AWR report. You should record output from the report over several successive intervals during which time the system is running optimally. For example, assume that for an Email server, the AWR report runs each Monday during the peak usage times of 10am to 2pm. The AWR report would contain the response time, or DB time, and the CPU consumption time, or CPU time, for calls for each service. The AWR report would also provide a breakdown of the work done and the wait times that are contributing to the response times.

Using `DBMS_MONITOR`, set a warning threshold for the payroll service at 0.5 seconds and a critical threshold for the payroll service at 0.75 seconds. In Oracle Database 10*g*, you must set these thresholds at all instances within an Oracle RAC database. You can schedule actions using Enterprise Manager jobs for alerts, or you can schedule actions to occur programmatically when the alert is received. In this example, thresholds are added for the `servall` service and set as follows:

```
EXECUTE DBMS_SERVER_ALERT.SET_THRESHOLD(
METRICS_ID => DBMS_SERVER_ALERT.ELAPSED_TIME_PER_CALL
, warning_operator => DBMS_SERVER_ALERT.OPERATOR_GE
```

```
, warning_value => '500000'
, critical_operator => DBMS_SERVER_ALERT.OPERATOR_GE
, critical_value => '750000'
, observation_period => 30
, consecutive_occurrences => 5
, instance_name => NULL
, object_type => DBMS_SERVER_ALERT.OBJECT_TYPE_SERVICE
, object_name => 'servall');
```

Verify the threshold configuration using the following SELECT statement:

```
SELECT METRICS_NAME, INSTANCE_NAME, WARNING_VALUE, CRITICAL_VALUE, OBSERVATION_
PERIOD FROM dba_thresholds ;
```

Enable Service, Module, and Action Monitoring You can enable performance data tracing for important modules and actions within each service. The performance statistics are available in the `V$SERV_MOD_ACT_STATS` view. As an example, set the following:

- Under the `ERP` service, enable monitoring for the exceptions pay action in the module, payroll.
- Under the `ERP` service, enable monitoring for the all actions in the module, payroll.
- Under the `HOT_BATCH` service, enable monitoring for the all actions in the module, posting.

```
EXECUTE DBMS_MONITOR.SERV_MOD_ACT_STAT_ENABLE(service_name => 'erp', module_name=>
'payroll', action_name => 'exceptions pay');
EXECUTE DBMS_MONITOR.SERV_MOD_ACT_STAT_ENABLE(service_name => 'erp', module_name
=> 'payroll', action_name => NULL);
EXECUTE DBMS_MONITOR.SERV_MOD_ACT_STAT_ENABLE(service_name => 'hot_batch', module
_name =>'posting', action_name => NULL);
```

Verify the enabled service, module, action configuration with the following `SELECT` statement:

```
COLUMN AGGREGATION_TYPE FORMAT A21 TRUNCATED HEADING 'AGGREGATION'
COLUMN PRIMARY_ID FORMAT A20 TRUNCATED HEADING 'SERVICE'
COLUMN QUALIFIER_ID1 FORMAT A20 TRUNCATED HEADING 'MODULE'
COLUMN QUALIFIER_ID2 FORMAT A20 TRUNCATED HEADING 'ACTION'
SELECT * FROM DBA_ENABLED_AGGREGATIONS ;
```

The output might appear as follows:

```
AGGREGATION            SERVICE              MODULE       ACTION
------------           --------------------  ----------   -------------
SERVICE_MODULE_ACTION  ERP                   PAYROLL      EXCEPTIONS PAY
SERVICE_MODULE_ACTION  ERP                   PAYROLL
SERVICE_MODULE_ACTION  HOT_BATCH             POSTING
```

Enabling Event Notification for Connection Failures in Oracle Real Application Clusters

Event notification is enabled if the `SQL_ORCLATTR_FAILOVER_CALLBACK` and `SQL_ORCLATTR_FAILOVER_HANDLE` attributes of the `SQLSetConnectAttr` function are set when a connection failure occurs in an Oracle RAC Database environment. Both attributes are set using the `SQLSetConnectAttr` function. The symbols for the new attributes are defined in the `sqora.h` file. The `SQL_ORCLATTR_FAILOVER_`

CALLBACK attribute is used to specify the address of a routine to call when a failure event takes place.

The SQL_ORCLATTR_FAILOVER_HANDLE attribute is used to specify a context handle which will be passed as one of the parameters in the callback routine. This attribute is necessary in order for the ODBC application to determine which connection the failure event is taking place on.

The function prototype for the callback routine is as follows:

```
void failover_callback(void *handle, SQLINTEGER fo_code)
```

The handle parameter is the value that was set by the SQL_ORCLATTR_FAILOVER_HANDLE attribute. Null is returned if the attribute has not been set.

The fo_code parameter identifies the failure event that is taking place. The failure events map directly to the events defined in the OCI programming interface. The list of possible events is as follows:

- ODBC_FO_BEGIN
- ODBC_FO_ERROR
- ODBC_FO_ABORT
- ODBC_FO_REAUTH
- ODBC_FO_END

The following is a sample program that demonstrates how to use this feature:

```
/*
NAME
ODBCCallbackTest
DESCRIPTION
Program to demonstrate the connection failover callback feature.
PUBLIC FUNCTION(S)
main
PRIVATE FUNCTION(S)
NOTES
Command Line: ODBCCallbackTest filename [odbc-driver]
*/
#include <malloc.h>
#include <stdio.h>
#include <string.h>
#include <sql.h>
#include <sqlext.h>
#include <sqora.h>
#define TRUE  1
#define FALSE 0
/*
 * Funtion Prototypes
 */
void display_errors(SQLSMALLINT HandleType, SQLHANDLE Handle);
void failover_callback(void *Handle, SQLINTEGER fo_code);
/*
 * Macros
 */
#define ODBC_STS_CHECK(sts) \
if (sts != SQL_SUCCESS) \
{ \
display_errors(SQL_HANDLE_ENV, hEnv); \
display_errors(SQL_HANDLE_DBC, hDbc); \
display_errors(SQL_HANDLE_STMT, hStmt); \
```

```
return FALSE; \
}
/*
 * ODBC Handles
 */
SQLHENV *hEnv = NULL; // ODBC Environment Handle
SQLHANDLE *hDbc = NULL; // ODBC Connection Handle
SQLHANDLE *hStmt = NULL; // ODBC Statement Handle
/*
 * MAIN Routine
 */
main(int argc, char **argv)
{
SQLRETURN rc;
/*
 * Connection Information
 */
SQLTCHAR *dsn = "odbctest";
SQLTCHAR *uid = "scott";
SQLTCHAR *pwd = "tiger";
SQLTCHAR *szSelect = "select * from emp";
/*
 * Allocate handles
 */
rc = SQLAllocHandle(SQL_HANDLE_ENV, SQL_NULL_HANDLE, (SQLHANDLE *)&hEnv);
ODBC_STS_CHECK(rc)
rc = SQLSetEnvAttr(hEnv, SQL_ATTR_ODBC_VERSION, (SQLPOINTER)SQL_OV_ODBC3, 0);
ODBC_STS_CHECK(rc);
rc = SQLAllocHandle(SQL_HANDLE_DBC, hEnv, (SQLHANDLE *)&hDbc);
ODBC_STS_CHECK(rc);
/*
 * Connect to the database
 */
rc = SQLConnect(hDbc, dsn, (SQLSMALLINT)strlen(dsn),
uid, (SQLSMALLINT)strlen(uid),
pwd, (SQLSMALLINT)strlen(pwd));
ODBC_STS_CHECK(rc);
/*
 * Set the connection failover attributes
 */
rc = SQLSetConnectAttr(hDbc, SQL_ORCLATTR_FAILOVER_CALLBACK, &failover_
callback,0);
ODBC_STS_CHECK(rc);
rc = SQLSetConnectAttr(hDbc, SQL_ORCLATTR_FAILOVER_HANDLE, hDbc, 0);
ODBC_STS_CHECK(rc);
/*
 * Allocate the statement handle
 */
rc = SQLAllocHandle(SQL_HANDLE_STMT, hDbc, (SQLHANDLE *)&hStmt);
ODBC_STS_CHECK(rc);
/*
 * Wait for connection failovers
 */
while (TRUE)
{
  sleep(5000);
  rc = SQLExecDirect(hStmt,szSelect, strlen(szSelect));
  ODBC_STS_CHECK(rc);
  rc = SQLFreeStmt(hStmt, SQL_CLOSE);
  ODBC_STS_CHECK(rc);
```

```
}
/*
 * Free up the handles and close the connection
 */
rc = SQLFreeHandle(SQL_HANDLE_STMT, hStmt);
ODBC_STS_CHECK(rc);
rc = SQLDisconnect(hDbc);
ODBC_STS_CHECK(rc);
rc = SQLFreeHandle(SQL_HANDLE_DBC, hDbc);
ODBC_STS_CHECK(rc);
rc = SQLFreeHandle(SQL_HANDLE_ENV, hEnv);
ODBC_STS_CHECK(rc);
return TRUE;
}
/*
 * Failover Callback Routine
 */
void failover_callback(void *Handle, SQLINTEGER fo_code)
{
switch (fo_code)
{
case ODBC_FO_BEGIN:
    printf("ODBC_FO_BEGIN recevied");
        break;
case ODBC_FO_ERROR:
    printf("ODBC_FO_ERROR recevied");
        break;
case ODBC_FO_ABORT:
        printf("ODBC_FO_ABORT recevied");
        break;
case ODBC_FO_REAUTH:
        printf("ODBC_FO_REAUTH recevied");
        break;
case ODBC_FO_END:
        printf("ODBC_FO_END recevied");
        break;
default:
        printf("Invalid or unknown ODBC failover code recevied");
        break;
};
return;
}
/*
 * Retrieve the errors associated with the handle passed
 * and display them.
 */
void display_errors(SQLSMALLINT HandleType, SQLHANDLE Handle)
{
SQLTCHAR MessageText[256];
SQLTCHAR SqlState[5+1];
SQLSMALLINT i=1;
SQLINTEGER NativeError;
SQLSMALLINT TextLength;
SQLRETURN sts = SQL_SUCCESS;
if (Handle == NULL) return;
/*
 * Make sure all SQLState text is null terminated
 */
SqlState[5] = '\0';
/*
```

```
 * Fetch and display all diagnostic records that exist for this handle
 */
while (sts == SQL_SUCCESS)
{
NativeError = 0;
TextLength = 0;
sts = SQLGetDiagRec(HandleType, Handle, i, SqlState, &NativeError,(SQLTCHAR
*)&MessageText, sizeof(MessageText),&TextLength);
if (sts == SQL_SUCCESS)
{
  printf("[%s]%s\n",NativeError, &MessageText);
  if (NativeError != 0)
  {
    printf("Native Error Code: %d", NativeError);
  }
  i++;
}
}
return;
}
```

7

Configuring Recovery Manager and Archiving

This chapter explains how to configure Recovery Manager (RMAN) for use in Oracle Real Application Clusters (Oracle RAC) environments. This chapter also provides procedures for using RMAN for archiving in Oracle RAC environments and discusses redo logs and archived redo logs considerations. The topics in this chapter include:

Overview of Configuring RMAN for Oracle Real Application Clusters

Recovery Manager (RMAN) enables you to back up, restore, and recover datafiles, control files, server parameter files (SPFILEs) and archived redo logs. It is included with the Oracle server and does not require separate installation. You can run RMAN from the command line or use RMAN in the Backup Manager in Oracle Enterprise Manager.

Configuring the RMAN Snapshot Control File Location

The snapshot control file is a temporary snapshot control file that RMAN creates to re-synchronize from a read-consistent version of the control file. RMAN only needs a snapshot control file when re-synchronizing with the recovery catalog or when making a backup of the current control file. In Oracle RAC, the snapshot control file is only needed on the nodes on which RMAN performs backups; the snapshot control file does not need to be globally available to all instances in an Oracle RAC environment.

You can specify a **cluster file system** file or a raw device destination for the location of your snapshot control file. Run the following RMAN command to determine the configured location of the snapshot control file:

```
SHOW SNAPSHOT CONTROLFILE NAME;
```

You can change the configured location of the snapshot control file. For example, on UNIX-based systems you can specify the snapshot control file location as `$ORACLE_HOME/dbs/scf/snap_prod.cf` by entering the following at the RMAN prompt:

```
CONFIGURE SNAPSHOT CONTROLFILE NAME TO '$ORACLE_HOME/dbs/scf/snap_prod.cf';
```

This command globally sets the configuration for the location of the snapshot control file throughout your **cluster database**. Therefore, ensure that the directory `$ORACLE_HOME/dbs/scf` exists on all nodes that perform backups.

The `CONFIGURE` command creates persistent settings across RMAN sessions. Therefore, you do not need to run this command again unless you want to change the location of the snapshot control file. You can also specify a cluster file system file or a raw device destination for the location of your snapshot control file. This file is shared across all nodes in the **cluster** just like other datafiles in Oracle RAC. Refer to *Oracle Database Backup and Recovery Reference* for more information about configuring the snapshot control file.

Configuring the RMAN Control File and SPFILE Autobackup Feature

If you set `CONFIGURE CONTROLFILE AUTOBACKUP` to `ON`, then RMAN automatically creates a control file and an SPFILE backup after you run the `BACKUP` or `COPY` commands. RMAN can also automatically restore an SPFILE if this is required to start an instance to perform recovery. This means that the default location for the SPFILE must be available to all nodes in your Oracle RAC database.

These features are important in disaster recovery because RMAN can restore the control file even without a recovery catalog. RMAN can restore an autobackup of the control file even after the loss of both the recovery catalog and the current control file. You can change the default name that RMAN gives to this file with the `CONFIGURE CONTROLFILE AUTOBACKUP FORMAT` command. Note that if you specify an absolute path name in this command, then this path must exist identically on all nodes that participate in backups.

RMAN performs the control file autobackup on the first allocated channel. Therefore, when you allocate multiple channels with different parameters, especially when you allocate a channel with the `CONNECT` command, determine which channel will perform the control file autobackup. Always allocate the channel for this node first. Refer to the *Oracle Database Backup and Recovery Advanced User's Guide* for more information about using the control file autobackup feature.

Besides using the RMAN control file, you can also use Enterprise Manager to use the RMAN features.

Note: The Enterprise Manager interface that you use to configure RMAN backup and recovery is documented in *Oracle Database Backup and Recovery Basics*. This chapter, Chapter 7, only describes topics for this subject if they are different from the single-instance description.

Configuring Channels for RMAN in Oracle Real Application Clusters

This section describes how to configure channels for RMAN. You can configure channels to use automatic workload balancing or you can specify specific channels for specific instances as described in the following topics:

- Configuring Channels to use Automatic Workload Balancing

Configuring Channels to use Automatic Workload Balancing

To configure channels to use automatic load balancing, use the following syntax:

```
CONFIGURE DEVICE TYPE [disk | sbt] PARALLELISM number of channels;
...
```

Where number of channels is the number of channels that you want to use for the operation. After you complete this one-time configuration, you can issue `BACKUP` or `RESTORE` commands.

Configuring Channels to Use a Specific Channel

To configure channels to use a specific channel, use the following syntax:

```
CONFIGURE CHANNEL DEVICE TYPE sbt CONNECT
'SYS/change_on_install@node1'
CONFIGURE CHANNEL DEVICE TYPE sbt CONNECT
'SYS/change_on_install@node2'
...
```

After this one-time configuration step, you can issue the `BACKUP` or `RESTORE` commands. In addition, you can use the `PARMS` command in this example to set vendor-specific parameters.

Managing Archived Redo Logs Using RMAN in Oracle Real Application Clusters

When a node generates an archived redo log, Oracle always records the filename of the log in the control file of the target database. If you are using a recovery catalog, then RMAN also records the archived redo log filenames in the recovery catalog when a re-synchronization occurs.

The archived redo log naming scheme that you use is important because when a node writes to a log with a specific filename on its file system, the file must be readable by any node that needs to access this archived redo log. For example, if node 1 archives a log to `/oracle/arc_dest/log_1_100_23452345.arc`, then node 2 can only back up this archived redo log only if it can read`/oracle/arc_dest/log_1_100_23452345.arc` on its own file system.

The backup and recovery strategy that you choose depends on how you configure the archiving destinations for each node. Whether only one node or all nodes perform archived redo log backups, you need to ensure that all archived redo logs are backed up. If you use RMAN parallelism during recovery, then the node that performs recovery must have read access to all archived redo logs in your cluster.

Multiple nodes can restore archived logs in parallel. However, during recovery, one one node applies the archived logs. Therefore, the node that is performing the recovery must be able to access all of the archived logs that are needed for the recovery operation. By default, the database determines the optimum number of parallel threads to use during the recovery operation. You can use the `PARALLEL` clause in the `RECOVER` command to change this number.

Guidelines and Considerations for Archived Redo Logs

The primary consideration is to ensure that all archived redo logs can be read from every node during recovery, and if possible during backups. This section illustrates the archived redo log naming issues for configuring archiving in your cluster database.

The scenario described here is for a non-cluster file system archiving scheme. Assume that the following conditions are met:

- Configure each node to write to a local archiving directory that is named the same on each node.
- Do *not* set up a cluster file system (in other words, each node can only read from and write to its own local file system). Refer to information about cluster file systems later in this chapter.
- Do not use NFS (network file system) or mapped drives to enable the nodes in the cluster to gain read/write access to one another.

Example 7–1 Example Configuration for the initialization parameters file

```
sid1.log_archive_dest_1 = (location=/arc_dest_1)
sid2.log_archive_dest_1 = (location=/arc_dest_2)
sid3.log_archive_dest_1 = (location=/arc_dest_3)
```

Assume that the filenames of the archived redo logs are recorded in the control file as follows:

```
/arc_dest_1/log_1_62_23452345.arc
/arc_dest_2/log_2_100_23452345.arc
/arc_dest_2/log_2_101_23452345.arc
/arc_dest_3/log_3_70_23452345.arc
/arc_dest_1/log_1_63_23452345.arc
```

During recovery, as long as the archived log destinations are visible from the node that performs the recovery, Oracle can successfully recover the archived log data.

Archived Redo Log File Conventions in Oracle RAC

For any archived redo log configuration, uniquely identify the archived redo logs with the `LOG_ARCHIVE_FORMAT` parameter. The format of this parameter is operating system-specific and it can include text strings, one or more variables, and a filename extension.

Table 7–1 Archived Redo Log Filename Format Parameters

Parameter	Description	Example
`%r`	Resetlogs identifier	`log_1_62_23452345`
`%R`	Padded resetlogs identifier	`log_1_62_0023452345`
`%s`	Log sequence number, not padded	`log_251`
`%S`	Log sequence number, left-zero-padded	`log_0000000251`
`%t`	Thread number, not padded	`log_1`
`%T`	Thread number, left-zero-padded	`log_0001`

All of the thread parameters, in either upper or lower case, are mandatory for Oracle RAC. This enables Oracle to create unique names for archive logs across the incarnation. This requirement is in effect when the `COMPATIBLE` parameter is set to `10.0` or greater.

Use the `%R` or `%r` parameters to include the resetlogs identifier to avoid overwriting the logs from a previous incarnation. If you do not specify a log format, then the default is operating system-specific and includes `%t`, `%s`, and `%r`.

As an example, if the instance associated with redo thread number 1 sets LOG_ARCHIVE_FORMAT to log_%t_%s_%r.arc, then its archived redo log files are named:

```
log_1_1000_23435343.arc
log_1_1001_23452345.arc
log_1_1002_23452345.arc
...
```

> **See Also:** *Oracle Database Administrator's Guide* about specifying the archived redo log filename format and destination, and Oracle platform-specific documentation about the default log archiving format and destination

RMAN Archiving Configuration Scenarios

This section describes the archiving scenarios for an Oracle RAC database. The two configuration scenarios in this chapter describe a three-node UNIX cluster for an Oracle RAC database. For both scenarios, the LOG_ARCHIVE_FORMAT that you specify for the instance performing recovery must be the same as the format that you specified for the instances that archived the files.

Automatic Storage Management and Cluster File System Archiving Scheme

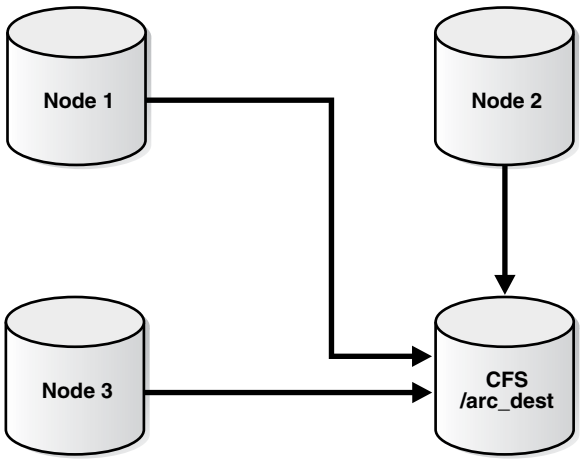
The preferred configuration for Oracle RAC is to use Automatic Storage Management (ASM) for a recovery area with a different disk group for your recovery set than for your datafiles. Alternatively, you can use a cluster file system archiving scheme.

In this case, each node writes to a single cluster file system archived redo log destination and can read the archived redo log files of the other nodes. Read access is achieved for all nodes with a cluster file system. For example, if node 1 archives a log to /arc_dest/log_1_100_23452345.arc on the cluster file system, then any other node in the cluster can also read this file.

> **Note:** The archive log naming format in this example is only for a CFS example. ASM uses an Oracle Managed Files (OMF)-based naming format.

If you do not use a cluster file system, then the archived redo log files cannot be on raw devices. This is because raw devices do not enable sequential writing of consecutive archive log files.

Figure 7–1 Cluster File System Archiving Scheme



Advantages of the Cluster File System Archiving Scheme

The advantage of this scheme is that none of the nodes uses the network to archive logs. Because the filename written by a node can be read by any node in the cluster, RMAN can back up all logs from any node in the cluster. Backup and restore scripts are simplified because each node has access to all archived redo logs.

Initialization Parameter Settings for the Cluster File System Archiving Scheme

In the cluster file system scheme, each node archives to a directory that is identified with the same name on all instances within the cluster database. To configure this, set values for the `LOG_ARCH_DEST_n` parameter for each instance using the `sid` designator as in the following example:

```
sid1.LOG_ARCHIVE_DEST_1="LOCATION=/arc_dest"
sid2.LOG_ARCHIVE_DEST_1="LOCATION=/arc_dest"
sid3.LOG_ARCHIVE_DEST_1="LOCATION=/arc_dest"
```

The following list shows archived redo log entry examples that would appear in the RMAN catalog or the in the control file based on the previous example. Note that any node can archive logs using any of the threads:

```
/arc_dest/log_1_999_23452345.arc
/arc_dest/log_1_1000_23435343.arc
/arc_dest/log_1_1001_23452345.arc <- thread 1 archived in node 3
/arc_dest/log_3_1563_23452345.arc <- thread 3 archived in node 2
/arc_dest/log_2_753_23452345.arc <- thread 2 archived in node 1
/arc_dest/log_2_754_23452345.arc
/arc_dest/log_3_1564_23452345.arc
```

Location of Archived Logs for the Cluster File System Archiving Scheme

Because the file system is shared and because each node is writing its archived redo logs to directory `/arc_dest` in the cluster file system, each node can read the logs written by itself as well as any other node.

Non-Cluster File System Local Archiving Scheme

In the non-cluster file system local archiving scheme, each node archives to a uniquely named local directory. If recovery is required, then you can configure the recovery

node so that it can access directories on the other nodes remotely. For example, use NFS on UNIX-based systems or mapped drives on Windows-based systems. Therefore, each node writes only to a local destination, but each node can also read archived redo log files in remote directories on the other nodes.

Considerations for Using Non-Cluster File System Local Archiving

If you use non-cluster file system local archiving for media recovery, then you must configure the node that is performing recovery for remote access to the other nodes so that it can read the archived redo log files in the archiving directories on the other nodes. In addition, if you are in recovery and if you do not have all of the available archive logs, then you must perform an incomplete recovery up to the first missing archived redo log sequence number. You do not have to use a specific configuration for this scheme. However, if you want to distribute the backup processing onto multiple nodes, then the easiest method is to configure channels as described in the backup scenarios in Chapter 8, "Managing Backup and Recovery".

Initialization Parameter Settings for Non-Cluster File System Local Archiving

You can set the archiving destination values as follows in the initialization parameter file:

```
sid1.LOG_ARCHIVE_DEST_1="LOCATION=/arc_dest_1"
sid2.LOG_ARCHIVE_DEST_1="LOCATION=/arc_dest_2"
sid3.LOG_ARCHIVE_DEST_1="LOCATION=/arc_dest_3"
```

The following list shows the possible archived redo log entries in the database control file. Note that any node is able to archive logs from any of the threads:

```
/arc_dest_1/log_1_1000_23435343.arc
/arc_dest_2/log_1_1001_23452345.arc <- thread 1 archived in node 2
/arc_dest_2/log_3_1563_23452345.arc <- thread 3 archived in node 2
/arc_dest_1/log_2_753_23452345.arc <- thread 2 archived in node 1
/arc_dest_2/log_2_754_23452345.arc
/arc_dest_3/log_3_1564_23452345.arc
```

Location of Archived Logs for Non-Cluster File System Local Archiving

As illustrated in Table 7–2, each node has a directory containing the locally archived redo logs. Additionally, if you mount directories on the other nodes remotely through NFS or mapped drives, then each node has two remote directories through which RMAN can read the archived redo log files that are archived by the remaining nodes.

Table 7–2 UNIX/NFS Location Log Examples, Non-Cluster File System Local Archiving

Node ...	Can read the archived redo log files in the directory ...	For logs archived by node ...
1	/arc_dest_1	1
1	/arc_dest_2	2 (through NFS)
1	/arc_dest_3	3 (through NFS)
2	/arc_dest_1	1 (through NFS)
2	/arc_dest_2	2
2	/arc_dest_3	3 (through NFS)
3	/arc_dest_1	1 (through NFS)
3	/arc_dest_2	2 (through NFS)

Table 7–2 (Cont.) UNIX/NFS Location Log Examples, Non-Cluster File System Local

Node ...	Can read the archived redo log files in the directory ...	For logs archived by node ...
3	/arc_dest_3	3

File System Configuration for Non-Cluster File System Local Archiving

If you are performing recovery and a surviving instance must read all of the logs that are on disk but not yet backed up, then you should configure NFS as shown in Table 7–3.

Table 7–3 UNIX/NFS Configuration for Shared Read Local Archiving Examples

Node	Directory ...	Is configured ...	And mounted on ...	On node ...
1	/arc_dest_1	Local read/write	n/a	n/a
1	/arc_dest_2	NFS read	/arc_dest_2	2
1	/arc_dest_3	NFS read	/arc_dest_3	3
2	/arc_dest_1	NFS read	/arc_dest_1	1
2	/arc_dest_2	Local read/write	n/a	n/a
2	/arc_dest_3	NFS read	/arc_dest_3	3
3	/arc_dest_1	NFS read	/arc_dest_1	1
3	/arc_dest_2	NFS read	/arc_dest_2	2
3	/arc_dest_3	Local read/write	n/a	n/a

Note: Windows users can achieve the same results depicted in the examples in this section by using mapped drives.

Changing the Archiving Mode in Oracle Real Application Clusters

You can run the ALTER DATABASE SQL statement to change the archiving mode in Oracle RAC as long as the database is mounted by the local instance but not open in any instances. You do not need to modify parameter settings to run this statement.

Note: You can also change the archive log mode by using the Recovery Settings page in the Maintenance tab of the Enterprise Manager Oracle RAC Database Home Page.

Monitoring the Archiver Processes

After your RMAN configuration is operative in your Oracle RAC environment, use the GV$ARCHIVE_PROCESSES and V$ARCHIVE_PROCESSES views to determine the status of the archiver processes. Depending on whether you query the global or local views, these views display information for all database instances, or for only the instance to which you are connected. Refer to *Oracle Database Reference* for more information about the database views.

8

Managing Backup and Recovery

This chapter explains instance recovery and how to use Recovery Manager (RMAN) to back up and restore Oracle Real Application Clusters (Oracle RAC) databases. This chapter also describes Oracle RAC instance recovery, parallel backup, recovery with SQL*Plus, and using the Flash Recovery Area in Oracle RAC. The topics in this chapter include:

- RMAN Backup Scenario for Non-Cluster File System Backups
- RMAN Restore Scenarios for Oracle Real Application Clusters
- RMAN Recovery Through Resetlogs in Oracle Real Application Clusters
- RMAN and Oracle Net in Oracle Real Application Clusters
- Instance Recovery in Oracle Real Application Clusters
- Media Recovery in Oracle Real Application Clusters
- Parallel Recovery in Oracle Real Application Clusters
- Using a Flash Recovery Area in Oracle Real Application Clusters

---

Note: For restore and recovery in Oracle RAC environments, you do not have to configure the instance that performs the recovery to also be the sole instance that restores all of the datafiles. IN Oracle RAC, datafiles are accessible from every node in the **cluster**, so any node can restore archived log files.

See Also: Chapter 3, "Administering Oracle Clusterware Components" for information about backing and restoring the Oracle Clusterware components such as the Oracle Cluster Registry (OCR) and the voting disk

RMAN Backup Scenario for Non-Cluster File System Backups

In a non-**cluster file system** environment, each node can back up only its own local archived redo logs. For example, node 1 cannot access the archived redo logs on node 2 or node 3 unless you configure the network file system for remote access. If you configure a network file system file for backups, then each node will backup its archived logs to a local directory.

RMAN Restore Scenarios for Oracle Real Application Clusters

This section describes the following common RMAN restore scenarios:

- Cluster File System Restore Scheme
- Non-Cluster File System Restore Scheme
- Using RMAN or Enterprise Manager to Restore the Server Parameter File (SPFILE)

> **Note:** The restore and recovery procedures in a cluster file system scheme do not differ substantially from Oracle single-instance scenarios.

Cluster File System Restore Scheme

The scheme that this section describes assumes that you are using the "Automatic Storage Management and Cluster File System Archiving Scheme" on page 7-5. In this scheme, assume that node 3 performed the backups to a CFS. If node 3 is available for the restore and recovery operation, and if all of the archived logs have been backed up or are on disk, then run the following commands to perform complete recovery:

```
RESTORE DATABASE;
RECOVER DATABASE;
```

If node 3 performed the backups but is unavailable, then configure a media management device for one of the remaining nodes and make the backup media from node 3 available to this node.

Non-Cluster File System Restore Scheme

The scheme that this section describes assumes that you are using the "Non-Cluster File System Local Archiving Scheme" on page 7-6. In this scheme, each node archives locally to a different directory. For example, node 1 archives to `/arc_dest_1`, node 2 archives to `/arc_dest_2`, and node 3 archives to `/arc_dest_3`. You must configure a network file system file so that the recovery node can read the archiving directories on the remaining nodes.

If all nodes are available and if all archived redo logs have been backed up, then you can perform a complete restore and recovery by mounting the database and running the following commands from any node:

```
RESTORE DATABASE;
RECOVER DATABASE;
```

Because the network file system configuration enables each node read access to the other nodes, then the recovery node can read and apply the archived redo logs located on the local and remote disks. No manual transfer of archived redo logs is required.

Using RMAN or Enterprise Manager to Restore the Server Parameter File (SPFILE)

RMAN can restore the server parameter file either to the default location or to a location that you specify. This procedure is described in *Oracle Database Backup and Recovery Basics*.

You can also use Enterprise Manager to restore SPFILE. From the Backup/Recovery section of the Maintenance tab, click **Perform Recovery**. The Perform Recovery link is context-sensitive and navigates you to the SPFILE restore only when the database is closed.

RMAN Recovery Through Resetlogs in Oracle Real Application Clusters

The `resetlogs` operation automatically archives online logs. This ensures that your database has the necessary archived redo logs if recovery was done to a point in time in the online or in the standby logs. You do not need to perform a full backup after a `resetlogs` operation.

The default archivelog format includes a resetlogs identifier. You do not need to change the backup scripts after performing a reset logs operation. RMAN backs up earlier incarnation logs on running `BACKUP ARCHIVELOG ALL` or `BACKUP ARCHIVELOG FROM TIME` or `BACKUP ARCHIVELOG FROM SCN` command.

RMAN and Oracle Net in Oracle Real Application Clusters

To facilitate RMAN in Oracle Net, RMAN only needs a net service name that creates a dedicated server connection. You can configure this net service name on any active instance within your Oracle RAC environment.

For any RMAN connection made through a net service name, each net service name must specify only one instance. This applies to all RMAN connections, whether you configure these connections from the command line or through the `CONNECT` clause in `ALLOCATE CHANNEL` or `CONFIGURE CHANNEL` RMAN commands. Additionally, when you use RMAN from the command line, you can only connect to one instance in an Oracle RAC database at a time. For example, assume that node1, node2, and node3 are net service names for three instances in an Oracle RAC environment. In this case, connect to the target database with only one of these net service names, for example:

```
% rman TARGET SYS/oracle@node2 CATALOG rman/cat@catdb
```

Instance Recovery in Oracle Real Application Clusters

Instance failure occurs when software or hardware problems disable an instance. After instance failure, Oracle automatically uses the online redo logs to perform recovery as described in this section.

Single Node Failure in Oracle Real Application Clusters

Instance recovery in Oracle RAC does not include the recovery of applications that were running on the failed instance. Oracle clusterware restarts the instance automatically. You can also use callout programs as described in the example on OTN to trigger application recovery.

Applications that were running continue by using failure recognition and recovery. This provides consistent and uninterrupted service in the event of hardware or software failures. When one instance performs recovery for another instance, the surviving instance reads online redo logs generated by the failed instance and uses that information to ensure that committed transactions are recorded in the database. Thus, data from committed transactions is not lost. The instance performing recovery rolls back transactions that were active at the time of the failure and releases resources used by those transactions.

Note: All online redo logs must be accessible for instance recovery. Therefore, Oracle recommends that you mirror your online redo logs.

Multiple-Node Failures in Oracle Real Application Clusters

When multiple node failures occur, as long as one instance survives, Oracle RAC performs instance recovery for any other instances that fail. If all instances of an Oracle RAC database fail, then Oracle automatically recovers the instances the next time one instance opens the database. The instance performing recovery can mount the database in either **cluster database** or exclusive mode from any node of an Oracle RAC database. This recovery procedure is the same for Oracle running in shared mode as it is for Oracle running in exclusive mode, except that one instance performs instance recovery for all of the failed instances.

Using RMAN to Create Backups in Oracle Real Application Clusters

Oracle provides RMAN for backing up and restoring the database. RMAN enables you to back up, restore, and recover datafiles, control files, SPFILEs, and archived redo logs. RMAN is included with the Oracle server and it is installed by default. You can run RMAN from the command line or you can use it from the Backup Manager in Oracle Enterprise Manager. In addition, RMAN is the recommended backup and recovery tool if you are using Automatic Storage Management (ASM).

The procedures for using RMAN in Oracle RAC environments do not differ substantially from those for Oracle single-instance environments. Refer to the Oracle Backup and Recovery documentation set for more information about single-instance RMAN backup procedures.

Channel Connections to Cluster Instances

Channel connections to the instances are determined using the connect string defined by channel configurations. For example, in the following configuration, three channels are allocated using `user1/pwd1@service_name`. If you configure the SQL Net service name with load balancing turned on, then he channels are allocated at a node as decided by the load balancing algorithm.

```
CONFIGURE DEVICE TYPE sbt PARALLELISM 3;
CONFIGURE DEFAULT DEVICE TYPE TO sbt;
CONFIGURE CHANNEL DEVICE TYPE SBT CONNECT 'user1/pwd1@<service_name>'
```

However, if the service name used in the connect string is not for load balancing, then you can control at which instance the channels are allocated using separate connect strings for each channel configuration as follows:

```
CONFIGURE DEVICE TYPE sbt PARALLELISM 3;
CONFIGURE CHANNEL 1.. CONNECT 'user1/pwd1@node1';
CONFIGURE CHANNEL 2.. CONNECT 'user2/pwd2@node2';
CONFIGURE CHANNEL 3.. CONNECT 'user3/pwd3@node3';
```

In the previous example, it is assumed that `node1`, `node2` and `node3` are SQL Net service names that connect to pre-defined nodes in your Oracle RAC environment. Alternatively, you can also use manually allocated channels to backup your database files. For example, the following command backs up the spfile, controlfile, datafiles and archived logs:

```
RUN
{
    ALLOCATE CHANNEL CH1 CONNECT 'user1/pwd1@node1';
    ALLOCATE CHANNEL CH2 CONNECT 'user2/pwd2@node2';
    ALLOCATE CHANNEL CH3 CONNECT 'user3/pwd3@node3';
    BACKUP DATABASE PLUS ARCHIVED LOG;
}
```

During a backup operation, as long as at least one of the channels allocated has access to the archived log, RMAN automatically schedules the backup of the specific log on that channel. Because the control file, spfile, and datafiles are accessible by any channel, the backup operation of these files is distributed across the allocated channels.

For a local archiving scheme, there must be at least one channel allocated to all of the nodes that write to their local archived logs. For a CFS archiving scheme, assuming that every node writes to the archived logs in the same CFS, the backup operation of the archived logs is distributed across the allocated channels.

During a backup, the instances to which the channels connect must be either all mounted or all open. For example, if the node1 instance has the database mounted while the node2 and node3 instances have the database open, then the backup fails.

Node Affinity Awareness of Fast Connections

In some cluster database configurations, some nodes of the cluster have faster access to certain datafiles than to other datafiles. RMAN automatically detects this, which is known as node affinity awareness. When deciding which channel to use to back up a particular datafile, RMAN gives preference to the nodes with faster access to the datafiles that you want to back up. For example, if you have a three-node cluster, and if node 1 has faster read/write access to datafiles 7, 8, and 9 than the other nodes, then node 1 has greater node affinity to those files than nodes 2 and 3.

> **See Also:** *Oracle Database Backup and Recovery Reference* for more information about the `CONNECT` clause of the `CONFIGURE CHANNEL` statement

Deleting Archived Redo Logs after a Successful Backup

Assuming that you have configured the automatic channels as defined in section "Channel Connections to Cluster Instances" on page 8-4, you can use the following example to delete the archived logs that you backed up `n` times. The device type can be `DISK` or `SBT`:

```
DELETE ARCHIVELOG ALL BACKED UP n TIMES TO DEVICE TYPE device_type;
```

During a delete operation, as long as at least one of the channels allocated has access to the archived log, RMAN will automatically schedule the deletion of the specific log on that channel. For a local archiving scheme, there must be at least one channel allocated that can delete an archived log. For a CFS archiving scheme, assuming that every node writes to the archived logs on the same CFS, the archived log can be deleted by any allocated channel.

If you have not configured automatic channels, then you can manually allocate the maintenance channels as follows and delete the archived logs.

```
ALLOCATE CHANNEL FOR MAINTENANCE DEVICE TYPE DISK CONNECT 'SYS/oracle@node1';
ALLOCATE CHANNEL FOR MAINTENANCE DEVICE TYPE DISK CONNECT 'SYS/oracle@node2';
ALLOCATE CHANNEL FOR MAINTENANCE DEVICE TYPE DISK CONNECT 'SYS/oracle@node3';
DELETE ARCHIVELOG ALL BACKED UP n TIMES TO DEVICE TYPE device_type;
```

Autolocation for Backup and Restore Commands

RMAN automatically performs autolocation of all files that it needs to back up or restore. If you use the non-cluster file system local archiving scheme, then a node can

only read the archived redo logs that were generated by an instance on that node. RMAN never attempts to back up archived redo logs on a channel it cannot read.

During a restore operation, RMAN automatically performs the autolocation of backups. A channel connected to a specific node only attempts to restore files that were backed up to the node. For example, assume that log sequence 1001 is backed up to the drive attached to node 1, while log 1002 is backed up to the drive attached to node 2. If you then allocate channels that connect to each node, then the channel connected to node 1 can restore log 1001 (but not 1002), and the channel connected to node 2 can restore log 1002 (but not 1001).

Media Recovery in Oracle Real Application Clusters

Media recovery must be user-initiated through a client application, whereas instance recovery is automatically performed by the database. In these situations, use RMAN to restore backups of the datafiles and then recover the database. The procedures for RMAN media recovery in Oracle RAC environments do not differ substantially from the media recovery procedures for single-instance environments.

The node that performs the recovery must be able to restore all of the required datafiles. That node must also be able to either read all of the required archived redo logs on disk or be able to restore them from backups.

Parallel Recovery in Oracle Real Application Clusters

Oracle automatically selects the optimum degree of parallelism for instance, crash, and media recovery. Oracle applies archived redo logs using an optimal number of parallel processes based on the availability of CPUs. You can use parallel instance recovery and parallel media recovery in Oracle RAC databases as described under the following topics:

- Parallel Recovery with RMAN
- Disabling Parallel Recovery

See Also: *Oracle Database Backup and Recovery Advanced User's Guide* for more information on these topics

Parallel Recovery with RMAN

With RMAN's `RESTORE` and `RECOVER` commands, Oracle automatically makes parallel the following three stages of recovery:

Restoring Datafiles When restoring datafiles, the number of channels you allocate in the RMAN recover 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 Logs With RMAN, the application of archived redo logs is performed in parallel. Oracle automatically selects the optimum degree of parallelism based on available CPU resources.

Disabling Parallel Recovery

You can override this using the procedures under the following topics:

- Disabling Instance and Crash Recovery Parallelism
- Disabling Media Recovery Parallelism

Disabling Instance and Crash Recovery Parallelism

To disable parallel instance and crash recovery on a multi-CPU system, set the `RECOVERY_PARALLELISM` parameter to 0.

Disabling Media Recovery Parallelism

Use the `NOPARALLEL` clause of the RMAN `RECOVER` command or the `ALTER DATABASE RECOVER` statement to force Oracle to use non-parallel media recovery.

Using a Flash Recovery Area in Oracle Real Application Clusters

To use a flash recovery area in Oracle RAC, you must place it on an ASM disk group, a Cluster File System, or on a shared directory that is configured through a network file system file for each Oracle RAC instance. In other words, the flash recovery area must be shared among all of the instances of an Oracle RAC database. In addition, set the parameter `DB_RECOVERY_FILE_DEST` to the same value on all instances.

Enterprise Manager enables you to set up a flash recovery area. To use this feature:

1. From the Cluster Database home page, click the **Maintenance** tab.
2. Under the Backup/Recovery options list, click **Configure Recovery Settings**.
3. Specify your requirements in the Flash Recovery Area section of the page.
4. Click the Help for this page for more information.

9

Administrative Options

This chapter describes administrative tasks or options within Oracle tools that are specific to Oracle Real Application Clusters (Oracle RAC) and not discussed elsewhere in this book. In some cases, you have a choice of tools to perform a task while other tasks must be performed through a specific tool, such as Enterprise Manager or SRVCTL. In addition, this chapter describes how to quiesce an Oracle RAC database and how to administer network interfaces with the Oracle Interface Configuration Tool (OIFCFG). The topics in this chapter are:

- Enterprise Manager Tasks for Oracle Real Application Clusters
- Oracle Real Application Clusters Administration Procedures for Enterprise Manager
- Additional Information About SQL*Plus in Oracle Real Application Clusters
- Quiescing Oracle Real Application Clusters Databases
- Administering System and Network Interfaces with OIFCFG
- Changing VIP Addresses

> **See Also:** *Oracle Enterprise Manager Concepts* and the Enterprise Manager online help for more information about Enterprise Manager

Enterprise Manager Tasks for Oracle Real Application Clusters

Within Enterprise Manager, Oracle RAC-specific administrative tasks generally focus on two levels: tasks that affect an entire **cluster database** and tasks that affect specific instances. For example, you can use Enterprise Manager to administer storage, the schema, and security at the cluster database level. Or you can perform instance-specific commands such as setting parameters or creating resource plans.

Because there is one Enterprise Manager Agent on each node of an Oracle RAC database, for Database Control you can use any URL for that database to administer it with Enterprise Manager. You can manage all of the following Oracle RAC components as targets in your Enterprise Manager framework:

- Host **cluster**: Accessible from the Cluster Database Home Page.
- Cluster database instances: Links to the instance pages appear on the Cluster Database Home Page.
- Hosts and Listeners: Links to hosts and Listeners appear on the Cluster Database Instance Pages.

See Also: *Oracle Enterprise Manager Concepts* for information about creating administrator accounts, using privileges, defining roles, and so on, and *Oracle Enterprise Manager Advanced Configuration* for information about configuring Enterprise Manager Grid Control for multiple Oracle RAC databases

Using Enterprise Manager Grid Control to Discover Nodes and Instances

Discovering Oracle RAC database and instance targets in Enterprise Manager enables monitoring and administration from the console. Database Control does not require discovery because DBCA performs any necessary configuration while creating the database. But for Grid Control, Enterprise Manager console interface can be used to discover Oracle RAC database and instance targets. If the Grid Control agents are installed on a cluster that already has Oracle RAC database, Oracle RAC database targets are discovered at install time. You can use the console interface to discover targets if a database is created after agents are installed or if a database is not automatically discovered at agent install time. To discover nodes and instances, use Enterprise Manager Grid Control as follows:

1. Log in to Enterprise Manager and click the **Targets** tab.
2. Click the **Database** tab to view all of the available targets. The column labeled Types shows the Oracle RAC databases using the entry "Cluster Database".
3. Add the database target by selecting the target name, then clicking **Add**. The Add Database Target: Specify Host page appears, which enables you to add databases, Listeners, and Automatic Storage Management (ASM) as monitored targets.
4. Click the flashlight icon to display the available host names, select a host, then click **Continue**. The Add Database: Specify Source page appears.
5. Either request Enterprise Manager to discover only single-instance databases and Listeners, or to discover all cluster databases, single-instance databases, and Listeners on the cluster, then click **Continue**.

   Enterprise Manager performs discovery to locate and display the cluster database and its associated instances. The Targets Discovered on Cluster page appears. If this procedure did not discover your reconfigured cluster database and all of its instances, you can use this page to manually configure your cluster databases and single-instance databases.

Enterprise Manager Pages for Oracle Real Application Clusters

This section describes the following Enterprise Manager pages for Oracle RAC:

- Databases Summary Page
- Cluster Database Home Page
- Cluster Database Instances Pages
- The Databases Overview Page for Oracle Real Application Clusters
- The Cluster Home Page for Oracle Real Application Clusters

Databases Summary Page

This is a top-level page in Enterprise Manager Grid Control. The page shows cluster and single-instance databases. If there are cluster databases in your environment, the Databases Summary page displays "Cluster Database" in the Type column. The page

also indicates cluster database availability as well as the ratio of active instances to inactive instances. Click a cluster database link and Enterprise Manager displays the Cluster Database Home Page for that database, which is described under the following heading.

Cluster Database Home Page

From the Cluster Database Home Page you can manage the cluster nodes and hosts as well as cluster subcomponents such as instances, Listeners, and interconnects. The Cluster Database Home Page is also a summary page for cluster database management that provides an overview of cluster database activity. Enterprise Manager uses a unique database name to identify the cluster database it represents. You can use the Administration tab on this page to perform many activities such as:

- Create undo tablespaces and redo threads and assign them to specific instances, SPFILE, create a backup
- Start, stop, and relocate database services at the cluster database level

You can use the Maintenance tab on this page to perform operations such as:

- Create backup and recovery scenarios
- Toggle the archive mode on and off
- Administer recovery settings
- Manage resource plans for the database and its instances

  You can define and modify the resource plans for the cluster database and also activate and deactivate resource plans for specific instances. You can also use the Resource Plan Schedule to schedule resource plan activation.

You can use the Interconnects tab on this page to perform tasks such as:

- Monitoring the interconnect interfaces
- Determining the load added by individual instances and databases on the interconnect
- Determining configuration issues
- Identifying transfer rate-related issues including excess traffic, and so on

Cluster Database Instances Pages

Instances' pages show instance-specific information similar to the information that you would see on a single-instance Oracle database. The Oracle RAC-specific contents of Instance Pages are:

- Configuration: You can view instance states, view and edit initialization parameters at the instance level and at the cluster database level, and view resource plan performance statistics. You can also view and modify the undo tablespaces assigned to an instance and the undo tablespace retention period.
- Sessions: You can list the statuses of connected users, view the latest SQL for specific sessions, and terminate sessions.
- Locks: You can view details for currently held User type and System type locks.

The Databases Overview Page for Oracle Real Application Clusters

The Databases Overview Page links to Cluster Home Pages and to the node or instance Home Pages.

The Cluster Home Page for Oracle Real Application Clusters

The Cluster Home Page displays an overview of activities and detailed reports at both the cluster and instance levels. The Cluster Home Page has the following sections:

- General Section: Provides a cluster status overview.
- Configuration Section: Lists the hardware platform, operating system and version, and Oracle or vendor clusterware version.
- Cluster Databases Table: Displays the cluster databases associated with a cluster, their availability, and any cluster database alerts. You can access the individual Cluster Database Home Pages from the Cluster Databases Table.
- Alerts Table: Provides alert information such as severity rating.
- Hosts Table: Displays information about the hosts or nodes in the cluster.

Oracle Real Application Clusters Administration Procedures for Enterprise Manager

The Cluster Database Home page shows all of the instances in the Oracle RAC database and provides an aggregate collection of several Oracle RAC-specific statistics that are collected by the **Automatic Workload Repository (AWR)** for server manageability.

You do not need to navigate to an instance-specific page to see these details. However, on the Cluster Database Home page, if an instance is down that should be operating, or if an instance has a high number of alerts, then you can drill down to the instance-specific page for each alert.

To perform specific administrative tasks as described in the remainder of this section, log in to the target Oracle RAC database, navigate to the Cluster Database Home page, and click the **Administration** tab.

Administering Enterprise Manager Jobs in Oracle Real Application Clusters

You can administer Enterprise Manager jobs at both the database and instance levels. For example, you can create a job at the cluster database level and the job will run on any active instance of the target Oracle RAC database. Or you can create a job at the instance level and the job will only run on the specific instance for which you created it. In the event of a failure, recurring jobs can run on a surviving instance.

Creating Enterprise Manager Jobs in Oracle Real Application Clusters

Because you can create jobs at the instance level, cluster level, or cluster database level, jobs can run on any available host in the cluster database. This applies to scheduled jobs as well. Enterprise Manager also displays job activity in several categories, namely, Active, History, and Library.

Use the Jobs tab to submit operating system scripts and SQL scripts and to examine scheduled jobs. For example, to create a backup job for a specific Oracle RAC database:

1. Click **Targets** and click the database for which you want to create the job.

2. Log in to the target database.
3. When Enterprise Manager displays the Database Home page, click **Maintenance**.
4. Complete the Enterprise Manage Job Wizard panels to create the job.

Administering Alerts in Oracle Real Application Clusters with Enterprise Manager

You can use Enterprise Manager to configure Oracle RAC environment alerts. You can also configure special Oracle RAC database tests, such as global cache converts, consistent read requests, and so on.

Enterprise Manager distinguishes between database- and instance-level alerts in Oracle RAC environments. Alert thresholds for instance level alerts, such as archive log alerts, can be set at the instance target level. This enables you to receive alerts for the specific instance if performance exceeds your threshold. You can also configure alerts at the database level, such as setting alerts for tablespaces. This enables you to avoid receiving duplicate alerts at each instance.

> **See Also:** OTN for an example of configuring alerts in Oracle RAC and the *Oracle Database PL/SQL Packages and Types Reference* for information about using packages to configure thresholds

Performing Scheduled Maintenance Using Defined Blackouts in Enterprise Manager

You can define blackouts for all managed targets of an Oracle RAC database to prevent alerts from occurring while performing maintenance. You can define blackouts for an entire cluster database or for specific cluster database instances.

Additional Information About SQL*Plus in Oracle Real Application Clusters

The following sections describe the use of SQL*Plus in Oracle RAC environments:

- How SQL*Plus Commands Affect Instances
- Verifying that Instances are Running

How SQL*Plus Commands Affect Instances

Most SQL statements affect the current instance. You can use SQL*Plus to start and stop instances in the Oracle RAC database. You do not need to run SQL*Plus commands as root on UNIX-based systems or as Administrator on Windows-based systems. You need only the proper database account with the privileges that you normally use for a single-instance Oracle database. Some examples of how SQL*Plus commands affect instances are:

- `ALTER SYSTEM CHECKPOINT LOCAL` affects only the instance to which you are currently connected, rather than the default instance or all instances.
- `ALTER SYSTEM CHECKPOINT` or `ALTER SYSTEM CHECKPOINT GLOBAL` affects *all* instances in the cluster database.
- `ALTER SYSTEM SWITCH LOGFILE` affects only the current instance.
  - To force a global log switch, use the `ALTER SYSTEM ARCHIVE LOG CURRENT` statement.
  - The `INSTANCE` option of `ALTER SYSTEM ARCHIVE LOG` enables you to archive each online redo log file for a specific instance.

Table 9–1 describes how SQL*Plus commands affect instances.

Table 9–1 How SQL*Plus Commands Affect Instances

SQL*Plus Command	Associated Instance
`ARCHIVE LOG`	Always affects the current instance.
`CONNECT`	Affects the default instance if no instance is specified in the `CONNECT` command.
`HOST`	Affects the node running the SQL*Plus session, regardless of the location of the current and default instances.
`RECOVER`	Does not affect any particular instance, but rather the database.
`SHOW INSTANCE`	Displays information about the current instance, which can be different from the default local instance if you have redirected your commands to a remote instance.
`SHOW PARAMETER` and `SHOW SGA`	Displays parameter and SGA information from the current instance.
`STARTUP` and `SHUTDOWN`	Always affects the current instance. These are privileged SQL*Plus commands.

Verifying that Instances are Running

To verify that instances are running, on any node from a SQL*Plus prompt enter:

```
CONNECT SYS/password as SYSDBA
SELECT * FROM V$ACTIVE_INSTANCES;
```

Oracle returns output similar to the following:

```
INST_NUMBER INST_NAME
-----------  ------------------
          1 db1-sun:db1
          2 db2-sun:db2
          3 db3-sun:db3
```

The output columns for this example are shown in Table 9–2.

Table 9–2 Descriptions of V$ACTIVE_INSTANCES Columns

Column	Description
`INST_NUMBER`	Identifies the instance number.
`INST_NAME`	Identifies the host name and instance name.

Quiescing Oracle Real Application Clusters Databases

The procedure for quiescing Oracle RAC databases is identical to quiescing a single-instance database. You use the `ALTER SYSTEM QUIESCE RESTRICTED` statement from one instance. You cannot open the database from any instance while the database is in the process of being quiesced. Once all non-DBA sessions become inactive, the `ALTER SYSTEM QUIESCE RESTRICTED` statement finishes, and the database is considered as in a quiesced state. In an Oracle RAC environment, this statement affects all instances, not just the one from which the statement is issued.

To successfully issue the `ALTER SYSTEM QUIESCE RESTRICTED` statement in an Oracle RAC environment, you must have the Database Resource Manager feature activated, and it must have been activated since instance startup for all instances in the cluster database. It is through the facilities of the Database Resource Manager that non-DBA sessions are prevented from becoming active. Also, while this statement is in

effect, any attempt to change the current resource plan will be queued until after the system is unquiesced.

These conditions apply to Oracle RAC:

- If you issued the `ALTER SYSTEM QUIESCE RESTRICTED` statement but Oracle has not finished processing it, you cannot open the database.
- You cannot open the database if it is already in a quiesced state.
- The `ALTER SYSTEM QUIESCE RESTRICTED` and `ALTER SYSTEM UNQUIESCE` statements affect all instances in an Oracle RAC environment, not just the instance that issues the command.

Quiesced State and Cold Backups

You cannot use the quiesced state to take a cold backup. This is because Oracle background processes may still perform updates for Oracle internal purposes even while the database is in quiesced state. In addition, the file headers of online datafiles continue to look like they are being accessed. They do not look the same as if a clean shutdown were done. You can still take online backups while the database is in a quiesced state. Refer to the *Oracle Database Administrator's Guide* for details on the quiesce database feature and the *Oracle Database Reference* for more information about the `ALTER SYSTEM QUIESCE RESTRICTED` syntax.

Administering System and Network Interfaces with OIFCFG

This section describes the following Oracle Interface Configuration (OIFCFG) topics:

- Defining Network Interfaces with OIFCFG
- Syntax and Commands for the OIFCFG Command-Line Tool

Use the OIFCFG command-line tool in single-instance Oracle databases and in Oracle RAC database environments to:

- Allocate and de-allocate network interfaces to components
- Direct components to use specific network interfaces
- Retrieve component configuration information

The Oracle Universal Installer (OUI) also uses OIFCFG to identify and display the interfaces available on the system.

Defining Network Interfaces with OIFCFG

The specification for a network interface uniquely identifies it using the interface name, its associated subnet, and interface type. The interface type indicates the purpose for which the network is configured. The supported interface types are:

- Public: An interface that can be used for communication with components external to Oracle RAC instances, such as Oracle Net and Virtual Internet Protocol (VIP) addresses
- Cluster interconnect: A private interface used for the cluster interconnect to provide inter-instance or **Cache Fusion** communication

A network interface can be stored as a global interface or as a node-specific interface. An interface is stored as a global interface when all of the nodes of an Oracle RAC cluster have the same interface connected to the same subnet (recommended). It is stored as a node-specific interface only when there are some nodes in the cluster that

have a different set of interfaces and subnets. If an interface is configured as both a global and a node-specific interface, the node-specific definition takes precedence over the global definition.

A network interface specification is in the form of:

interface_name/*subnet*:*interface_type*

For example, the following identifies qfe0 as a cluster interconnect located at the address 204.152.65.32:

```
qfe0/204.152.65.32:cluster_interconnect
```

Syntax and Commands for the OIFCFG Command-Line Tool

Use the `oifcfg -help` command to display online help for OIFCFG. The elements of OIFCFG commands, some of which are optional depending on the command, are:

- `nodename`: Name of the Oracle Clusterware node as listed in the output from the `olsnodes` command
- `if_name`: Name by which the interface is configured in the system
- `subnet`: Subnet address of the interface
- `if_type`: Type of interface: public or cluster_interconnect

You can use OIFCFG to list the interface names and the subnets of all of the interfaces available on the local node by executing the `iflist` keyword as shown in this example:

```
oifcfg iflist
hme0     139.185.141.0
qfe0     204.152.65.16
```

You can also retrieve specific OIFCFG information with a `getif` command using the following syntax:

```
oifcfg getif [ [-global | -node nodename] [-if if_name[/subnet]] [-type if_type] ]
```

To store a new interface use the `setif` keyword. For example, to store the interface hme0, with the subnet 139.185.141.0, as a global interface (to be used as an interconnect for all of the Oracle RAC instances in your cluster), you would use the command:

```
oifcfg setif -global hme0/139.185.141.0:cluster_interconnect
```

For a cluster interconnect that exists between only two nodes, for example rac1 and rac2, you could create the cms0 interface with the following commands, assuming 139.185.142.0 is the subnet addresses for the interconnect on rac1 and rac2 respectively:

```
oifcfg setif -global cms0/139.185.142.0:cluster_interconnect
```

Use the OIFCFG `delif` command to delete the stored configuration for global or node-specific interfaces. A specific node-specific or global interface can be deleted by supplying the interface name, with an optional subnet, on the command line. Without the `-node` or `-global` options, the `delif` keyword deletes either the given interface or all of the global and node-specific interfaces on all of the nodes in the cluster. For example, the following command deletes the global interface named qfe0 for the subnet 204.152.65.0:

```
oifcfg delif -global qfe0/204.152.65.0
```

On the other hand, the next command deletes all of the global interfaces stored with OIFCFG:

```
oifcfg delif -global
```

Changing VIP Addresses

Use the following procedure to change a VIP address:

1. Stop all database and ASM instances.
2. Stop the Listeners, and node applications using the `srvctl stop nodeapps` command.
3. Run the following command to verify node connectivity between all of the nodes for which your cluster is configured. This command discovers all of the network interfaces available on the cluster nodes and verifies the connectivity between all of the nodes by way of the discovered interfaces. This command also lists all of the interfaces available on the nodes which are suitable for use as VIPs.

   ```
   cluvfy comp nodecon -n all [-verbose]
   ```

   See Also: Appendix A, "Troubleshooting" for more information about enabling and using the Cluster Verification Utility (CVU)

4. Run the `srvctl modify nodeapps` command with the `-A` option as described in Appendix E. Use the `crs_stat` command to identify all active node applications.
5. Restart all of the instances and node applications that you stopped in Step 1 and 2.

10

Adding and Deleting Nodes and Instances on UNIX-Based Systems

This chapter describes how to add and delete nodes and instances in Oracle Real Application Clusters (Oracle RAC) databases on UNIX-based systems. The preferred method to add nodes and instances to Oracle RAC databases is to use the Oracle cloning procedures that are described in the *Oracle Universal Installer and OPatch User's Guide*. You can also use Enterprise Manager Grid Control to perform cloning operations. Cloning enables you to copy images of Oracle Clusterware and Oracle RAC software onto the other nodes that have identical hardware and software. If you do not want to use the cloning process, then you can use the manual procedures that are described in this chapter to add nodes and instances. The topics in this chapter are:

- Cloning Oracle Clusterware and Oracle RAC Software in Grid Environments
- Quick-Start Node and Instance Addition and Deletion Procedures
- Detailed Node and Instance Addition and Deletion Procedures

---

Note: For all of the add node and delete node procedures for UNIX-based systems, temporary directories such as `/tmp`, `$TEMP`, or `$TMP`, *should not be* shared directories. If your temporary directories are shared, then set your temporary environment variable, such as `$TEMP`, to a non-shared location on a local node. In addition, use a directory that exists on all of the nodes.

Note: The entries for *`CRS_home`* and *`Oracle_home`* as used in this chapter refer to substitutes for either environment variables or full path names for Oracle Clusterware and Oracle home with Oracle RAC respectively.

Cloning Oracle Clusterware and Oracle RAC Software in Grid Environments

The preferred method for extending your Oracle RAC environment is to use the Oracle cloning procedures in the *Oracle Universal Installer and OPatch User's Guide*. Only use the procedures in this chapter if you choose not to use Oracle cloning.

See Also: "Cloning Oracle Clusterware and Oracle RAC Software in Grid Environments" on page 1-11 for a summary about Oracle cloning

Quick-Start Node and Instance Addition and Deletion Procedures

This section explains node and instance addition and deletion for UNIX-based systems using procedures that are presented in a quick-start format. For node addition, ensure that you install the required operating system patches and updates on the new nodes. Then configure the new nodes to be part of your **cluster** at the network level. Extend the Oracle Clusterware home from an existing Oracle Clusterware home to the new nodes and then extend the Oracle database software with Oracle RAC components to the new nodes. Finally, make the new nodes members of the existing Oracle RAC database. This section includes the following topics:

- Adding an Oracle Clusterware Home to a New Node
- Adding an Oracle Home with Oracle RAC to a New Node
- Deleting an Oracle Home with Oracle RAC from an Existing Node
- Deleting an Oracle Clusterware Home from an Existing Node

Note: If you are using Oracle Clusterware without vendor clusterware, then you can add and delete nodes without stopping the existing nodes. If you are using Oracle Clusterware with vendor clusterware, then you can add nodes on some UNIX-based systems without stopping the existing nodes if your clusterware supports this. Refer to your vendor-specific clusterware documentation for more information.

Note: For all of the procedures in this chapter, it is very important that you perform each step in the order shown.

See Also: Your Oracle Real Application Clusters platform-specific installation and configuration guide for procedures about using the Database Configuration Assistant (DBCA) to create and delete Oracle RAC databases

Adding an Oracle Clusterware Home to a New Node

Use one of the procedures described in this section to use OUI to add an Oracle Clusterware home to a node that is going to be part of your Oracle RAC cluster. These procedures assume that you are adding `node2` and that you have already successfully installed Oracle Clusterware on `node1` in a non-shared home, where *`CRS_home`* represents the successfully installed home. This section describes the following procedures:

- Adding an Oracle Clusterware Home to a New Node Using OUI in Interactive Mode
- Adding an Oracle Clusterware Home to a New Node Using OUI in Silent Mode

---

Note: When you extend an Oracle RAC database, you must first extend the Oracle Clusterware home to the new nodes and then extend the Oracle home. In other words, you extend the software onto the new nodes in the same order as you installed the clusterware and Oracle database software components on the existing nodes.

The following sections are based on the addition of a node named node2 to an existing cluster that has a node named node1.

Adding an Oracle Clusterware Home to a New Node Using OUI in Interactive Mode

1. Ensure that you have successfully installed Oracle Clusterware on at least one node in your cluster environment. To use these procedures as shown, your $CRS_HOME environment variable must identify your successfully installed Oracle Clusterware home.
2. Go to *CRS_home*/oui/bin and run the addNode.sh script.
3. The Oracle Universal Installer (OUI) displays the Node Selection Page on which you should select the node or nodes that you want to add and click **Next**.
4. Verify the entries that OUI displays on the Summary Page and click **Next**.
5. Run the rootaddNode.sh script from the *CRS_home/install/* directory on the node from which you are running OUI.
6. Run the orainstRoot.sh script on the new node if OUI prompts you to do so.

Note: The orainstRoot.sh script updates the contents of the oraInventory file on all of the nodes in a cluster. If your cluster's oraInventory file is stored in a shared directory, such as in a directory on a cluster file system, Oracle Database displays the following error when you run addnode.sh:

```
SEVERE: Remote 'UpdateNodeList' failed on nodes: 'cpqshow2'.
 Refer to '/install/sana/orainv/logs/UpdateNode List2006-08-11
_08-58-33AM.log' for details.
```

If Oracle Database displays this error, run the following command to complete the update of the oraInventory file:

```
/install/sana/rachome1/oui/bin/runInstaller -updateNodeList
 -noClusterEnabled ORACLE_HOME=/install/sana/rachome1 CLUSTER
_NODES=cpqshow1,cpqshow2 CRS=false "INVENTORY
_LOCATION=/install/sana/orainv" LOCAL_NODE=node_on_which_
command_is_to_be_run
```

---

7. Run the root.sh script on the new node from *CRS_home* to start Oracle Clusterware on the new node.
8. Obtain the remote port identifier, which you need to know for the next step, by running the following command on the existing node from the *CRS_home*/opmn/conf directory:

   ```
   ocrdump -stdout -keyname DATABASE.ONS_HOSTS.host_name.PORT
   ```

9. From the *CRS_home*/bin directory on an existing node, run the Oracle Notification Service (RACGONS) utility as in the following example where *remote_port* is the port number from the previous step and node2 is the name of the node that you are adding:

   ```
   ./racgons add_config node2:remote_port
   ```

Adding an Oracle Clusterware Home to a New Node Using OUI in Silent Mode

1. Ensure that you have successfully installed Oracle Clusterware on at least one node in your cluster environment. To use these procedures as shown, your $CRS_

HOME environment variable must identify your successfully installed Oracle Clusterware home.

2. Go to *CRS_home*/oui/bin and run the addNode.sh script using the following syntax where node2 is the name of the new node that you are adding, node2-priv is the private node name for the new node, and node2-vip is the VIP name for the new node:

```
./addNode.sh -silent "CLUSTER_NEW_NODES={node2}"
"CLUSTER_NEW_PRIVATE_NODE_NAMES={node2-priv}"
"CLUSTER_NEW_VIRTUAL_HOSTNAMES={node2-vip}"
```

Note: The addnode.sh script updates the contents of the oraInventory file on all of the nodes in a cluster. If your cluster's oraInventory file is stored in a shared directory, such as in a directory on a cluster file system, Oracle Database displays the following error when you run addnode.sh:

```
SEVERE: Remote 'UpdateNodeList' failed on nodes: 'cpqshow2'.
 Refer to '/install/sana/orainv/logs/UpdateNode List2006-08-11
_08-58-33AM.log' for details.
```

If Oracle Database displays this error, run the following command to complete the update of the oraInventory file:

```
/install/sana/rachome1/oui/bin/runInstaller -updateNodeList
 -noClusterEnabled ORACLE_HOME=/install/sana/rachome1 CLUSTER
_NODES=cpqshow1,cpqshow2 CRS=false "INVENTORY
_LOCATION=/install/sana/orainv" LOCAL_NODE=node_on_which_
command_is_to_be_run
```

---

3. Perform OUI-related steps 5 through 9 from the previous section about using OUI interactively under the heading "Adding an Oracle Clusterware Home to a New Node Using OUI in Interactive Mode" on page 10-3.

Adding an Oracle Home with Oracle RAC to a New Node

Use one of the following procedures to add an Oracle home to a new node using OUI. These procedures assume that you want to extend an existing Oracle home with Oracle RAC on node1 to node2. Node2 should already be a member node of the cluster to which node1 belongs. The contents of these procedures assume that you have successfully installed Oracle RAC on node1 in a non-shared home and that *Oracle_home* represents the successfully installed Oracle home. This section describes the following procedures:

- Adding an Oracle Home with Oracle RAC to a New Node Using OUI in Interactive Mode
- Adding an Oracle Home with Oracle RAC to a New Node Using OUI in Silent Mode

Adding an Oracle Home with Oracle RAC to a New Node Using OUI in Interactive Mode

1. Ensure that you have successfully installed Oracle with the Oracle RAC software on at least one node in your cluster environment. To use these procedures as shown, your $ORACLE_HOME environment variable must identify your successfully installed Oracle home.

2. Go to *Oracle_home*/oui/bin and run the addNode.sh script.
3. When OUI displays the Node Selection Page, select the node or nodes to be added and click **Next**.
4. Verify the entries that OUI displays on the Summary Page and click **Next**.
5. Run the root.sh script on the new node from *Oracle_home* when OUI prompts you to do so.

Note: The root.sh script updates the contents of the oraInventory file on all of the nodes in a cluster. If your cluster's oraInventory file is stored in a shared directory, such as in a directory on a cluster file system, Oracle Database displays the following error when you run addnode.sh:

```
SEVERE: Remote 'UpdateNodeList' failed on nodes: 'cpqshow2'.
 Refer to '/install/sana/orainv/logs/UpdateNode List2006-08-11
_08-58-33AM.log' for details.
```

If Oracle Database displays this error, run the following command on any one *but only one* of the nodes in the cluster to complete the update of the oraInventory file:

```
/install/sana/rachome1/oui/bin/runInstaller -updateNodeList
 -noClusterEnabled ORACLE_HOME=/install/sana/rachome1 CLUSTER
_NODES=cpqshow1,cpqshow2 CRS=false "INVENTORY
_LOCATION=/install/sana/orainv" LOCAL_NODE=node_on_which_
command_is_to_be_run
```

---

6. On the new node, run the Oracle Net Configuration Assistant (NETCA) as the Oracle RAC user to add a Listener.
7. Use the Enterprise Manager or DBCA to add an instance as described under the heading "Step 5: Adding Database Instances to New Nodes" on page 10-21.

See Also: *Oracle Database Net Services Administrator's Guide* for more information about NETCA

Adding an Oracle Home with Oracle RAC to a New Node Using OUI in Silent Mode

1. Ensure that you have successfully installed Oracle with the Oracle RAC software on at least one node in your cluster environment. To use these procedures, your $ORACLE_HOME environment variable must identify your successfully installed Oracle home and the node to be added is named node2.
2. Go to *Oracle_home*/oui/bin and run the addNode.sh script using the following syntax:

```
./addNode.sh -silent "CLUSTER_NEW_NODES={node2}"
```

Note: The `addnode.sh` script updates the contents of the `oraInventory` file on all of the nodes in a cluster. If your cluster's `oraInventory` file is stored in a shared directory, such as in a directory on a cluster file system, Oracle Database displays the following error when you run `addnode.sh`:

```
SEVERE: Remote 'UpdateNodeList' failed on nodes: 'cpqshow2'.
 Refer to '/install/sana/orainv/logs/UpdateNode List2006-08-11
_08-58-33AM.log' for details.
```

If Oracle Database displays this error, run the following command on any one *but only one* of the nodes in the cluster to complete the update of the `oraInventory` file:

```
/install/sana/rachome1/oui/bin/runInstaller -updateNodeList
 -noClusterEnabled ORACLE_HOME=/install/sana/rachome1 CLUSTER
_NODES=cpqshow1,cpqshow2 CRS=false "INVENTORY
_LOCATION=/install/sana/orainv" LOCAL_NODE=node_on_which_
command_is_to_be_run
```

3. Perform steps 5 through 7 from the previous section about using OUI interactively under the heading "Adding an Oracle Home with Oracle RAC to a New Node Using OUI in Interactive Mode" on page 10-4.

Deleting an Oracle Home with Oracle RAC from an Existing Node

Use the following procedures to delete nodes at the database Oracle home layer on Windows-based systems. These procedures assume that an Oracle RAC database home is installed on both `node1` and `node2` and that you want to delete the database home on node2. Also assume that *`Oracle_home`* represents the location of this home on the nodes. The procedures for deleting an Oracle home assume that you have successfully installed Oracle RAC on the node from which you want to delete the Oracle home. You can use either of the following procedures to delete an Oracle home from a node:

- Deleting an Oracle Home with Oracle RAC Using OUI in Interactive Mode
- Deleting an Oracle Home with Oracle RAC Using OUI in Silent Mode

Note: When you remove Oracle Clusterware and Oracle RAC database software, you must first remove the Oracle database software and then remove Oracle Clusterware from the nodes that you are deleting. In other words, you remove the software components from the nodes that you are deleting in the *reverse order* that you originally installed the clusterware and Oracle database software components.

Note: For all of the procedures in this chapter, it is very important that you perform each step in the order shown.

Deleting an Oracle Home with Oracle RAC Using OUI in Interactive Mode

1. From a node that is to remain a part of your Oracle RAC database environment, use Enterprise Manager or DBCA to remove any database instances from the node

that you want to delete if instances exist on that node. To do this, refer to the procedure titled "Step 1: Deleting Instances from Oracle Real Application Clusters Databases" on page 10-24.

2. If you use ASM and this is the home from which the ASM instance runs, then perform the ASM clean up procedures as described under "Step 3: ASM Instance Clean-Up Procedures for Node Deletion" on page 10-29.

3. If this is the home from which the node-specific Listener runs, then use NETCA to remove the Listener and its Oracle Clusterware resources.

   See Also: *Oracle Database Net Services Administrator's Guide* for more information about NETCA

4. On the node to be deleted, ensure that the `$ORACLE_HOME` environment variable is set to the Oracle home, then run the following command only with a non-shared Oracle home from *`Oracle_home`*`/oui/bin` where *`node_name`* is the name of the node to be deleted:

   ```
   ./runInstaller -updateNodeList ORACLE_HOME=Oracle_home
   "CLUSTER_NODES={node_name}" -local
   ```

   For a non-shared home, on each node that you are deleting, run OUI from the home and deinstall this home. Make sure that you choose the home to be removed and not just the products under that home.

   Note: If the contents of the Oracle home are not completely removed, then remove the remaining contents of the Oracle home using the `rm -rf` *`ORACLE_HOME`* command, where *`ORACLE_HOME`* is the complete path to the Oracle home that you want to finish removing.

5. On the node to be deleted, ensure that the `$ORACLE_HOME` environment variable is defined for the shared home location and run the following command on each of the nodes that are to be deleted:

   ```
   ./runInstaller -detachHome -local ORACLE_HOME=Oracle_home
   ```

   For a non-shared home, on each node that you are deleting, ensure that the `$ORACLE_HOME` environment variable is defined for the home that you are deleting and run the following command:

   ```
   ./runInstaller -deinstall -silent "REMOVE_HOMES={Oracle_home}"
   ```

6. On any node *other than the node that you are deleting*, make sure that the `$ORACLE_HOME` environment variable is defined for the Oracle home that you are deleting. Run the following command from *`Oracle_home`*`/oui/bin` where *`remaining_nodes_list`* is a comma-delimited list of the nodes that are going to remain as part of your Oracle RAC database:

   ```
   ./runInstaller -updateNodeList ORACLE_HOME=Oracle_home
   "CLUSTER_NODES={remaining_nodes_list}"
   ```

   When using a shared Oracle home, run the following version of the command:

   ```
   ./runInstaller -updateNodeList -noClusterEnabled ORACLE_HOME=CRS_home
   "CLUSTER_NODES={remaining_nodes_list}" CRS=TRUE
   ```

See Also: *Oracle Database Net Services Administrator's Guide* for more information about NETCA

Deleting an Oracle Home with Oracle RAC Using OUI in Silent Mode

Note: Use the following procedure only in a non-shared Oracle home.

1. Perform steps 1 through 4 from the previous section about using OUI interactively under the heading "Deleting an Oracle Home with Oracle RAC Using OUI in Interactive Mode" on page 10-6.
2. Depending on whether you have a shared or non-shared Oracle home, complete one of the following two procedures:
   - For a shared home, ensure that the `$ORACLE_HOME` environment variable is defined for the shared home location and run the following command on each of the nodes that are to be deleted:

     ```
     ./runInstaller -detachHome -local ORACLE_HOME=Oracle_home
     ```

   - For a non-shared home, on each node that you are deleting, ensure that the `$ORACLE_HOME` environment variable is defined for the home that you are deleting and perform the following step:

     ```
     ./runInstaller -deinstall -silent "REMOVE_HOMES={Oracle_home}"
     ```

3. Perform Step 6 from the procedure, "Deleting an Oracle Home with Oracle RAC Using OUI in Interactive Mode" on page 10-7.

Deleting an Oracle Clusterware Home from an Existing Node

The procedures for deleting an Oracle Clusterware home assume that you have successfully installed the clusterware on the node from which you want to delete the Oracle Clusterware home. You can use either of the following procedures to delete an Oracle Clusterware home from a node:

- Deleting an Oracle Clusterware Home Using OUI in Interactive Mode
- Deleting an Oracle Clusterware Home Using OUI in Silent Mode

Deleting an Oracle Clusterware Home Using OUI in Interactive Mode

1. Perform the delete node operation for database homes as described in the section titled "Deleting an Oracle Home with Oracle RAC Using OUI in Interactive Mode" on page 10-6 or use the procedure, "Deleting an Oracle Home with Oracle RAC Using OUI in Silent Mode" on page 10-8, and ensure that the `$CRS_HOME` environment variable is defined to identify the appropriate Oracle Clusterware home on each node.
2. If you ran the Oracle Interface Configuration Tool (OIFCFG) with the `-global` flag during the installation, then skip this step. Otherwise, from a node that is going to remain in your cluster, from the *`CRS_home`*`/bin` directory, run the following command where `node2` is the name of the node that you are deleting:

   ```
   ./oifcfg delif -node node2
   ```

3. Obtain the remote port number, which you will use in the next step, using the following command from the *CRS_home*/bin directory:

   ```
   ocrdump -stdout -keyname DATABASE.ONS_HOSTS.host_name.PORT
   ```

4. From *CRS_home*/bin on a node that is going to remain in the cluster, run the Oracle Notification Service Utility (RACGONS) as in the following example where *remote_port* is the ONS remote port number that you obtained in the previous step and node2 is the name of the node that you are deleting:

   ```
   ./racgons remove_config node2:remote_port
   ```

5. On the node to be deleted, run rootdelete.sh as the root user from the *CRS_home/install* directory. If you are deleting more than one node, then perform this step on all of the other nodes that you are deleting.

6. From any node that you are *not* deleting, run the following command from the *CRS_home/install* directory as the root user where node2,node2-*number* represents the node and the node number that you want to delete:

   ```
   ./rootdeletenode.sh node2,node2-number
   ```

   If necessary, identify the node number using the following command on the node that you are deleting:

   ```
   CRS_home/bin/olsnodes -n
   ```

7. *Perform this step only if your are using a non-shared Oracle home.* On the node or nodes to be deleted, run the following command from the *CRS_home*/oui/bin directory where *node_to_be_deleted* is the name of the node that you are deleting:

   ```
   ./runInstaller -updateNodeList ORACLE_HOME=CRS_home
   "CLUSTER_NODES={node_to_be_deleted}"
   CRS=TRUE -local
   ```

8. *Perform this step only if your are using a non-shared Oracle home.* On the node that you are deleting, run OUI using the runInstaller command from the *CRS_home*/oui/bin directory to deinstall Oracle Clusterware.

   Deinstall the Oracle Clusterware home from the node that you are deleting using OUI as follows by running the following command from the *Oracle_home*/oui/bin directory, where *CRS_home* is the name defined for the Oracle Clusterware home:

   ```
   ./runInstaller -deinstall -silent "REMOVE_HOMES={CRS_home}"
   ```

9. If you are using a non-shared Oracle home, on any node other than the node that you are deleting, run the following command from the *CRS_home*/oui/bin directory where *remaining_nodes_list* is a comma-delimited list of the nodes that are going to remain part of your Oracle RAC database:

   ```
   ./runInstaller -updateNodeList ORACLE_HOME=CRS_home
   "CLUSTER_NODES={remaining_nodes_list}" CRS=TRUE
   ```

   If you are using a shared Oracle home, on any node other than the node that you are deleting, run the following command from the *CRS_home*/oui/bin directory where *remaining_nodes_list* is a comma-delimited list of the nodes that are going to remain part of your Oracle RAC database:

   ```
   ./runInstaller -updateNodeList -noClusterEnabled ORACLE_HOME=Oracle_home
   "CLUSTER_NODES={remaining_nodes_list}"
   ```

Deleting an Oracle Clusterware Home Using OUI in Silent Mode

1. Perform steps 1 through 7 from the previous section about using OUI interactively under the heading "Deleting an Oracle Clusterware Home Using OUI in Interactive Mode" on page 10-8. Also ensure that the `$CRS_HOME` environment variable is defined to identify the appropriate Oracle Clusterware home on each node.
2. Deinstall the Oracle Clusterware home from the node that you are deleting using OUI as follows by running the following command from the *`Oracle_home`*`/oui/bin` directory, where *`CRS_home`* is the name defined for the Oracle Clusterware home:

   ```
   ./runInstaller -deinstall -silent "REMOVE_HOMES={CRS_home}"
   ```

3. Perform step 9 from the previous section about using OUI interactively under the heading "Deleting an Oracle Clusterware Home Using OUI in Interactive Mode" on page 10-8.

> **Note:** Oracle recommends that you back up your voting disk and OCR files after you complete the node deletion process.

Detailed Node and Instance Addition and Deletion Procedures

This section provides detailed procedures for adding and deleting nodes to clusters. The details of these steps appear in the following sections:

- Overview of Node Addition Procedures
- Adding Nodes that Already Have Clusterware and Oracle Software to a Cluster
- Overview of Node Deletion Procedures

Overview of Node Addition Procedures

This section explains how to add nodes to clusters using detailed manual procedures. Do this by setting up the new nodes to be part of your **cluster** at the network level. Then extend the Oracle Clusterware home from an existing Oracle Clusterware home to the new nodes and then extend the Oracle database software with Oracle RAC components to the new nodes. Finally, make the new nodes members of the existing Oracle RAC database.

> **Note:** You can add nodes on some UNIX-based platforms without stopping existing nodes if your clusterware supports this. Refer to your vendor-specific clusterware documentation for more information.

If the nodes that you are adding to your cluster do not have clusterware or Oracle software installed on them and if you are not using Oracle cloning, then you must complete the following five steps to add nodes. The procedures in these steps assume that you already have an operative UNIX-based Oracle RAC environment. The details of these steps appear in the following sections.

- Step 1: Connecting New Nodes to the Cluster
- Step 2: Extending Clusterware and Oracle Software to New Nodes
- Step 3: Preparing Storage on New Nodes

- Step 4: Adding Nodes at the Oracle RAC Database Layer
- Step 5: Adding Database Instances to New Nodes

To add a node to your cluster when the node is already configured with clusterware and Oracle software, follow the procedure described in "Adding Nodes that Already Have Clusterware and Oracle Software to a Cluster" on page 10-23.

> **See Also:** Your platform-specific Oracle Real Application Clusters installation and configuration guide for procedures about using DBCA to create and delete Oracle RAC databases

Step 1: Connecting New Nodes to the Cluster

Complete the following procedures to connect the new nodes to the cluster and to prepare them to support your Oracle RAC database:

- Making Physical Connections
- Installing the Operating System
- Creating Oracle Users
- Verifying the Installation with the Cluster Verification Utility
- Checking the Installation

Making Physical Connections Connect the new nodes' hardware to the network infrastructure of your cluster. This includes establishing electrical connections, configuring network interconnects, configuring shared disk subsystem connections, and so on. Refer to your hardware vendor documentation for details about this step.

Installing the Operating System Install a cloned image of the operating system that matches the operating system on the other nodes in your cluster. This includes installing required service patches and drivers. Refer to your hardware vendor documentation for details about this process.

Creating Oracle Users As `root` user, create the Oracle users and groups using the same user ID and group ID as on the existing nodes.

Verifying the Installation with the Cluster Verification Utility Verify your installation using the Cluster Verification Utility (CVU) as in the following steps:

1. From the directory *`CRS_home`*`/bin` on the existing nodes, run the CVU command to verify your installation at the post hardware installation stage as shown in the following example, where *`node_list`* is a comma-delimited list of nodes you want in your cluster:

   ```
   cluvfy stage -post hwos -n node_list|all [-verbose]
   ```

   This command causes CVU to verify your hardware and operating system environment at the post-hardware setup stage. After you have configured the hardware and operating systems on the new nodes, you can use this command to verify node reachability, for example, to all of the nodes from the local node. You can also use this command to verify user equivalence to all given nodes the local node, node connectivity among all of the given nodes, accessibility to shared storage from all of the given nodes, and so on.

Note: You can only use the `all` option with the `-n` argument if you have set the `CV_NODELIST` variable to represent the list of nodes on which you want to perform the CVU operation.

See Also: "Using the Cluster Verification Utility" on page A-10 for more information about enabling and using the CVU

2. From the directory *`CRS_home`*`/bin` on the existing nodes, run the CVU command to obtain a detailed comparison of the properties of the reference node with all of the other nodes that are part of your current cluster environment where *`ref_node`* is a node in your existing cluster against which you want CVU to compare, for example, the newly added nodes that you specify with the comma-delimited list in *`node_list`* for the `-n` option, *`orainventory_group`* is the name of the Oracle inventory group, and *`osdba_group`* is the name of the OSDBA group:

```
cluvfy comp peer [ -refnode ref_node ] -n node_list
[ -orainv orainventory_group ] [ -osdba osdba_group ] [-verbose]
```

Note: For the reference node, select a node from your existing cluster nodes against which you want CVU to compare, for example, the newly added nodes that you specify with the `-n` option.

Checking the Installation To verify that your installation is configured correctly, perform the following steps:

1. Ensure that the new nodes can access the private interconnect. This interconnect must be properly configured before you can complete the procedures in "Step 2: Extending Clusterware and Oracle Software to New Nodes" on page 10-13.
2. If you are not using a cluster file system, then determine the location on which your cluster software was installed on the existing nodes. Make sure that you have at least 250MB of free space on the same location on each of the new nodes to install Oracle Clusterware. In addition, ensure you have enough free space on each new node to install the Oracle binaries.
3. Ensure that the Oracle Cluster Registry (OCR) and the voting disk are accessible by the new nodes using the same path as the other nodes use. In addition, the OCR and voting disk devices must have the same permissions as on the existing nodes.
4. Verify user equivalence to and from an existing node to the new nodes using `rsh` or `ssh`.

After completing the procedures in this section, your new nodes are connected to the cluster and configured with the required software to make them visible to the clusterware. Configure the new nodes as members of the cluster by extending the cluster software to the new nodes as described in "Step 2: Extending Clusterware and Oracle Software to New Nodes" on page 10-13.

Note: Do not change a hostname after the Oracle Clusterware installation. This includes adding or deleting a domain qualification.

Step 2: Extending Clusterware and Oracle Software to New Nodes

The following topics describe how to add new nodes to the clusterware and to the Oracle database software layers using OUI:

- Adding Nodes at the Vendor Clusterware Layer
- Adding Nodes at the Oracle Clusterware Layer

Adding Nodes at the Vendor Clusterware Layer Add the new nodes at the clusterware layer according to the vendor clusterware documentation. For systems using shared storage for the Oracle Clusterware home, ensure that the existing clusterware is accessible by the new nodes. Also ensure that the new nodes can be brought online as part of the existing cluster. Proceed to the next section to add the nodes at the clusterware layer.

Adding Nodes at the Oracle Clusterware Layer Before beginning this procedure, ensure that your existing nodes have the `$CRS_HOME` environment variable set correctly. The OUI requires access to the private interconnect that you verified as part of the installation validation in Step 1. If OUI cannot make the required connections, then you will not be able to complete the following steps to add nodes.

> **Note:** Instead of performing the first six steps of this procedure, you can alternatively run the `addNode.sh` script in silent mode as described at the end of this section.

1. On one of the *existing* nodes go to the *`CRS_home`*`/oui/bin` directory and run the `addNode.sh` script to start OUI.

   > **Note:** The `addnode.sh` script updates the contents of the `oraInventory` file on all of the nodes in a cluster. If your cluster's `oraInventory` file is stored in a shared directory, such as in a directory on a cluster file system, Oracle Database displays the following error when you run `addnode.sh`:
   >
   > ```
   > SEVERE: Remote 'UpdateNodeList' failed on nodes: 'cpqshow2'.
   >  Refer to '/install/sana/orainv/logs/UpdateNode List2006-08-11
   > _08-58-33AM.log' for details.
   > ```
   >
   > If Oracle Database displays this error, run the following command to complete the update of the `oraInventory` file:
   >
   > ```
   > /install/sana/rachome1/oui/bin/runInstaller -updateNodeList
   >  -noClusterEnabled ORACLE_HOME=/install/sana/rachome1 CLUSTER
   > _NODES=cpqshow1,cpqshow2 CRS=false "INVENTORY
   > _LOCATION=/install/sana/orainv" LOCAL_NODE=node_on_which_
   > command_is_to_be_run
   > ```

2. The OUI runs in `add node` mode and the OUI Welcome page appears. Click **Next** and the Specify Cluster Nodes for Node Addition page appears.
3. The upper table on the Specify Cluster Nodes for Node Addition page shows the existing nodes, the private node names, and the virtual IP (VIP) addresses that are associated with Oracle Clusterware. Use the lower table to enter the public, private node names and the virtual hostnames of the new nodes.
4. If you are using vendor clusterware, then the public node names automatically appear in the lower table. Click **Next** and OUI verifies connectivity on the existing

nodes and on the new nodes. The verifications that OUI performs include determining whether:

- The nodes are up
- The nodes and private node names are accessible by way of the network

---

Note: If any of the existing nodes are down, you can proceed with the procedure. However, once the nodes are up, you must run the following command on each of those nodes *only if you are using a local (non-shared) Oracle home*:

```
runInstaller -updateNodeList -local
"CLUSTER_NODES={available_node_list}"
ORACLE_HOME=CRS_home
```

This operation should be run from the *CRS_home*`/oui/bin` directory and the *available_node_list* values is comma-delimited list of all of nodes currently in the cluster and *CRS_home* defines the Oracle Clusterware home directory.

- The virtual hostnames are not already in use on the network.

5. If any verifications fail, then OUI re-displays the Specify Cluster Nodes for Node Addition page with a Status column in both tables indicating errors. Correct the errors or deselect the nodes that have errors and proceed. However, you cannot deselect existing nodes; you must correct problems on nodes that are already part of your cluster before you can proceed with node addition. If all the checks succeed, then OUI displays the Node Addition Summary page.

Note: Oracle strongly recommends that you install Oracle Clusterware on *every* node in the cluster on which you have installed vendor clusterware.

---

6. The Node Addition Summary page displays the following information showing the products that are installed in the Oracle Clusterware home that you are extending to the new nodes:
   - The source for the add node process, which in this case is the Oracle Clusterware home
   - The private node names that you entered for the new nodes
   - The new nodes that you entered
   - The required and available space on the new nodes
   - The installed products listing the products that are already installed on the existing Oracle Clusterware home

   Click **Next** and OUI displays the Cluster Node Addition Progress page.

7. The Cluster Node Addition Progress page shows the status of the cluster node addition process. The table on this page has two columns showing the four phases of the node addition process and the phases' statuses as follows:
   - Instantiate Root Scripts: Instantiates `rootaddNode.sh` with the public nodes, private node names, and virtual hostnames that you entered on the Cluster Node Addition page.

- Copy the Oracle Clusterware home to the New Nodes: Copies the Oracle Clusterware home to the new nodes unless the Oracle Clusterware home is on a cluster file system.
- Save Cluster Inventory: Updates the node list associated with the Oracle Clusterware home and its inventory.
- Run `rootaddNode.sh` and `root.sh`: Displays a dialog prompting you to run the `rootaddNode.sh` script from the local node (the node on which you are running OUI) and to run the `root.sh` script on the new nodes. If OUI detects that the new nodes do not have an inventory location, then OUI instructs you to run `orainstRoot.sh` on those nodes. The central inventory location is the same as that of the local node. The `addNodeActions`*`timestamp`*`.log` file, where *`timestamp`* shows the session start date and time, contains information about which scripts you need to run and on which nodes you need to run them.

The Cluster Node Addition Progress page's Status column displays `In Progress` while the phase is in progress, `Suspended` when the phase is pending execution, and `Succeeded` after the phase completes. On completion, click **Exit** to end the OUI session. After OUI displays the End of Node Addition page, click **Exit** to end the OUI session.

For shared Oracle home users, run the following command *only once on any of the nodes* from the `$ORACLE_HOME/oui/bin` directory, where *`nodes_list`* is a comma-delimited list of the nodes that are part of your cluster:

```
./runInstaller -updateNodeList -noClusterEnabled ORACLE_HOME=Oracle_home
 CLUSTER_NODES=nodes_list
```

8. Obtain the remote port number, which you will use in the next step, using the following command from the *`CRS_home`*`/bin` directory:

```
ocrdump -stdout -keyname DATABASE.ONS_HOSTS.host_name.PORT
```

If you are using a shared Oracle home, verify that the `usesharedinstall=true` entry is included in the `$ORACLE_HOME/opmn/conf/ons.config` file. If it is not, do the following:

a. Navigate to the `$CRS_HOME/opmn/conf` directory.

b. Enter the following:

```
$ cat >> ons.config
usesharedinstall=true
```

c. Press **Ctrl-D**.

d. Restart the Oracle Notification Server.

9. Run the `racgons` utility from the `bin` subdirectory of the Oracle Clusterware home to configure the Oracle Notification Services (ONS) port number. Use the following command, supplying the name of the node that you are adding for *`new_node_name`* and the remote port number obtained in the previous step:

```
racgons add_config new_node_name:remote_port
```

10. Check that your cluster is integrated and that the cluster is not divided into partitions by completing the following operations:

- Run the following CVU command to obtain detailed output for verifying cluster manager integrity on all of the nodes that are part of your Oracle RAC environment:

```
cluvfy comp clumgr -n all [-verbose]
```

- Use the following CVU command to obtain detailed output for verifying cluster integrity on all of the nodes that are part of your Oracle RAC environment:

  ```
  cluvfy comp clu [-verbose]
  ```

- Use the following command to perform an integrated validation of the Oracle Clusterware setup on all of the configured nodes, both the pre-existing nodes and the nodes that you have added:

  ```
  cluvfy comp stage -post crinst -n all [-verbose]
  ```

  See Also: "Using the Cluster Verification Utility" on page A-10 for more information about enabling and using the CVU

You can optionally run `addNode.sh` in silent mode, replacing steps 1 through 7, as follows where `nodeI`, `nodeI+1`, and so on are the new nodes that you are adding:

```
addNode.sh -silent "CLUSTER_NEW_NODES={nodeI, nodeI+1, … nodeI+n}"
"CLUSTER_NEW_PRIVATE_NODE_NAMES={pnI, pnI+1, … pnI+n}"
"CLUSTER_NEW_VIRTUAL_HOSTNAMES={vipI, vipI+1,…,vipI+n}"
```

You can alternatively specify the `variable=value` entries in a response file and run the `addNode.sh` script as follows:

```
addNode.sh -silent -responseFile filename OR addNode.bat -silent -responseFile
filename
```

See Also: *Oracle Universal Installer and OPatch User's Guide* for details about how to configure command-line response files

---

Notes:

- Command-line values always override response file values.
- The `addnode.sh` script updates the contents of the `oraInventory` file on all of the nodes in a cluster. If your cluster's `oraInventory` file is stored in a shared directory, such as in a directory on a cluster file system, Oracle Database displays the following error when you run `addnode.sh`:

  ```
  SEVERE: Remote 'UpdateNodeList' failed on nodes: 'cpqshow2'.
   Refer to '/install/sana/orainv/logs/UpdateNode
   List2006-08-11_08-58-33AM.log' for details.
  ```

  If Oracle Database displays this error, run the following command to complete the update of the `oraInventory` file:

  ```
  /install/sana/rachome1/oui/bin/runInstaller -updateNodeList
   -noClusterEnabled ORACLE_HOME=/install/sana/rachome1 CLUSTER
  _NODES=cpqshow1,cpqshow2 CRS=false "INVENTORY
  _LOCATION=/install/sana/orainv" LOCAL_NODE=node_on_which_
  command_is_to_be_run
  ```

Run `rootaddNode.sh` on the local node, or the node on which you are performing this procedure, and run `root.sh` on the new nodes. If OUI detects that the new nodes

do not have an inventory location, then OUI instructs you to run `orainstRoot.sh` on those nodes. The central inventory location is the same as that of the local node. The `addNodeActions`*`timestamp`*`.log` file, where *`timestamp`* shows the session start date and time, contains the information about which scripts you need to run and on which nodes you need to run them.

After you have completed the procedures in this section for adding nodes at the Oracle Clusterware layer, you have successfully extended the Oracle Clusterware home from your existing the Oracle Clusterware home to the new nodes. Proceed to "Step 3: Preparing Storage on New Nodes" on page 10-17 to prepare storage for Oracle RAC on the new nodes.

Step 3: Preparing Storage on New Nodes

To extend an existing Oracle RAC database to your new nodes, configure the shared storage for the new instances to be added on new nodes so that the storage type is the same as the storage that is already used by the existing nodes' instances. Prepare the same type of storage on the new nodes as you are using on the other nodes in the Oracle RAC environment that you want to extend as follows:

- Automatic Storage Management (ASM)

  If you are using ASM, then make sure that the new nodes can access the ASM disks with the same permissions as the existing nodes.

- Oracle Cluster File System (OCFS)

  If you are using Oracle Cluster File Systems, then make sure that the new nodes can access the cluster file systems in the same way that the other nodes access them.

- Vendor Cluster File Systems

  If your cluster database uses vendor cluster file systems, then configure the new nodes to use the vendor cluster file systems. Refer to the vendor clusterware documentation for the pre-installation steps for your UNIX platform.

- Raw Device Storage

  If your cluster database uses raw devices, then prepare the new raw devices by following the procedures described in the next section.

> **See Also:** *Oracle Database Oracle Clusterware and Oracle Real Application Clusters Installation Guide for Microsoft Windows* for more information about the Oracle Cluster File System

Run the following command to verify your cluster file system and obtain detailed output where *`nodelist`* includes both the pre-existing nodes and the newly added nodes and *`file system`* is the name of the file system that you used for the Oracle Cluster File System:

```
cluvfy comp cfs -n nodelist -f file system [-verbose]
```

> **See Also:** "Using the Cluster Verification Utility" on page A-10 for more information about enabling and using the CVU

Raw Device Storage Preparation for New Nodes To prepare raw device storage on the new nodes, you need at least two new disk partitions to accommodate the redo logs for each new instance. Make these disk partitions the same size as the redo log partitions

that you configured for the existing nodes' instances. Also create an additional logical partition for the undo tablespace for automatic undo management.

On applicable operating systems, you can create symbolic links to your raw devices. Optionally, you can create a raw device mapping file and set the `DBCA_RAW_CONFIG` environment variable so that it points to the raw device mapping file. Use your vendor-supplied tools to configure the required raw storage.

> **See Also:** Your platform-specific Oracle Real Application Clusters installation and configuration guide for procedures about using DBCA to create and delete Oracle RAC databases

Run the following command to verify that the prepared raw device storage is accessible from all of the configured cluster nodes where *`node_list`* includes both the pre-existing nodes and the newly added nodes and *`storageID_list`* is a comma-delimited list of storage identifiers:

```
cluvfy comp ssa [ -n node_list ] [ -s storageID_list ] [-verbose]
```

> **See Also:** "Using the Cluster Verification Utility" on page A-10 for more information about enabling and using the CVU

After completing the procedures in this section, you have configured your shared storage for use by the instances to be added on the new nodes so that the new nodes can access the Oracle software. Additionally, the existing nodes can access the new nodes and instances. Use OUI as described in the procedures in "Step 4: Adding Nodes at the Oracle RAC Database Layer" on page 10-18 to configure the new nodes at the Oracle RAC database layer.

Step 4: Adding Nodes at the Oracle RAC Database Layer

To add nodes at the Oracle RAC database later, run OUI in `add node` mode to configure your new nodes. Before beginning this procedure, ensure that your existing nodes have the `$ORACLE_HOME` environment variable set correctly. If you have multiple Oracle homes, then perform the following steps for each Oracle home that you want to include on the new nodes:

> **Note:** Instead of performing the first six steps of this procedure, you can alternatively run `addNode.sh` in silent mode as described at the end of this section.

1. On an existing node from the *`Oracle_home`*`/oui/bin` directory, run the `addNode.sh` script. This starts OUI in `add node` mode and displays the OUI Welcome page. Click **Next** on the Welcome page and OUI displays the Specify Cluster Nodes for Node Addition page.

Note: The `addnode.sh` script updates the contents of the `oraInventory` file on all of the nodes in a cluster. If your cluster's `oraInventory` file is stored in a shared directory, such as in a directory on a cluster file system, Oracle Database displays the following error when you run `addnode.sh`:

```
SEVERE: Remote 'UpdateNodeList' failed on nodes: 'cpqshow2'.
 Refer to '/install/sana/orainv/logs/UpdateNode List2006-08-11
_08-58-33AM.log' for details.
```

If Oracle Database displays this error, run the following command to complete the update of the `oraInventory` file:

```
/install/sana/rachome1/oui/bin/runInstaller -updateNodeList
 -noClusterEnabled ORACLE_HOME=/install/sana/rachome1 CLUSTER
_NODES=cpqshow1,cpqshow2 CRS=false "INVENTORY
_LOCATION=/install/sana/orainv" LOCAL_NODE=node_on_which_
command_is_to_be_run
```

2. The Specify Cluster Nodes for Node Addition page has a table showing the existing nodes associated with the Oracle home from which you launched OUI. A node selection table appears on the bottom of this page showing the nodes that are available for addition. Select the nodes that you want to add and click **Next**.
3. The OUI verifies connectivity and performs availability checks on the existing nodes and on the nodes that you want to add. Some of checks performed determine whether:
   - The nodes are up
   - The nodes are accessible by way of the network
4. If any of the checks fail, then fix the problem and proceed or deselect the node that has the error and proceed. You cannot deselect existing nodes; you must correct problems on the existing nodes before proceeding with node addition. If all of the checks succeed, then OUI displays the Node Addition Summary page.

   Note: If any of the existing nodes are down, then perform the `updateNodeList` procedure on each of the nodes to fix the node list after the nodes are up. Run the following command where *`node_list`* is a comma-delimited list of all of the nodes on which Oracle RAC is deployed:

   ```
   oui/bin/runInstaller -updateNodeList
   "CLUSTER_NODES={node_list}" -local
   ```

5. The Node Addition Summary page has the following information about the products that are installed in the Oracle home that you are going to extend to the new nodes:
   - The source for the add node process, which in this case is the Oracle home
   - The existing nodes and new nodes
   - The new nodes that you selected
   - The required and available space on the new nodes

- The installed products listing all of the products that are already installed in the existing Oracle home

Click **Finish** and OUI displays the Cluster Node Addition Progress page.

6. The Cluster Node Addition Progress page shows the status of the cluster node addition process. The table on this page has two columns showing the four phases of the node addition process and each phases' status as follows:
   - Copy the Oracle Home to the New Nodes: Copies the entire Oracle home from the local node to the new nodes unless the Oracle home is on a cluster file system
   - Save Cluster Inventory: Updates the node list associated with the Oracle home and its inventory
   - Run `root.sh`: Displays the dialog prompting you to run `root.sh` on the new nodes

   The Cluster Node Addition Progress page's Status column displays `Succeeded` if the phase completes, `In Progress` if the phase is in progress, and `Suspended` when the phase is pending execution. After OUI displays the End of Node Addition page, click **Exit** to end the OUI session.
7. Run the `root.sh` script on all of the new nodes.

   The Oracle Clusterware issues the `oifcfg` command as in the following example:

   ```
   oifcfg setif -global  eth0/146.56.76.0:public eth1/192.0.0.0:cluster_
   interconnect
   ```

   This sets both networks to `global`. Therefore, you do not need to run the `oifcfg` command manually after you add a node unless the network interfaces differ.
8. For shared Oracle home users, run the following command *only once on any of the nodes* from the `$ORACLE_HOME/oui/bin` directory, where *`nodes_list`* is a comma-delimited list of the nodes that are part of your cluster:

   ```
   ./runInstaller -updateNodeList -noClusterEnabled ORACLE_HOME=Oracle_home
    CLUSTER_NODES=nodes_list
   ```

9. Add a Listener to the new node by running the Net Configuration Assistant (NetCA) from new node and selecting only the new node on the Node Selection page.

You can optionally run `addNode.sh` in silent mode, replacing steps 1 through 6, as follows where `nodeI`, `nodeI+1`, and so on are the new nodes that you are adding:

```
addNode.sh -silent "CLUSTER_NEW_NODES={nodeI, nodeI+1, … nodeI+n}"
```

You can also specify the `variable=value` entries in a response file, known as *`filename`*, and you can run the `addNode` script as follows:

```
addNode.sh -silent -responseFile filename
```

Notes:

- Command-line values always override response file values.
- The `addnode.sh` script updates the contents of the `oraInventory` file on all of the nodes in a cluster. If your cluster's `oraInventory` file is stored in a shared directory, such as in a directory on a cluster file system, Oracle Database displays the following error when you run `addnode.sh`:

```
SEVERE: Remote 'UpdateNodeList' failed on nodes: 'cpqshow2'.
 Refer to '/install/sana/orainv/logs/UpdateNode
 List2006-08-11_08-58-33AM.log' for details.
```

  If Oracle Database displays this error, run the following command to complete the update of the `oraInventory` file:

```
/install/sana/rachome1/oui/bin/runInstaller -updateNodeList
 -noClusterEnabled ORACLE_HOME=/install/sana/rachome1 CLUSTER
_NODES=cpqshow1,cpqshow2 CRS=false "INVENTORY
_LOCATION=/install/sana/orainv" LOCAL_NODE=node_on_which_
command_is_to_be_run
```

See Also: *Oracle Universal Installer and OPatch User's Guide* for more information about how to configure command-line response files and *Oracle Database Net Services Administrator's Guide* for more information about NETCA

After completing the procedures in this section, you have defined the new nodes at the cluster database layer. You can now add database instances to the new nodes as described in "Step 5: Adding Database Instances to New Nodes" on page 10-21.

Step 5: Adding Database Instances to New Nodes

You can use Enterprise Manager, or the Database Configuration Assistant (DBCA) in either interactive mode or in silent mode, to add database instances to new nodes. Before beginning this procedure, ensure that your existing nodes have the `$ORACLE_HOME` environment variable set correctly. Use one of the following procedures to add the database instances to the new nodes:

- Using Enterprise Manager to Add Database Instances to New Nodes
- Using DBCA in Interactive Mode to Add Database Instances to New Nodes
- Using DBCA in Silent Mode to Add Database Instances to New Nodes

Using Enterprise Manager to Add Database Instances to New Nodes To add a database instance to a new node with Enterprise Manager, perform the following procedure:

1. From the Cluster Database Home page, click the **Maintenance** tab.
2. Under the Deployments section, click **Add Instance**. This initiates a wizard to guide you through the instance addition process.
3. Perform the following tasks for each wizard step:
   - If the database uses ASM, then provide host and ASM credentials.
   - Specify the hosts for which you want to add instances.
   - Review and submit the job.

After you submit the job, the wizard provides a summary page that shows whether the job succeeded and the wizard also provides other detailed information about the job, such as the elapsed time and an output log.

After adding the instances to the new nodes using the steps described in this section, perform any needed service configuration procedures as described in Chapter 6, "Introduction to Workload Management".

Using DBCA in Interactive Mode to Add Database Instances to New Nodes To add a database instance to a new node with DBCA in interactive mode, perform the following procedure:

1. Start the Database Configuration Assistant (DBCA) by entering `dbca` at the system prompt from the `bin` directory in the *`Oracle_home`* directory.

   The DBCA displays the Welcome page for Oracle RAC. Click **Help** on any DBCA page for additional information.

2. Select Oracle Real Application Clusters database, click **Next**, and DBCA displays the Operations page.

3. Select **Instance Management**, click **Next**, and DBCA displays the Instance Management page.

4. Select **Add Instance** and click **Next**. The DBCA displays the List of Cluster Databases page that shows the databases and their current status, such as `ACTIVE`, or `INACTIVE`.

5. From the List of Cluster Databases page, select the active Oracle RAC database to which you want to add an instance. Enter user name and password for the database user that has SYSDBA privileges. Click **Next** and DBCA displays the List of Cluster Database Instances page showing the names of the existing instances for the Oracle RAC database that you selected.

6. Click **Next** to add a new instance and DBCA displays the Adding an Instance page.

7. On the Adding an Instance page, enter the instance name in the field at the top of this page if the instance name that DBCA provides does not match your existing instance naming scheme. Then select the new node name from the list, click **Next**, and DBCA displays the Services Page.

8. Enter the services information for the new node's instance, click **Next**, and DBCA displays the Instance Storage page.

9. If you are using raw devices or raw partitions, then on the Instance Storage page select the Tablespaces folder and expand it. Select the undo tablespace storage object and a dialog appears on the right-hand side. Change the default datafile name to the raw device name for the tablespace.

10. If you are using raw devices or raw partitions or if you want to change the default redo log group file name, then on the Instance Storage page select and expand the Redo Log Groups folder. For each redo log group number that you select, DBCA displays another dialog box. Enter the raw device name that you created in the section "Raw Device Storage Preparation for New Nodes" on page 10-17 in the File Name field.

11. If you are using a cluster file system, then click **Finish** on the Instance Storage page. If you are using raw devices, then repeat step 10 for all of the other redo log groups, click **Finish**, and DBCA displays a Summary dialog.

12. Review the information on the Summary dialog and click **OK** or click **Cancel** to end the instance addition operation. The DBCA displays a progress dialog showing DBCA performing the instance addition operation. When DBCA completes the instance addition operation, DBCA displays a dialog asking whether you want to perform another operation.
13. After you terminate your DBCA session, run the following command to verify the administrative privileges on the new node and obtain detailed information about these privileges where *nodelist* consists of the newly added nodes:

```
cluvfy comp admprv -o db_config -d oracle_home -n nodelist [-verbose]
```

After adding the instances to the new nodes using the steps described in this section, perform any needed service configuration procedures as described in Chapter 6, "Introduction to Workload Management".

Using DBCA in Silent Mode to Add Database Instances to New Nodes You can use the Database Configuration Assistant (DBCA) in silent mode to add instances to nodes onto which you have extended an Oracle Clusterware home and an Oracle home. Use the following syntax to perform this operation where *node* is the node onto which you want to add the instance, *gdbname* is the global database name, *instname* is the name of the new instance, *sysdba* is the name of an Oracle user with SYSDBA privileges, and *password* is the password for the user name in *sysdba*:

```
dbca -silent -addInstance -nodeList node -gdbName gdbname [-instanceName instname]
-sysDBAUserName sysdba -sysDBAPassword password
```

Note that you only need to provide an instance name if you want to override the Oracle naming convention for Oracle RAC instance names.

After you have completed either of the DBCA procedures in this section, DBCA has successfully added the new instance to the new node and completed the following steps:

- Created and started an ASM instance on each new node if the existing instances were using ASM
- Created a new database instance on each new node
- Created and configured high availability components
- Created the Oracle Net configuration
- Started the new instance
- Created and started services if you entered services information on the Services Configuration page

After adding the instances to the new nodes using the steps described in this section, perform any needed service configuration procedures as described in Chapter 6, "Introduction to Workload Management".

Adding Nodes that Already Have Clusterware and Oracle Software to a Cluster

Before beginning this procedure, ensure that your existing nodes have the `$CRS_HOME` and `$ORACLE_HOME` environment variables set correctly. To add nodes to a cluster that already have clusterware and Oracle software installed on them, you must configure the new nodes with the Oracle software that is on the existing nodes of the cluster. To do this, you must run two versions of an OUI process: one for the clusterware and one for the database layer as described in the following procedures:

1. Add new nodes at the Oracle Clusterware layer by running OUI from the Oracle Clusterware home on an existing node, using the following command:

   ```
   CRS_home/oui/bin/addNode.sh -noCopy
   ```

2. Add new nodes at the Oracle software layer by running OUI from the Oracle home as follows:

   ```
   Oracle_home/oui/bin/addNode.sh -noCopy
   ```

In the `-noCopy` mode, OUI performs all add node operations except for the copying of software to the new nodes.

> **Note:** Oracle recommends that you back up your voting disk and OCR files after you complete the node addition process.

Overview of Node Deletion Procedures

This section explains how to delete nodes from clusters using detailed manual procedures. The details of these steps appear in the following sections:

- Step 1: Deleting Instances from Oracle Real Application Clusters Databases
- Step 2: Deleting Nodes from Oracle Real Application Clusters Databases
- Step 3: ASM Instance Clean-Up Procedures for Node Deletion

Step 1: Deleting Instances from Oracle Real Application Clusters Databases

The procedures in this section explain how to use Enterprise Manager, or DBCA in interactive or silent mode, to delete an instance from an Oracle RAC database.

- Using Enterprise Manager to Delete Database Instances from Existing Nodes
- Using DBCA in Interactive Mode to Delete Database Instances from Existing Nodes
- Using DBCA in Silent Mode to Delete Instance from Existing Nodes

Using Enterprise Manager to Delete Database Instances from Existing Nodes To delete an instance with Enterprise Manager from an existing node, perform the following steps:

1. From the Cluster Database Home page, click the **Maintenance** tab.
2. Under the Deployments section, click **Delete Instance**. This action initiates a wizard to guide you through the deletion process.
3. Perform the following tasks for each wizard step:
   - If the database uses ASM, then provide host and ASM credentials.
   - Specify hosts from which to delete instances.
   - Review and submit the job.

   After you submit the job, the wizard displays a summary page that shows whether the job succeeded. The wizard also provides other detailed information about the job, such as an output log and information about the elapsed time.

Using DBCA in Interactive Mode to Delete Database Instances from Existing Nodes To delete an instance using DBCA in interactive mode, perform the following steps:

1. Start DBCA on a node *other than* the node that hosts the instance that you want to delete. On the DBCA Welcome page select Oracle Real Application Clusters Database, click **Next**, and DBCA displays the Operations page.
2. On the DBCA Operations page, select Instance Management, click **Next**, and DBCA displays the Instance Management page.
3. On the Instance Management page, Select Delete Instance, click **Next**, and DBCA displays the List of Cluster Databases page.
4. Select an Oracle RAC database from which to delete an instance. Enter a user name and password for the database user that has SYSDBA privileges. Click **Next** and DBCA displays the List of Cluster Database Instances page. The List of Cluster Database Instances page shows the instances that are associated with the Oracle RAC database that you selected and the status of each instance.
5. Select an instance to delete and click **Finish**.
6. If you have services assigned to this instance, then the DBCA Services Management page appears. Use this feature to reassign services from this instance to other instances in the cluster database.
7. Review the information about the instance deletion operation on the Summary page and click **OK**. Otherwise, click **Cancel** to cancel the instance deletion operation. If you click **OK**, then DBCA displays a Confirmation dialog.
8. Click **OK** on the Confirmation dialog to proceed with the instance deletion operation and DBCA displays a progress dialog showing that DBCA is performing the instance deletion operation. During this operation, DBCA removes the instance and the instance's Oracle Net configuration. When DBCA completes this operation, DBCA displays a dialog asking whether you want to perform another operation.
9. Click **No** and exit DBCA or click **Yes** to perform another operation. If you click **Yes**, then DBCA displays the Operations page.

Using DBCA in Silent Mode to Delete Instance from Existing Nodes Use DBCA to delete a database instance from a node as follows, where the variables are the same as those in the preceding add instance command:

```
dbca -silent -deleteInstance [-nodeList node] -gdbName gdbname -instanceName
instname -sysDBAUserName sysdba -sysDBAPassword password
```

You only need to provide a node name if you are deleting an instance from a node other than the one on which you are running DBCA.

At this point, you have accomplished the following:

- De-registered the selected instance from its associated Oracle Net Services listeners
- Deleted the selected database instance from the instance's configured node
- Removed the Oracle Net configuration
- Deleted the Oracle Flexible Architecture directory structure from the instance's configured node.

Step 2: Deleting Nodes from Oracle Real Application Clusters Databases

Before beginning these procedures, ensure that your existing nodes have the `$CRS_HOME` and `$ORACLE_HOME` environment variables set correctly. Use the following procedures to delete nodes from Oracle clusters on UNIX-based systems:

Note: You can perform some of the steps in this procedure in silent mode as described at the end of this section.

1. If there are instances on the node that you want to delete, then perform the procedures in the section titled "Step 1: Deleting Instances from Oracle Real Application Clusters Databases" on page 10-24 before executing these procedures. If you are deleting more than one node, then delete the instances from all the nodes that you are going to delete.
2. If you use ASM, then perform the procedures in the following section, "Step 3: ASM Instance Clean-Up Procedures for Node Deletion" on page 10-29.
3. If this is the Oracle home from which the node-specific listener named `LISTENER_`*`nodename`* runs, then use NETCA to remove this listener. If necessary, re-create this listener in another home.

   See Also: *Oracle Database Net Services Administrator's Guide* for more information about NETCA

4. For a non-shared home, on each node that you are deleting, perform the following two steps:
   - Run the following command:

     ```
     runInstaller -updateNodeList ORACLE_HOME=Oracle_home
     "CLUSTER_NODES={node_to_be_deleted}" -local
     ```

     The `runInstaller` command is located in the directory *`Oracle_home`*`/oui/bin`. Using this command does not launch an installer GUI.
   - Run OUI from the home and deinstall this home. Make sure that you choose the home to be removed and not just the products under that home.
5. If you are using a *non-shared* Oracle home, from an existing node, run the following command where *`node_list`* is a comma-delimited list of nodes that remain in the cluster:

   ```
   runInstaller -updateNodeList ORACLE_HOME=Oracle_home "CLUSTER_NODES={node_
   list}"
   ```

   If you are using a *shared* Oracle home, from an existing node, run the following command where *`node_list`* is a comma-delimited list of nodes that remain in the cluster:

   ```
   runInstaller -updateNodeList -noClusterEnabled ORACLE_HOME=Oracle_home
   "CLUSTER_NODES={node_list}"
   ```

6. Run the following commands to remove node-specific interface configurations where *`nodename`* is the name of the node that you want to delete and *`remote_port`* is port on the deleted node:

   ```
   racgons remove_config nodename:remote_port
   oifcfg delif -node nodename
   ```

7. On the node that you are deleting, run the command *`CRS_home`*`/install/rootdelete.sh` to disable the Oracle Clusterware applications that are on the node. Only run this command *once* and use the `nosharedhome` argument if you are using a local file system. The default for this command is

sharedhome which prevents you from updating the permissions of local files such that they can be removed by the oracle user.

If the Oracle Cluster Registry (OCR) is on a shared path, then run the command *CRS_home*/install/rootdelete.sh remote sharedvar. If the ocr.loc file is not on a shared file system, then run the *CRS_home*/install/rootdelete.sh remote nosharedvar command.

If you are deleting more than one node from your cluster, then repeat this step on each node that you are deleting.

8. Run *CRS_home*/install/rootdeletenode.sh on any remaining node in the cluster to delete the nodes from the Oracle cluster and to update OCR. If you are deleting multiple nodes, then run the command *CRS_home*/install/rootdeletenode.sh node1,*node1-number*,node2,*node2-number*,... *nodeN*,*nodeN-number* where *node1* through *nodeN* is a list of the nodes that you want to delete, and *node1-number* through *nodeN-number* represents the node number. To determine the node number of any node, run the command *CRS_home*/bin/olsnodes -n. To delete only one node, enter the node name and number of the node that you want to delete with the command *CRS_home*/install/rootdeletenode.sh node1,node1-number.

9. For a non-shared Oracle home, on each node that you are deleting, perform the following two steps:

   - Run the following command:

     ```
     runInstaller -updateNodeList ORACLE_HOME=CRS_home
     CLUSTER_NODES="" -local CRS=true
     ```

     The runInstaller command is located in the *CRS_home*/oui/bin directory. Executing this command does not launch an installer GUI.

   - Run OUI from the home and deinstall this home. Make sure that you choose the home to be removed and not just the products under that home.

10. If using a non-shared Oracle home, from an existing node, run the following command:

    ```
    runInstaller -updateNodeList ORACLE_HOME=CRS_home
    "CLUSTER_NODES={nodelist}"
    ```

    where *nodelist* is a comma-delimited list of nodes that remain in the cluster.

    For shared Oracle home users, run the following command on an existing node from the $ORACLE_HOME/oui/bin directory, where *nodes_list* is a comma-delimited list of the nodes that remain in your cluster:

    ```
    ./runInstaller -updateNodeList -noClusterEnabled ORACLE_HOME=CRS_home
     CLUSTER_NODES=nodes_list
    ```

11. Run the following command to verify that the node is no longer a member of the cluster and to verify that the Oracle Clusterware components have been removed from this node:

    ```
    cluvfy comp crs -n all [-verbose]
    ```

    The response from this command should not contain any information about the node that you deleted; the deleted node should no longer have the Oracle Clusterware components on it. This verifies that you have deleted the node from the cluster.

See Also: "Using the Cluster Verification Utility" on page A-10 for more information about enabling and using the CVU

As mentioned earlier in this procedure, you can optionally delete nodes from Oracle Real Application Clusters databases in silent mode by completing the following steps:

1. Complete steps 1 through 3 of the procedure described at the start of this section under the heading "Step 2: Deleting Nodes from Oracle Real Application Clusters Databases" on page 10-25.
2. Depending on whether you have a shared or non-shared Oracle home, complete one of the following two procedures:
   - For a shared home, run the following command on each of the nodes that are to be deleted:

     ```
     ./runInstaller -detachHome -local ORACLE_HOME=Oracle_home
     ```

   - For a non-shared home, on each node that you are deleting, perform the following two steps:
     - Run the following command:

       ```
       runInstaller -updateNodeList ORACLE_HOME=Oracle_home
       CLUSTER_NODES="" -local
       ```

       The `runInstaller` command is located in the directory *`Oracle_home`*`/oui/bin`. Using this command does not launch an installer GUI.
     - Deinstall the Oracle home from the node that you are deleting by running the following command from the *`Oracle_home`*`/oui/bin` directory:

       ```
       ./runInstaller -deinstall -silent "REMOVE_HOMES={Oracle_home}"
       ```

3. Complete steps 5 through 10 from the procedure described in "Step 2: Deleting Nodes from Oracle Real Application Clusters Databases" on page 10-25.
4. Depending on whether you have a shared or non-shared Oracle Clusterware home, complete one of the following two procedures:
   - For shared homes, do not perform a deinstall operation. Instead, perform a detach home operation on the node that you are deleting. To do this, run the following command from *`CRS_home`*`/oui/bin`:

     ```
     ./runInstaller -detachHome ORACLE_HOME=CRS_home
     ```

   - For a non-shared home, on each node that you are deleting, perform the following two steps:
     - Run the following command:

       ```
       runInstaller -updateNodeList ORACLE_HOME=CRS_home
       CLUSTER_NODES="" -local CRS=true
       ```

       The `runInstaller` command is located in the directory *`CRS_home`*`/oui/bin`. Executing this command does not launch an installer GUI.
     - On each node that you are deleting, perform the following step from the *`CRS_home`*`/oui/bin` directory:

       ```
       ./runInstaller -deinstall -silent "REMOVE_HOMES={CRS_home}"
       ```

where *CRS_home* is the name given to the Oracle Clusterware home you are deleting.

5. Complete steps 10 and 11 of the procedure described at the start of this section.

Step 3: ASM Instance Clean-Up Procedures for Node Deletion

If you are using ASM, then perform the following procedure to remove the ASM instances:

1. Stop all of the databases that use the ASM instance that is running from the Oracle home that is on the node that you are deleting.
2. On the node that you are deleting, if this is the Oracle home which from which the ASM instance runs, then remove the ASM configuration by completing the following steps. Run the command `srvctl stop asm -n node_name` for all of the nodes on which this Oracle home exists. Run the command `srvctl remove asm -n node` for all nodes on which this Oracle home exists. If there are databases on this node that use ASM, then use DBCA Disk Group Management to create an ASM instance on one of the existing Oracle homes on the node, restart the databases if you stopped them.
3. If you are using a cluster file system for your ASM Oracle home, then ensure that your local node has the `$ORACLE_BASE` and `$ORACLE_HOME` environment variables set correctly. Run the following commands from a node other than the node that you are deleting, where *node_number* is the node number of the node that you are deleting:

```
rm -r $ORACLE_BASE/admin/+ASM
rm -f $ORACLE_HOME/dbs/*ASMnode_number
```

> **Note:** You can identify the node number of the node that you want to delete by running the command *CRS_home*`/bin/olsnodes -n node` on the node that you are deleting.

4. If you are not using a cluster file system for your ASM Oracle home, then run the `rm` or `delete` commands mentioned in the previous step on each node on which the Oracle home exists.

11

Adding and Deleting Nodes and Instances on Windows-Based Systems

This chapter describes how to add and delete nodes and instances in Oracle Real Application Clusters (Oracle RAC) databases on Windows-based systems. The preferred method to add nodes and instances to Oracle RAC databases is to use the Oracle cloning procedures that are described in the *Oracle Universal Installer and OPatch User's Guide*. You can also use Enterprise Manager Grid Control to perform cloning operations. Cloning enables you to copy images of Oracle Clusterware and Oracle RAC software onto the other nodes that have identical hardware and software. If you do not want to use the cloning process, then you can use the manual procedures that are described in this chapter to add nodes and instances. The topics in this chapter are:

- Cloning Oracle Clusterware and Oracle RAC Software in Grid Environments
- Quick-Start Node and Database Instance Addition and Deletion Procedures
- Detailed Node and Database Instance Addition and Deletion Procedures
- Step 3: ASM Instance Clean-Up Procedures for Node Deletion

Note: For all of the add node and delete node procedures, temporary directories such as `%TEMP%` or `C:\Temp` *should not be* shared directories. If your temporary directories are shared, then set your temporary environment variable, such as `%TEMP%`, to a non-shared location on a local node. In addition, use a directory that exists on all of the nodes.

Note: The entries for *`CRS_home`* and *`Oracle_home`* as used in this chapter refer to substitutes for either environment variables or full path names for the Oracle Clusterware and Oracle home with Oracle RAC respectively.

Cloning Oracle Clusterware and Oracle RAC Software in Grid Environments

The preferred method for extending your Oracle RAC environment is to use the Oracle cloning procedures in the *Oracle Universal Installer and OPatch User's Guide*. Only use the procedures in this chapter if you choose not to use Oracle cloning.

> **See Also:** "Cloning Oracle Clusterware and Oracle RAC Software in Grid Environments" on page 1-11 for a summary about Oracle cloning

Quick-Start Node and Database Instance Addition and Deletion Procedures

This section explains node and instance addition and deletion using procedures that are presented in a quick-start format. For node addition, these procedures require that you install the required operating system patches and updates on the new nodes. Then configure the new nodes to be part of your cluster at the network level. Extend the Oracle Clusterware home from an existing Oracle Clusterware home to the new nodes and then extend the Oracle database software with Oracle RAC components to the new nodes. Finally, make the new nodes members of the existing Oracle RAC database. This section includes the following topics:

- Adding an Oracle Clusterware Home to a New Node
- Adding an Oracle Home with Oracle RAC to a New Node
- Deleting an Oracle Home with Oracle RAC from an Existing Node
- Deleting an Oracle Clusterware Home from an Existing Node

Note: For all of the procedures in this chapter, it is very important that you perform each step in the order shown.

See Also: *Oracle Database Oracle Clusterware and Oracle Real Application Clusters Installation Guide for Microsoft Windows* for procedures about using the Database Configuration Assistant (DBCA) to create and delete Oracle RAC databases

Adding an Oracle Clusterware Home to a New Node

Use one of the procedures described in this section to use OUI to add an Oracle Clusterware home to a node that is going to be part of your Oracle RAC cluster. These procedures assume that you are adding `node2` and that you have already successfully installed Oracle Clusterware on `node1` in a non-shared home, where *`CRS_home`* represents the successfully installed home.

- Adding an Oracle Clusterware Home to a New Node Using OUI in Interactive Mode
- Adding an Oracle Clusterware Home to a New Node Using OUI in Silent Mode

---

Note: Oracle recommends that you back up your voting disk and Oracle Cluster Registry files after you complete any node addition or deletion procedures.

Adding an Oracle Clusterware Home to a New Node Using OUI in Interactive Mode

Use the following procedure to add an Oracle Clusterware home to a new node, `node2`, to your cluster with an interactive OUI session.

1. Go to *`CRS_home`*\oui\bin on `node1` and run the `addnode.bat` script.
2. The OUI displays the Node Selection page on which you must specify the node, private node name, and the VIP address for the new node that you are adding and click **Next**.
3. Verify the contents that OUI displays on the summary page and click **Next**. This installs the Oracle Clusterware home with Oracle RAC on the new node.

4. From *CRS_home*\install on node1, run the crssetup.add.bat script.You

Adding an Oracle Clusterware Home to a New Node Using OUI in Silent Mode

Use the following procedure to add an Oracle Clusterware home to a new node, node2, to your cluster with a silent OUI session.

1. Go to *CRS_home*\oui\bin on node1 and run the addnode.bat script as follows:

```
addnode.bat -silent "CLUSTER_NEW_NODES={node2}"
"CLUSTER_NEW_PRIVATE_NODE_NAMES={node2-priv}"
"CLUSTER_NEW_VIRTUAL_HOSTNAMES={node2-vip}"
```

2. Perform step 4 from the previous section about using OUI interactively under the heading "Adding an Oracle Clusterware Home to a New Node Using OUI in Interactive Mode" on page 11-2 to add node2 to the cluster.

Adding an Oracle Home with Oracle RAC to a New Node

Use one of the following procedures to add an Oracle home to a new node using OUI. These procedures assume that you want to extend an existing Oracle home with Oracle RAC on node1 to node2. Node2 should already be a member node of the cluster to which node1 belongs. The contents of these procedures assume that you have successfully installed Oracle RAC on node1 in a non-shared home and that *Oracle_home* represents the successfully installed Oracle home. This section describes the following procedures:

- Adding an Oracle Home with Oracle RAC to a New Node Using OUI in Interactive Mode
- Adding an Oracle Home with Oracle RAC to a New Node Using OUI in Silent Mode

> **Note:** Oracle recommends that you back up your voting disk and Oracle Cluster Registry files after you complete any node addition or deletion procedures.

Adding an Oracle Home with Oracle RAC to a New Node Using OUI in Interactive Mode

Use the following procedure to add an Oracle home to a new node, node2, using OUI in interactive mode.

1. Go to *Oracle_home*\oui\bin and run the addnode.bat script.
2. The OUI displays the Node Selection page on which you should select the nodes that you want to add and then click **Next**.
3. Verify the contents that OUI displays on the Summary page and click **Next**. This installs the Oracle home with Oracle RAC on the new node.
4. On node2, run NETCA to add a Listener.

> **See Also:** *Oracle Database Net Services Administrator's Guide* for more information about NETCA

5. To add a database instance to the new node, use Enterprise Manager or DBCA as described under the heading "Step 5: Adding Database Instances to New Nodes" on page 11-16

Adding an Oracle Home with Oracle RAC to a New Node Using OUI in Silent Mode

Use the following procedure to add an Oracle home to a new node, node2, using OUI in interactive mode.

1. Go to *Oracle_home*\oui\bin and run the addnode.bat script as follows:

```
addnode.bat -silent "CLUSTER_NEW_NODES={node2}"
```

2. Perform steps 4 and 5 from the previous section for using OUI in interactive mode under the heading "Adding an Oracle Home with Oracle RAC to a New Node Using OUI in Interactive Mode" on page 11-3 to add the Listener and to create the database instance for the new node.

> **Note:** The same steps are applicable for node additions using a shared home.

Deleting an Oracle Home with Oracle RAC from an Existing Node

Use the following procedures to delete nodes at the database Oracle home layer on Windows-based systems. These procedures assume that an Oracle RAC database home is installed on both node1 and node2 and that you want to delete the database home on node2. Also assume that *Oracle_home* represents the location of this home on the nodes. The procedures in this section are:

- Deleting an Oracle Home with Oracle RAC Using OUI in Interactive Mode
- Deleting an Oracle Home with Oracle RAC Using OUI in Silent Mode

> **Note:** Oracle recommends that you back up your voting disk and Oracle Cluster Registry files after you complete any node addition or deletion procedures.

Deleting an Oracle Home with Oracle RAC Using OUI in Interactive Mode

Use the following procedures to use OUI to delete an Oracle home:

1. Remove any instances that are on node2 with Enterprise Manager or DBCA as described under the heading "Step 1: Deleting Instances from Oracle Real Application Clusters Databases" on page 11-20. Only delete the database instance on node2 that is associated with the Oracle home that you are deleting. Other instances may exist on node2 that you do not want to delete.
2. If you use ASM and this is the home from which the ASM instance runs, then perform the ASM instance clean-up procedures under the heading "Step 3: ASM Instance Clean-Up Procedures for Node Deletion" on page 11-24.
3. If this is the home from which the node-specific listener runs, then use NETCA to remove the listener and its CRS resources. If necessary, re-create this listener in other homes.

> **See Also:** *Oracle Database Net Services Administrator's Guide* for more information about NETCA

4. On the node to be deleted, which in this example is node2, run the following command from *Oracle_home*\oui\bin:

```
setup.exe -updateNodeList ORACLE_HOME=Oracle_home
"CLUSTER_NODES={node2}" -local
```

5. On the node to be deleted, node2 in this case:
   - If the home is a non-shared home, then deinstall the database by running the setup.exe script from *Oracle_home*\oui\bin.
   - If the home is a shared home then do not perform a deinstall. Instead, perform the following steps on the node to be deleted:
     - Perform a detach home on node2 by running the following command from *Oracle_home*\oui\bin on node2:

       ```
       setup.exe -detachHome -silent ORACLE_HOME=Oracle_home
       ```

     - On node 2, stop and delete any services that are associated with this Oracle home. In addition, delete any Registry entries and path entries that are associated with this Oracle home. Also, delete all of the start menu items associated with this Oracle home.
6. On node1, or in the case of an installation with more than two nodes on any node other than the node to be deleted, run the following command from *Oracle_home*\oui\bin where *node_list* is a comma-delimited list of nodes that are to remain part of the Oracle RAC installation:

```
setup.exe -updateNodeList ORACLE_HOME=Oracle_home
"CLUSTER_NODES={node_list}"
```

Deleting an Oracle Home with Oracle RAC Using OUI in Silent Mode

Use the following procedures to delete an Oracle home by using OUI in silent mode:

1. Perform steps 1 through 4 from the previous OUI procedure for node deletion.
2. On node2, run OUI by running the setup.exe script from *Oracle_home*\oui\bin:
   - If you have a non-shared home, then deinstall the Oracle home as follows:

     ```
     setup.exe -silent  -deinstall "REMOVE_HOMES={Oracle_home}"
     ```

   - If you have a shared home, then do not perform a deinstall. Instead, perform the following steps on the node that you want to delete:
     - Run the following command from *Oracle_home*\oui\bin to detach the Oracle home on node2:

       ```
       setup.exe -detachHome -silent ORACLE_HOME=Oracle_home
       ```

     - On node 2, stop and delete any services that are associated with this Oracle home. In addition, delete any Registry entries and path entries that are associated with this Oracle home. Also, delete all of the start menu items associated with this Oracle home.
3. Perform step 6 from the previous OUI procedure to update the node list.

Deleting an Oracle Clusterware Home from an Existing Node

Use the following procedures to delete nodes at the Oracle Clusterware layer on Windows-based systems. These procedures assume that an Oracle Clusterware home

is installed on node1 and node2, and that you want to delete node2 from the cluster. The topics in this section are:

- Deleting an Oracle Clusterware Home Using OUI in Interactive Mode
- Deleting an Oracle Clusterware Home Using OUI in Silent Mode

---

Note: Oracle recommends that you back up your voting disk and Oracle Cluster Registry files after you complete any node addition or deletion procedures.

Deleting an Oracle Clusterware Home Using OUI in Interactive Mode

Perform the following procedure to use OUI to delete a node at the clusterware layer:

1. Perform the delete node operation for database homes as described in the section titled "Deleting an Oracle Home with Oracle RAC Using OUI in Interactive Mode" on page 11-4.
2. If you did not run the oifcfg command with the -global option, then from node1 at Well, run the following command:

   ```
   oifcfg delif -node node2
   ```

3. From node1 in the *CRS_home*\bin directory run the following command where *remote_port* is the ONS remote port number:

   ```
   racgons remove_config node2:remote_port
   ```

   You can determine the remote port by viewing the contents of the file, *CRS_home*\opmn\conf\ons.config.

4. Run srvctl to stop and remove the nodeapps from node 2. From *CRS_home*/bin run the following commands:

   ```
   srvctl stop nodeapps -n node2
   srvctl remove nodeapps -n node2
   ```

5. On node1, or on any node that is not being deleted, run the following command from *CRS_home*\bin where *node_name* is the node to be deleted and *node_number* is the node's number as obtained from the output from the olsnodes -n command:

   ```
   crssetup del -nn node_name,node_number
   ```

6. On the node(s) to be deleted (node2 in this case), run the following command from *CRS_home*\oui\bin:

   ```
   setup.exe -updateNodeList ORACLE_HOME=CRS_home
   "CLUSTER_NODES={node2}" CRS=TRUE -local
   ```

7. On node2, using OUI setup.exe from *CRS_home*\oui\bin:
   - If you have a non-shared home, then deinstall the Oracle Clusterware installation by running the setup.exe script from *CRS_home*\oui\bin.
   - If you have a shared home, then do not perform a deinstallation. Instead, perform the following steps on the node that you want to delete:
     - Run the following command from *CRS_home*\oui\bin to detach the Oracle Clusterware home on node2:

       ```
       setup.exe -detachHome -silent ORACLE_HOME=CRS_home
       ```

– On node2, stop and delete any services that are associated with this Oracle Clusterware home. In addition, delete any Registry entries and path entries that are associated with this Oracle Clusterware home. Also, delete all of the start menu items associated with this Oracle Clusterware home. Delete the central inventory as well as the non-Oracle home files under C:\WINDOWS\system32\drivers.

8. On node1, or in the case of a multiple node installation, on any node other than the one to be deleted, run the following command from *CRS_home*\oui\bin where *node_list* is a comma-delimited list of nodes that are to remain part of the Oracle clusterware:

```
setup.exe -updateNodeList ORACLE_HOME=CRS_home
"CLUSTER_NODES={node_list}" CRS=TRUE
```

Deleting an Oracle Clusterware Home Using OUI in Silent Mode

Use the following procedure to delete an Oracle Clusterware home by using OUI in silent mode:

1. Perform steps 1 through 6 from the previous section for using OUI interactively under the heading "Deleting an Oracle Clusterware Home Using OUI in Interactive Mode" on page 11-6 to delete nodes at the Oracle Clusterware layer.
2. On node2, using OUI setup.exe from *CRS_home*\oui\bin:
   - If you have a non-shared home, then deinstall the Oracle Clusterware home as follows:

     ```
     setup.exe -silent  -deinstall "REMOVE_HOMES={CRS_home}"
     ```

   - If you have a shared home, then do not perform a deinstallation. Instead, perform the following steps on the node that you want to delete:
     – Run the following command from *CRS_home*\oui\bin to detach the Oracle Clusterware home on node2:

       ```
       setup.exe -detachHome -silent ORACLE_HOME=CRS_home
       ```

     – On node 2, stop and delete any services that are associated with this Oracle Clusterware home. In addition, delete any Registry entries and path entries that are associated with this Oracle Clusterware home. Also, delete all of the start menu items associated with this Oracle Clusterware home. Delete the central inventory as well as the non-Oracle Clusterware home files under C:\WINDOWS\system32\drivers.
3. Perform step 8 from the previous OUI procedure to update the node list.

Detailed Node and Database Instance Addition and Deletion Procedures

This section provides detailed procedures for adding and deleting nodes to clusters. The details of these steps appear in the following sections:

- Overview of Node Addition Procedures
- Step 1: Connecting New Nodes to the Cluster
- Step 2: Extending Oracle Software to New Nodes at the Oracle Clusterware Layer
- Step 3: Preparing Storage on New Nodes

- Step 4: Adding Nodes at the Oracle RAC Database Layer
- Step 5: Adding Database Instances to New Nodes
- Adding Nodes that Already Have Clusterware and Oracle Software to a Cluster
- Overview of Node Deletion Procedures
- Step 1: Deleting Instances from Oracle Real Application Clusters Databases
- Step 2: Deleting Nodes from Oracle Real Application Clusters Databases
- Step 3: ASM Instance Clean-Up Procedures for Node Deletion

> **See Also:** *Oracle Database Oracle Clusterware and Oracle Real Application Clusters Installation Guide for Microsoft Windows* for procedures about using the Database Configuration Assistant (DBCA) to create and delete Oracle RAC databases

Overview of Node Addition Procedures

This section explains how to add nodes to clusters using detailed manual procedures. Do this by setting up the new nodes to be part of your **cluster** at the network level. Then extend the Oracle Clusterware home from an existing Oracle Clusterware home to the new nodes and then extend the Oracle database software with Oracle RAC components to the new nodes. Finally, make the new nodes members of the existing Oracle RAC database.

If the nodes that you are adding to your cluster do not have Oracle Clusterware or Oracle software installed on them, then complete the following five steps. The procedures in these steps assume that you already have an operative Windows-based Oracle RAC environment. The details of these steps appear in the following sections.

- Step 1: Connecting New Nodes to the Cluster
- Step 2: Extending Oracle Software to New Nodes at the Oracle Clusterware Layer
- Step 3: Preparing Storage on New Nodes
- Step 4: Adding Nodes at the Oracle RAC Database Layer
- Step 5: Adding Database Instances to New Nodes

To add a node to your cluster when the node is already configured with Oracle Clusterware and Oracle software, follow the procedure described in "Adding Nodes that Already Have Clusterware and Oracle Software to a Cluster" on page 11-19.

> **See Also:** *Oracle Database Oracle Clusterware and Oracle Real Application Clusters Installation Guide for Microsoft Windows* for procedures about using DBCA to create and delete Oracle RAC databases

Step 1: Connecting New Nodes to the Cluster

Complete the following procedures to connect the new nodes to the cluster and to prepare them to support your Oracle RAC database:

- Making Physical Connections
- Installing the Operating System
- Verifying the Installation with the Cluster Verification Utility
- Checking the Installation

Making Physical Connections

Connect the new nodes' hardware to the network infrastructure of your cluster. This includes establishing electrical connections, configuring network interconnects, configuring shared disk subsystem connections, and so on. Refer to your hardware vendor documentation for details about this step.

Installing the Operating System

As the Windows Administrator, install a cloned image of the operating system that matches the operating system on the other nodes in your cluster. This includes installing any required service patches and drivers. Refer to your hardware vendor documentation for details about this process.

Verifying the Installation with the Cluster Verification Utility

Verify your installation using the Cluster Verification Utility (CVU) as in the following steps:

1. From the directory *CRS_home*\bin on the existing nodes, run the CVU command to verify your installation at the post hardware installation stage where *node_list* is a list of the nodes to include in the CVU operation as shown in the following example:

   ```
   cluvfy stage -post hwos -n node_list|all [-verbose]
   ```

   After you have configured the hardware and operating systems on the new nodes, you can use this command to verify node reachability, for example, to all of the nodes from the local node. You can also use this command to verify user equivalence to all given nodes from the local node, node connectivity among all of the given nodes, accessibility to shared storage from all of the given nodes, and so on.

   Note: You can only use the `all` option with the `-n` argument if you have set the `CV_NODE_ALL` variable to represent the list of nodes on which you want to perform the CVU operation.

   See Also: Appendix A, "Troubleshooting" for more information about enabling and using CVU

2. From the directory *CRS_home*\bin on the existing nodes, run the CVU command to obtain a detailed comparison of the properties of the reference node with all of the other nodes that are part of your current cluster environment where *node* is the node, *node_list* is a list of the nodes to include, *orainventory_group* is the name of the Oracle inventory group, and *osdba_group* is the DBA group name:

   ```
   cluvfy comp peer [ -refnode node ] -n node_list [-r { 10gR1 | 10gR2 } ] [
   -orainv orainventory_group ] [ -osdba osdba_group ] [-verbose]
   ```

   Note: For the reference node, select a node from your existing cluster nodes against which you want CVU to compare, for example, the newly added nodes that you specify with the `-n` option.

Checking the Installation

To verify that your installation is configured correctly, perform the following steps:

1. Ensure that the new nodes can access the private interconnect. This interconnect must be properly configured before you can complete the procedures in "Step 2: Extending Oracle Software to New Nodes at the Oracle Clusterware Layer" on page 11-10.
2. If you are not using a **cluster file system**, then determine the location on which your cluster software was installed on the existing nodes. Make sure that you have at least 250MB of free space on the same location on each of the new nodes to install Oracle Clusterware. In addition, ensure you have enough free space on each new node to install the Oracle binaries.
3. Ensure that the Oracle Cluster Registry (OCR) and the voting disk are accessible by the new nodes using the same path as the other nodes use. In addition, the OCR and voting disk devices must have the same permissions as on the existing nodes.
4. Ensure that user equivalence is established on the new nodes by performing the following:
   - Make sure that you can run the following command from *all* of the existing nodes of your cluster where the `hostname` is the public network name of the new node:

     ```
     NET USE \\hostname\C$
     ```

     You have the required administrative privileges on each node if the operating system responds with:

     ```
     Command completed successfully.
     ```

After completing the procedures in this section, your new nodes are connected to the cluster and configured with the required software to make them visible to the clusterware. Configure the new nodes as members of the cluster by extending the cluster software to the new nodes as described in "Step 2: Extending Oracle Software to New Nodes at the Oracle Clusterware Layer" on page 11-10.

Note: Do not change a hostname after the Oracle Clusterware installation. This includes adding or deleting a domain qualification.

Step 2: Extending Oracle Software to New Nodes at the Oracle Clusterware Layer

The following section describes how to add new nodes to Oracle Clusterware and to the Oracle database software layers using OUI. The OUI requires access to the private interconnect that you checked as part of the installation validation in Step 1.

1. On one of the *existing* nodes go to the *`CRS_home`*`\oui\bin` directory and run the `addnode.bat` script to start OUI.
2. The OUI runs in the `add node` mode and the OUI Welcome page appears. Click **Next** and the Specify Cluster Nodes for Node Addition page appears.
3. The upper table on the Specify Cluster Nodes for Node Addition page shows the existing nodes, the private node names and the virtual IP (VIP) addresses that are

associated with Oracle Clusterware. Use the lower table to enter the public, private node names and the virtual hostnames of the new nodes.

4. Click **Next** and OUI verifies connectivity on the existing nodes and on the new nodes. The verifications that OUI performs include determining whether:

   - The nodes are up
   - The nodes are accessible by way of the network

   Note: If any of the existing nodes are down, then you can proceed with the procedure. However, once the nodes are up, you must run the following command on each of those nodes:

   ```
   setup.exe -updateNodeList -local
   "CLUSTER_NODES={available_node_list}"
   ORACLE_HOME=CRS_home
   ```

   This operation should be run from the *CRS_home*\oui\bin directory and the *available_node_list* value is a comma-delimited list of all of nodes currently in the cluster and *CRS_home* defines the Oracle Clusterware home directory.

   - The virtual hostnames are not already in use on the network
   - The user has write permission to create the Oracle Clusterware home on the new nodes
   - The user has write permission to the OUI inventory `in the C:\Program Files\Oracle\Inventory` directory

5. If OUI detects that the new nodes do not have an inventory location, then:

   - The OUI automatically updates the inventory location in the Registry key

   If any verifications fail, then OUI re-displays the Specify Cluster Nodes for Node Addition page with a Status column in both tables indicating errors. Correct the errors or deselect the nodes that have errors and proceed. However, you cannot deselect existing nodes; you must correct problems on nodes that are already part of your cluster before you can proceed with node addition. If all of the checks succeed, then OUI displays the Node Addition Summary page.

6. The Node Addition Summary page displays the following information showing the products that are installed in the Oracle Clusterware home that you are extending to the new nodes:

   - The source for the add node process, which in this case is the Oracle Clusterware home
   - The private node names that you entered for the new nodes
   - The new nodes that you entered
   - The required and available space on the new nodes
   - The installed products listing the products that are already installed on the existing the Oracle Clusterware home

   Click **Next** and OUI displays the Cluster Node Addition Progress page.

7. The Cluster Node Addition Progress page shows the status of the cluster node addition process. The table on this page has two columns showing the phase of the node addition process and the phase's status according to the following:

This page shows the following three OUI phases:

- Copy the Oracle Clusterware Home to New Nodes: Copies the Oracle Clusterware home to the new nodes unless the Oracle Clusterware home is on the Oracle Cluster File System.
- Perform Oracle Home Setup: Updates the Registry entries for the new nodes, creates the services, and creates folder entries.
- Save Cluster Inventory: Updates the node list associated with the Oracle Clusterware home and its inventory.

The Cluster Node Addition Progress page's Status column displays `In Progress` while the phase is in progress, `Suspended` when the phase is pending execution, and `Succeeded` after the phase completes. On completion, click **Exit** to end the OUI session. After OUI displays the End of Node Addition page, click **Exit** to end the OUI session.

8. From *`CRS_home`*`\install` on `node1`, run the `crssetup.add.bat` script.
9. Use the following command to perform an integrated validation of the Oracle Clusterware setup on all of the configured nodes, both the pre-existing nodes and the nodes that you have added

```
cluvfy stage -post crinst -n all [-verbose]
```

The CVU `-post crinst` stage check verifies the integrity of the Oracle Clusterware components. After you have completed the procedures in this section for adding nodes at the Oracle Clusterware layer, you have successfully extended the Oracle Clusterware home from your existing the Oracle Clusterware home to the new nodes. Proceed to Step 3 to prepare the storage for Oracle RAC on the new nodes.

You can optionally run `addnode.bat` in silent mode, replacing steps 1 through 6 as follows, where `nodeI`, `nodeI+1`, and so on are the new nodes that you are adding:

```
addnode.bat -silent "CLUSTER_NEW_NODES={nodeI,nodeI+1,…nodeI+n}"
"CLUSTER_NEW_PRIVATE_NODE_NAMES={node-privI,node-privI+1,…node-privI+n}"
"CLUSTER_NEW_VIRTUAL_HOSTNAMES={node-vipI,node-vipI+1,…,node-vipI+n}"
```

You can alternatively specify the `variable=value` entries in a response file and run `addnode` as follows:

```
addnode.bat -silent -responseFile filename
```

Command-line values always override response file values.

> **See Also:** *Oracle Universal Installer and OPatch User's Guide* for details about how to configure command-line response files

Run `crssetup.add.bat` on the local node, or on the node on which you were performing this procedure.

After you have completed the procedures in this section for adding nodes at the Oracle Clusterware layer, you have successfully extended the Oracle Clusterware home from your existing the Oracle Clusterware home to the new nodes. Proceed to "Step 3: Preparing Storage on New Nodes" on page 11-13 to prepare storage for Oracle RAC on the new nodes.

Step 3: Preparing Storage on New Nodes

To extend an existing Oracle RAC database to your new nodes, configure the shared storage for the new instances to be added on new nodes so that the storage type is the same as the storage that is already used by the existing nodes' instances. Prepare the same type of storage on the new nodes as you are using on the other nodes in the Oracle RAC environment that you want to extend as follows:

- Automatic Storage Management (ASM)

  If you are using ASM, then make sure that the new nodes can access the ASM disks with the same permissions as the existing nodes.

- Oracle Cluster File System (OCFS)

  If you are using Oracle Cluster File Systems, then make sure that the new nodes can access the cluster file systems in the same way that the other nodes access them.

- Raw Device Storage

  If your cluster database uses raw devices, then prepare the new raw devices by following the procedures described in"Raw Device Storage Preparation for New Nodes" on page 11-13.

> **See Also:** *Oracle Database Oracle Clusterware and Oracle Real Application Clusters Installation Guide for Microsoft Windows* for more information about the Oracle Cluster File System

If you are using Oracle Cluster File System, then run the following command to verify your cluster file system and obtain detailed output where *node_list* includes both the pre-existing nodes and the newly added nodes:

```
cluvfy comp ssa -n node_list -s storageID_list [-verbose]
```

> **See Also:** Appendix A, "Troubleshooting" for more information about enabling and using the Cluster Verification Utility (CVU)

Raw Device Storage Preparation for New Nodes

To prepare raw device storage on the new nodes, you need at least two new disk partitions to accommodate the redo logs for each new instance. Make these disk partitions the same size as the redo log partitions that you configured for the existing nodes' instances. Also create an additional logical partition for the undo tablespace for automatic undo management. You can create a raw device mapping file and set the `DBCA_RAW_CONFIG` environment variable so that it points to the raw device mapping file.

> **See Also:** *Oracle Database Oracle Clusterware and Oracle Real Application Clusters Installation Guide for Microsoft Windows* for more information about configuring raw partitions and using raw device mapping files

Configure Raw Partitions

Perform the following steps from one of the existing nodes of the cluster:

1. Create or identify an extended partition.
2. Right click inside an unallocated part of the extended partition.

3. Choose Create from the Partition menu. A dialog box appears in which you should enter the size of the partition. Ensure you use the same sizes as those you used on your existing nodes.
4. Click the newly created partition and select Assign Drive Letter from the Tool menu.
5. Select Don't Assign Drive Letter, and click **OK**.
6. Repeat steps 2 through 5 for the second and any additional partitions.
7. Select Commit Changes Now from the Partition menu to save the new partition information.
8. Enable the new and the existing nodes to recognize all of the partitions on the cluster. To do this, create logical names so that the existing nodes and the new nodes recognize the partitions by following these steps:
   a. Start the Object Link Manager (OLM) by entering the following command from the *CRS_home*\bin directory on one of the existing nodes:

      ```
      GUIOracleOBJManager
      ```

   b. The OLM starts and automatically detects the logical names of the partitions and displays them in OLM's graphical user interface.
   c. Recall the disk and partition numbers for the partitions that you created in the previous section. Look for the disk and partition numbers in the OLM page and perform the following tasks:
      – Right-click next to the box under the New Link column and enter the logical name for the first partition.
      – Repeat the previous step for the second and any additional partitions.

        For example, if your Oracle RAC database name is *db* and your database consists of two instances running on two nodes and you are adding a third instance on the third node, then your logical names for your redo logs should be *db*_redo3_1, *db*_redo3_2, and so on.
      – To enable automatic undo management for a new node's instance, enter the logical name for the partition for the undo tablespace that you created in the previous section. For example, if your Oracle RAC database name is *db* and if it has two instances running on two nodes and you are adding a third instance on a third node, then your logical name for the undo tablespace should be *db*_undotbs3.
      – Select **Commit** from the Options menu. This creates the new logical names on the current node.
      – Select **Sync Nodes** from the Options menu. This makes the new logical names visible to all of the nodes in the cluster, including the new nodes.
      – Select **Exit** from the Options menu to exit the Object Link Manager.

After completing the procedures in this section, you have configured your cluster storage so that the new nodes can access the Oracle software. Additionally, the existing nodes can access the new nodes and instances.

Run the following command to verify that the prepared raw device storage is accessible from all of the configured cluster nodes where *nodelist* includes both the pre-existing nodes and the newly added nodes:

```
cluvfy comp ssa -n node_list -s storageID_list -verbose
```

See Also: Appendix A, "Troubleshooting" for more information about enabling and using the Cluster Verification Utility (CVU)

Proceed to the next section, "Step 4: Adding Nodes at the Oracle RAC Database Layer" on page 11-15.

Step 4: Adding Nodes at the Oracle RAC Database Layer

To add nodes at the Oracle RAC database later, run OUI in `add node` mode to configure your new nodes. If you have multiple Oracle homes, then perform the following steps for each Oracle home that you want to include on the new nodes:

1. On an existing node from the *`Oracle_home`*`\oui\bin` run the `addnode.bat` script. This starts OUI in the `add node` mode and displays the OUI Welcome page. Click **Next** on the Welcome page and OUI displays the Specify Cluster Nodes for Node Addition page.
2. The Specify Cluster Nodes for Node Addition page has a table showing the existing nodes associated with the Oracle home from which you launched OUI. A node selection table appears on the bottom of this page showing the nodes that are available for addition. Select the nodes that you want to add and click **Next**.
3. The OUI verifies connectivity and performs availability checks on both the existing nodes and on the nodes that you want to add. Some of checks performed determine whether:
   - The nodes are up
   - The nodes are accessible by way of the network
   - The user has write permission to create the Oracle home on the new nodes
   - The user has write permission to the OUI inventory in the `C:\Program Files\Oracle\Inventory` directory on the existing nodes and on the new nodes
4. If the new nodes do not have an inventory set up, then OUI automatically updates the Registry entries for the inventory location. If any of the other checks fail, then fix the problem and proceed or deselect the node that has the error and proceed. You cannot deselect existing nodes; you must correct any problems on the existing nodes before proceeding with node addition. If all of the checks succeed, then OUI displays the Node Addition Summary page.
5. The Node Addition Summary page has the following information about the products that are installed in the Oracle home that you are going to extend to the new nodes:
   - The source for the add node process, which in this case is the Oracle home
   - The existing nodes and new nodes
   - The new nodes that you selected
   - The required and available space on the new nodes
   - The installed products listing all of the products that are already installed in the existing Oracle home

   Click **Finish** and OUI displays the Cluster Node Addition Progress page.
6. The Cluster Node Addition Progress page shows the status of the cluster node addition process. The table on this page has two columns showing the phase of the

node addition process and the phase's status. The Cluster Node Addition Progress shows the following three OUI phases:

- Copy the Oracle Home To New Nodes: Copies the entire Oracle home to the new nodes unless the Oracle home is on a cluster file system
- Performs Oracle Home Setup: Updates the Registry entries for the new nodes, creates the services, and creates folder entries
- Save Cluster Inventory: Updates the node list associated with the Oracle home and its inventory

The Cluster Node Addition Progress page's Status column displays `Succeeded` if the phase completes, `In Progress` if the phase is in progress, and `Suspended` when the phase is pending execution. After OUI displays the End of Node Addition page, click **Exit** to end the OUI session.

7. Add a Listener to the new node by running the Net Configuration Assistant (NetCA) from the new node and selecting only the new node on the Node Selection page.

After completing the procedures in this section, you have defined the new nodes at the cluster database layer. You can now add database instances to the new nodes as described in Step 5 on page 11-16.

You can optionally run `addnode.bat` in silent mode, replacing steps 1 through 6, as follows where `nodeI`, `nodeI+1`, and so on are the new nodes that you are adding:

```
addnode.bat -silent "CLUSTER_NEW_NODES={nodeI,nodeI+1,…nodeI+n}"
```

The `variable=value` entries can also be specified in a response file, *`filename`*, and `addnode` can be run as:

```
addnode.bat -silent -responseFile filename
```

> **See Also:** *Oracle Universal Installer and OPatch User's Guide* for details about how to configure command-line response files

Command-line values always override response file values. Proceed to the next section, "Step 5: Adding Database Instances to New Nodes" on page 11-16.

> **See Also:** *Oracle Database Net Services Administrator's Guide* for more information about NETCA

Step 5: Adding Database Instances to New Nodes

You can use Enterprise Manager, or the Database Configuration Assistant (DBCA) in either interactive mode or in silent mode, to add database instances to new nodes as described under the following headings:

- Using Enterprise Manager to Add Database Instances to New Nodes
- Using DBCA in Interactive Mode to Add Database Instances to New Nodes
- Using DBCA in Silent Mode to Add Database Instances to New Nodes

Using Enterprise Manager to Add Database Instances to New Nodes

To add a database instance to a new node with Enterprise Manager, perform the following procedure:

1. From the Cluster Database Home page, click the **Maintenance** tab.
2. Under the Deployments section, click **Add Instance**. This initiates a wizard to guide you through the instance addition process.
3. Perform the following tasks for each wizard step:
   - If the database was using ASM, then provide host and ASM credentials.
   - Specify the hosts for which you want to add instances.
   - Review and submit the job.

   After you submit the job, the wizard provides a summary page that shows whether the job succeeded and the wizard also provides other detailed information about the job, such as the elapsed time and an output log.

After adding the instances to the new nodes using the steps described in this section, perform any needed service configuration procedures as described in Chapter 6, "Introduction to Workload Management".

Using DBCA in Interactive Mode to Add Database Instances to New Nodes

To add a database instance to a new node with DBCA in interactive mode, perform the following procedure:

1. Start the Database Configuration Assistant (DBCA) by entering `dbca` at the system prompt from the `bin` directory in the *`Oracle_home`* directory.

   The DBCA displays the Welcome page for Oracle RAC. Click **Help** on any DBCA page for additional information.
2. Select Real Application Clusters database, click **Next**, and DBCA displays the Operations page.
3. Select **Instance Management**, click **Next**, and DBCA displays the Instance Management page.
4. Select **Add Instance** and click **Next**. The DBCA displays the List of Cluster Databases page that shows the databases and their current status, such as `ACTIVE`, or `INACTIVE`.
5. From the List of Cluster Databases page, select the active Oracle RAC database to which you want to add an instance. Enter user name and password for the database user that has SYSDBA privileges. Click **Next** and DBCA displays the List of Cluster Database Instances page showing the names of the existing instances for the Oracle RAC database that you selected.
6. Click **Next** to add a new instance and DBCA displays the Adding an Instance page.
7. On the Adding an Instance page, enter the instance name in the field at the top of this page if the instance name that DBCA provides does not match your existing instance naming scheme. Then select the new node name from the list, click **Next**, and DBCA displays the Services Page.
8. Enter the services information for the new node's instance, click **Next**, and DBCA displays the Instance Storage page.
9. If you are using raw devices or raw partitions, then on the Instance Storage page select the Tablespaces folder and expand it. Select the undo tablespace storage object and a dialog appears on the right-hand side. Change the default datafile name to the raw device name for the tablespace.

10. If you are using raw devices or raw partitions or if you want to change the default redo log group file name, then on the Instance Storage page select and expand the Redo Log Groups folder. For each redo log group number that you select, DBCA displays another dialog box. Enter the raw device name that you created in the section "Raw Device Storage Preparation for New Nodes" on page 11-13 in the File Name field.
11. If you are using a cluster file system, then click **Finish** on the Instance Storage page. If you are using raw devices, then repeat step 10 for all of the other redo log groups, click **Finish**, and DBCA displays a Summary dialog.
12. Review the information on the Summary dialog and click **OK** or click **Cancel** to end the instance addition operation. The DBCA displays a progress dialog showing DBCA performing the instance addition operation. When DBCA completes the instance addition operation, DBCA displays a dialog asking whether you want to perform another operation.
13. After you terminate your DBCA session, run the following command to verify the administrative privileges on the new node and obtain detailed information about these privileges where *nodelist* consists of the newly added nodes:

    ```
    cluvfy comp admprv -o db_config -d oracle_home -n nodelist [-verbose]
    ```

After adding the instances to the new nodes using the steps described in this section, perform any needed service configuration procedures as described in Chapter 6, "Introduction to Workload Management".

Using DBCA in Silent Mode to Add Database Instances to New Nodes

You can use the Database Configuration Assistant (DBCA) in silent mode to add instances to nodes onto which you have extended an Oracle Clusterware home and an Oracle home. Use the following syntax to perform this operation where *node* is the node onto which you want to add the instance, *gdbname* is the global database name, *instname* is the name of the new instance, *sysdba* is the name of an Oracle user with SYSDBA privileges, and *password* is the password for the user name in *sysdba*:

```
dbca -silent -addInstance -nodeList node -gdbName gdbname [-instanceName instname]
-sysDBAUserName sysdba -sysDBAPassword password
```

Note that you only need to provide an instance name if you want to override the Oracle naming convention for Oracle RAC instance names.

After you have completed either of DBCA procedures in this section, DBCA has successfully added the new instance to the new node and completed the following steps:

- Created and started an ASM instance on each new node if the existing instances were using ASM
- Created a new database instance on each new node
- Created and configured high availability components
- Created the Oracle Net configuration
- Started the new instance
- Created and started services if you entered services information on the Services Configuration page

After adding the instances to the new nodes using the steps described in this section, perform any needed service configuration procedures as described in Chapter 6, "Introduction to Workload Management".

Connecting to iSQL*Plus after Adding a Node

After you add a node to an Oracle RAC database on Windows-based systems, you must manually create the following directories in the *Oracle_base**Oracle_home*\oc4j\j2ee\isqlplus directory before you can run iSQL*Plus on the new node:

- connectors
- log
- persistence
- tldcache

After you create these directories, you can start iSQL*Plus either by running `isqlplusctl start` at the command prompt or by starting iSQL*Plus from the Windows Control Panel Services tool. If you try to connect to the iSQL*Plus URL without creating these directories, then you will not be able to connect.

Adding Nodes that Already Have Clusterware and Oracle Software to a Cluster

To add nodes to a cluster when the new nodes already have clusterware and Oracle software installed on them, you must configure the new nodes with the Oracle software that is on the existing nodes of the cluster. To do this, you must run two versions of an OUI process: one for the clusterware and one for the database layer as described in the following procedures:

1. Add new nodes at the Oracle Clusterware layer by running OUI using the following command:

   ```
   CRS_home\oui\bin\addnode.bat -noCopy
   ```

2. Add new nodes at the Oracle software layer by running OUI from the Oracle home as follows:

   ```
   Oracle_home\oui\bin\addnode.bat -noCopy
   ```

In the `-noCopy` mode, OUI performs all add node operations except for the copying of software to the new nodes.

Note: Oracle recommends that you back up your voting disk and Oracle Cluster Registry files after you complete the node addition process.

Overview of Node Deletion Procedures

This section explains how to delete nodes from clusters using detailed manual procedures. The details of these steps appear in the following sections:

- Step 1: Deleting Instances from Oracle Real Application Clusters Databases
- Step 2: Deleting Nodes from Oracle Real Application Clusters Databases

Step 1: Deleting Instances from Oracle Real Application Clusters Databases

The procedures in this section explain how to use Enterprise Manager, or DBCA in interactive or silent mode, to delete an instance from an Oracle RAC database.

Using Enterprise Manager to Delete Database Instances from Existing Nodes

To delete an instance with Enterprise Manager from an existing node, perform the following steps:

1. From the Cluster Database Home page, click the **Maintenance** tab.
2. Under the Deployments section, click **Delete Instance**. This action initiates a wizard to guide you through the deletion process.
3. Perform the following tasks for each wizard step:
   - If the database was using ASM, provide host and ASM credentials.
   - Specify hosts from which to delete instances.
   - Review and submit the job.

   After you submit the job, the wizard displays a summary page that shows whether the job succeeded. The wizard also provides other detailed information about the job, such as an output log and information about the elapsed time.

Using DBCA in Interactive Mode to Delete Database Instances from Existing Nodes

To delete an instance using DBCA in interactive mode, perform the following steps:

1. Start DBCA on a node *other than* the node that hosts the instance that you want to delete. On the DBCA Welcome page select Oracle Real Application Clusters Database, click **Next**, and DBCA displays the Operations page.
2. On the DBCA Operations page, select Instance Management, click **Next**, and DBCA displays the Instance Management page.
3. On the Instance Management page, Select Delete Instance, click **Next**, and DBCA displays the List of Cluster Databases page.
4. Select an Oracle RAC database from which to delete an instance. Enter a user name and password for the database user that has SYSDBA privileges. Click **Next** and DBCA displays the List of Cluster Database Instances page. The List of Cluster Database Instances page shows the instances that are associated with the Oracle RAC database that you selected and the status of each instance.
5. Select an instance to delete and click **Finish**.
6. If you have services assigned to this instance, then the DBCA Services Management page appears. Use this feature to reassign services from this instance to other instances in the cluster database.

7. Review the information about the instance deletion operation on the Summary page and click **OK**. Otherwise, click **Cancel** to cancel the instance deletion operation. If you click **OK**, then DBCA displays a Confirmation dialog.
8. Click **OK** on the Confirmation dialog to proceed with the instance deletion operation and DBCA displays a progress dialog showing that DBCA is performing the instance deletion operation. During this operation, DBCA removes the instance and the instance's Oracle Net configuration. When DBCA completes this operation, DBCA displays a dialog asking whether you want to perform another operation.
9. Click **No** and exit DBCA or click **Yes** to perform another operation. If you click **Yes**, then DBCA displays the Operations page.

Using DBCA in Silent Mode to Delete Instance from Existing Nodes

Use DBCA to delete a database instance from a node as follows, where the variables are the same as those in the preceding add instance command:

```
dbca -silent -deleteInstance [-nodeList node] -gdbName gdbname -instanceName
instname -sysDBAUserName sysdba -sysDBAPassword password
```

You only need to provide a node name if you are deleting an instance from a node other than the one on which you are running DBCA.

At this point, you have accomplished the following:

- De-registered the selected instance from its associated Oracle Net Services listeners
- Deleted the selected database instance from the instance's configured node
- Removed the Oracle Net configuration
- Deleted the Oracle Flexible Architecture directory structure from the instance's configured node.

Step 2: Deleting Nodes from Oracle Real Application Clusters Databases

Execute the following procedures to delete nodes from Oracle clusters on Windows-based systems.

Perform the following steps on a node *other than* the node that you want to delete:

1. Use the Database Configuration Assistant (DBCA) to delete the instance.
2. Use the Net Configuration Assistant (NETCA) to delete the Listener.

Perform the following steps *on* the node that you want to delete:

> **See Also:** *Oracle Database Net Services Administrator's Guide* for more information about NETCA

> **Note:** You can perform some of the steps in the following procedure in silent mode as described at the end of this section.

1. If the node that you are deleting has an ASM instance, then delete the ASM instance using the procedures in the following section, "Step 3: ASM Instance Clean-Up Procedures for Node Deletion" on page 11-24.

2. On the that you are deleting, for example, node2, run the following command where *location* is the full path location of the Oracle home:

```
setup.exe -updateNodeList ORACLE_HOME=location
CLUSTER_ NODES="" -local
```

3. Depending on whether you have a shared or non-shared Oracle home, complete one of the following two procedures:
   - For a non-shared home, run OUI from the Oracle home and deinstall this home. You can run the setup.exe command from *Oracle_home*\oui\bin to start OUI so that you can deinstall the Oracle home.
   - For a shared home:
     - Run the following command from the *Oracle_home*\oui\bin directory:

       ```
       setup.exe -detachHome ORACLE_HOME=Oracle_home
       ```

     - Delete the services associated with this Oracle home.
     - Manually update the PATH environment variable by removing the entries associated with the Oracle home that you are removing.
     - Manually delete any Start menu folder items associated with the deleted Oracle home.
4. On node1, or in the case of multiple node installations, on any node other than the node that you are deleting, run the following command from *Oracle_home*\oui\bin where *node_list* is a comma-delimited list of nodes that are to remain part of the Oracle RAC installation:

```
setup.exe -updateNodeList ORACLE_HOME=Oracle_home
"CLUSTER_NODES={node_list}"
```

5. From *CRS_home*\bin on any existing node, run the following command where *remote_port* is the number of the remote port:

```
racgons remove_config node2:remote_port
```

   You can determine the remote port by viewing the contents of the file, *CRS_home*\opmn\conf\ons.config.

6. Run SRVCTL to stop and remove the node applications from node2. From *CRS_home*\bin run the following commands:

```
srvctl stop nodeapps -n node2
srvctl remove nodeapps -n node2
```

7. On node1, or on any node that you are not deleting, run the following command from *CRS_home*\bin where *node_name* is the node to be deleted and *node_number* is the node's number as obtained from the output of the olsnodes -n command:

```
crssetup del -nn node_name,node_number
```

8. On the node or nodes that you are deleting, node2 in this example, run the following command from *CRS_home*\oui\bin:

```
setup.exe -updateNodeList ORACLE_HOME=CRS_home
"CLUSTER_NODES={node2}" CRS=TRUE -local
```

9. On node2, using OUI setup.exe from *CRS_home*\oui\bin:

- If you have a non-shared home, then deinstall the Oracle Clusterware installation by running the `setup.exe` script from *`CRS_home`*`\oui\bin`.
- If you have a shared home, then do not perform a deinstallation. Instead, perform the following steps on the node that you want to delete:
  - Run the following command from *`CRS_home`*`\oui\bin` to detach the Oracle Clusterware home on `node2`:

    ```
    setup.exe -detachHome ORACLE_HOME=CRS_home
    ```

  - On `node2`, stop any services that are associated with this Oracle Clusterware home. The associated service s are namely: `OracleCRSService`, `OracleEVMService`, `OracleCSService`, and `OracleClusterVolumeService`.
  - Remove the Oracle services.
  - Manually delete all of the Start menu items associated with this Oracle Clusterware home.
  - Manually update the `PATH` environment variable to remove entries associated with this Clusterware home.
  - Then remove the following files under `%SystemRoot%\System32\drivers`: `ocfs.sys`, `orafencedrv.sys`, and `orafenceservice.sys`.

10. On `node1`, or in the case of a multiple node installation, on any node other than the one to be deleted, run the following command from *`CRS_home`*`\oui\bin` where *`node_list`* is a comma-delimited list of nodes that are to remain part of the Oracle RAC database:

    ```
    setup.exe -updateNodeList ORACLE_HOME=CRS_home
    "CLUSTER_NODES={node_list}" CRS=TRUE
    ```

As mentioned at the beginning of this procedure, you can optionally delete nodes from Oracle Real Application Clusters databases in silent mode by completing the following steps:

1. Perform steps 1 and 2 from the previous procedure.
2. On the node to be deleted, `node2` in this case:
   - If you have a non-shared home, then deinstall the Oracle home as follows:

     ```
     setup.exe -silent  -deinstall "REMOVE_HOMES={Oracle_home}"
     ```

   - If the home is a shared home, then do not perform a deinstall. Instead, perform the following steps on the node to be deleted:
     - Perform a detach home on `node2` by running the following command from *`Oracle_home`*`\oui\bin` on `node2`:

       ```
       setup.exe -detachHome -silent ORACLE_HOME=Oracle_home
       ```

     - On node 2, stop and delete any services that are associated with this Oracle home. In addition, delete any Registry entries and path entries that are associated with this Oracle home. Also, delete all of the start menu items associated with this Oracle home.
3. Perform steps 4 through 8 from the previous procedure.
4. On `node2`, using OUI `setup.exe` from *`CRS_home`*`\oui\bin`:

- If you have a non-shared home, then deinstall the Oracle Clusterware home as follows:

  ```
  setup.exe -silent  -deinstall "REMOVE_HOMES={CRS_home}"
  ```

- If you have a shared home, then do not perform a deinstallation. Instead, perform the following steps on the node that you want to delete:
  - Run the following command from *CRS_home*\oui\bin to detach the Oracle Clusterware home on node2:

    ```
    setup.exe -detachHome -silent ORACLE_HOME=CRS_home
    ```

  - On node2, stop any services that are associated with this Oracle Clusterware home. The associated service s are namely: OracleCRSService, OracleEVMService, OracleCSService, and OracleClusterVolumeService.
  - Remove the Oracle services.
  - Manually delete all of the Start menu items associated with this Oracle Clusterware home.
  - Manually update the PATH environment variable to remove entries associated with this Clusterware home.
  - Then remove the following files under %SystemRoot%\System32\drivers: ocfs.sys, orafencedrv.sys, and orafenceservice.sys.

5. Perform step 10 from the previous procedure.

Note: Oracle recommends that you back up your voting disk and Oracle Cluster Registry files after you complete the node deletion process.

Step 3: ASM Instance Clean-Up Procedures for Node Deletion

If you are using ASM, then the delete node procedure requires the following additional steps to remove the ASM instances:

1. If this is the Oracle home from which the node-specific Listener named LISTENER_*nodename* runs, then use NETCA to remove this Listener. If necessary, re-create this Listener in another home.

   See Also: *Oracle Database Net Services Administrator's Guide* for more information about NETCA

2. If this is the Oracle home from which the ASM instance runs, then remove the ASM configuration by running the following command for all nodes on which this Oracle home exists:

   ```
   srvctl stop asm -n node
   ```

   Then run the following command for the nodes that you are removing:

   ```
   srvctl remove asm -n node
   ```

3. Run the following command on each node that you are going to delete that has an ASM instance:

```
oradim -delete -asmsid +ASMnode_number
```

4. If you are not using a cluster file system for your ASM Oracle home, then run the following commands on the deleted node:

```
rd /s /q ORACLE_BASE\admin\+ASM
del Oracle_home\database\*ASM*
```

12

Design and Deployment Techniques

This chapter briefly describes database design and deployment techniques for Oracle Real Application Clusters (Oracle RAC) environments. It also describes general high availability topics such as how Oracle Clusterware manages services within Oracle RAC. The topics in this chapter are:

- Service Configuration Recommendations for High Availability
- General Database Deployment Topics for Oracle Real Application Clusters

Service Configuration Recommendations for High Availability

This section describes the following high availability service configuration recommendations:

- Service Topologies and Workload Management in Oracle Real Application Clusters
- Recommended Oracle Real Application Clusters Service Configurations
- Automatic Workload Repository
- Setting Service Levels and Thresholds

Service Topologies and Workload Management in Oracle Real Application Clusters

Services are the basis for workload management in Oracle RAC. Clients and mid-tier applications make connection requests by specifying a global service name. Because Oracle RAC can reallocate services among instances in response to planned and unplanned outages, services greatly extend the availability and scalability of Oracle RAC environments.

> **See Also:** *Oracle Enterprise Manager Concepts* for more information about administering services with Enterprise Manager

Recommended Oracle Real Application Clusters Service Configurations

The recommended service configuration is to uniformly distribute service assignments across all available nodes. This simplifies your configuration and provides optimal high availability. Another approach is to non-uniformly configure services. In other words, workload sharing configurations can resemble many different topologies.

For example, assume that you have a five-node **cluster** with two instances, A and B, serving as the preferred instances for Customer Relationship Management (CRM). This same cluster could have instances C, D, and E as the preferred instances for Accounts Payable (AP). Instances A and B are the available instances for AP if one or

more of AP's preferred instances become unavailable. Instances C, D, and E are the available instances for CRM if one or more of the CRM preferred instances becomes unavailable.

This configuration enables each service to use a group of instances that acts as both the preferred instances and as the instances that are available in case of a failure. After an outage, a client recovers its connections on another instance in the same group.

In this configuration, during normal operations Oracle RAC routes application sessions by service to separate groups of instances. If a preferred instance becomes unavailable, then Oracle Clusterware relocates connections among the remaining Oracle RAC instances that offer that service.

Workload managed configurations achieve the highest availability and performance by transparently maintaining affinity based on service. Planned and unplanned outages on one domain can be isolated from other domains and the affected service is recovered or upgraded in isolation.

Automatic Workload Repository

The **Automatic Workload Repository (AWR)** tracks service level statistics as metrics. Server generated alerts can be placed on these metrics when they exceed or fail to meet certain thresholds. You can then respond, for example, by changing the priority of a job, stopping overloaded processes, or by modifying a service level requirement. This enables you to maintain continued service availability despite service level changes. You can configure the service level for one service to have priorities relative to other services, and you can also configure:

- The measurement of service quality
- Event notification and alert mechanisms to monitor service quality changes
- Recovery scenarios for responses to service quality changes

The Automatic Workload Repository ensures that the Oracle Clusterware workload management framework and resource manager have persistent and global representations of performance data. This information helps Oracle schedule job classes by service and to assign priorities to consumer groups. If necessary, you can re-balance workloads manually with the `DBMS_SERVICE.DISCONNECT_SESSION` PL/SQL procedure. You can also use this procedure to disconnect a series of sessions and leave the service running.

> **See Also:** *Oracle Database Performance Tuning Guide* for details about the Automatic Workload Repository and *Oracle Database PL/SQL Packages and Types Reference* for details about Oracle packages

Setting Service Levels and Thresholds

Enterprise Manager and local Listeners subscribe to events that indicate changes in service levels. You can set service level metric thresholds with either Enterprise Manager or with Oracle packages.

You can see historical values for metrics in the `V$SERVICEMETRIC_HISTORY` view. Information about a service from the application level is available in the `V$SESSION` and `V$SQL` views. Service levels, or thresholds, are the baseline operational levels, and events indicate violations of these baselines. You can also examine `GV$SVCMETRIC` for timings such as resource consumption. Use the `V$ACTIVE_SERVICES` and `GV$ACTIVE_SERVICES` views to identify which services are running on which instances.

See Also: Chapter 6, "Introduction to Workload Management" for more information about how to configure services in Oracle RAC environments

How Oracle Clusterware Manages Service Relocation

When an instance goes offline due to a planned outage or failure, Oracle Clusterware relocates the service to another available instances and re-establishes the connection without service interruption. This occurs as long as the underlying service components on which the relocation relies are enabled for relocation and restart.

General Database Deployment Topics for Oracle Real Application Clusters

This section describes a few topics to consider when deploying Oracle RAC databases. Your Oracle RAC database performance is not compromised if you do not employ these techniques. If you have an effective single-instance design, then your application will run well on an Oracle RAC database. This section contains the following topics:

- Tablespace Use in Oracle Real Application Clusters
- Object Creation and Performance in Oracle Real Application Clusters
- Node Addition and Deletion and the SYSAUX Tablespace in Oracle RAC
- Distributed Transactions and Oracle Real Application Clusters

Tablespace Use in Oracle Real Application Clusters

In addition to using locally managed tablespaces, you can further simplify space administration by using automatic segment-space management and automatic undo management.

Automatic segment-space management distributes instance workloads among each instance's subset of blocks for inserts. This improves Oracle RAC performance because it minimizes block transfers. To deploy automatic undo management in an Oracle RAC environment, each instance must have its own undo tablespace.

Object Creation and Performance in Oracle Real Application Clusters

As a general rule, only use DDL statements for maintenance tasks and avoid executing DDL statements during peak system operation periods. In most systems, the amount of new object creation and other DDL statements should be limited. Just as in single-instance Oracle databases, excessive object creation and deletion can increase performance overhead.

Node Addition and Deletion and the SYSAUX Tablespace in Oracle RAC

If you add nodes to your Oracle RAC database environment, then you may need to increase the size of the `SYSAUX` tablespace. Conversely, if you remove nodes from your **cluster database**, then you may be able to reduce the size of your `SYSAUX` tablespace.

See Also: our Oracle Real Application Clusters installation and configuration guide for guidelines about sizing the `SYSAUX` tablespace for multiple instances.

Distributed Transactions and Oracle Real Application Clusters

When you use Oracle Distributed Transaction Processing (DTP) in Oracle RAC, which includes both XA and distributed SQL transactions, all tightly coupled branches of a distributed transaction must be hosted on the same instance. To ensure this, create multiple DTP services, with one or more on each Oracle RAC instance. Each DTP service is a singleton service that is available on one and only one Oracle RAC instance. All access to the database server for distributed transaction processing must be done by way of the DTP services. Ensure that all of the branches of a single global distributed transaction use the same DTP service. In other words, a network connection descriptor, such as a TNS name, a JDBC URL, and so on, must use a DTP service to support distributed transaction processing.

See Also: "Services and Distributed Transaction Processing in Oracle RAC" on page 6-16 for more details about enabling services and distributed transactions and *Oracle Database Application Developer's Guide - Fundamentals* for more information about distributed transactions in Oracle RAC

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Monitoring Performance

This chapter describes how to monitor Oracle Real Application Clusters (Oracle RAC) performance. This chapter explains how to verify the interconnect settings, how to use the performance views for Oracle RAC, and descriptions of Oracle RAC-specific statistics and how to monitor them. This chapter describes **Automatic Workload Repository (AWR)**, how to analyze Oracle RAC statistics, and how to analyze Oracle RAC wait events. This chapter also explains how to monitor performance in Oracle RAC databases with Enterprise Manager. This chapter contains these topics:

Overview of Monitoring Oracle Real Application Clusters Databases

All single-instance tuning practices for Oracle Database apply to applications running on Oracle RAC databases. Therefore, implement the single-instance tuning methodologies described in *Oracle Database Performance Tuning Guide*.

Verifying the Interconnect Settings for Oracle Real Application Clusters

The interconnect and internode communication protocols can affect **Cache Fusion** performance. In addition, the interconnect bandwidth, its latency, and the efficiency of the IPC protocol determine the speed with which Cache Fusion processes block transfers.

Influencing Interconnect Processing

Once your interconnect is operative, you cannot significantly influence its performance. However, you can influence an interconnect protocol's efficiency by adjusting the IPC buffer sizes.

The Oracle Cluster Registry (OCR) stores your system's interconnect information. Use the `oifcfg` command or OCRDUMP utility to identify the interconnect that you are

using. You can then change the interconnect that you are using by running an `oifcfg` command.

> **See Also:** Your vendor-specific interconnect documentation for more information about adjusting IPC buffer sizes

Although you *rarely* need to set the `CLUSTER_INTERCONNECTS` parameter, you can use it to assign a private network IP address or NIC as in the following example:

```
CLUSTER_INTERCONNECTS=10.0.0.1
```

If you are using an operating system-specific vendor IPC protocol, then the trace information may not reveal the IP address.

> **Note:** You can also use the `oifcfg` command as described in "Administering System and Network Interfaces with OIFCFG" on page 9-7 to assign private network or private IP addresses.

Performance Views in Oracle Real Application Clusters

Each instance has a set of instance-specific views. You can also query global dynamic performance views to retrieve performance information from all of the qualified instances. Global dynamic performance view names are prefixed with *GV$*. A global view contains all columns from its respective instance-specific view as well as the `INST_ID` column. The instance number is also appended to the names of the archived redo log threads to create a unique identifier for each instance's archived redo logs.

> **See Also:** *Oracle Database Reference* for restrictions on GV$ views and complete descriptions of related parameters and views

Creating Oracle Real Application Clusters Data Dictionary Views with CATCLUST.SQL

If you did not create your Oracle RAC database with the Database Configuration Assistant (DBCA), then you must run the `CATCLUST.SQL` script to create Oracle RAC-related views and tables. You must have `SYSDBA` privileges to run this script.

> **See Also:** our Oracle Real Application Clusters installation and configuration guide for more information about creating your Oracle RAC database

Oracle Real Application Clusters Performance Statistics

This section provides an overview of the V$ and GV$ views that provide statistics that you can use evaluate block transfers in your **cluster**. Use these statistics to analyze interconnect block transfer rates as well as the overall performance of your Oracle RAC database.

The Content of Oracle Real Application Clusters Statistics

Oracle RAC-specific statistics appear as message request counters or as timed statistics. Message request counters include statistics showing the number of certain types of block mode conversions. Timed statistics reveal the total or average time waited for read and write I/O for particular types of operations.

Automatic Workload Repository in Oracle Real Application Clusters Environments

In Oracle RAC environments, each Automatic Workload Repository (AWR) snapshot captures data from all active instances within the cluster. The data for each snapshot set that is captured for all active instances is from the same point in time. In addition, the data for each instance is stored separately and is identified with an instance identifier. For example, the `buffer_busy_wait` statistic shows the number of buffer waits on each instance. AWR does not store data that is aggregated from across the entire cluster. In other words, the data is stored for each individual instance.

Monitoring Oracle Real Application Clusters Statistics and Events

This section explains wait events and statistics specific to Oracle RAC and how to interpret them when assessing performance data generated by the Automatic Workload Repository, Statspack, or by ad-hoc queries of the dynamic performance views.

> **See Also:** *Oracle Database Performance Tuning Guide* for more information about wait event analysis and the `spdoc.txt` file for details about the Statspack utility

Oracle RAC Statistics and Events in AWR and Statspack Reports

The statistics snapshots generated by AWR and Statspack can be evaluated by producing reports displaying summary data such as load and cluster profiles based on regular statistics and wait events gathered on each instance.

Most of the relevant data is summarized on the Oracle RAC Statistics Page. This information includes:

- Global cache load profile
- Global cache efficiency percentages: workload characteristics
- Global cache and Enqueue Service (GES): messaging statistics

Additional Oracle RAC-related sections appear later in the report:

- Global enqueue statistics
- Global CR statistics
- Global CURRENT served statistics
- Global cache transfer statistics.

Oracle Real Application Clusters Wait Events

Analyzing and interpreting what sessions are waiting for is an important method to determine where time is spent. In Oracle RAC, the wait time is attributed to an event which reflects the exact outcome of a request. For example, when a session on an instance is looking for a block in the global cache, it does not know whether it will receive the data cached by another instance or whether it will receive a message to read from disk. The wait events for the global cache now convey precise information and waiting for global cache blocks or messages is:

- Summarized in a broader category called Cluster Wait Class
- Temporarily represented by a placeholder event which is active while waiting for a block, for example:

- gc current block request
- gc cr block request

- Attributed to precise events when the outcome of the request is known, for example:
  - gc current block 3-way
  - gc current block busy
  - gc cr block grant 2-way

In summary, the wait events for Oracle RAC convey information valuable for performance analysis. They are used in Automatic Database Diagnostic Monitor (ADDM) to enable precise diagnostics of the impact of cache fusion.

Monitoring Performance by Analyzing GCS and GES Statistics

In order to determine the amount of work and cost related to inter-instance messaging and contention, examine block transfer rates, remote requests made by each transaction, the number and time waited for global cache events as described under the following headings:

- Analyzing Cache Fusion Impact in Oracle Real Application Clusters
- Analyzing Performance Using GCS and GES Statistics

Analyzing Cache Fusion Impact in Oracle Real Application Clusters

The effect of accessing blocks in the global cache and maintaining coherency is represented by

- The Global Cache Service statistics for current and cr blocks, for example, gc current blocks received, gc cr blocks received, and so on)
- The Global Cache Service wait events, for gc current block 3-way, gc cr grant 2-way, and so on.

The response time for cache fusion transfers is determined by the messaging and processing times imposed by the physical interconnect components, the IPC protocol and the GCS protocol. It is not affected by disk I/O factors other than occasional log writes. The cache fusion protocol does not require I/O to data files in order to guarantee **cache coherency** and Oracle RAC inherently does not cause any more I/O to disk than a non-clustered instance.

Analyzing Performance Using GCS and GES Statistics

This section describes how to monitor Global Cache Service performance by identifying data blocks and objects which are frequently used ("hot") by all instances. High concurrency on certain blocks may be identified by Global Cache Service wait events and times.

The gc current block busy wait event indicates that the access to cached data blocks was delayed because they were busy either in the remote or the local cache. This means that the blocks were pinned or held up by sessions or delayed by a log write on a remote instance or that a session on the same instance is already accessing a block which is in transition between instances and the current session needs to wait behind it (for example, gc current block busy).

The `V$SESSION_WAIT` view to identify objects and data blocks with contention. The gc wait events contain the file and block number for a block request in p1 and p2, respectively.

An additional segment statistic, gc buffer busy, has been added to quickly determine the "busy" objects without recourse to the query on V$SESSION_WAIT mentioned earlier.

The AWR infrastructure provides a view of active session history which can also be used to trace recent wait events and their arguments. It is therefore useful for hot block analysis. Most of the reporting facilities used by AWR and Statspack contain the object statistics and cluster wait class category, so that sampling of the views mentioned earlier is largely unnecessary.

It is advisable to run ADDM on the snapshot data collected by the AWR infrastructure to obtain an overall evaluation of the impact of the global cache. The advisory will also identify the busy objects and SQL highest cluster wait time.

Analyzing Cache Fusion Transfer Impact Using GCS Statistics

This section describes how to monitor Global Cache Service performance by identifying objects read and modified frequently and the service times imposed by the remote access. Waiting for blocks to arrive may constitute a significant portion of the response time, in the same way that reading from disk could increase the block access delays, only that cache fusion transfers in most cases are faster than disk access latencies.

The following wait events indicate that the remotely cached blocks were shipped to the local instance without having been busy, pinned or requiring a log flush:

- gc current block 2-way
- gc current block 3-way
- gc cr block 2-way
- gc cr block 3-way

The object statistics for gc current blocks received and gc cr blocks received enable quick identification of the indexes and tables which are shared by the active instances. As mentioned earlier, creating an ADDM analysis will, in most cases, point you to the SQL statements and database objects that could be impacted by inter-instance contention.

Note: You must run Statspack at level 7 to collect statistics related to block contention and segment block waits.

Any increases in the average wait times for the events mentioned earlier could be caused by the following occurrences:

- High load: CPU shortages, long run queues, scheduling delays
- Misconfiguration: using public instead of private interconnect for message and block traffic

If the average wait times are acceptable and no interconnect or load issues can be diagnosed, then the accumulated time waited can usually be attributed to a few SQL statements which need to be tuned to minimize the number of blocks accessed.

The column CLUSTER_WAIT_TIME in V$SQLAREA represents the wait time incurred by individual SQL statements for global cache events and will identify the SQL which may need to be tuned.

Analyzing Response Times Based on Wait Events

Most global cache wait events that show a high total time as reported in the AWR and Statspack reports or in the dynamic performance views are normal and may present themselves as the top database time consumers without actually indicating a problem. This section describes the most important and frequent wait events that you should be aware of when interpreting performance data.

If user response times increases and a high proportion of time waited is for global cache (gc), then the cause should be determined. Most reports include a breakdown of events sorted by percentage of the total time.

It is useful to start with an ADDM report, which would analyze the routinely collected performance statistics with respect to their impact and point to the objects and SQL contributing most to the time waited, and then move on to the more detailed reports produced by AWR and Statspack. The most important wait events for Oracle RAC include various categories, such as:

- Block-oriented
  - gc current block 2-way
  - gc current block 3-way
  - gc cr block 2-way
  - gc cr block 3-way
- Message-oriented
  - gc current grant 2-way
  - gc cr grant 2-way
- Contention-oriented
  - gc current block busy
  - gc cr block busy
  - gc buffer busy
- Load-oriented
  - gc current block congested
  - gc cr block congested

The block-oriented wait event statistics indicate that a block was received as either the result of a 2-way or a 3-way message, that is, the block was sent from either the resource master requiring 1 message and 1 transfer, or was forwarded to a third node from which it was sent, requiring 2 messages and 1 block transfer.

The gc current block busy and gc cr block busy wait events indicate that the remote instance received the block after a remote instance processing delay. In most cases, this is due to a log flush. The existence of these wait events does not necessarily characterize high concurrency for the blocks. High concurrency is instead evidenced by the existence of the gc buffer busy event. This event indicates that the block was pinned or held up by a session on a remote instance. It can also indicate that a session on the same instance has already requested the block, which in either case is in transition between instances and the current session needs to wait behind it.

These events are usually the most frequent in the absence of block contention and the length of the wait is determined by the time it takes on the physical network, the time to process the request in the serving instances and the time it takes for the requesting process to wake up after the block arrives.

The average wait time and the total wait time should be considered when being alerted to performance issues where these particular waits have a high impact. Usually, either interconnect or load issues or SQL execution against a large shared working set can be found to be the root cause.

The message-oriented wait event statistics indicate that no block was received because it was not cached in any instance. Instead a global grant was given, enabling the requesting instance to read the block from disk or modify it.

If the time consumed by these events is high, then it may be assumed that the frequently used SQL causes a lot of disk I/O (in the event of the cr grant) or that the workload inserts a lot of data and needs to find and format new blocks frequently (in the event of the current grant).

The contention-oriented wait event statistics indicate that a block was received which was pinned by a session on another node, was deferred because a change had not yet been flushed to disk or because of high concurrency, and therefore could not be shipped immediately. A buffer may also be busy locally when a session has already initiated a cache fusion operation and is waiting for its completion when another session on the same node is trying to read or modify the same data. High service times for blocks exchanged in the global cache may exacerbate the contention, which can be caused by frequent concurrent read and write accesses to the same data.

The load-oriented wait events indicate that a delay in processing has occurred in the GCS, which is usually caused by high load, CPU saturation and would have to be solved by additional CPUs, load-balancing, off loading processing to different times or a new cluster node.For the events mentioned, the wait time encompasses the entire round trip from the time a session starts to wait after initiating a block request until the block arrives.

Monitoring Performance with Oracle Enterprise Manager

Oracle Enterprise Manager is an Oracle Web-based integrated management solution for monitoring and administering your computing environment. From any location where you can access a Web browser, you can manage Oracle RAC databases, application servers, host computers, and Web applications, as well as related hardware and software. For example, you can monitor your Oracle RAC database performance from your office, home, or a remote site, as long as you have access to a Web browser.

> **See Also:** *Oracle Enterprise Manager Concepts* and the Enterprise Manager Online Help for more information about Enterprise Manager

Overview of Enterprise Manager Monitoring

You can install, configure, and monitor an Oracle RAC database from a single location using either Oracle Enterprise Manager Database Control or Oracle Enterprise Manager Grid Control as follows:

- Oracle Enterprise Manager Database Control is designed to manage a single Oracle RAC10g Database with its instance, Listener, host, cluster, and Automatic Storage Management (ASM) targets. The Database Configuration Assistant (DBCA) automatically configures Database Control when you create a database.
- Oracle Enterprise Manager Grid Control enables you to centrally manage your entire computing enterprise. You can install Grid Control separately onto servers either inside or outside of your cluster to manage multiple Oracle RAC databases and multiple cluster targets. Grid Control consists of the Grid Control console and

one or more Oracle Management Services, the Oracle Management Repository, and remote Oracle Management Agents installed on each monitored host.

Both Database Control and Grid Control are cluster-aware and provide a central console to manage your cluster database. From the Cluster Database pages, you can:

- View the overall system status, such as the number of nodes in the cluster database and their current statuses. 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 alerts aggregated across all of the instances with drilldowns to the source of each alert. An alert 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.
- Set thresholds for alert generation on a cluster database-wide basis. Thresholds are values that indicate whether a warning or critical alert should be initiated.
- Monitor performance metrics aggregated across all of the instances or displayed side by side so you can readily compare instances.
- Monitor cluster cache coherency statistics to help you identify processing trends and optimize performance for your Oracle RAC environment.
- Perform cluster database-wide operations, including initiating back up and recovery operations, starting and stopping instances, and so on.

Enterprise Manager accumulates data over specified periods of time, called collection-based data. Enterprise Manager also provides current data, known as real-time data. The following sections explain how to monitor both types of data.

Collection-Based Monitoring

Enterprise Manager responds to metrics from an Oracle RAC database and publishes alerts when thresholds are exceeded. The following sections explain metrics, alerts, and thresholds.

Metrics

Metrics are units of measurement used to determine the health of a target. It is through the use of metrics and associated thresholds that Enterprise Manager sends out alerts notifying you of problems with the target. A complete list of all the metrics for a target are available by clicking **All Metrics** on the target's home page. From the displayed All Metrics page, you can view all of the metrics for the target and then drill down to any particular metric for additional information. Examples of Oracle RAC database metric categories are Tablespaces Full, Data Guard Status, and Database Cardinality. Examples of Oracle RAC database instance metric categories are Global Cache Statistics, Instance Throughput, and Alert Log.

Enterprise Manager monitors metrics at the database and instance levels, and any available node can monitor database metrics. However, only one node at a time monitors the entire database while each node monitors metrics for its local instance.

Alerts

An alert indicates a potential problem. Either a warning or critical threshold for a monitored metric has been crossed, or the target is no longer available. You can receive critical alerts when a monitored metric has crossed its critical threshold, or warning alerts when a monitored metric has crossed its warning threshold. Also, you can receive alerts on various target availability states, such as when the:

- Target is down
- Target is blacked out
- Oracle Management Agent that is monitoring the target is unreachable

An alert can also signal that a warning or critical threshold has been crossed. You can define a response action to be executed if a metric reaches the level for warnings or critical severity alerts once a threshold is crossed.

When you receive an alert, you can use Enterprise Manager to obtain more information to help you decide how to address the issue. For example, using the Warning Alerts page, a message for a target host could state that the CPU Utilization is 93.925667%. From this description, you can decide how to best redistribute the CPU load.

Thresholds

Thresholds are boundary values against which monitored metric values are compared. You can specify a warning threshold so that when a monitored metric value crosses that threshold, a warning alert is generated. This alert then notifies you about impending problems that you can address in a timely manner.

If a threshold is exceeded for a metric, then an alert appears on the Cluster Database Home page. You can also copy thresholds from one instance to other instances in Database Control and Grid Control, or you can copy thresholds between different Oracle RAC databases in Grid Control. Database Control does not manage multiple Oracle RAC databases.

Real-Time Performance Monitoring

Enterprise Manager provides performance pages to monitor all levels of a cluster environment, including the cluster, the cluster database, and the cluster database instances. Enterprise Manager uses data from the Automatic Workload Repository (AWR) to display performance information and initiate database alerts. Statistics collected by AWR are aggregated for all instances in an Oracle RAC database and displayed on a summary Enterprise Manager Performance page.

Oracle Enterprise Manager provides several real-time performance charts and drilldowns for the targets that you manage. Enterprise Manager displays both aggregate and instance-specific performance statistics using color-coded charts for easier viewing. To help you identify the source of a problem and resolve it, you can click a legend link next to a chart to display a detail page that provides comprehensive information.

The Cluster Database Home page is your entry point for monitoring Enterprise Manager. From that page, you can access the following Oracle RAC-specific performance pages that show performance trends across one or more cluster databases:

- Cluster Database Performance Page
- Cluster Database Instance Performance Page
- Cluster Performance Page

The following sections describe each of these pages as well as other related pages.

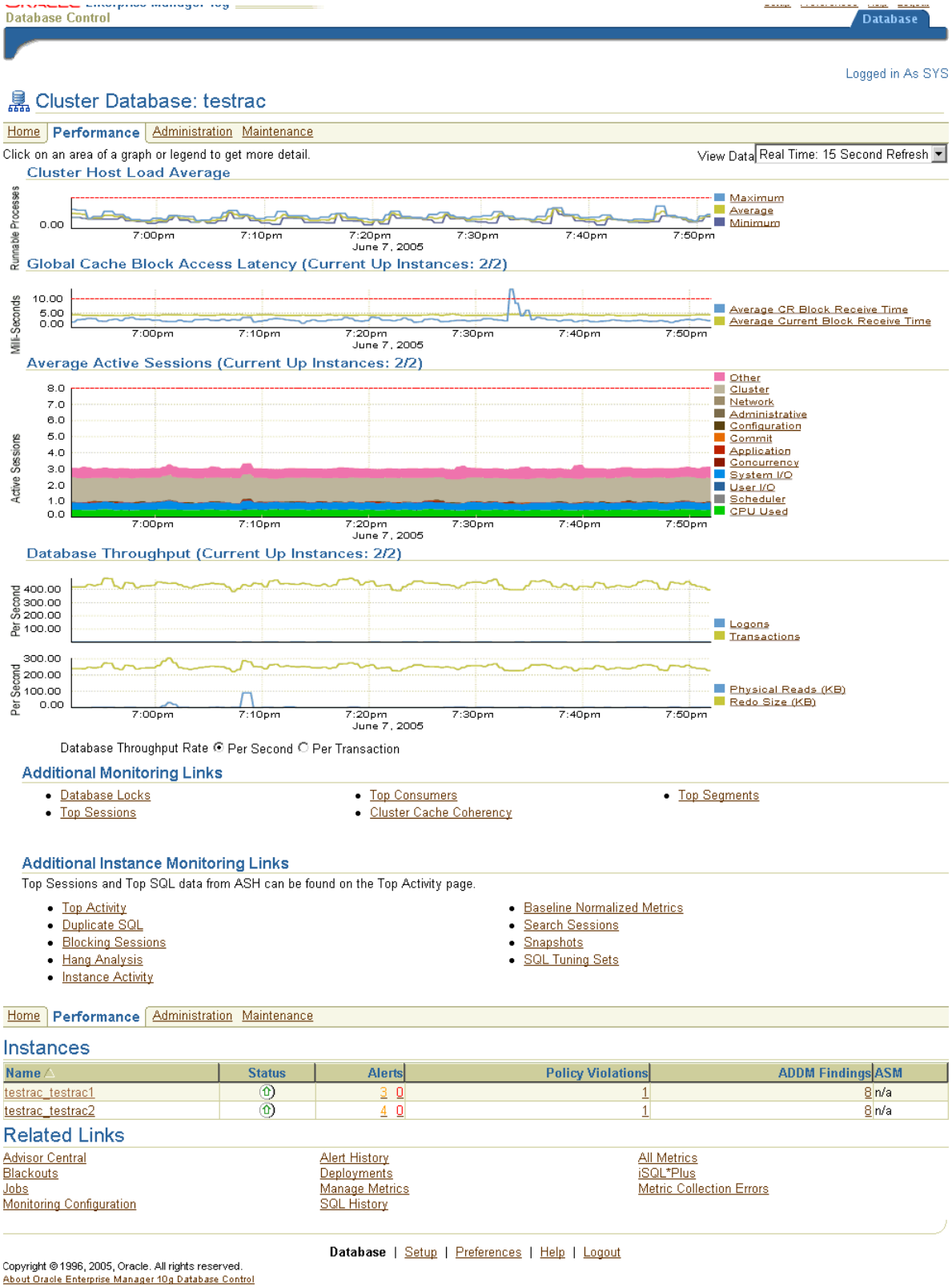
Using the Cluster Database Performance Page

The Cluster Database Performance page provides a quick glimpse of the performance statistics for a database. Statistics are rolled up across all of the instances in the cluster database. Using links that are next to the charts at the bottom of the page, you can drill down to:

- 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

Figure 13–1 shows the Cluster Database Performance page that you can access by clicking the **Performance** tab from the Cluster Database Home page.

Figure 13–1 Cluster Database Performance Page



The following sections provide a description for several important charts, performance monitoring pages, and diagnostic pages.

Cluster Host Load Average Chart

The Cluster Host Load Average chart in the Cluster Database Performance page shows potential problems that are outside of the database. The chart shows maximum, average, and minimum values for available hosts for the previous hour. These values appear at the same level for a cluster that has an evenly balanced load. For Windows-based systems, CPU usage is displayed.

If the load average is higher than the average of the total number of CPUs across all of 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.

Global Cache Block Access Latency Chart

The Global Cache Block Access Latency summary chart in the Cluster Database Performance page shows the end-to-end elapsed time or latency for a block request.

If accessing a database block of any class does not locate a buffered copy in the local cache, a global cache operation is initiated. Before reading a block from disk, an attempt is made to find the block in the buffer cache of another instance. If the block is in another instance, a version of the block may be shipped. Two different types of blocks are distinguished: current and consistent read blocks.

Long latencies can be caused by:

- A high number of requests caused by SQL statements that are not tuned.
- A large number of processes in the run queue waiting for CPU or scheduling delays.
- Platform-specific operating system parameter settings that affect IPC buffering or process scheduling.
- Slow, busy, or faulty interconnects. In these cases, look for dropped packets, retransmits, or cyclic redundancy check (CRC) errors. Ensure that the network is private and that inter-instance traffic is not routed through a public network. You can access the Cluster Interconnects page from the Cluster Cache Coherency page to monitor the transfer and related statistics for interconnects.

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 normally cause performance problems. However, when global cache requests cause a performance problem, optimizing SQL plans and the schema to achieve effective local cache hit efficiency and minimize I/O is a successful strategy for performance tuning. If the value for CR and current block request time reaches 10 ms, then your first step in resolving the problem should be to drill down to the Cluster Cache Coherency page for more detailed information.

To access the Cluster Cache Coherency page, click **Cluster Cache Coherency** in the Additional Monitoring Links section of the Performance page. You can alternatively click either of the legends to the right of the Global Cache Block Access Latency chart. The Cluster Cache Coherency page appears, as shown in Figure 13–2, which contains summary charts for cache coherency metrics for the cluster.

Figure 13–2 Cluster Cache Coherency Page

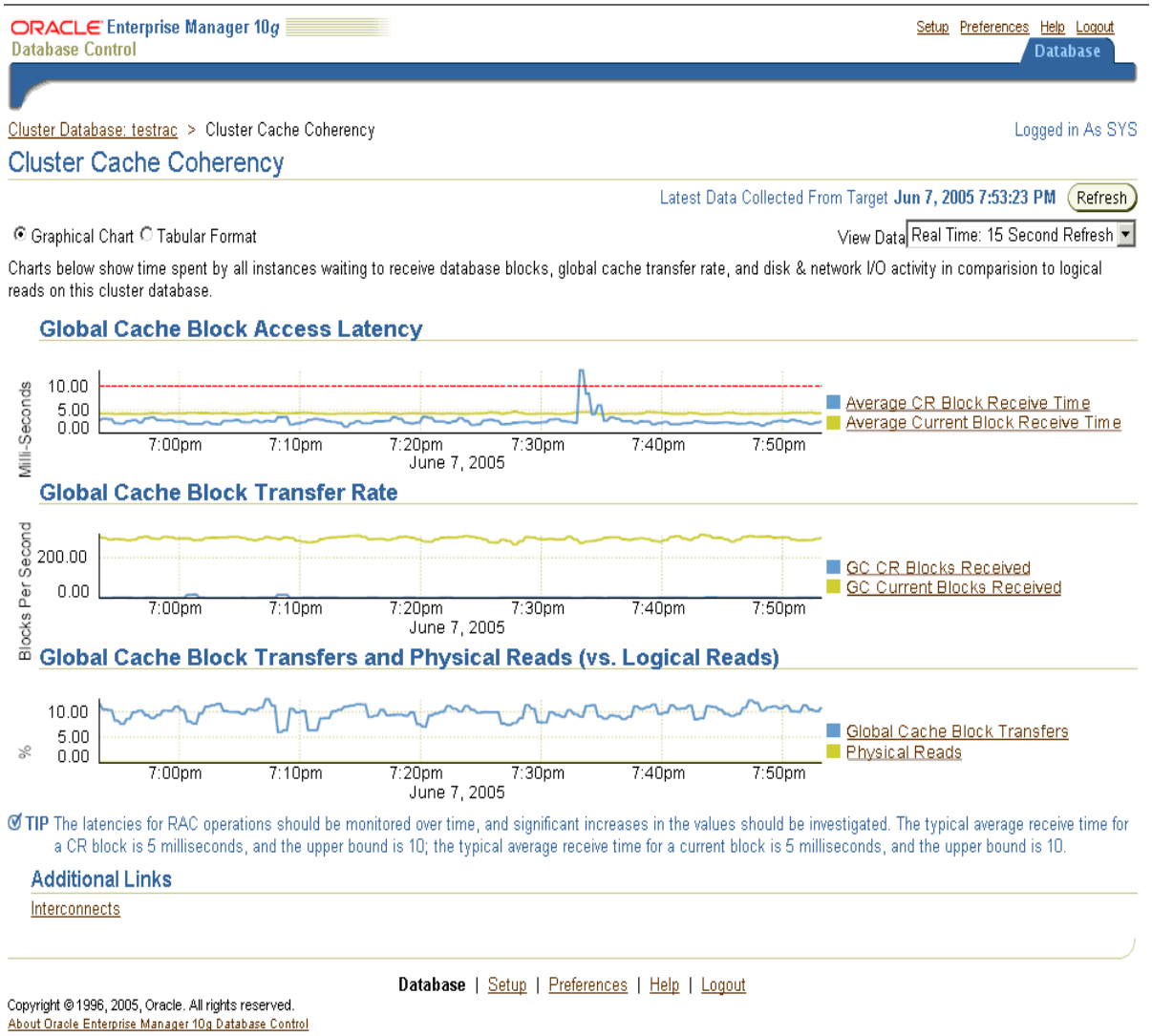


Table 13–1 provides a description of the Cluster Cache Coherency charts and their drilldowns for accessing more comprehensive information for problem resolution.

For additional information about interpreting these charts and metrics, click **Help** in the Cluster Cache Coherency page.

Table 13–1 Cluster Cache Coherency Charts

Name	Description
Global Cache Block Access Latency	Shows the end-to-end elapsed time or latency for a block request. Click one of the legends to the right of the chart to go to the Global Cache Block Receive Time by Instance page. From there, you can click an instance legend under the chart to go to the Block Transfer for Local Instance page, where you can identify block classes that are subject to intense global cache activity. You can also view the types of blocks that are being transferred, as well as which instances are transferring most of the blocks. Cache transfer indicates how many current and CR blocks per block class were received from remote instances, including how many transfers incurred a delay (busy) or an unexpected longer delay (congested).
Global Cache Block Transfer Rate	Shows the total aggregated number of data blocks received by all instances in the cluster by way of an interconnect. Click one of the legends to the right of the chart to go to the Global Cache Blocks Received by Instance page. From there, you can click an instance legend under the chart to go to the Segment Statistics by Instance page, where you can see segments causing cache contention.
Global Cache Block Transfers and Physical Reads	Shows the percentage of logical reads that read 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 non-local references that incur some latency overhead. Click 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 segments causing cache contention.

Average Active Sessions Chart

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 waiting for 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 load on the instance and identifies performance bottlenecks. At the cluster database level, this chart shows the aggregate wait class statistics across all of the instances.

The Session Count is computed by categorizing the time that all active sessions consumed in the last sampling interval into different wait classes, summing the amount in each wait class, and dividing it by the sampling interval. For example, If there are 3 active sessions in the last sampling interval (15 seconds), and each session spent half of the time on CPU (7.5 seconds each) and half of the time idling, then 3 x 7.5 / 15 = 1.5 active sessions on CPU appear for that sampling interval.

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 but throughput is low, then consider tuning the database.

The wait class legends beside the Average Active Sessions chart enable you to drill down to instance-level information stored in Active Sessions by Instance pages. These pages show the service times for up to four top instances. From these pages, you can select an instance of interest to see wait events, top SQL, top sessions, top services, top modules, and top actions if you need to diagnose and fix problems causing higher waits in a specific category.

Database Throughput Charts

The Database Throughput charts summarize any contentions that appear in the Average Active Sessions chart, and also show how much work the database is performing on behalf of the user. The Per Second view is for databases that handle SQL queries, shown as Physical Reads in the bottom chart. The Per Transaction view is for databases that handle transactions, shown as Transactions in the top chart and Redo Size in the bottom chart. Logons show how many users are logged onto the database per second.

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 for all active instances of the rolled-up Database Throughput chart on the Cluster Database Performance page. 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 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 page. For more information on this page, see "Top Sessions Page" on page 13-15.

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 top database consumers (top services, top modules, top clients, and top actions) of system resources. You can access the Top Consumers page by clicking the **Top Consumers** link in the Additional Monitoring Links section of the Cluster Database Performance page.

By default, the Top Consumers page initially displays the Overview tab, which shows aggregated summary data for all top consumers. For instance-level information about a consumer, click the portion of a chart representing the consumer or click the link under the chart for that consumer. The page that appears shows the running instances that are serving the consumer. You can expand the names in the Module column to show data for individual instances.

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 and then decide whether you want to stop the sessions. You can access the Top Sessions page by clicking the **Top Sessions** link in the Additional Monitoring Links section of the Cluster Database Performance page.

The summary list shows sessions for all instances. You can narrow the display to a particular instance by clicking the name in the Instance Name column. When you click the name, the Top Sessions page for the database instance appears and lists only sessions that are applicable to that instance.

You can see session details for a user by clicking a number assigned to the user name in the SID (Session ID) column. The Session Details page displays complete information about all aspects of a particular session.

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 access top sessions statistics for a particular metric by clicking a metric legend under the chart if in Graphic mode, or by clicking a name in the summary table if in Tabular mode. You can also use the Switch Database

Instance drop-down menu to toggle from one database instance to another. You can view data on a per-second or per-transaction basis. You can access this page by clicking the **Instance Activity** link in the Additional Monitoring Links section at the bottom of the Cluster Database Performance page.

Top Segments Page

Collecting and viewing segment-level statistics is an effective method for identifying hot 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 CR and current blocks received by an object. A high number of current blocks received plus a high number of buffer waits may indicate potential contention.

You can access the Top Segments page by clicking the **Top Segments** link in the Additional Monitoring Links section. You can view segments for all instances, or use a filter to see segments for a specific instance.

Database Locks Page

Use the Database Locks page to determine whether multiple instances are holding locks for the same object. The page shows blocking locks, user locks, or all database locks. You can use this information to stop a session that is unnecessarily locking an object. You can access the Database Locks page by clicking the **Database Locks** link in the Additional Monitoring Links section.

Using the Cluster Database Instance Performance Page

To access the Cluster Database Instance Performance page, click the **Performance** tab in the Cluster Database Home page, and then click an instance name at the bottom of the page.

Page Characteristics

Statistics are rolled up for the instance. You can drill down from links that appear alongside the charts, or at the bottom of the page, to perform the following tasks:

- Identify the cause of performance issues.
- Decide whether resources need to be added or redistributed to resolve performance issues.
- Tune your SQL plan and schema for better optimization.
- Resolve performance issues.

The Cluster Database Instance Performance page is essentially the same as the Cluster Database Performance page with the following exceptions:

- This page shows performance data for a single instance, rather than enabling you to access data for all instances in a cluster database.
- You can access the Top Activity page, which displays all wait classes and related statistics for Active Sessions, Top SQL, Top Sessions, Top Files, and Top Objects for an instance.
- An Instance Disk I/O chart shows the total requests that represent the rate at which the database instance is issuing read/write requests.
- You can run Automatic Database Diagnostic Monitor (ADDM) and Active Session History (ASH) reports for an instance.

See Also: *Oracle Database Performance Tuning Guide* for more information about managing and monitoring database instances

Creating Reports

The Cluster Database Instance Performance page provides the means for running ADDM and ASH reports.

- **ADDM Report**: enables you to create a new AWR snapshot and run ADDM on this and the previous snapshot. After you run ADDM, you can drill down for a detailed performance analysis and report page.
- **ASH Report**: enables you to create a performance data report of the database based on session-sampling data over a specified period of time. This report is very useful for diagnosing small (five- to ten-minute) performance spikes that might be averaged out and consequently hidden or minimized by other issues in the 1-hour AWR report.

Using the Cluster Performance Page

To access the Cluster Performance page, click the **Cluster** link in the General section of the Cluster Database Performance page, and then click the **Performance** tab from the Cluster Home 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 resources need to be added, suspended, or redistributed.

You can 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 charts. The resulting Host page also shows statistics for CPU load, memory scan page rate, and longest service time.

Using the Cluster Interconnects Page

The Cluster Interconnects page enables you to monitor the interconnect interfaces, determine configuration issues, and identify 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 that are outside Oracle Database.

To access this page, click the **Cluster** link in the General section of the Cluster Database Home page, then click the **Interconnects** tab. The Cluster Interconnects page appears, as shown in Figure 13–3.

Figure 13–3 Cluster Interconnects Page

The Cluster Interconnects page contains the following summary tables:

- Interfaces by Hosts
- Interfaces in Use by Cluster Databases

These tables enable you 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.

Note: Low transfer rates or an incorrect configuration, such as using the public network instead of the private network for the interconnect, generates metric alerts.

14

Making Applications Highly Available Using Oracle Clusterware

This chapter explains how you can extend the high availability of the Oracle Clusterware framework to your applications. You do this by wrapping your applications with Oracle Clusterware commands. That is, you can use the same high availability mechanisms of the Oracle database and Oracle Real Application Clusters to make your custom applications highly available. You can use Oracle Clusterware to monitor, relocate, and restart your applications as described in this chapter under the following topics:

- Overview of Managing Custom Applications with Oracle Clusterware Commands
- Creating Application Profiles
- Example of Using Oracle Clusterware Commands to Create Application Resources
- Oracle Clusterware Action Program Guidelines
- Using Oracle Clusterware Commands

> **See Also:** Appendix B, "High Availability Oracle Clusterware Command-Line Reference and C API" for detailed information about Oracle Clusterware commands and Appendix C, "Oracle Clusterware Messages" for information about Oracle Clusterware error messages

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Note: You can install the Oracle Clusterware high availability Application Programming Interface (API) from the Oracle Database 10*g* release 10.2 client installation media. As described in this chapter, you can use the API to integrate non-oracle applications with Oracle Clusterware to make them highly available.

Overview of Using the Oracle Clusterware Commands to Enable High Availability

The Oracle Clusterware includes a high availability framework that provides an infrastructure to manage any application. The Oracle Clusterware ensures that applications that it manages start when the system starts. The Oracle Clusterware also monitors the applications to make sure that they are always available. For example, if a 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 processes that normally run on the failed node to restart on another node. The monitoring frequency,

starting, and stopping of the applications and the application dependencies are configurable.

To make applications highly available, first create an application profile that identifies your application. The application profile uses a second component, an action program, that describes how Oracle Clusterware should monitor your application and how Oracle Clusterware should respond to changes in your application's status. Oracle stores application profile attributes in the OCR. The definitions of an application profile, action program, and the other primary Oracle Clusterware high availability components are as follows:

- **Action Program**: A program that defines the location of your program, the monitoring frequency, and the start and stop actions that Oracle Clusterware should perform on the application. The start action starts the application, the stop action stops the application, and the monitoring or check action checks the application's status.
- **Application Profile**: An Oracle Clusterware resource file that describes the attributes of your application. An application profile influences your application's behavior and it identifies other programs or scripts that Oracle Clusterware should run to perform various actions.
- **Privileges**: Access and usage privileges that enable Oracle Clusterware to control all of the components of your application for high availability operations, including the right to start processes under other user identities. The Oracle Clusterware must run as a privileged user to control applications with the correct start and stop processes. On UNIX-based platforms, this usually implies that Oracle Clusterware must run as the `root` user and on Windows-based platforms Oracle Clusterware must run as `Administrator`.
- **Resource**: An entity that Oracle Clusterware manages for high availability such as your application.

  Note: A resource in the Oracle Clusterware context is not the same as a resource in the Oracle database sense, such as "Resource Manager". A resource that Oracle Clusterware uses only refers to application programs.

- **Resource Dependency**: A relationship among resources or applications that implies an operational ordering. For example, during a start operation, parent resources are started before resources that have dependencies. During a stop, the most dependent resources are stopped first.
- **Oracle Cluster Registry (OCR)**: A mechanism that stores configuration information that Oracle Clusterware and other Oracle RAC manageability systems use. The OCR uses a hierarchical name space for key value pairs. Keys and subkeys have enforced `user`, `group`, and `other` permissions. The OCR is stored either on a shared raw partition or on a non-cached, shared file system file.
- **Template**: A user-created text file that contains the default values for application profile attributes. Template files contain default values for profile attributes.

  See Also: Appendix B, "High Availability Oracle Clusterware Command-Line Reference and C API" for more information about using Oracle Clusterware commands to make your applications highly available

Overview of Managing Custom Applications with Oracle Clusterware Commands

You can use the Oracle Clusterware commands to start, stop, relocate, and check the status of your custom applications. Do this by defining your application with an application profile. The profile defines attributes that affect how Oracle Clusterware manages your application. Then register your application information in the OCR using the `crs_register` command. Use the following steps to create an application profile:

1. Create an application profile by editing an ASCII file or by running the `crs_profile` command. Refer to Table 14–1 for a listing of required and optional entries for the Oracle Clusterware profiles.
2. Register the application profile using the `crs_register` command.
3. Run the `crs_start` command to initiate the application profile and then Oracle Clusterware runs the `action program` command that you have included in the profile to start your application.
4. The Oracle Clusterware periodically runs the `action program` command to check an application's status.
5. In the event of a check or node failure, Oracle Clusterware recovers the applications either by restarting it on the current node or by relocating the application to another node.
6. If you run the `crs_stop` command to stop the application, then Oracle Clusterware runs the `action program` command to stop it.

You can manage application availability as follows:

- Specify starting resources during cluster or node start up
- Restart applications that fail
- Relocate applications to other nodes if they cannot run in their current location

Full administrative privileges are not required when using Oracle Clusterware. Any user can create resources or applications. However, the creator or owner must grant permission to other users or user groups in order for others to be able to use Oracle Clusterware on those applications. Additionally, profiles that have privileges defined can only be modified by privileged users. The following sections provide further details about application profiles.

Note: Do not use the Oracle Clusterware commands `crs_register`, `crs_profile`, `crs_start` or `crs_stop` on resources with names beginning with the prefix `ora` unless either Oracle Support asks you to, or unless Oracle has certified you as described in `http://metalink.oracle.com`. Server Control (SRVCTL) is the correct utility to use on Oracle resources. You can create resources that depend on resources that Oracle has defined. You can also use the Oracle Clusterware commands to inspect the configuration and status.

Creating Application Profiles

Application profiles have attributes that define how Oracle Clusterware starts, manages, and monitors applications. One attribute is the location of the `action program` that Oracle Clusterware uses to manipulate the application. The Oracle

Clusterware uses the `action program` to monitor or check the application status and to start and stop it. Oracle reads application profiles from files stored in specified locations and stores the information in the OCR. You use the Oracle Clusterware commands within profiles to designate resource dependencies and to determine what happens to an application or service when it loses access to a resource on which it depends.

The filenames of application profiles must be in the form *`resource_name`*`.cap` where *`resource_name`* is the name that you or the system assigns to an application and `cap` is the file suffix. The Oracle Clusterware commands in profiles refer to applications by name, such as `resource_name`, but not by the full filename. The following section describes this in more detail.

Application Resource Profiles

Attributes are defined by `name=value` entries in profile files and these entries can be in any order in the file. The following are some of the primary attributes of an application profile:

- Resources that are required by an application which are defined by settings for the `REQUIRED_RESOURCES` parameter. The Oracle Clusterware relocates or stops an application if a required resource becomes unavailable. Required resources are defined for each node.
- Rules for choosing the node on which to start or restart an application are defined by settings for the `PLACEMENT` parameter. The application must be accessible by the nodes that you nominate for placement.
- A list of nodes to use in order of preference when Oracle Clusterware starts or fails over an application which is defined by settings for the `HOSTING_MEMBERS` parameter. This list is used if the placement policy defined by `the PLACEMENT` parameter is favored or restricted.

Required and Optional Profile Attributes

Application profiles have optional and required profile attributes. Optional profile attributes may be left unspecified in the profile. Optional profile attributes that have default values are merged at registration time with the values that are stored in the template for that resource type and for the generic template. Default values are derived from the template.

Each resource type has a template file named `TYPE_resource_type.cap` that is stored in the `template` subdirectory under the `crs` directory of the Oracle Clusterware home. A generic template file for values that are used in all types of resources is stored in the same location in the file named `TYPE_generic.cap`.

Application Profile Attributes

Table 14–1 lists the Oracle Clusterware application profile attributes in alphabetical order. For each attribute, the table shows whether the attribute is required, its default value, and an attribute description.

Table 14–1 Application Profile Attributes

Attribute	Required	Default	Description
ACTION_ SCRIPT	Yes	None	The resource-specific script for starting, stopping, and checking a resource. You may specify a full path for the action program file. Otherwise, the default paths are used: *CRS_home*/crs/script for privileged, and *CRS_home*/crs/public for public. You may also specify a relative path with this default path as the starting point.
ACTIVE_ PLACEMENT	No	0	When set to 1, Oracle Clusterware re-evaluates the placement of a resource during addition or restart of a cluster node.
AUTO_START	No	restore	Indicates whether Oracle Clusterware should automatically start a resource after a cluster restart. Valid AUTO_START values are: always—Causes the resource to restart when the node restarts regardless of the resource's state when the node stopped. restore—Does not start the resource at restart time if it was in an offline state, such as STATE=OFFLINE, TARGET=OFFLINE, when the node stopped. The resource is restored to its state when the node went down. The resource is started only if it was online before and not otherwise. never—Oracle Clusterware never restarts the resource regardless of the resource's state when the node stopped. **Note:** Oracle only supports lower-case values for always, restore, and never.
CHECK_ INTERVAL	No	60	The time interval, in seconds, between repeated executions of the check entry point of a resource's action program. There can be some overhead associated if you set the check interval to a low value and enable frequent checks.
DESCRIPTION	No	Name of the resource	A description of the resource.
FAILOVER_ DELAY	No	0	The amount of time, in seconds, that Oracle Clusterware waits before attempting to restart or fail over a resource.
FAILURE_ INTERVAL	No	0	The interval, in seconds, during which Oracle Clusterware applies the failure threshold. If the value is zero (0), then tracking of failures is disabled.
FAILURE_ THRESHOLD	No	0	The number of failures detected within a specified FAILURE_ INTERVAL before Oracle Clusterware marks the resource as unavailable and no longer monitors it. If a resource's check script fails this number of times, then the resource is stopped and set offline. If the value is zero (0), then tracking of failures is disabled. The maximum value is 20.

Table 14–1 (Cont.) Application Profile Attributes

Attribute	Required	Default	Description
HOSTING_ MEMBERS	Sometimes	None	An ordered list of cluster nodes separated by blank spaces that can host the resource. This attribute is required only if PLACEMENT equals favored or restricted. This attribute must be empty if PLACEMENT equals balanced. Enter node names as values for the HOSTING_MEMBERS attribute, not virtual host names or physical host names. Use the node names that you used when you installed Oracle Clusterware. The resources that you mention should contain the node name for the node on which they run. Run the olsnodes commands to see your node names. The HOSTING_MEMBERS Oracle Clusterware attribute is set automatically when these Oracle Clusterware resources are created; you do not need to take further action to ensure that the attribute is set. The node name is usually the same as the physical host name. However, it can be different. For example, when vendor clusterware is present, the Oracle Clusterware nodes are named the same as the vendor clusterware nodes. Not all vendor clusterware implementations use the physical node names as node names. Use the lsnodes command to display vendor clusterware node names. When there is no vendor clusterware, then the Oracle Clusterware node names must be the same as the physical hostname. Your Listener.ora file should contain one entry for the virtual internet protocol (VIP) address, using the VIP's name, and another entry for the physical host, by IP address not name.
NAME	Yes	None	The name of the application. The application name is a string that contains a combination of letters a-z or A-Z, and digits 0-9. The naming convention is to start with an alphanumeric prefix, such as ora, and complete the name with an identifier for to describe it. The name can contain any platform-supported characters except the exclamation point (!). However, the application name cannot begin with a period.
OPTIONAL_ RESOURCES	No	None	An ordered list of resource names separated by blank spaces that this resource uses during placement decisions. Up to 58 user-defined resources can be listed.
PLACEMENT	No	balanced	The placement policy (balanced, favored, or restricted) specifies how Oracle Clusterware chooses the cluster node on which to start the resource.
REQUIRED_ RESOURCES	No	None	An ordered list of resource names separated by blank spaces that this resource depends on. Each resource to be used as a required resource in this profile must be registered with Oracle Clusterware or the resource's profile registration will fail.
RESTART_ ATTEMPTS	No	1	The number of times that Oracle Clusterware attempts to restart a resource on a single cluster node before attempting to relocate the resource. A value of 1 means that Oracle Clusterware only attempts to restart the resource once on a node. A second failure causes an attempt to relocate the resource.
RESTART_ COUNT			The counter maintained by the Oracle Clusterware daemon for the number of times that a resource had been restarted. It goes from zero to RESTART_ATTEMPTS. This is also written to OCR.
SCRIPT_ TIMEOUT	No	60	The maximum time, in second, that an action program may require to complete before an error is returned. This attribute specifies the time out value for the "check" action of the action script. If the check action does not return before this time, Oracle Clusterware will consider the action failed.

Table 14–1 (Cont.) Application Profile Attributes

Attribute	Required	Default	Description
START_ TIMEOUT			This attribute specifies the timeout value for the "start" action of the action script. If the start action does not return before this time, Oracle Clusterware will consider the action failed.
STOP_TIMEOUT			This attribute specifies the timeout value for the "stop" action of the action script. If the stop action does not return before this time, Oracle Clusterware will consider the action failed.
TYPE	Yes	None	Must be APPLICATION.
UPTIME_ THRESHOLD			The value for UPTIME_THRESHOLD represents the length of time that a resource must be up before Oracle Clusterware considers the resource to be stable. By setting a value for the UPTIME_THESHOLD attribute, you can indicate a resource's stability.

Default Profile Locations

Profiles may be located anywhere and need not be on a cluster-visible file system. Oracle RAC provides default locations for profiles as described in the next sub-section. The default location for profiles with root privileges on UNIX-based systems or Administrator privileges on Windows-based systems is the profile subdirectory under the crs directory of the Oracle Clusterware home. The default location for profiles with non-root or non-Administrator privileges is the public subdirectory under the crs directory of the Oracle Clusterware home.

Example of Using Oracle Clusterware Commands to Create Application Resources

The example in this section creates an application named postman. The Oracle Clusterware uses the script /opt/email/bin/crs_postman to start, stop, and monitor whether the application is running (action_script). The Oracle Clusterware checks postman every five seconds as specified by the setting for the check_interval parameter. The Oracle Clusterware restarts postman no more than once if it fails. When deciding on which node to place the postman application, Oracle Clusterware considers the value for the optional_resources parameter. If possible, Oracle Clusterware places postman on the same node. Finally, in order for postman to run, the resource network1 must be running on the same node as specified by the setting for the required_resources parameter. If network1 fails or if it is relocated to another node, then Oracle Clusterware stops or moves the postman application.

Note: Do not use the Oracle Clusterware commands crs_ register, crs_profile, crs_start or crs_stop on resources with names beginning with the prefix ora unless either Oracle Support asks you to, or unless Oracle has certified you as described in http://metalink.oracle.com. Server Control (SRVCTL) is the correct utility to use on Oracle resources. You can create resources that depend on resources that Oracle has defined. You can also use the Oracle Clusterware commands to inspect the configuration and status.

Using crs_profile to Create An Application Resource Profile

The following example uses the crs_profile command to create an application profile for monitoring email.

```
# crs_profile -create postman -t application -B /opt/email/bin/crs_postman \
-d "Email Application" -r network1 -l application2 \
-a postman.scr -o ci=5,ft=2,fi=12,ra=2
```

The contents of the application profile file that the example creates are as follows:

```
NAME=postman
TYPE=application
ACTION_SCRIPT=/oracle/crs/script/postman.scr
ACTIVE_PLACEMENT=0
AUTO_START=restore
CHECK_INTERVAL=5
DESCRIPTION=email app
FAILOVER_DELAY=0
FAILURE_INTERVAL=12
FAILURE_THRESHOLD=2
HOSTING_MEMBERS=
OPTIONAL_RESOURCES=application2
PLACEMENT=balanced
REQUIRED_RESOURCES=network1
RESTART_ATTEMPTS=2
SCRIPT_TIMEOUT=60
```

> **See Also:** Appendix B, "High Availability Oracle Clusterware Command-Line Reference and C API" for an explanation of the command options

The Oracle Clusterware Required Resources List

The Oracle Clusterware uses the required resources list, with the placement policy and hosting nodes list, to determine the cluster nodes that are eligible to host an application. Required resources must be `ONLINE` on the nodes on which the application is running or started.

The failure of a required resource on a hosting node causes Oracle Clusterware to attempt to restart the application on the current node. If `RESTART_ATTEMPTS` is not set to `0`, and if the application cannot start on the current node, then Oracle Clusterware attempts to fail the application over to another node that provides the required resource. Alternatively, Oracle Clusterware stops the application if there is no suitable node. In this case, Oracle Clusterware posts a `not restarting` event notification.

You can also use required resource lists to start, stop, and relocate groups of interdependent applications when you use the `crs_start`, `crs_stop`, or `crs_relocate` commands with the force (`-f`) option. In other words, you can configure a set of resources to have other required resources. For example you can configure resources `A`, `B`, and `C` where `A` and `B` depend on `C`. Then if you stop resource `C` with `-force` option, this action will stop all three resources. The same is true for the `crs_relocate` command.

In addition, using the `-force` option can relocate an online dependency, if necessary, to enable the starting of a resource. For instance, assume that resource `VIP_A` that has a primary node assignment of node `A` is running instead on node `B`. If you perform a `crs_start` on the instance resource for node A, then this operation will fail. This is because the `VIP_A` resource is required for the instance on node A and the `VIP_A` resource is online. However, the resource is on a node where the resource cannot run. Performing a `crs_start -f` on instance B, however, forces the `VIP_A` resource to relocate and then start the instance.

Creating VIPs for Applications

If your application is accessed by way of a network, then Oracle recommends that you create a virtual internet protocol address for the application as a dependent resource. In the previous example, `network1` is an application VIP address. Create application VIP addresses as follows:

```
crs_profile -create network1 -t application \
-a $CRS_HOME/bin/usrvip \
-o oi=eth0,ov=138.3.83.78,on=255.255.240.0
```

In this example, `$CRS_HOME` is the home directory for the Oracle Clusterware installation. In addition, `eth0` is the name of the public network adapter, `138.3.83.78` which resolves by way of DNS to a new IP address that will be used to locate your application regardless of the node it is running on. Finally, `255.255.240.0` is the netmask for the public IP address. As the `oracle` user, register the VIP address with Oracle Clusterware as follows:

```
crs_register network1
```

On UNIX-based operating systems, the application VIP address script must run as the `root` user. As the `root` user, change the owner of the resource as follows:

```
crs_setperm network1 -o root
```

As the `root` user, enable the `oracle` user to run this script:

```
crs_setperm network1 -u user:oracle:r-x
```

As the `oracle` user, start the VIP address as follows:

```
crs_start network1
```

Application Placement Policies

The placement policy specifies how Oracle Clusterware selects a node on which to start an application and where to relocate the application after a node failure. Only cluster nodes on which all of the required resources are available, as listed in an application's profile, are eligible to be considered as hosting nodes for an application. The Oracle Clusterware supports the following placement policies:

- `balanced`: The Oracle Clusterware favors starting or restarting the application on the node that is currently running the fewest resources. A placement that is based on optional resources is considered first. Next, the host with the fewest resources running is chosen. If no node is favored by these criteria, then any available node is chosen.
- `favored`: The Oracle Clusterware refers to the list of nodes in the `HOSTING_MEMBERS` attribute of the application profile. Only cluster nodes that are in this list and that satisfy the resource requirements are eligible for placement consideration. Placement due to optional resources is considered first. If no node is eligible based on optional resources, then the order of the hosting nodes determines which node runs the application. If none of the nodes in the hosting node list are available, then Oracle Clusterware places the application on any available node. This node may or may not be included in the `HOSTING_MEMBERS` list.
- `restricted`: Similar to `favored` except that if none of the nodes on the hosting list are available, then Oracle Clusterware does not start or restart the application. A restricted placement policy ensures that the application never runs on a node that is not on the list, even if you manually relocate it to that node.

You must specify hosting nodes in the HOSTING_MEMBERS attribute to use a favored or restricted placement policy. Do not specify hosting nodes in the HOSTING_MEMBERS attribute with a balanced placement policy. Otherwise, the application will not validate and you cannot register it. If ACTIVE_PLACEMENT is set to 1, then the placement of the application is re-evaluated whenever you add a node to the cluster or if the cluster node restarts. This enables Oracle Clusterware to relocate applications to a preferred node after the node recovers from a failure.

Optional Resources in Placement Decisions

The Oracle Clusterware uses optional resources to choose a hosting node based on the number of optional resources that are in an ONLINE state on the hosting node. If each node has an equal number of optional resources in an ONLINE state, then Oracle Clusterware considers the order of the optional resources as follows:

- The Oracle Clusterware compares the state of the optional resources on each node starting at the first resource that you list in the application profile and then proceeds through the list.
- For each consecutive resource in your list, if the resource is ONLINE on one node, then any node that does not have the resource ONLINE is not considered.
- The Oracle Clusterware evaluates each resource in the list in this manner until only one node is available to host the resource.
- The maximum number of optional resources is 58.

If this algorithm results in multiple preferred nodes, then the resource is placed on one of these nodes chosen according to its placement policy.

Oracle Clusterware Action Program Guidelines

This section provides the following guidelines for writing Oracle Clusterware action programs that interpret Oracle Clusterware start, stop, and check commands:

- The Oracle Clusterware relies on a status code upon exiting from an action program to set the resource state to ONLINE or OFFLINE. On Windows-based systems, the program should be non-blocking, which may imply a Windows service or a Windows resource that does not block during console interactions.
- Action programs must return a status code to indicate success or failure. For example, on UNIX-based systems if the script is written in Bourne Shell, then the program should issue exit(1) to indicate failure, and exit(0) to indicate success. Similarly, on Windows-based systems, the action program should return a status of (0) to indicate success and (1) to indicate failure.
- After application failure, Oracle Clusterware calls the action program with a check parameter. The action program replies to Oracle Clusterware with a status of (1) to indicate failure. After receiving this failure status, Oracle Clusterware calls the action program with a stop parameter. It is important that the action program returns a status of (0) to indicate a successful stop of the application, even though the application was not running when the stop request was called.
- The Oracle Clusterware sets the resource state to UNKNOWN if an action program's stop entry point fails to exit within the number of seconds in the SCRIPT_TIMEOUT value, or if the action program returns with a code that indicates failure. This may occur during a start, relocation, or stop operation. Ensure that the action program's stop entry point exits with a value that indicates success if the resource is successfully stopped or if the resource is not running.

- When a daemon or service starts, it usually needs to start as a background process, depending on the platform. However, a resource started in this way always returns success during a start attempt. This means that the default scripts cannot detect failures caused by minor errors, such as misspelled command paths.
  - On UNIX-based systems, if a resource does not move to the background immediately upon startup, then you can start the application in the background by adding an ampersand (`&`) to the end of the line that starts the application.
  - On Windows-based systems, you can use `net start` to start a service that needs to start in the background.
  - When using commands to start daemons or services in the background, interactively make test runs of the commands used in the script to eliminate errors before using the script with Oracle Clusterware.

How Oracle Clusterware Runs Action Programs

This section describes how Oracle Clusterware runs action programs. The first argument to an action program is the command `start`, `stop`, or `check` depending on which action Oracle Clusterware is running. The second argument is the Oracle Clusterware resource name of the application. This enables a script to determine which instance of the resource that Oracle Clusterware is starting, stopping, or checking.

An action program can retrieve any of its Oracle Clusterware resource attributes from the environment by using `$_CAA_`*`attribute_name`*. For example, `$_CAA_NAME` contains the application name, the second argument to the script, and `$_CAA_HOSTING_MEMBERS` contains its `HOSTING_MEMBERS` attribute.

User Defined Attributes

The Oracle Clusterware supports user-defined attributes in Oracle Clusterware applications, which are attributes having names that contain `USR`. User-defined attributes are stored as part of the Oracle Clusterware application profile for the application. You can reference them in an action program using `$_USR_`*`attributename`*.

To add a user-defined attribute, add it to the file *`CRS home`*`/crs/template/application.tdf` using the following syntax:

```
#
# an example user-defined attribute
#
#!============================
attribute: USR_EXAMPLE
type: string
switch: -o example
default:
required: no
```

The `attribute` parameter contains the name of the new attribute. The `type` parameter defines the type of the user-defined attribute and can be one of the following:

- `string`
- `boolean`
- `integer`: a numeric attribute

- `positive_integer`: a numeric attribute that must be positive
- `name string`
- `name_list`: a comma-delimited list of names

The `switch` parameter describes how the attribute is specified for the `crs_profile` command. Set the `required` field to `no` for user-defined attributes.

Note: User-defined attribute names that begin with `USR_ORA` are reserved for use by Oracle.

Windows crsuser Program

This section describes the Windows-based `crsuser` program. If you create an Oracle Clusterware application, then run the following command:

```
crsuser add [domain\]username
```

Provide the user's Windows password. This creates the service `OracleCRSToken_user` that Oracle Clusterware needs for starting the Oracle Clusterware resources under the given user ID. You can also use the `crsuser` command `remove [domain\]username` to remove a token service and `crsuser` list to list a registered users.

Using Oracle Clusterware Commands

This section describes how to use the Oracle Clusterware commands under the following topics:

Registering Application Resources

Each application that you manage with Oracle Clusterware must have an application profile and the profile must be registered in the OCR. Use the `crs_register` command to register applications in the OCR. For example, enter the following command to register the mail monitoring application from the previous example:

```
# crs_register postman
```

If you modify a profile, then update the OCR by re-running the `crs_register -u` command.

Starting Application Resources

To start an application resource that is registered with Oracle Clusterware, use the `crs_start` command. For example:

```
# crs_start postman
```

The following text is an example of the command output:

```
Attempting to start `postman` on node `rac1`
Start of `postman` on node `rac1` succeeded.
```

The application now runs on the node named `rac1`.

Note: The name of the application resource may or may not be the same as the name of the application.

See Also : Appendix B, "High Availability Oracle Clusterware Command-Line Reference and C API" for examples of Oracle Clusterware command output

The command waits for the amount of time specified by the setting for the `SCRIPT_TIMEOUT` parameter to receive a notification of success or failure from the action program each time the action program is called. Application resources can be started if they have stopped due to exceeding their failure threshold values. You must register a resource with `crs_register` before you can start it.

To start and resources, use the `crs_start` and `crs_stop` commands. Manual starts or stops outside of Oracle Clusterware can invalidate the resource status. In addition, Oracle Clusterware may attempt to restart a resource on which you perform a manual stop operation.

All required resources must be online on the node where you start the resource. If the resources that the `REQUIRED_RESOURCES` parameter identifies are offline, then the command `crs_start` *`resource_name`* will start the required resources before starting the resource.

Running the `crs_start` command on a resource sets the resource target value to `ONLINE`. The Oracle Clusterware attempts to change the state to match the target by running the action program with the `start` parameter. When a resource is running, both the target state and current state are `ONLINE`.

Starting an Application on an Unavailable Node

When starting an application on a cluster node that is unavailable, `crs_start` can give indeterminate results. In this scenario, the start section of the action program is run, but the cluster node fails before notification of the start is displayed on the command line. The `crs_start` command returns a failure with the error `Remote start for` *`resource_name`* `failed on node` *`node_name`*. The application is actually `ONLINE` but fails over to another node making the application appear as though it were started on the incorrect node.

If a cluster node fails while you are starting a resource on that node, then check the state of the resource on the cluster by using the `crs_stat` command to determine the state of that resource.

Relocating Applications and Application Resources

Use the `crs_relocate` command to relocate applications and application resources. For example, to relocate the mail monitoring application to the node known as `rac2`, enter the following command:

```
# crs_relocate postman -c rac2
```

Each time that the action program is called, the `crs_relocate` command waits for the duration identified by the value for the `SCRIPT_TIMEOUT` parameter to receive notification of success or failure from the action program. A relocation attempt fails if:

- The application has required resources that are `ONLINE` on the initial node
- Applications that require the specified resource are `ONLINE` on the initial node

To relocate an application and its required resources, use the `-f` option with the `crs_relocate` command. The Oracle Clusterware relocates or starts all resources that are required by the application regardless of their state.

Stopping Applications and Application Resources

To stop applications and application resources, use the `crs_stop` command. Immediately after the `crs_stop` command completes, the application status converts to `OFFLINE`. Because Oracle Clusterware always attempts to match a resource's state to its target, the Oracle Clusterware subsystem stops the application. The following example stops the mail application from the example:

```
# crs_stop postman
```

The following text is an example of the command output:

```
Attempting to stop `postman` on node `rac1`
Stop of `postman` on node `rac1` succeeded.
```

You cannot stop an application if the application is a required resource for another online application unless you use the force (`-f`) option. If you use the `crs_stop -f` *`resource_name`* command on an application that is required by other resources and if those resources are online, then Oracle Clusterware stops the application. In addition, all of the resources that require that application that are online are also stopped.

Note: The Oracle Clusterware can only stop applications and application resources. The Oracle Clusterware cannot stop network, tape, or media changer resources.

Managing Automatic Oracle Clusterware Resource Operations for Action Scripts

The following section explains additional information for controlling how Oracle Clusterware manages restarts. You can prevent Oracle Clusterware from automatically restarting a resource by setting several action program attributes. You can also control how Oracle Clusterware manages the restart counters for your action programs. In addition, you can customize the timeout values for the `start`, `stop`, and `check` actions that Oracle Clusterware performs on action scripts. These topics are described under the following headings:

- Preventing Automatic Database Instance Restarts
- Automatically Manage Restart Attempts Counter for Resources
- Implications of Restart and Timeout Features for Previous Releases

Preventing Automatic Database Instance Restarts

When a node stops and restarts, Oracle Clusterware starts the instance as soon as the node starts. This may not be desirable because instance startup might fail if system components on which the instance depends, such as a volume manager or a file

system, are not running. This is especially true if Oracle Clusterware does not manage the system component resources on which the instance depends. To manage automatic restarts, you can use the AUTO_START attribute to specify whether Oracle Clusterware should automatically start a resource when a node restarts. Valid AUTO_START values are:

- always: Causes the resource to restart when the node restarts regardless of the resource's state when the node stopped.
- restore: Does not start the resource at restart time if it was in an offline state, such as STATE=OFFLINE, TARGET=OFFLINE, when the node stopped. The resource is restored to its state when the node went down. The resource is started only if it was online before and not otherwise. This is the default value.s
- never: The Oracle Clusterware never restarts the resource regardless of the resource's state when the node stopped.

> **Note:** Oracle only supports lower-case values for always, restore, and never.

Automatically Manage Restart Attempts Counter for Resources

When a resource fails, Oracle Clusterware restarts the resource for only the number of times specified in the profile attribute RESTART_ATTEMPTS regardless of how often the resource fails. The CRSD process maintains an internal counter to track how often a resource has been restarted. There is a mechanism by which Oracle Clusterware can automatically manage the restart attempts counter based on the stability of a resource. Use the UPTIME_THESHOLD attribute to indicate resource stability.

You can specify the time for the UPTIME_THRESHOLD attribute in different units of measure, such as seconds (s), minutes (m), hours (h), days (d) or weeks (w). Examples of valid values for this attribute are: 7d for seven days, 5h for five hours, 180m for 180 minutes, and so on. Specify the time period as a numeric value and the unit of measure as the last character, s, m, h, d, or w.

After the time period that you have indicated by the setting for UPTIME_THRESHOLD has elapsed, Oracle Clusterware resets the value for RESTART_COUNTS to 0. The Oracle Clusterware can alert you when the value for RESTART_COUNT reaches the value that you have set for RESTART_ATTEMPTS.

> **Note:** Oracle Clusterware writes an alert to the CRSD log file when the value for RESTART_COUNT reaches the value that you have set for RESTART_ATTEMPTS. The Oracle Clusterware does not write this message to the alert file.

RESTART_ATTEMPTS and RESTART_COUNT Failure Scenarios Some of the failure scenarios for the RESTART_ATTEMPTS and RESTART_COUNT attributes are:

- When a resource keeps restarting: The resource does not meet the uptime threshold criteria and it will be stopped after restarting for the number of attempts set by the value for RESTART_ATTEMPTS.
- When a node fails or restarts: The Oracle Clusterware resets the value for RESTART_COUNTER to 0 either when the resource relocates or when it restarts on the same node.

- If the crsd process fails: Because both RESTART_COUNT and RESTART_ATTEMPTS are stored in OCR, the behavior is not affected.

Implications of Restart and Timeout Features for Previous Releases

If you have a pre-Oracle Database 10*g* release 2 (10.2) installation, add the release 2 (10.2) attributes to your profiles by doing one of the following:

- Modify your resources with the release 2 (10.2) attributes and re-register the resources. This causes the separate timeouts to be effective.
- Do not modify your resources. This retains the pre-release 2 (10.2) behavior of using the value in SCRIPT_TIMEOUT as the timeout for all start, stop, and check actions.

Unregistering Applications and Application Resources

To unregister an application or an application resource, use the crs_unregister command. You cannot unregister an application or resource that is ONLINE or required by another resource. The following example unregisters the mail application:

```
# crs_unregister postman
```

The unregistration process frees space on the OCR. Additionally, run the crs_unregister command as a clean-up step when a resource is no longer managed by Oracle Clusterware. Generally, you should unregister all permanently stopped applications.

Displaying Clusterware Application and Application Resource Status Information

To display status information about applications and resources that are on cluster nodes, use the crs_stat command. The following example displays the status information for the postman application:

```
# crs_stat postman
NAME=postman
TYPE=application
TARGET=ONLINE
STATE=ONLINE on rac2
```

Enter the following command to view information about all applications and resources in tabular format:

```
# crs_stat -t
```

The following text is an example of the command output:

```
Name         Type        Target      State     Host
------------------------------------------------------------
cluster_lockd application ONLINE    ONLINE     rac2
dhcp          application OFFLINE   OFFLINE
```

Enter the following command to determine:

- How many times an application resource has been restarted
- How many times an application resource has failed within the failure interval
- The maximum number of times that an application or resource can be restarted or fail
- The target state of the application or resource and the normal status information

```
# crs_stat -v
```

To view verbose content in tabular format, enter the following command:

```
# crs_stat -v -t
```

The following text is an example of the command output:

```
Name           Type        R/RA  F/FT   Target    State    Host
----------------------------------------------------------------------
cluster_lockd  application 0/30  0/0    ONLINE    ONLINE   rac2
dhcp           application 0/1   0/0    OFFLINE   OFFLINE
named          application 0/1   0/0    OFFLINE   OFFLINE
network1       application 0/1   0/0    ONLINE    ONLINE   rac1
```

Enter the following command to view the application profile information that is stored in the OCR:

```
# crs_stat -p
```

The following text is an example of the command output:

```
NAME=cluster_lockd
TYPE=application
ACTION_SCRIPT=cluster_lockd.scr
ACTIVE_PLACEMENT=0
AUTO_START=1
CHECK_INTERVAL=5
DESCRIPTION=Cluster lockd/statd
FAILOVER_DELAY=30
FAILURE_INTERVAL=60
FAILURE_THRESHOLD=1
HOSTING_MEMBERS=
OPTIONAL_RESOURCES=
PLACEMENT=balanced
REQUIRED_RESOURCES=
RESTART_ATTEMPTS=2
SCRIPT_TIMEOUT=60 ...
```

Refer to the `crs_stat` command for more information.

> **See Also:** Appendix B, "High Availability Oracle Clusterware Command-Line Reference and C API" for detailed information about the Oracle Clusterware commands

15

Application-Specific Deployment Topics

This chapter discusses topics for deploying online (OLTP), data warehouse, and general purpose (hybrid) applications in Oracle Real Application Clusters (Oracle RAC) environments. The topics in this chapter are:

- General Deployment Strategies for Oracle Real Application Clusters-Based Applications
- Deploying OLTP Applications in Oracle Real Application Clusters
- Deploying Data Warehouse Applications with Oracle Real Application Clusters
- Data Security Considerations in Oracle Real Application Clusters

General Deployment Strategies for Oracle Real Application Clusters-Based Applications

All single-instance application development and deployment techniques apply to Oracle RAC. If your applications run well on a single-instance Oracle database, then they will run well on an Oracle RAC database.

Deploying OLTP Applications in Oracle Real Application Clusters

Cache Fusion makes Oracle RAC databases the optimal deployment servers for online transaction processing (OLTP) applications. This is because these types of applications require:

- High availability in the event of failures
- Scalability to accommodate increased system demands
- Load balancing according to demand fluctuations

The high availability features of Oracle and Oracle RAC can re-distribute and load balance workloads to surviving instances without interrupting processing. Oracle RAC also provides excellent scalability so that if you add or replace a node, then Oracle re-masters resources and re-distributes processing loads.

Flexible Implementation with Cache Fusion

To accommodate the frequently changing workloads of online transaction processing systems, Oracle RAC remains flexible and dynamic despite changes in system load and system availability. Oracle RAC addresses a wide range of service levels that, for example, fluctuate due to:

- Varying user demands

- Peak scalability issues like trading storms (bursts of high volumes of transactions)
- Varying availability of system resources

Deploying Data Warehouse Applications with Oracle Real Application Clusters

This section discusses how to deploy data warehouse systems in Oracle RAC environments by briefly describing the data warehouse features available in shared disk architectures. The topics in this section are:

- Speed-Up for Data Warehouse Applications on Oracle Real Application Clusters
- Parallel Execution in Data Warehouse Systems and Oracle RAC
- Using Parallel Instance Groups

Speed-Up for Data Warehouse Applications on Oracle Real Application Clusters

Oracle RAC is ideal for data warehouse applications because it augments the single instance benefits of Oracle. Oracle RAC does this by maximizing the processing available on all of the nodes that belong to an Oracle RAC database to provide speed-up for data warehouse systems.

The query optimizer considers parallel execution when determining the optimal execution plans. The default cost model for the query optimizer is **CPU+I/O** and the cost unit is **time**. In Oracle RAC, the query optimizer dynamically computes intelligent defaults for parallelism based on the number of processors in the nodes of the cluster. An evaluation of the costs of alternative access paths, table scans versus indexed access, for example, takes into account the degree of parallelism (DOP) available for the operation. This results in Oracle selecting the execution plans that are optimized for your Oracle RAC configuration.

Parallel Execution in Data Warehouse Systems and Oracle RAC

Oracle's parallel execution feature uses multiple processes to run SQL statements on one or more CPUs. Parallel execution is available on both single-instance Oracle databases and Oracle RAC databases.

Oracle RAC takes full advantage of parallel execution by distributing parallel processing across all available instances. The number of processes that can participate in parallel operations depends on the DOP assigned to each table or index.

> **See Also:** *Oracle Database Performance Tuning Guide* for more information about the query optimizer

Using Parallel Instance Groups

You can control the instances that allocate parallel execution server processes with instance groups. To do this, assign each active instance to at least one or more instance groups. Then dynamically control which instances spawn parallel processes by activating a particular group of instances.

Note: An instance can belong to one or more groups. You can enter several instance group names with the `INSTANCE_GROUPS` parameter using a comma as a separator.

Data Security Considerations in Oracle Real Application Clusters

This section describes the following two Oracle RAC security considerations:

- Transparent Data Encryption and Wallets
- Windows Firewall Considerations

Transparent Data Encryption and Wallets

Wallets used by Oracle RAC instances for Transparent Database Encryption may be a local copy of a common wallet shared by multiple nodes or a shared copy residing on a network file system that all of the nodes can access. A deployment with a single wallet on a shared disk requires no additional configuration to use Transparent Data Encryption. Deployments where no shared storage exists require that each Oracle RAC node maintain its own local wallet. Details about creating and provisioning a wallet can be found in the Database Security Guide.

After you create and provision a wallet a single node, you must copy the wallet and make it available to all of the other nodes. For systems using Transparent Data Encryption with encrypted wallets, you can use any standard file transport protocol. For systems using Transparent Data Encryption with obfuscated wallets, file transport through a secured channel is recommended. The wallet must reside in the directory specified by the setting for the `WALLET_LOCATION` or `ENCRYPTION_WALLET_LOCATION` parameter in `sqlnet.ora`. The local copies of the wallet need not be synchronized for the duration of Transparent Data Encryption usage until the server key is re-keyed though the `ALTER SYSTEM SET KEY` SQL statement. Each time you run the `ALTER SYSTEM SET KEY` statement at a database instance, you must again copy the wallet residing on that node and make it available to all of the other nodes. To avoid unnecessary administrative overhead, reserve re-keying for exceptional cases where you are certain that the server master key is compromised and that not re-keying it would cause a serious security problem.

Windows Firewall Considerations

By default, all installations of Windows Server 2003 Service Pack 1 and higher enable the Windows Firewall to block virtually all TCP network ports to incoming connections. As a result, any Oracle products that listen for incoming connections on a TCP port will not receive any of those connection requests, and the clients making those connections will report errors.

Depending upon which Oracle products you install and how they are used, you may need to perform additional Windows post-installation configuration tasks so that the Firewall products are functional on Windows Server 2003.

This section contains these topics:

- Oracle Executables Requiring Firewall Exceptions
- Configuring the Windows Firewall
- Troubleshooting Windows Firewall Exceptions

Oracle Executables Requiring Firewall Exceptions

Table 15–1 lists the Oracle Database 10*g* Release 1 (10.1) or later executables that listen on TCP ports on Windows. If they are in use and accepting connections from a remote client computer, then Oracle recommends that you add them to the Windows Firewall exceptions list to ensure correct operation. Except as noted, they can be found in *ORACLE_HOME*\bin.

The RMI registry application and daemon executable listed in Table 15–1 are used by Oracle Ultra Search to launch a remote crawler. They must be added to the Windows Firewall exception list if you are using the Ultra Search remote crawler feature, and if the remote crawler is running on a computer with the Windows Firewall enabled.

Note: If multiple Oracle homes are in use, then several firewall exceptions may be needed for the same executable: one for each home from which that executable loads.

Table 15–1 Oracle Executables Requiring Windows Firewall Exceptions

File Name	Executable Name
CRS_HOME\bin\crsd.exe	OracleCRService
CRS_HOME\bin\evmd.exe	OracleEVMService
CRS_HOME\bin\evmlogger.exe	Event manager logging daemon
CRS_HOME\bin\GuiOracleObjManager.exe	Oracle Object Link Manager (GUI version)
CRS_HOME\bin\ocssd.exe	OracleCSService
CRS_HOME\bin\OracleObjManager.exe	Oracle Object Link Manager (CLI version)
CRS_HOME\bin\racgvip.exe	Virtual Internet Protocol Configuration Assistant
CRS_HOME\cfs\Ocfsfindvol.exe	Oracle Cluster Volume Service
dgmgrl.exe	Data Guard Manager
emagent.exe	Oracle Database Control
extproc.exe	External Procedures
hdodbc.exe	Generic Connectivity
oidldapd.exe	Oracle Internet Directory LDAP Server
omtsreco.exe	Oracle Services for Microsoft Transaction Server
oracle.exe	Oracle Database
ORACLE_HOME\apache\apache\apache.exe	Apache Web Server
ORACLE_HOME\bin\emagent.exe	Enterprise Manager Agent
ORACLE_HOME\bin\omtsreco.exe	Oracle services for Microsoft Transaction Server
ORACLE_HOME\bin\ORACLE.EXE	Oracle
ORACLE_HOME\bin\racgimon.exe	RACG
ORACLE_HOME\bin\TNSLSNR.exe	Oracle Listener
ORACLE_HOME\jdk\bin\java.exe	Java Virtual Machine
ORACLE_HOME\jdk\bin\rmid.exe	RMI daemon executable
ORACLE_HOME\jdk\bin\rmiregistry.exe	RMI registry application
ORACLE_HOME\jdk\jre\bin\rmiregistry.exe	RMI registry application
ORACLE_HOME\opmn\bin\ons.exe	Oracle Notification Service
ORACLE_HOME\opmn\bin\opmn.exe	Oracle Process Manager
pg4arv.exe	Oracle Procedural Gateway for APPC
pg4mqc.exe	Oracle Procedural Gateway for Websphere MQ
pg4mqs.exe	Oracle Procedural Gateway for Websphere MQ

Table 15–1 (Cont.) Oracle Executables Requiring Windows Firewall Exceptions

File Name	Executable Name
pg4t4ic.exe	Oracle Procedural Gateway for APPC
tg4drsrv.exe	Oracle Transparent Gateway for DRDA
tg4msql.exe	Oracle Transparent Gateway for MS-SQL Server
tg4sybs.exe	Oracle Transparent Gateway for SYBASE
tg4tera.exe	Oracle Transparent Gateway for Teradata
tnslsnr.exe	Oracle TNS Listener
WINDOWS_HOME\system32\drivers\Ocfs.sys	System file for Oracle Cluster File System

Configuring the Windows Firewall

Post-installation configuration for the Windows Firewall must be undertaken if *all* of the following conditions are met:

- Oracle server-side components are installed.

  These components include the Oracle Database, network listeners, and any Web servers or services.

- The computer services connections from other computers over a network.

  If no other computers connect to the computer with the Oracle software, then no post-installation configuration steps are required and the Oracle software will function as expected.

- The Windows Firewall is enabled.

  If the Windows Firewall is not enabled, then no post-installation configuration steps are required.

You can configure Windows Firewall by opening specific static TCP ports in the firewall or by creating exceptions for specific executables so that they are able to receive connection requests on any ports they choose. To configure the firewall, choose **Control Panel > Windows Firewall > Exceptions** or enter `netsh firewall add...` at the command line.

Alternatively, Windows will inform you if a foreground application is attempting to listen on a port, and it will ask you if you wish to create an exception for that executable. If you choose to do so, then the effect is the same as creating an exception for the executable either in the Control Panel or from the command line.

Troubleshooting Windows Firewall Exceptions

If you cannot establish certain connections even after granting exceptions to the executables listed in Table 15–1, then follow these steps to troubleshoot the installation:

1. Examine Oracle configuration files (such as `*.conf` files), the Oracle key in the Windows registry, and network configuration files in *ORACLE_HOME*`\network\admin`.
2. Pay particular attention to any executable listed in *ORACLE_HOME*`\network\admin\listener.ora` in a `PROGRAM=` clause. Each of these must be granted an exception in the Windows Firewall, because a connection can be made through the TNS Listener to that executable.
3. Examine Oracle trace files, log files, and other sources of diagnostic information for details on failed connection attempts. Log and trace files on the database client

computer may contain useful error codes or troubleshooting information for failed connection attempts. The Windows Firewall log file on the server may contain useful information as well.

4. If the preceding troubleshooting steps do not resolve a specific configuration issue on Windows XP Service Pack 2, then provide the output from command `netsh firewall show state verbose=enable` to Oracle Support for diagnosis and problem resolution.

See Also:

- `http://www.microsoft.com/downloads/details.aspx?FamilyID=a7628646-131d-4617-bf68-f0532d8db131&displaylang=en` for information on Windows Firewall troubleshooting
- `http://support.microsoft.com/default.aspx?scid=kb;en-us;875357` for more information on Windows Firewall configuration

A

Troubleshooting

This appendix explains how diagnose problems for Oracle Clusterware and Oracle Real Application Clusters (Oracle RAC) components. The appendix explains how to do this by using dynamic debugging, enabling tracing, as well as by using trace and log file information. This appendix also includes information about the Cluster Verification Utility (CVU). The topics in this appendix are:

- Overview of Troubleshooting Oracle Real Application Clusters
- Diagnosing Oracle Clusterware High Availability Components
- Diagnosing Oracle Real Application Clusters Components
- Using the Cluster Verification Utility

Overview of Troubleshooting Oracle Real Application Clusters

Both Oracle Clusterware and Oracle RDBMS components have sub-components that you can troubleshoot as described in this chapter. You can enable dynamic debugging to troubleshoot Oracle Clusterware processing. You can also enable debugging and tracing for specific components and specific Oracle Clusterware resources to focus your troubleshooting efforts. A special clusterware health check command enables you to determine the status of several Oracle Clusterware components at one time.

The trace and log files that Oracle generates for Oracle RAC are available for both the Oracle Clusterware components and for the Oracle RDBMS with Oracle RAC components. For Oracle Clusterware, Oracle stores these under a unified directory log structure. In addition to debugging and tracing tools, you can use the Cluster Verification Utility (CVU) and instance-specific alert files for troubleshooting.

Diagnosing Oracle Clusterware High Availability Components

This section describes the diagnosability features for Oracle Clusterware which include log files for the Oracle Clusterware daemon, as well as log files for the Event Manager daemon (EVM) and the Oracle Notification Service (RACGONS) under the following topics:

- Dynamic Debugging
- Component Level Debugging
- Oracle Clusterware Shutdown and Startup
- Diagnostics Collection Script
- The Oracle Clusterware Alerts

Dynamic Debugging

You can use `crsctl` commands as the `root` user to enable dynamic debugging for Oracle Clusterware, the Event Manager (EVM), and the clusterware subcomponents. You can also dynamically change debugging levels using `crsctl` commands. Debugging information remains in the Oracle Cluster Registry (OCR) for use during the next startup. You can also enable debugging for resources. The `crsctl` syntax to enable debugging for Oracle Clusterware is:

```
crsctl debug log crs "CRSRTI:1,CRSCOMM:2"
```

The `crsctl` syntax to enable debugging for EVM is:

```
crsctl debug log evm "EVMCOMM:1"
```

The `crsctl` syntax to enable debugging for resources is:

```
crsctl debug log res "resname:1"
```

Component Level Debugging

You can enable debugging for the CRS daemons, EVM, and their modules by setting environment variables or by running `crsctl` commands as follows where *`module_name`* is the name of the module, `crs`, `evm`, or `css` and *`debugging_level`* is a level from 1 to 5:

```
crsctl debug log module_name component:debugging_level
```

Run the following command to obtain component names where *`module_name`* is the name of the module, `crs`, `evm`, or `css`:

```
crsctl lsmodules module_name
```

Note: You do not have to be the `root` user to run the `crsctl` command with the `lsmodules` option.

Oracle Clusterware Shutdown and Startup

You can use a `crsctl` command as follows to stop Oracle Clusterware and its related resources on a specific node:

```
crsctl stop crs
```

You can use a `crsctl` command as follows to start Oracle Clusterware and its related resources on a specific node:

```
crsctl start crs
```

Note: You must run these `crsctl` commands as the `root` user.

Enabling and Disabling Oracle Clusterware Daemons

When the Oracle Clusterware daemons are enabled, they start automatically at the time the node is started. To prevent the daemons from starting during the boot process, you can disable them using `crsctl` commands. You can use `crsctl` commands as follows to enable and disable the startup of the Oracle Clusterware daemons. Run the following command to enable startup for all of the Oracle Clusterware daemons:

```
crsctl enable crs
```

Run the following command to disable the startup of all of the Oracle Clusterware daemons:

```
crsctl disable crs
```

Notes:

- You must run these `crsctl` commands as the `root` user.
- Neither of these `crsctl` commands is supported on Windows.

Diagnostics Collection Script

Use the `diagcollection.pl` script to collect diagnostic information from an Oracle Clusterware installation. The diagnostics provide additional information so that Oracle Support can resolve problems. Run this script from the following location:

CRS_HOME`/bin/diagcollection.pl`

Note: You must run this script as the `root` user.

The Oracle Clusterware Alerts

The Oracle Clusterware posts alert messages when important events occur. The following is an example of an alert from the CRSD process:

```
[NORMAL] CLSD-1201: CRSD started on host %s
[ERROR] CLSD-1202: CRSD aborted on host %s. Error [%s].
Details is    %s.
ERROR] CLSD-1203: Failover failed for the CRS resource %s. Details     in %s.
[NORMAL] CLSD-1204: Recovering CRS resources for host %s
[ERROR] CLSD-1205: Auto-start failed for the CRS resource %s. Details in %s.
```

The location of this alert log on UNIX-based systems is *CRS Home*`/log/hostname/alerthostname.log` where *CRS_Home* is the name of the location of Oracle Clusterware. Windows-based systems use the same path structure.

The following is an example of an EVMD alert:

```
[NORMAL] CLSD-1401: EVMD started on node %s
[ERROR] CLSD-1402: EVMD aborted on node %s. Error [%s]. Details in %s.
```

Resource Debugging

You can use `crsctl` commands to enable resource debugging using the following syntax:

```
crsctl debug log res "ora.node1.vip:1"
```

This has the effect of setting the environment variable `USER_ORA_DEBUG`, to `1`, before running the start, stop, or check action scripts for the `ora.node1.vip` resource.

Note: You must run this `crsctl` command as the `root` user.

Checking the Health of the Clusterware

Use the `crsctl check` command to determine the health of your clusterware as in the following example:

```
crsctl check crs
```

This command displays the status of the CSSD, EVMD, and CRSD processes. Run the following command to determine the health of individual daemons where *`daemon`* is `crsd`, `cssd` or `evmd`:

```
crsctl check daemon
```

Note: You do not have to be the `root` user to perform health checks.

Clusterware Log Files and the Unified Log Directory Structure

Oracle uses a unified log directory structure to consolidate the Oracle Clusterware component log files. This consolidated structure simplifies diagnostic information collection and assists during data retrieval and problem analysis.

Oracle retains one current log file and five older log files that are 20 MB in size (120 MB of storage) for the `cssd` process, and one current log file and 10 older log files that are 10 MB in size (110 MB of storage) for the `crsd` process. In addition, Oracle overwrites the oldest retained log file for any log file group when the current log file gets stored. Alert files are stored in the following directory structures as described under the following headings:

- The Cluster Ready Services Daemon (crsd) Log Files
- Oracle Cluster Registry (OCR) Log Files
- Cluster Synchronization Services (CSS) Log Files
- Event Manager (EVM) Log Files
- RACG Log Files

Note: This section uses UNIX-based directory structure examples. The directory structure in all cases is identical for Windows-based platforms.

The Cluster Ready Services Daemon (crsd) Log Files

Log files for the CRSD process (`crsd`) can be found in the following directories:

CRS home/log/*hostname*/crsd

Oracle Cluster Registry (OCR) Log Files

The Oracle Cluster Registry (OCR) records log information in the following location:

CRS Home/log/*hostname*/client

Cluster Synchronization Services (CSS) Log Files

You can find CSS information that the OCSSD generates in log files in the following locations:

CRS Home/log/*hostname*/cssd

Event Manager (EVM) Log Files

Event Manager (EVM) information generated by evmd is recorded in log files in the following locations:

CRS Home/log/*hostname*/evmd

RACG Log Files

The Oracle RAC high availability trace files are located in the following two locations:

CRS home/*log*/hostname/racg
$ORACLE_HOME/log/hostname/racg

Core files are in the sub-directories of the log directories. Each RACG executable has a sub-directory assigned exclusively for that executable. The name of the RACG executable sub-directory is the same as the name of the executable.

Troubleshooting the Oracle Cluster Registry

This section explains how to troubleshoot the Oracle Cluster Registry (OCR) under the following topics:

- Using the OCRDUMP Utility to View Oracle Cluster Registry Content
- Using the OCRCHECK Utility
- Oracle Cluster Registry Troubleshooting

Using the OCRDUMP Utility to View Oracle Cluster Registry Content

This section explains how to use the OCRDUMP utility to view OCR content for troubleshooting. The OCRDUMP utility enables you to view the OCR contents by writing OCR content to a file or stdout in a readable format.

You can use a number of options for OCRDUMP. For example, you can limit the output to a key and its descendents. You can also write the contents to an XML-based file that you can view using a browser. OCRDUMP writes the OCR keys as ASCII strings and values in a datatype format. OCRDUMP retrieves header information based on a best effort basis. OCRDUMP also creates a log file in *CRS_Home*/log/*hostname*/client. To change the amount of logging, edit the file *CRS_Home*/srvm/admin/ocrlog.ini.

To change the logging component, edit the entry containing the `comploglvl=` entry. For example, to change the logging of the ORCAPI component to 3 and to change the logging of the OCRRAW component to 5, make the following entry in the `ocrlog.ini` file:

```
comploglvl="OCRAPI:3;OCRRAW:5"
```

> **Note:** Make sure that you have file creation privileges in the *`CRS Home`*`/log/`*`hostname`*`/client` directory before using the OCRDUMP utility.

OCRDUMP Utility Syntax and Options This section describes the OCRDUMP utility command syntax and usage. Run the `ocrdump` command with the following syntax where *`filename`* is the name of a target file to which you want Oracle to write the OCR output and where *`keyname`* is the name of a key from which you want Oracle to write OCR subtree content:

```
ocrdump [file_name|-stdout] [-backupfile backup_file_name] [-keyname keyname]
[-xml] [-noheader]
```

Table A–1 describes the OCRDUMP utility options and option descriptions.

Table A–1 OCRDUMP Options and Option Descriptions

Options	Description
`file_name`	Name of a file to which you want OCRDUMP to write output.
`-stdout`	The predefined output location that you can redirect with, for example, a filename.
`-keyname`	The name of an OCR key whose subtree is to be dumped.
`-xml`	Writes the output in XML format.
`-noheader`	Does not print the time at which you ran the command and when the OCR configuration occurred.
`-backupfile`	Option to identify a backup file.
`backup_file_name`	The name of the backup file the content of which you want to view. You can query the backups using the `ocrconfig -showbackup` command.

OCRDUMP Utility Examples The following `ocrdump` utility examples extract various types of OCR information and write it to various targets:

```
ocrdump
```

Writes the OCR content to a file called `OCRDUMPFILE` in the current directory.

```
ocrdump MYFILE
```

Writes the OCR content to a file called `MYFILE` in the current directory.

```
ocrdump -stdout -keyname SYSTEM
```

Writes the OCR content from the subtree of the key `SYSTEM` to `stdout`.

```
ocrdump -stdout -xml
```

Writes the OCR content to `stdout` in XML format.

Sample OCRDUMP Utility Output The following OCRDUMP examples show the KEYNAME, VALUE TYPE, VALUE, permission set (user, group, world) and access rights for two sample runs of the ocrdump command. The following shows the output for the SYSTEM.language key that has a text value of AMERICAN_AMERICA.WE8ASCII37.

```
[SYSTEM.language]
ORATEXT : AMERICAN_AMERICA.WE8ASCII37
SECURITY : {USER_PERMISSION : PROCR_ALL_ACCESS, GROUP_PERMISSION : PROCR_READ,
OTHER_PERMISSION : PROCR_READ, USER_NAME : user, GROUP_NAME : group
}
```

The following shows the output for the SYSTEM.version key that has integer value 3:

```
[SYSTEM.version]
UB4 (10) : 3
SECURITY : {USER_PERMISSION : PROCR_ALL_ACCESS, GROUP_PERMISSION : PROCR_READ,
OTHER_PERMISSION : PROCR_READ, USER_NAME : user, GROUP_NAME : group
}
```

Using the OCRCHECK Utility

The OCRCHECK utility displays the version of the OCR's block format, total space available and used space, OCRID, and the OCR locations that you have configured. OCRCHECK performs a block-by-block checksum operation for all of the blocks in all of the OCRs that you have configured. It also returns an individual status for each 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
```

OCRCHECK creates a log file in the directory *CRS_Home*/log/*hostname*/client. To change amount of logging, edit the file *CRS_Home*/srvm/admin/ocrlog.ini.

Oracle Cluster Registry Troubleshooting

Table A–2 describes common OCR problems with corresponding resolution suggestions.

Table A–2 Common OCR Problems and Solutions

Problem	Solution
Not currently using OCR mirroring and would like to.	Run the ocrconfig command with the -replace option as described on page 3-3.
An OCR failed and you need to replace it. Error messages in Enterprise Manager or OCR log file.	Run the ocrconfig command with the -replace option as described on page 3-4.
An OCR has a mis-configuration.	Run the ocrconfig command with the -repair option as described on page 3-4.

Table A–2 (Cont.) Common OCR Problems and Solutions

Problem	Solution
You are experiencing a severe performance effect from OCR processing or you want to remove an OCR for other reasons.	Run the `ocrconfig` command with the `-replace` option as described on page 3-3.

Enabling Additional Tracing for Oracle Real Application Clusters High Availability

Oracle Support may ask you to enable tracing to capture additional information. Because the procedures described in this section may affect performance, only perform these activities with the assistance of Oracle Support. This section includes the following topics:

- Generating Additional Trace Information for a Running Resource
- Verifying Event Manager Daemon Communications

Generating Additional Trace Information for a Running Resource

To generate additional trace information for a running resource, Oracle recommends that you use `CRSCTL` commands. For example, run the following command to turn on debugging for resources:

```
crsctl debug log res "resname:level"
```

Alternatively, you can set the `USR_ORA_DEBUG` parameter in your resource profile to the value `1` using `crsctl`.

Verifying Event Manager Daemon Communications

The event manager daemons (`evmd`) running on separate nodes communicate through specific ports. To determine whether the `evmd` for a node can send and receive messages, perform the test described in this section while running session 1 in the background.On node 1, session 1 enter:

```
$ evmwatch -A -t "@timestamp @@"
```

On node 2, session 2 enter:

```
$ evmpost -u "hello" [-h nodename]
```

Session 1 should show output similar to the following:

```
$ 21-Aug-2002 08:04:26 hello
```

Ensure that each node can both send and receive messages by executing this test in several permutations.

Diagnosing Oracle Real Application Clusters Components

This section describes the diagnosability features for Oracle Real Application Clusters components. This section includes the following topics:

- Where to Find Files for Analyzing Errors
- Using Instance-Specific Alert Files in Oracle Real Application Clusters
- Enabling Tracing for Java-Based Tools and Utilities in Oracle Real Application Clusters
- Resolving Pending Shutdown Issues

Where to Find Files for Analyzing Errors

Oracle records information about important events that occur in your Oracle RAC environment in trace files. The trace files for Oracle RAC are the same as those in single-instance Oracle databases. As a best practice, monitor and back up trace files regularly for all instances to preserve their content for future troubleshooting.

Information about ORA-600 errors appear in the *alert_SID*.log file for each instance where *SID* is the instance identifier. For troubleshooting, you may need to also provide files from the following bdump locations:

- $ORACLE_HOME/admin/db_name/bdump on UNIX-based systems
- %ORACLE_HOME%\admin\db_name\bdump on Windows-based systems

Some files may also be in the udump directory.

In addition, the directory cdmp_*timestamp* contains in-memory traces of Oracle RAC instance failure information. This directory is located in *ORACLE_HOME*/admin/db_name/bdump/cdmp_*timestamp*, where *timestamp* is the time at which the error occurred.

Trace dump files are stored under the cdmp directory. Oracle creates these files for each process that is connected to the instance. The naming convention for the trace dump files is same as for trace files, but with .trw as the file extension.

Background Thread Trace Files in Oracle Real Application Clusters

Oracle RAC background threads use trace files to record database operations and database errors. These trace logs help troubleshoot and also enable Oracle support to more efficiently debug **cluster database** configuration problems.

Background thread trace files are created regardless of whether the BACKGROUND_DUMP_DEST parameter is set in the server parameter file (SPFILE). If you set BACKGROUND_DUMP_DEST, then the trace files are stored in the directory specified. If you do not set the parameter, then the trace files are stored as follows:

- $ORACLE_BASE/admin/*db_name*/bdump on UNIX-based systems
- %ORACLE_BASE%\admin*db_name*\bdump on Windows-based systems
- *SID*_dbwr_1202.trc
- *SID*_smon_4560.trc

Oracle creates a different trace file for each background thread. For both UNIX- and Windows-based systems, trace files for the background processes are named SID_*process name_process identifier*.trc, for example:

User Process Trace Files in Oracle Real Application Clusters

Trace files are created for user processes if you set the USER_DUMP_DEST initialization parameter. User process trace file names have the format *SID*_ora_*process_identifier*/*thread_identifier*.trc, where *process_identifier* is a 5-digit number indicating the process identifier (PID) on UNIX-based systems and *thread_identifier* is the thread identifier on Windows-based systems.

Using Instance-Specific Alert Files in Oracle Real Application Clusters

Each instance in an Oracle RAC database has one alert file. The alert file for each instance, *alert.SID.log*, contains important information about error messages and exceptions that occur during database operations. Information is appended to the alert

file each time you start the instance. All process threads can write to the alert file for the instance.

The *alert_SID*`.log` file is in the directory specified by the `BACKGROUND_DUMP_DEST` parameter in the `init`*db_name*`.ora` initialization parameter file. If you do not set the `BACKGROUND_DUMP_DEST` parameter, the *alert_SID*`.log` file is generated in the following locations:

- `$ORACLE_BASE/admin/`*db_name*`/bdump` on UNIX-based systems.
- `%ORACLE_BASE%\admin\`*db_name*`\bdump` on Windows-based system

Enabling Tracing for Java-Based Tools and Utilities in Oracle Real Application Clusters

All Java-based tools and utilities that are available in Oracle RAC are invoked by executing scripts of the same name as the tool or utility. This includes the Cluster Verification Utility (CVU), Database Configuration Assistant (DBCA), the Net Configuration Assistant (NETCA), the Virtual Internet Protocol Configuration Assistant (VIPCA), Server Control (SRVCTL), and the Global Services Daemon (GSD). For example to run DBCA, enter the command `dbca`.

By default, Oracle enables traces for DBCA and the Database Upgrade Assistant (DBUA). For the CVU, GSDCTL, SRVCTL, and VIPCA, you can set the `SRVM_TRACE` environment variable to `TRUE` to make Oracle generate traces. Oracle writes traces to log files. For example, Oracle writes traces to log files in *`Oracle home`*`/cfgtoollogs/dbca` and *`Oracle home`*`/cfgtoollogs/dbua` for DBCA and the Database Upgrade Assistant (DBUA) respectively.

Resolving Pending Shutdown Issues

In some situations a `SHUTDOWN IMMEDIATE` may be pending and Oracle will not quickly respond to repeated shutdown requests. This is because Oracle Clusterware may be processing a current shutdown request. In such cases, issue a `SHUTDOWN ABORT` using SQL*Plus for subsequent shutdown requests.

Using the Cluster Verification Utility

This section describes the Cluster Verification Utility (CVU) under the following topics:

- Cluster Verification Utility Requirements
- Understanding CVU Commands, Help, Output, and Nodelist Shortcuts
- Cluster Verification Utility Nodelist Shortcuts

> **See Also:** Your platform-specific Oracle Clusterware and Oracle RAC installation guide for information about how to manually install CVU

The CVU can verify the primary **cluster** components during an operational phase or stage. A component can be basic, such as free disk space, or it can be complex, such as checking the Oracle Clusterware integrity. For example, CVU can verify multiple Oracle Clusterware subcomponents across the Oracle Clusterware layers. Additionally, CVU can check disk space, memory, processes, and other important cluster components. A stage could be, for example, database installation, for which CVU can perform a pre-check to verify whether your system meets the criteria for an Oracle RAC installation. Other stages include the initial hardware setup and the establishing of system requirements through the fully operational cluster setup.

When verifying stages, CVU uses entry and exit criteria. In other words, each stage has entry criteria that define a specific set of verification tasks to be performed before initiating that stage. This pre-check prevents you from beginning a stage, such as installing Oracle Clusterware, unless you meet the Oracle Clusterware stage's pre-requisites.

The exit criteria for a stage define another set of verification tasks that you need to perform after the completion of the stage. Post-checks ensure that the activities for that stage have been completed. Post-checks identify stage-specific problems before they propagate to subsequent stages.

The node list that you use with CVU commands should be a comma-delimited list of host names without a domain. The CVU ignores domains while processing node lists. If a CVU command entry has duplicate node entries after removing domain information, then CVU eliminates the duplicate node entries. Wherever supported, you can use the `-n all` option to verify all of your cluster nodes that are part of a specific Oracle RAC installation. You do not have to be the `root` user to use the CVU and the CVU assumes that the current user is the `oracle` user.

Note: The CVU only supports an English-based syntax and English online help.

For network connectivity verification, the CVU discovers all of the available network interfaces if you do not specify an interface on the CVU command line. For storage accessibility verification, the CVU discovers shared storage for all of the supported storage types if you do not specify a particular storage identification on the command line. The CVU also discovers the Oracle Clusterware home if one is available.

Run the CVU command-line tool using the `cluvfy` command. Using `cluvfy` does not adversely affect your cluster environment or your installed software. You can run `cluvfy` commands at any time, even before the Oracle Clusterware installation. In fact, the CVU is designed to assist you as soon as your hardware and operating system are operational. If you run a command that requires Oracle Clusterware on a node, then the CVU reports an error if Oracle Clusterware is not yet installed on that node.

You can enable tracing by setting the environment variable `SRVM_TRACE` to true. For example, in `tcsh` an entry such as `setenv SRVM_TRACE true` enables tracing. The CVU trace files are created in the `CV_HOME/cv/log` directory. Oracle 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 place if needed. The CVU does not generate trace files unless you enable tracing.

Cluster Verification Utility Requirements

The CVU requirements are:

- At least 30MB free space for the CVU software on the node from which you run the CVU
- A location for the current JDK, Java 1.4.1 or later
- A work directory with at least 25MB free space on each node

Note: When using the CVU, the CVU attempts to copy any needed information to the CVU work directory. Make sure that the CVU work directory exists on all of the nodes in your cluster database and that the directory on each node has write permissions established for the CVU user. Set this directory using the `CV_DESTLOC` environment variable. If you do not set this variable, then the CVU uses `/tmp` as the work directory on UNIX-based systems, and `C:\temp` on Windows-based systems.

Understanding CVU Commands, Help, Output, and Nodelist Shortcuts

This section describes the following Cluster Verification Utility topics:

- Using CVU Help
- Verbose Mode and UNKNOWN Output
- Cluster Verification Utility Nodelist Shortcuts

Using CVU Help

The `cluvfy` commands have context sensitive help that shows their usage based on the command-line arguments that you enter. For example, if you enter `cluvfy`, then the CVU displays high-level generic usage text describing the stage and component syntax. If you enter `cluvfy comp -list`, then the CVU shows the valid components with brief descriptions about each of them. If you enter `cluvfy comp -help`, then the CVU shows detailed syntax for each of the valid component checks. Similarly, `cluvfy stage -list` and `cluvfy stage -help` display valid stages and their syntax for their checks respectively.

If you enter an invalid CVU command, then the CVU shows the correct usage for that command. For example, if you type `cluvfy stage -pre dbinst`, then CVU shows the correct syntax for the pre-check commands for the `dbinst` stage. Enter the `cluvfy -help` command to see detailed CVU command information.

Verbose Mode and UNKNOWN Output

Although by default the CVU reports in non-verbose mode by only reporting the summary of a test, you can obtain detailed output by using the `-verbose` argument. The `-verbose` argument produces detailed output of individual checks and where applicable shows results for each node in a tabular layout.

If a `cluvfy` command responds with `UNKNOWN` for a particular node, then this is because the CVU cannot determine whether a check passed or failed. The cause of this could be a loss of reachability or the failure of user equivalence to that node. The cause could also be any system problem that was occurring on that node at the time that CVU was performing a check.

If you run the CVU using the `-verbose` argument and the CVU responds with `UNKNOWN` for a particular node, then this is because the CVU cannot determine whether a check passed or failed. The following is a list of possible causes for an `UNKNOWN` response:

- The node is down
- Executables that the CVU requires are missing in *`CRS_home`*`/bin` or the *`Oracle home`* directory
- The user account that ran the CVU does not have privileges to run common operating system executables on the node

- The node is missing an operating system patch or a required package
- The node has exceeded the maximum number of processes or maximum number of open files, or there is a problem with IPC segments, such as shared memory or semaphores

Cluster Verification Utility Nodelist Shortcuts

You can use the following nodelist shortcuts:

To provide the CVU a list of all of the nodes of a cluster, enter `-n all`. CVU attempts to obtain the node list in the following order:

1. If vendor clusterware is available, then the CVU selects all of the configured nodes from the vendor clusterware using the `lsnodes` utility.
2. If Oracle Clusterware is installed, then the CVU selects all of the configured nodes from Oracle Clusterware using the `olsnodes` utility.
3. If neither the vendor nor Oracle Clusterware is installed, then the CVU searches for a value for the `CV_NODE_ALL` key in the configuration file.
4. If vendor and Oracle Clusterware are not installed and no key named `CV_NODE_ALL` exists in the configuration file, then the CVU searches for a value for the `CV_NODE_ALL` environmental variable.

If you have not set this variable, then the CVU reports an error.

To provide a partial node list, you can set an environmental variable and use it in the CVU command. For example, on UNIX-based systems you can enter:

```
setenv MYNODES node1,node3,node5
cluvfy comp nodecon -n $MYNODES [-verbose]
```

Cluster Verification Utility Configuration File

You can use CVU's configuration file to define specific inputs for the execution of the CVU. The path for the configuration file is `CV_HOME/cv/admin/cvu_config`. You can modify this using a text editor. The inputs to the tool are defined in the form of key entries. You must follow these rules when modifying the CVU configuration file:

- Key entries have the syntax `name=value`
- Each key entry and the value assigned to the key only defines one property
- Lines beginning with the number sign (#) are comment lines and are ignored
- Lines that do not follow the syntax `name=value` are ignored

The following is the list of keys supported by CVU:

- `CV_NODE_ALL`: If set, it specifies the list of nodes that should be picked up when Oracle Clusterware is not installed and a `-n` all option has been used in the command line. By default, this entry is commented out.
- `CV_RAW_CHECK_ENABLED`: If set to `TRUE`, it enables the check for accessibility of shared disks on RedHat release 3.0. This shared disk accessibility check requires that you install a `cvuqdisk` rpm on all of the nodes. By default, this key is set to `TRUE` and shared disk check is enabled.
- `CV_XCHK_FOR_SSH_ENABLED`: If set to `TRUE`, it enables the X-Windows check for verifying user equivalence with ssh. By default, this entry is commented out and X-Windows check is disabled.

- ORACLE_SRVM_REMOTESHELL: If set, it specifies the location for ssh/rsh command to override CVU's default value. By default, this entry is commented out and the tool uses /usr/sbin/ssh and /usr/sbin/rsh.
- ORACLE_SRVM_REMOTECOPY: If set, it specifies the location for the scp or rcp command to override the CVU default value. By default, this entry is commented out and CVU uses /usr/bin/scp and /usr/sbin/rcp.

If CVU does not find a key entry defined in the configuration file, then the CVU searches for the environment variable that matches the name of the key. If the environment variable is set, then the CVU uses its value, otherwise the CVU uses a default value for that entity.

Performing Various CVU Tests

You can perform the following tests using CVU as described under the following topics:

- Cluster Verification Utility System Requirements Verifications
- Cluster Verification Utility Storage Verifications
- Cluster Verification Utility Connectivity Verifications
- Cluster Verification Utility User and Permissions Verifications
- Cluster Verification Utility Node Comparisons and Verifications
- Cluster Verification Utility Installation Verifications
- Cluster Verification Utility Oracle Clusterware Component Verifications
- Cluster Verification Utility Cluster Integrity Verifications
- Cluster Verification Utility Argument and Option Definitions

> **See Also:** Table A–3 for details about the arguments and options used in the following CVU examples

Cluster Verification Utility System Requirements Verifications

To verify the minimal system requirements on the nodes prior to installing Oracle Clusterware or Oracle RAC, use the sys component verification command as follows:

```
cluvfy comp sys [ -n node_list ] -p { crs | database } }  [-r { 10gR1 | 10gR2 } ]
[ -osdba osdba_group ] [ -orainv orainventory_group ] [-verbose]
```

To check the system requirements for installing Oracle RAC, use the -p database argument, and to check the system requirements for installing Oracle Clusterware, use the -p crs argument. To check the system requirements for installing Oracle Clusterware or Oracle RAC from Oracle Database 10*g* release 1 (10.1), use the -r 10gR1 argument. For example, verify the system requirements for installing Oracle Clusterware on the cluster nodes known as node1,node2 and node3 by running the following command:

```
cluvfy comp sys -n node1,node2,node3 -p crs -verbose
```

Cluster Verification Utility Storage Verifications

To verify whether storage is shared among the nodes in your cluster database or to identify all of the storage that is available on the system and can be shared across the cluster nodes, use the component verification command ssa as follows:

```
cluvfy comp ssa [ -n node_list ] [ -s storageID_list ] [-verbose]
```

> **See Also:** Refer to "Known Issues for the Cluster Verification Utility" on page A-18 for the types of storage that CVU supports.

For example, discover all of the shared storage systems available on your system by running the following command:

```
cluvfy comp ssa  -n all -verbose
```

You can verify the accessibility of a specific storage location, such as `/dev/sda`, across the cluster nodes by running the following command:

```
cluvfy comp ssa  -n all -s /dev/sda
```

To verify whether a certain amount of free space is available on a specific location in the nodes of your cluster database, use the component verification command `space`.

```
cluvfy comp space  [ -n node_list ] -l storage_location -z disk_space {B|K|M|G}
[-verbose]
```

For example, you can verify the availability of at least 2GB of free space at the location `/home/dbadmin/products` on all of the cluster nodes by running the following command:

```
cluvfy comp space  -n all -l  / home/dbadmin/products  -z 2G -verbose
```

To verify the integrity of your Oracle Cluster File System (OCFS) on platforms on which OCFS is available, use the component verification command `cfs` as follows:

```
cluvfy comp cfs  [ -n node_list ] -f file_system [-verbose]
```

For example, you can verify the integrity of the **cluster file system** `/oradbshare` on all of the nodes by running the following command:

```
cluvfy comp cfs -f /oradbshare -n all -verbose
```

> **Note:** The sharedness check for the file system is supported for Oracle Cluster File System version 1.0.14 or higher.

Cluster Verification Utility Connectivity Verifications

To verify the reachability of the cluster nodes from the local node or from any other cluster node, use the component verification command `nodereach` as follows:

```
cluvfy comp nodereach -n node_list [ -srcnode node ]  [-verbose]
```

To verify the connectivity between the cluster nodes through all of the available network interfaces or through specific network interfaces, use the component verification command `nodecon` as follows:

```
cluvfy comp nodecon -n node_list [ -i interface_list ]  [-verbose]
```

Use the `nodecon` command without the `-i` option as follows to use CVU to:

- Discover all of the network interfaces that are available on the cluster nodes
- Review the interfaces' corresponding IP addresses and subnets

- Obtain the list of interfaces that are suitable for use as VIPs and the list of interfaces to private interconnects
- Verify the connectivity between all of the nodes through those interfaces

```
cluvfy comp nodecon -n all [-verbose]
```

You can run this command in verbose mode to identify the mappings between the interfaces, IP addresses, and subnets. To verify the connectivity between all of the nodes through specific network interfaces, use the `comp nodecon` command with the `-i` option. For example, you can verify the connectivity between the nodes `node1`,`node2`, and `node3`, through interface `eth0` by running the following command:

```
cluvfy comp nodecon -n node1,node2,node3 -i eth0 -verbose
```

Cluster Verification Utility User and Permissions Verifications

To verify user accounts and administrative permissions-related issues, use the component verification command `admprv` as follows:

```
cluvfy comp admprv  [ -n node_list ]  [-verbose]
                | -o user_equiv [-sshonly]
                | -o crs_inst  [-orainv orainventory_group ]
                | -o db_inst  [-orainv orainventory_group ] [-osdba osdba_group ]
                | -o db_config  -d oracle_home
```

To verify whether user equivalence exists on specific nodes, use the `-o user_equiv` argument. On UNIX-based platforms, this command verifies user equivalence first using `ssh` and then using `rsh`, if the `ssh` check fails. To verify the equivalence only through `ssh`, use the `-sshonly` option. By default, the equivalence check does not verify X-Windows configurations, such as whether you have disabled X-forwarding, whether you have the proper setting for the `DISPLAY` environment variable, and so on.

To verify X-Windows aspects during user equivalence checks, set the `CV_XCHK_FOR_SSH_ENABLED` key to `TRUE` in the configuration file that resides in the path `CV_HOME/cv/admin/cvu_config` before you run the `admprv -o user_equiv` command. Use the `-o crs_inst` argument to verify whether you have permissions to install Oracle Clusterware.

You can use the `-o db_inst` argument to verify the permissions that are required for installing Oracle RAC and the `-o db_config` argument to verify the permissions that are required for creating an Oracle RAC database or for modifying an Oracle RAC database's configuration. For example, you can verify user equivalence for all of the nodes by running the following command:

```
cluvfy comp admprv  -n all -o user_equiv -verbose
```

On Linux and Unix platforms, this command verifies user equivalence by first using ssh and then using rsh if the ssh check fails. To verify the equivalence only through ssh, use the `-sshonly` option. By default, the equivalence check does not verify X-Windows configurations, such as when you have disabled X-forwarding with the setting of the `DISPLAY` environment variable. To verify X-Windows aspects during user equivalence checks, set the `CV_XCHK_FOR_SSH_ENABLED` key to `TRUE` in the configuration file `CV_HOME/cv/admin/cvu_config` before you run the `admprv -o user_equiv` command.

To verify the existence of node applications, namely VIP, ONS and GSD, on all of the nodes, use the component `nodeapp` command:

```
cluvfy comp nodeapp  [ -n node_list ]  [-verbose]
```

Cluster Verification Utility Node Comparisons and Verifications

Use the component verification `peer` command to compare the nodes as follows:

```
cluvfy comp peer [ -refnode node ] -n node_list [-r { 10gR1 | 10gR2 } ] [ -orainv
orainventory_group ] [ -osdba osdba_group ]  [-verbose]
```

The following command lists the values of several pre-selected properties on different nodes from Oracle Database 10*g* release 2 (10.2):

```
cluvfy comp peer -n node_list [-r 10gR2] [-verbose]
```

You can also use the `comp peer` command with the `-refnode` argument to compare the properties of other nodes against the reference node.

Cluster Verification Utility Installation Verifications

To verify whether your system meets all of the criteria for an Oracle Clusterware installation, use the pre-check command for the Oracle Clusterware installation stage as follows:

```
cluvfy stage -pre crsinst -n node_list
 [ -c ocr_location ] [-r { 10gR1 | 10gR2 } ][ -q voting_disk ]
 [ -osdba osdba_group ]
 [ -orainv orainventory_group ]  [-verbose]
```

After you have completed phase one, verify that Oracle Clusterware is functioning properly before proceeding with phase two of your Oracle RAC installation by running the `post-check` command for the Oracle Clusterware installation stage or, `-post crsinst` as follows:

```
cluvfy stage -post crsinst -n node_list [-verbose]
```

To verify whether your system meets all of the criteria for an Oracle RAC installation, use the pre-check command for the Database Installation stage as follows:

```
cluvfy stage -pre dbinst -n node_list [-r { 10gR1 | 10gR2 } ]
 [ -osdba osdba_group ]
 [ -orainv orainventory_group ]  [-verbose]
```

To verify whether your system meets all of the criteria for creating a database or for making a database configuration change, use the pre-check command for the Database Configuration stage as follows:

```
cluvfy stage -pre dbcfg -n node_list -d oracle_home [-verbose]
```

Cluster Verification Utility Oracle Clusterware Component Verifications

To verify the integrity of all of the Oracle Clusterware components, use the component verification `crs` command as follows:

```
cluvfy comp crs  [ -n node_list ]  [-verbose]
```

To verify the integrity of each individual Cluster Manager sub-component, use the component verification command `clumgr` as follows:

```
cluvfy comp clumgr  [ -n node_list ]  [-verbose]
```

To verify the integrity of the Oracle Cluster Registry, use the component verification command `ocr` as follows:

```
cluvfy comp ocr  [ -n node_list ] [-verbose]
```

Cluster Verification Utility Cluster Integrity Verifications

To check the integrity of your entire cluster, which means to verify that all of the nodes in the cluster have the same view of the cluster configuration, use the component verification command `clu` as follows:

```
cluvfy comp clu
```

Cluster Verification Utility Argument and Option Definitions

Table A–3 describes the CVU arguments and options used in the previous examples:

Table A–3 Cluster Verification Utility Arguments and Options

Argument or Option	Definition
`-n` *node_list*	The comma-delimited list of non-domain qualified node names on which the test should be conducted. If `all` is specified, then all of the nodes in the cluster will be used for verification.
`-i` *interface_list*	The comma-delimited list of interface names.
`-f` *file_system*	The name of the file system.
`-s storageID_list`	The comma-delimited list of storage identifiers.
`-l storage_location`	The storage path.
`-z disk_space`	The required disk space, in units of bytes (B), kilobytes (K), megabytes (M), or gigabytes (G).
`-osdba osdba_group`	The name of the OSDBA group. The default is `dba`.
`-orainv orainventory_group`	The name of the Oracle inventory group. The default is `oinstall`.
`-verbose`	Makes CVU print detailed output.
`-o user_equiv`	Checks user equivalence between the nodes.
`-sshonly`	Check user equivalence for ssh setup only.
`-o crs_inst`	Checks administrative privileges for installing Oracle Clusterware.
`-o db_inst`	Checks administrative privileges for installing Oracle RAC.
`-o db_config`	Checks administrative privileges for creating or configuring a database.
`-refnode`	The node that will be used as a reference for checking compatibility with other nodes.
`-srcnode`	The node from which the reachability to other nodes should be checked.
`-r { 10gR1 | 10gR2 }`	The release of Oracle Database 10*g* for which the requirements for installation of Oracle Clusterware or Oracle RAC are to be verified. If this options is not specified, then Oracle Database 10*g* release 2 (10.2) is assumed.

Known Issues for the Cluster Verification Utility

This section describes the following known limitations for CVU:

- Database Versions Supported by Cluster Verification Utility
- Linux Shared Storage Accessibility (ssa) Check Reports Limitations

Database Versions Supported by Cluster Verification Utility

The current CVU release supports only Oracle Database 10*g* RAC and Oracle Clusterware and it is not backward compatible. In other words, CVU cannot check or verify pre-Oracle Database 10*g* products.

Linux Shared Storage Accessibility (ssa) Check Reports Limitations

The current release of `cluvfy` has the following limitations on Linux regarding shared storage accessibility check.

- Currently NAS storage (r/w, no attribute caching) and OCFS (version 1.0.14 or higher) are supported.
- For sharedness checks on NAS, `cluvfy` commands require you to have write permission on the specified path. If the `cluvfy` user does not have write permission, `cluvfy` reports the path as `not shared`.

Shared Disk Discovery on Red Hat Linux

To perform discovery and shared storage accessibility checks for SCSI disks on Red Hat Linux 3.0 and SUSE Linux Enterprise Server, CVU requires the CVUQDISK package. If you attempt to use CVU and the CVUQDISK package is not installed on all of the nodes in your Oracle RAC environment, then CVU responds with an error.

Perform the following procedure to install the CVUQDISK package:

1. Login as the `root` user.
2. Copy the rpm, `cvuqdisk-1.0.1-1.rpm`, to a local directory. You can find this rpm in the `rpm` sub-directory of the top-most directory in the Oracle Clusterware installation media. For example, you can find `cvuqdisk-1.0.1-1.rpm` in the directory `/`*`mountpoint`*`/clusterware/rpm/` where *`mountpoint`* is the mounting point for the disk on which the directory is located.
3. Set the environment variable to a group that should own the CVUQDISK package binaries. If `CVUQDISK_GRP` is not set, then by default the `oinstall` group is the owner's group.
4. Determine whether previous versions of the CVUQDISK package are installed by running the command `rpm -q cvuqdisk`. If you find previous versions of the CVUQDISK package, then remove them by running the command `rpm -e cvuqdisk` *`previous_version`* where *`previous_version`* is the identifier of the previous CVUQDISK version.
5. Install the latest CVUQDISK package by running the command `rpm -iv cvuqdisk-1.0.1-1.rpm`.

B

High Availability Oracle Clusterware Command-Line Reference and C API

This appendix describes the Oracle Clusterware application program interface (API) command reference and includes the following topics:

- Using Oracle Clusterware Commands
- The Oracle Clusterware Commands
- C Application Programming Interface to Oracle Clusterware
- Functions for Managing Resource Structures

> **See Also:** Chapter 14, "Making Applications Highly Available Using Oracle Clusterware" for detailed information about using Oracle Clusterware to make applications highly available and Appendix C, "Oracle Clusterware Messages" for information about Oracle Clusterware error messages

Using Oracle Clusterware Commands

This section explains how to use the Oracle Clusterware commands to manage applications and application resources under the Oracle Clusterware framework.

Application Profile Syntax

The examples in this appendix show the command syntaxes that you use in application profiles. Lines starting with a pound sign (#) are comment lines and are not processed as part of a profile. A backslash (\) at the end of a line indicates that the next line is a continuation of the previous line. Refer to the section titled "Using crs_profile to Create An Application Resource Profile" on page 14-7 to see a profile example.

Security and Permissions

The Oracle Clusterware uses UNIX-like security where permissions may be specified for the owner, nodes of a group, or holders of specific privileges. There may also be default permissions for other users. These permissions are `read`, `write`, and `run` on Windows-based systems, and `rwx` on UNIX-based systems. Default ownership and permissions are set when you create an application profile. Table B–1 shows the Oracle Clusterware commands and their owners as well as which commands require write permission and which commands require run permission.

Table B–1 Oracle Clusterware Command Owner and Permissions Matrix

Owner	Read	Write Permission Required	Run/Execute Permission Required

User	`crs_stat {any options}`	`crs_register {no arguments}`
		`crs_register -u`
		`crs_unregister`
			`crs_start`
			`crs_stop`
			`crs_relocate`
			`crs_stat {no arguments}`
			`crs_stat -l -t -r`

Group	`crs_stat {any options}`	`crs_register {no arguments}`
		`crs_register -u`
		`crs_unregister`
			`crs_start`
			`crs_stop`
			`crs_relocate`
			`crs_stat {no arguments}`
			`crs_stat -l -t -r`

Other	`crs_stat {any options}`	`crs_register {no arguments}`
		`crs_register -u`
		`crs_unregister`
			`crs_start`
			`crs_stop`
			`crs_relocate`
			`crs_stat {no arguments}`
			`crs_stat -l -t -r`

Note: On platforms that do not have a group concept, the group permissions are `NULL` or not set.

Note: Do not use the Oracle Clusterware commands `crs_register`, `crs_profile`, `crs_start` or `crs_stop` on resources with names beginning with the prefix `ora` unless either Oracle Support asks you to, or unless Oracle has certified you as described in `http://metalink.oracle.com`. Server Control (SRVCTL) is the correct utility to use on Oracle resources. You can create resources that depend on resources that Oracle has defined. You can also use the Oracle Clusterware commands to inspect the configuration and status.

The Oracle Clusterware Commands

Table B–2 alphabetically lists the Oracle Clusterware commands that this appendix describes. Note that the `-q` option runs all commands in quiet mode. This means that no messages are displayed on the console.

Table B–2 Oracle Clusterware Commands Summary

Command	Description
crs_getperm on page B-3	Inspects the permissions associated with a resource.
crs_profile on page B-3	Creates, validates, deletes, and updates an Oracle Clusterware application profile
crs_register on page B-16	Registers configuration information for an application with the OCR.

Table B–2 (Cont.) Oracle Clusterware Commands Summary

Command	Description
crs_relocate on page B-9	Relocates an application profile to another node.
crs_setperm on page B-11	Sets permissions associated with a resource.
crs_stat on page B-11	Lists the status of an application profile.
crs_start on page B-13	Starts applications that have been registered.
crs_stop on page B-15	Stops an Oracle Clusterware application.
crs_unregister on page B-16	Removes the configuration information for an application profile from the OCR.

Note: On platforms that do not have a group concept, the group permissions are `NULL` or not set.

crs_getperm

Inspects the permissions associated with a resource.

Syntax and Options for crs_getperm

Use the `crs_getperm` command with the following syntax:

```
crs_getperm resource_name [-u user|-g group]
```

To obain the permissions associated with a resource, use the following syntax:

```
crs_getperm resource_name
```

Example of crs_getperm

To list the permissions associated with the `postman` application, use the following command:

```
crs_getperm postman
```

crs_profile

Creates, validates, deletes, and updates an Oracle Clusterware application profile. It works on the user's copy of a profile. This command does not operate against the database that Oracle Clusterware is using.

You can also use `crs_profile` to generate a template script. The `crs_profile` command creates new application profiles and validates, updates, deletes, or lists existing profiles. An application profile assigns values to attributes that define how a resource should be managed or monitored in a **cluster**. For the `root` user, profiles are written to the *`CRS home`*`/crs/profile` directory. For non-privileged users, the profile is written to the *`CRS home`*`/crs/public` directory. Values in the profile that are left blank are ignored and may be omitted if not required. Omitted profile variables that are required for a resource type can cause validation or registration to fail.

After you have created an application profile and registered the application with Oracle Clusterware using the `crs_register` command, you can use other Oracle Clusterware commands, such as `crs_stat`, `crs_start`, `crs_stop`, `crs_relocate`, and `crs_unregister`, on the application. You must register applications using the `crs_register` command *before* the other Oracle Clusterware commands

are available to manage the application. The `crs_profile` command may have other options for defining user-defined attributes in a profile.

Syntax and Options for crs_profile

Use the `crs_profile` command with the following syntax to create an application profile template:

```
crs_profile -create resource_name -t application [-a action_script] [-B
executable_pathname] [-dir directory] [-d description] [-p placement_policy] [-h
hosting_nodes] [-r required_resources] [-l optional_resources]  [-o option,[...]]
[attribute_flag attribute_value] [...] [-f] [-q]
```

To create an application profile from an application profile template:

```
crs_profile -create resource_name -I template_file [-f] [-q]
```

To validate the application profile syntax of a profile, enter the following command:

```
crs_profile -validate resource_name [-q]
```

To list one or more application profiles:

```
crs_profile -print [resource_name [...]] [-q]
```

To create an application profile template from an existing application profile:

```
crs_profile -template resource_name [-O template_file] [-q]
```

To update an application profile:

```
crs_profile -update resource_name [option [...]] [-q]
```

To delete an application profile and its associated action program:

```
crs_profile -delete resource_name [-q]
```

Note: The `crs_profile -delete` command deletes the resource profile file but does not delete the action script file.

Table B–3 crs_profile Options

Option	Description
`-create resource_name`	Creates a resource for the indicated application according to the specified options. A *`resource_name`* is a string containing a combination of characters [`a-z`, `A-Z`, `0-9`, `'.','_'`]. The resource name may not start with a period (`.`). The maximum length for a resource name is 128 characters. Resource profiles are created in the directory that you specify.
`-t application`	Indicates an application or application resource type.
`[-a action_script]`	Specifies the action program for the application. An action program has start, stop, and check entry points that are called by Oracle Clusterware. You can specify either a full path name for the script file or its filename.
`[-B executable_pathname]`	Specifies the location of the application executable and causes the `crs_profile` command to generate an action program file that contains the application executable path name.
`[-dir directory]`	Specifies the file location.

Table B–3 (Cont.) crs_profile Options

Option	Description
[-d description]	Specifies the description of the application. Enclose the description in double quotation marks ("") if it contains white space. If you do not specify an application description, then Oracle Clusterware uses the application name.
[-p placement_ policy]	Specifies the policy according to which Oracle Clusterware selects the node on which to start or restart the application. You can specify balanced, favored, or restricted as placement policies. All policies except for balanced require you to also specify the -h flag.
[-h hosting_nodes]	Specifies an ordered list of nodes, separated by white space, that can host the application. If there is more than one node, then the list must be enclosed in double quotation marks (""). If you specify the -p option with a placement policy of preferred or unavailable, then you must also specify the -h option.
[-r required_ resources]	Specifies an ordered list of resources, separated by spaces, on which the application depends. These resources must be active on any node on which the application is running. If there are multiple required resources, then the list must be enclosed in double quotation marks (""). If you do not specify a required resources list, then Oracle Clusterware imposes no required dependencies upon the application resource.
[-l optional_ resources]	Specifies an ordered list of optional resources, separated by white space. If there are multiple optional resources specified, then the list must be enclosed in double quotation marks ("").
[-o option[,...]]	comma-delimited list of attribute option names and their values. To see the list of attribute option names, run the crs_profile -help command.
-f	Forces relocation of the specified applications, all applications dependent on them and all applications that they are dependent upon. This option is required for relocating applications that require another application or one that is required by any ONLINE application.

Table B–4 Options for the -o Flag

Option	Description
st=script_timeout	Sets the maximum time for an action program to run. The Oracle Clusterware commands and the Oracle Clusterware daemon return an error message and post an event to Event Manager (EVM) when they invoke action program entry points and the script does not complete its execution within this time. The default is 60 seconds.
ap=active_ placement	When set to 1, it re-evaluates the placement policy when a new cluster node becomes available. With placement policies of FAVORED and RESTRICTED, a highly available application relocates to a more highly favored cluster node. The default is 0.
as=auto_start	Indicates whether Oracle Clusterware should automatically start a resource after a cluster restart. Valid AUTO_START values are: always—Restarts the resource when the node restarts regardless of the state of the resource when the node stopped. restore—Restores the resource to the same state that it was in when the node went down. If the state of the resource was offline (STATE=OFFLINE, TARGET=OFFLINE) when the node went down, then the resource remains offline when the node comes back up. The resource is started only if it was online before the node went down. never—Oracle Clusterware never restarts the resource regardless of the state of the resource when the node stopped. The default is restore. **Note:** Oracle only supports lower-case values for always, restore, and never.
ci=check_interval	Sets the time (in seconds) at which the check entry point of the application's action program runs. The check interval is the maximum amount of time that an application can be unavailable to clients before Oracle Clusterware attempts to restart it. The default check interval is 60 seconds.

Table B–4 (Cont.) Options for the -o Flag

Option	Description
`ft=failure_threshold`	Specifies the number of times that Oracle Clusterware may detect an application or application resource failure within the failure interval before it marks the application or application resource as unavailable and stops monitoring it. The value must be in the range `0-20`. Setting the value to `0` (zero) turns off failure threshold monitoring. If you do not specify a failure threshold, then Oracle Clusterware uses a default failure threshold of `0` (zero).
`fi=failure_interval`	Specify the time (in seconds) during which the failure threshold is calculated and applied. The default failure interval is `0` (zero). The Oracle Clusterware uses a default failure interval of `0`, which turns off monitoring of failure threshold and failure intervals. Specifying a nonzero failure interval has no effect unless the failure threshold is also nonzero.
`ra=restart_attempts`	Specifies the number of times that Oracle Clusterware attempts to restart the application or application resource on the current node before attempting to relocate it. The default number of restart attempts is `1`.
`fd=failover_delay`	Specifies the number of seconds that Oracle Clusterware waits before attempting to relocate the application resource. An application resource that was running on a cluster node that failed restarts immediately on that node if it becomes available again within the failover delay period. If application resources are dependent on each other due to required resources defined in application profiles, then all interdependent application resources wait for the largest failover delay that you have defined for any of the resources. The default failover delay is `0` (zero) seconds.

Examples of crs_profile

The following is an example of using the `crs_profile` command to create the application profile for an application named `dtcalc`:

```
crs_profile -create dtcalc
```

The following is an example of using the `crs_profile` command to validate the application profile named `dtcalc`:

```
crs_profile -validate dtcalc
```

If you do not specify either the `-a` or `-B` options, then the profile is created without an action program value. You should create a readable, executable script and update the profile with this script's value before attempting to start the application. If you specify the `-a` option alone, then the action program specified must exist at the specified location or in the default directory if no path is specified. Otherwise, the command fails.

Errors for crs_profile

This corresponding text message is given if the command fails:

```
A failure has occurred.
```

crs_register

The `crs_register` command registers one or more applications specified with the *`resource_name`* parameter for each application. This command requires write access to the target application. This command only succeeds if the profile is found either in the default location or in the directory specified by the `-dir` option. An application must be registered in order for Oracle Clusterware to monitor the resource or to start, restart, or relocate a highly available application associated with an application

resource. An application registration must be updated for any changes to an application profile to take effect. This command requires full administrative privileges.

An application can be registered or updated only if the Oracle Clusterware daemon is active and an Oracle Clusterware application profile exists in the profile directory for this application. If fields are missing from an application profile, then the profile is merged with the default profile template and Oracle uses the values in the default profile template.

The ownership and default permissions for the application are set during the registration process. You can register any `.cap` file as long as the permissions for the file permit `read` and `write`, for example, `crs_profile` and `crs_register` must be able to read the file. By default, the user who registers the application is the owner of the application. If the profile cannot be registered, then Oracle Clusterware displays messages explaining why. Use the `crs_stat` command to verify that the application is registered.

Syntax and Options for crs_register

You can use the `crs_register` command to register and update applications. Use the following `crs_register` syntax to register an application:

```
crs_register resource_name [-dir directory_path] [...] [-u] [-f] [-q]
```

The *`resource_name`* `[...]` parameter can be the name of one or more application resources as specified in an application profile. If you do not specify any options, then the `crs_relocate` command relocates each specified application resource according to its placement policy and required resource lists. The Oracle Clusterware does not relocate a resource if there are interdependent application resources unless you specify the `-f` option. A profile must exist for the application that you are registering.

The `-dir` option specifies where the `.cap` file is if it is not in the default directory.

Use `crs_register -u` immediately after a `crs_profile -update` or a manual edit of an application profile to ensure that the changes take effect immediately.

Table B–5 crs_register Options

Option	Description
`-c cluster_node`	Relocates each indicated application or application resource to the specified node regardless of its placement policy. If required resources are not available on the destination node or if the application resource is restricted from that node, then the `crs_relocate` command fails and the application or application resource remains on the current node.
`-s source_node`	Relocates all running applications or application resources from the *`source_node`*. If you do not also specify the `-c` option, then the `crs_relocate` command relocates each resource according to its placement policy and required resource lists.
`-f`	Forces relocation of the specified applications, all applications dependent on them and all applications that they are dependent upon. This option is necessary for relocating any application that requires another application or one that is required by any `ONLINE` application.

Use the following `crs_register` command syntax to update a registered application:

```
crs_register resource_name -update [option ...] [-o option,...] [-q]
```

See Also: Table B–3 and Table B–4 for the listing of options and their definitions for using `-update`; the options for `-update` are the same as for the `crs_profile` command

Example of crs_register

The following example registers an application named `postman` for which an application profile exists in the *`CRS home`*`/crs/profile` directory:

```
CRS home/bin/crs_register postman
```

Note: The profile will be in the `crs/profile` directory if the profile is created by the `root` user. The profile will be in the `crs/public` directory if the profile is created by any other user.

Errors for crs_register

Oracle displays a corresponding text message for the following error conditions:

- No root privilege
- The Oracle Clusterware daemon is not running
- Resource specified on the command line does not match the resource specified in the profile
- Resource is already registered with the Oracle Clusterware daemon
- Resource type cannot be updated

Related Commands for crs_register

`crs_stat`, `crs_profile`, `crs_relocate`, `crs_start`, `crs_stop`, `crs_unregister`

crs_relocate

The `crs_relocate` command relocates applications and application resources as specified by the command options that you use and the entries in your application profile. The specified application or application resource must be registered and running under Oracle Clusterware in the cluster environment before you can relocate it. The command displays a message if you specify a cluster node that is unavailable or if the attempt to relocate failed. You must have full administrative privileges to use this command. When you perform a `crs_relocate` command, Oracle Clusterware first runs the stop entry point of the action program on the node on which it is currently running. The Oracle Clusterware then performs the start entry point of the action program to start it on a new node.

If Oracle Clusterware fails to stop the application or application resource on the current node due to an action program error, then it marks it as `UNKNOWN`. You cannot run `crs_relocate` on a resource in this state. Instead, run a `crs_stop -f` command on the resource and restart it with `crs_start` to return it to the `ONLINE` state before you attempt to relocate it again. If Oracle Clusterware fails to restart an application resource, then you may need to check the resource action program.

If the action program start entry point fails to run successfully, then the stop entry point is run. If the stop entry point fails to run successfully, then the state is marked as `UNKNOWN` and relocation attempts are stopped. If the stop entry point succeeds, then the state is set to `OFFLINE`. The target state remains `ONLINE` however, so subsequent

cluster node failures or restarts can cause Oracle Clusterware to attempt to restart the application. If you have not specified the node to which to relocate it and if there are available cluster nodes that satisfy the placement criteria, then Oracle Clusterware attempts to start the application on one of these available nodes.

If one or more user-defined attributes have been defined for application resources, then you can specify values for these attributes when relocating an application with the `crs_relocate` command. The specified value is passed to the action program as an environment variable with the attribute name.

The actions that Oracle Clusterware takes while relocating an application resource are echoed on the command line. You can also monitor them using the Event Manager (EVM). Standard error and standard output from a resource action program that is started by the `crs_relocate` command are redirected to the standard error and standard output for `crs_relocate`. Note that if the Oracle Clusterware daemon starts an application, then standard error and standard output of the action program is lost. Within an action program, you can check for user invocation of the action program using reason codes.

Syntax and Options for crs_relocate

Use the `crs_relocate` command with the following syntax:

```
crs_relocate resource_name [...] [-c cluster_node] [-f] [-q]

crs_relocate resource_name [-c cluster_node] [-q]

crs_relocate [USR_attribute_name=value] [...] resource_name [-c cluster_node] [-q]

crs_relocate -s source_node [-c cluster_node] [-q]
```

Table B–6 crs_relocate Options

Option	Description
`-ls`	Lists resources, owners, and permissions for all resources.
`-ls` *resource_name*	Lists resources, owners, and permissions for a specified resource.
`-t`	Lists information for all resources in a tabular form.
`-v`	Lists how many times a resource has been restarted or has failed within the resource failure interval; the maximum number of times that a resource can be restarted or can fail; and the target state of the application. Also lists normal status information.

Example of crs_relocate

The following example relocates an application resource to the node known as `rac1`:

```
crs_relocate postman -c rac1
Attempting to stop `postman` on node `rac2`
Stop of `postman` on node `rac1` succeeded
Attempting to start `postman` on node `rac1`
Start of `postman` on node `rac1` succeeded
```

The following example attempts to relocate all application resources from node `rac2` to node `rac1`:

```
crs_relocate -s rac2 -c rac1
Attempting to stop `postman` on node `rac2`
Stop of `postman` on node `rac2` succeeded.
Attempting to start `postman` on node `rac1`
```

```
Start of `postman` on node `rac1` succeeded.
Attempting to stop `calc` on node `rac2`
Stop of `calc` on node `rac2` succeeded.
Attempting to start `calc` on node `rac1`
Start of `calc` on node `rac1` succeeded.
```

If a user-defined attribute `USR_DEBUG` has been defined, then the following example runs the stop and start entry point of the action program with the `USR_DEBUG` environment variable set to `FALSE`. This overrides any value set in the application profile. In the corresponding action program, if you add the following line to the appropriate section of the action program, then you can view the value:

```
echo $USR_DEBUG
```

Then run the following command:

```
# crs_relocate USR_DEBUG=false database
```

Errors for crs_relocate

Oracle displays a corresponding text message for the following error conditions:

- No root privilege
- Application is not running
- Cluster node intended for relocation is not available
- Relocation failed

crs_setperm

Modifies the permissions associated with a resource. This command is similar to the `chmod` command in UNIX-based systems or the Windows desktop options, in this order: File, Properties, Security, and Permissions.

Syntax and Options for crs_setperm

Use the `crs_setperm` command with the following syntax:

```
crs_setperm resource_name -u aclstring [-q]
crs_setperm resource_name -x aclstring [-q]
crs_setperm resource_name -o user_name [-q]
crs_setperm resource_name -g group_name [-q]
```

In the previous example syntax, `-u` updates the acl string, `-x` deletes the acl string, `-o` changes the owner of the resource, and `-g` changes the primary group of the resource, and *`aclstring`* is one of the following:

```
user:username:rwx
group:groupname:r-x
other::r--
```

Example of crs_setperm

The following example modifies the permissions on the `admin1` user for the `postman` application:

```
crs_setperm postman -u user:admin1:r-x
```

crs_stat

The crs_stat command provides status information for resources on the cluster nodes. To query resources with the crs_stat command, resource files must have read and execute permissions (r and x permissions on UNIX-based systems). An exception is the -g option, that anyone can use to verify whether a resource exists.

Resources are either ONLINE or OFFLINE as shown in the STATE attribute. An application resource in the ONLINE state is running successfully on a cluster node. This cluster node is shown indicating its state.

The TARGET value shows the state to which Oracle Clusterware attempts to set the resource. If the TARGET value is ONLINE and a cluster node fails, then Oracle Clusterware attempts to restart the application on another node if possible. If there is a condition forcing a resource STATE to be OFFLINE, such as a required resource that is OFFLINE, then the TARGET value remains ONLINE and Oracle Clusterware attempts to start the application or application resource once the condition is corrected.

A TARGET value for all non-application resources should be ONLINE unless the resource has a failure count higher than the failure threshold, in which case the TARGET is changed to OFFLINE. The Oracle Clusterware then treats the resource as if its STATE were OFFLINE. If the STATE is ONLINE and the TARGET is OFFLINE, then you can reset the target value to ONLINE using the crs_start command.

The verbose status -v gives additional information that may be useful, especially for troubleshooting. The RESTART_COUNT value shows how many times an application resource has been restarted on a single cluster node. The maximum number of restarts before Oracle Clusterware stops restarting the application is equal to RESTART_ATTEMPTS. FAILURE_COUNT shows the number of times that a resource has failed within the FAILURE_INTERVAL defined in the application profile. The maximum number of failures before Oracle Clusterware stops restarting an application is equal to the value set for the FAILURE_THRESHOLD parameter. If a cluster node fails and applications are waiting to be relocated due to the profile FAILOVER_DELAY attribute, then the verbose status also shows the FAILOVER_STATUS field. The FAILOVER_STATUS field is not shown at any other time. The FAILOVER_STATUS field shows the node the application failed on and how much time is left waiting for that node to restart before restarting on another node.

Syntax and Options for crs_stat

Use the crs_stat command with the following syntax:

```
crs_stat [resource_name [...]] [-v] [-l] [-q] [-c cluster_node]

crs_stat [resource_name [...]] -t [-v] [-q] [-c cluster_node]

crs_stat -p [resource_name [...]] [-q]

crs_stat [-a] resource_name -g

crs_stat [-a] resource_name -r [-c cluster_node]

crs_stat -f [resource_name [...]] [-q] [-c cluster_node]

crs_stat -ls resource_name
```

To view information about all resources, enter the command with no arguments.

- -v: Displays extended information about the status of resources. Extra attributes shown include RESTART_COUNT and FAILURE_COUNT. The RESTART_COUNT

attribute shows the number of restarts of the application that have been attempted since it was started. The FAILURE_COUNT attribute shows how many failures have occurred during the last FAILURE_THRESHOLD in seconds. The attribute FAILOVER_STATUS shows the time at which an application resource started while waiting to relocate due to a cluster node failure if the resource has a FAILOVER_DELAY value greater than 0. It is not displayed otherwise.

- -l: Displays the status in a list (non-tabular) format. This is the default format.
- -t: Displays the status in tabular format.
- -p *resource_name* [...]]: Displays the status of the in-memory profile for the specified resources. If no resources are specified, then the status of the in-memory profile for all registered resources is displayed. If a resource is not registered, its status is not displayed.
- -a *resource_name*: Used with the -g or -r option to verify whether the specified resource is registered or running under Oracle Clusterware. Specify the name of the resource as listed in its application profile.
- -f: Displays all information about the resource including extended information (-v) and the in-memory profile (-p).
- -g: Returns 0 (zero) if the specified application or application resource is registered with Oracle Clusterware; returns 1 if it is not. This option only works if a single resource is specified with the -a option.
- -r: Returns 0 (zero) if the specified application or application resource is running under Oracle Clusterware; returns 1 if it is not. This option can only be successful if a single resource is specified with the -a option.
- -c *cluster_node*: Displays information about applications or application resources on the specified cluster node.

Examples of crs_stat

The following example displays the status information for the postman application:

```
crs_stat postman

NAME=postman
TYPE=application
TARGET=ONLINE
STATE=ONLINE on rac2
```

The following example displays the status information in a tabular form:

```
crs_stat -t

Name         Type        Target      State     Host
------------------------------------------------------------
cluster_lockd application ONLINE    ONLINE     rac2
dhcp          application OFFLINE   OFFLINE
```

The following example shows the output for the command crs_stat with the -v option for the node rac2:

```
crs_stat -v

NAME=cluster_lockd
TYPE=application
RESTART_ATTEMPTS=30
RESTART_COUNT=0
```

```
FAILURE_THRESHOLD=0
FAILURE_COUNT=0
TARGET=ONLINE
STATE=ONLINE on rac2
```

crs_start

The `crs_start` command sets an application or application resource target state to `ONLINE` and attempts to start specified registered applications or application resources. The target state is the state that Oracle Clusterware attempts to achieve. You must have full administrative privileges to use this command.

There are several user-defined attributes available for starting an application with `crs_start`. The specified value is passed to the action program as an environment variable with the attribute name.

If you do not specify one node on which to start the application and there are available cluster nodes that satisfy the placement criteria, then Oracle Clusterware attempts to start the application on one of the available nodes. You must stop a resource that has failed before restarting it. You should also confirm why your action program is failing.

The `crs_start` command starts dependent resources as defined in the application profile `REQUIRED_RESOURCE` fields. After a registered resource is started, you must use the `crs_stop` command to end its execution.

The `crs_start` command displays status messages and if there are problems starting an application, then feedback is displayed. If network, tape, or media changer resources are defined as required resources for an application or as an application resource that is started, then messages stating that Oracle Clusterware is attempting to start these non-application resources appear. The Oracle Clusterware is not actually attempting to start these resources, but is testing the state of the devices. You can ignore these messages.

Standard error and standard output from a resource action program invoked by `crs_start` are redirected to the standard error and standard output for `crs_start`. Note that if the Oracle Clusterware daemon starts an application, then standard error and standard output of the action program is lost. Within an action program, you can check for user invocation of the action program using reason codes.

Syntax and Options for crs_start

```
crs_start resource_name  [...] [-c cluster_node] [-q] [-f]

crs_start -all [-q]

crs_start [USR_attribute_name=value] [...] resource_name [-c node_name] [-q]
```

For *resource_name* [...], the names are as specified in an application profile of one or more resources to be started. The resource must be registered with Oracle Clusterware. You can use the following options:

- `-c` *node_name*: Starts each indicated resource on the specified node if the cluster node is enabled by the placement policy and resource dependencies. If the cluster node specified is not enabled by the placement policy and resource dependencies, then the `crs_start` command fails. If the specified node is not available, the command fails. If one of the specified resources fails to start, then the command still attempts to start other resources listed on the command line.

- `-all`: Starts all registered Oracle Clusterware applications or application resources on active cluster nodes, according to their placement policies and required resource lists.
- `-q`: Runs the `crs_start` command in quiet mode; no messages are displayed.
- `-f`: Forces starting of a specified application or application resource if all of the required resources are available or can be started. Any applications or application resources in the specified application profile's required resource list are started if not currently running or are relocated if they are running on another cluster node. Use this option with only one specified application resource at a time.

Examples of crs_start

The following example starts an application named `postman`:

```
crs_start postman
Attempting to start `postman` on node `rac1`
Start of `postman` on node `rac1` succeeded.
```

The following example starts the application on a specific cluster node `rac2`:

```
crs_start -c rac2 postman
Attempting to start `postman` on node `rac2`
Start of `postman` on node `rac2` succeeded.
```

Errors for crs_start

A failure has occurred. Oracle displays a corresponding text message for the following error conditions:

- No root privilege
- The Oracle Clusterware daemon is not running
- The application is running
- A start action program is not found
- The cluster node was specified and it was not available
- A timeout was reached before the startup was unsuccessful

crs_stop

Stops an application on the specified node. You can run the `crs_stat` command to verify that the application you specify is stopped.

Syntax and Options for crs_stop

Use the `crs_stop` command with the following syntax:

```
crs_stop resource_name [...] [-f] [-q]

crs_stop -c cluster_node [...] [-q]

crs_stop -all [-q]

crs_stop [USR_attribute_name=value] [...] resource_name [-q]

-c cluster_node [...]
```

Specifies one or more active cluster nodes on which to stop all of the applications or application resources. You can use the following options:

- `-all`: Stops all applications or application resources on all active cluster nodes.
- `-f`: Forces termination of the indicated applications or application resources and all application resources dependent on the specified resources. This option is useful to stop all application resources when the `crs_stop` command fails because of application resources that are dependent on the specified resource or if the application is in the `UNKNOWN` state because of an unsuccessful stop. This option makes `crs_stop` ignore any errors that are reported by an action program.

Examples of crs_stop

To stop an application named `dtcalc`, enter the following command:

```
crs_stop dtcalc
```

The Oracle Clusterware displays status messages as follows:

```
Attempting to stop `dtcalc` on node `rac2`
Stop of `dtcalc` on node `rac2` succeeded.
```

crs_unregister

The `crs_unregister` command removes the registration information of Oracle Clusterware resources from the binary Oracle Clusterware registry database. The Oracle Clusterware will no longer acknowledge this resource. An application associated with a resource that is unregistered is no longer highly available. You must have full administrative privileges to use this command.

Upon successful completion of the `crs_unregister` command, the resource is removed from the online Oracle Clusterware environment. You cannot unregister a resource that is a required resource for another resource. You must stop the resource by using the `crs_stop` command before unregistering it.

Syntax and Options for crs_unregister

Use the `crs_unregister` command with the following syntax:

```
crs_unregister resource_name [...] [-q]
```

The only option available for this command is `-q`, that runs the `crs_unregister` command in quiet mode, which means no messages are displayed.

Example of crs_unregister

The following example unregisters a highly available application called `postman`:

```
crs_unregister postman
```

Errors for crs_unregister

Oracle displays a corresponding text message for the following error conditions:

- No root privilege
- CAA daemon is not running
- The application is running
- The application is not registered

> **See Also:** Chapter 14, "Making Applications Highly Available Using Oracle Clusterware" for information about using the Oracle Clusterware commands

C Application Programming Interface to Oracle Clusterware

The APIs described in this section provide access to operational control of resources that Oracle Clusterware manages. The API is used to register user applications to the Oracle Clusterware system so that they can be managed by Oracle Clusterware and made highly available. When an application is registered, the application can be started and its state queried. If the application is no longer to be run, it can be stopped and unregistered from Oracle Clusterware. The Oracle Clusterware services are provided by another process, such as the `crsd` process, running outside the database server. These APIs communicate with the `crsd` process using an IPC mechanism.

clscrs_init_crs

Initializes a context for communications with Oracle Clusterware.

Parameters

- `ctx`: Context to initialize, caller allocated storage
- `errf`: A Callback function for the error info, or `NULL`
- `errCtx`: Context for the error callback func, or `NULL`
- `flags`: `CLSCRS_FLAG_TRACE`, to enable tracing of lower layers
- `CLSCRS_FLAG_USETHREADS`: Enables using the `clscrs` context in multiple threads

Returns

Status `enum`.

Syntax

```
CLSCRS_STAT clscrs_init_crs(clscrs_ctx **ctx, clscrs_msgf errf, void *errCtx, ub4
flags);
```

clscrs_term_crs

Releases a context for communications with Oracle Clusterware.

Parameter

`ctx`: Context previously initialized with `clscrs_init_crs`.

Returns

status `enum`

Syntax

```
CLSCRS_STAT clscrs_term_crs( clscrs_ctx **ctx);
```

clscrs_getnodename

Returns the correct node name. If you issue this command within a configured cluster, then this is the name as known to the clusterware. If not in a cluster, then the name is as known through other clusterware means. Getting a node name may require a lot of

resources in the first call, especially if CLSCRS was not initialized with a pre-existing CSS context.

Parameters

- ctx: Context previously initialized with clscrs_init
- node_name: Filled in node name

Syntax

```
CLSCRS_STAT clscrs_getnodename(clscrs_ctx *ctx, oratext *node_name);
```

clscrs_env_create

Creates a call environment describing the parameters to the Oracle Clusterware calls. The memory is owned by clscrs which is released by a call to clscrs_env_delete.

Parameters

- context: Input context
- env: Output environment pointer

Returns

status enum

Syntax

```
CLSCRS_STAT clscrs_env_create( clscrs_ctx *ctx, clscrs_env *env );
```

clscrs_env_set

Sets an attribute or value argument in an environment for the Oracle Clusterware calls; the value may be NULL.

Parameters

- env: Previously created environment
- attr: Attribute name
- val: Attribute value, may be NULL pointer

Returns

environment status enum

Syntax

```
CLSCRS_ENVCODE clscrs_env_set(clscrs_env env, const  oratext *attr, const oratext
*val);
```

clscrs_env_delete

Deletes an environment for the Oracle Clusterware calls. The environment must be created again before use. You cannot delete an environment and then set new parameters.

Parameters

- `env`: The environment whose contents are deleted

Returns

environment status `enum`.

Syntax

```
CLSCRS_ENVCODE clscrs_env_delete(clscrs_env env);
```

clscrs_env_format

Creates a callback with formatted environment lines.

Parameters

- `env`: Env to dump
- `msgf`: Callback function
- `msgp`: Argument to msgp, uninterpreted

Returns

None.

Syntax

```
void clscrs_env_format( clscrs_env env, clscrs_msgf msgf, void *msgp );
```

clscrs_start_resource

Direct Oracle Clusterware to start a named set of resources. If a host is specified, then start there, otherwise start according to the placement policy for the resources in question. If the flag is `async`, then `msgf` is never called and Oracle returns the `OK` status after initiating the call to Oracle Clusterware, and the actual starts are performed asynchronously, and `msgf` will never be called. If flag is not `async` and `msgf` is not `NULL`, then `msgf` will be driven one line at a time with collected output from the start programs.

Parameters

- `ctx`: The context
- `names`: The resource(s) to start
- `num_names`: The number of resources in names to start
- `host`: The host name on which to start the resource, may be `NULL`
- `env`: Environment arguments to start
- `msgf`: User message callback, may be `NULL`

- msgp: User callback argument, may be NULL
- msgf: Callback function
- msgf: Callback function

Returns

status enum

Syntax

```
CLSCRS_STAT clscrs_start_resource( clscrs_ctx *ctx, const oratext *name[], sword
num_names, const oratext *host, clscrs_env env, clscrs_msgf msgf, void *msgp,
uword flag );
```

clscrs_stop_resource

Direct Oracle Clusterware to stop a named set of resources. The flag enables async stop.

Parameters

- ctx: the context
- names: The resource(s) to stop
- num_names: Number of resources in names[] to stop
- flag: Async, force options

Returns

status enum

Syntax

```
clscrs_stop_resource( clscrs_ctx *ctx, const oratext *names[], sword num_names,
clscrs_env env, clscrs_msgf msgf, void *msgarg, uword flag );
```

clscrs_check_resource

Direct Oracle Clusterware to run the check actions for the identified resources. A delay can be specified to indicate a time to wait in seconds before the check action is performed on the server. This occurs after the call returns. This can be used to let something run before performing the check. For each resource identified by the in_splist, a status will be returned in the op_status, indicating whether the resource exists and whether the caller has permission to invoke operations on the resource. A resource that is explicitly named with no pattern matching will have a NOTFOUND error. A pattern that has no matches will return no error. There will be no valid attributes returned for the resources. There is no way of knowing exactly when the checks will actually be run or be completed. Returns SUCCESS if the operation status of all of the identified resources is SUCCESS, otherwise FAILURE and specific status will be found in the op_status entries. The caller must create the op_status list before the call and destroy it when done.

Parameters

- in_splist [in]: List of resources to check

- `delay_secs [in]`: Time to wait before the check is run, as appropriate to the resource
- `flags [in]`: None
- `op_status [out]`: Resource list structure holding the status of the check operation for each resource

Returns

status `enum`.

Syntax

```
clscrs_check_resource( clscrs_splist *in_splist, ub4 delay_seconds, uword flags,
clscrs_reslist *op_status);
```

clscrs_register_resource

Register the resources in the input resource list. The attributes for the resources are encapsulated in the input resource list. The output `op_status` list contains the results of the register operation for each resource and contains no valid resource attributes.

The caller must create and populate the `in_reslist` and must create the `op_status` list. Both the lists must be destroyed by the caller. The `op_status` list cannot be reused with another API call, you must create and destroy it for each API call.

One or more attributes of an already registered resource can be modified by passing the `CLSCRS_FLAG_REG_UPDATE` flag. The flags apply to all resources in the input reslist.

Parameters

- `in_reslist [in]`: List of resources to be registered
- `flags [in]`: `CLSCRS_FLAG_REG_UPDATE` or 0
- `op_status [out]`: Resource list holding the status of the register operation for each resource

Returns

- `CLSCRS_STAT_SUCCESS`: If all input resources are successfully registered
- `CLSCRS_STAT_FAIL`: If atleast one resource could not be registered
- `CLSCRS_STAT_CONNECTION`: If there is a communication error with the crsd process

Syntax

```
clscrs_register_resource(clscrs_reslist *in_reslist, uword flags, clscrs_reslist
*op_status);
```

clscrs_unregister_resource

Unregister the resources in the input list of resource names. The output `op_status` list contains the results of the unregister operation for each resource. The caller must create and populate the `rqlist` and must create the `op_status` list. Both the lists

must be destroyed by the caller. The op_status list cannot be reused with another API call. You must create and destroy it for each API call.

Parameters

- rqlist [in]: List of resources names to be unregistered
- flags [in]: Option flags
- op_status [out]: Resource list holding the status of the unregister operation for each resource

Returns

- CLSCRS_STAT_SUCCESS: If all input resources are successfully unregistered
- CLSCRS_STAT_FAIL: If atleast one resource could not be unregistered
- CLSCRS_STAT_CONNECTION: If there is a communication error with the crsd process

Syntax

```
clscrs_unregister_resource(clscrs_splist *rqlist, uword flags, clscrs_reslist *op_
status);
```

clscrs_stat

Obtains information about the resources identified in rqlist. The resources can be restricted to a specific node given in the nodename parameter. The information is returned in the output out_reslist.

If the rqlist is NULL, information about all registered resources is returned. If the node name is not NULL, the result is restricted to resources running on the specific node. Otherwise, all nodes in the cluster are considered.

The res_flags are used to scope the resource domain that is matched. There are no values for this parameter. The res_attrs identifies the attributes to be returned in the out_reslist. The caller may create a specific list of attributes of interest or use a pre-defined list returned by one of the macros CLSCRS_ATTRS_NONE, CLSCRS_ATTRS_ALL, CLSCRS_ATTRS_STATE, CLSCRS_ATTRS_SHORT. The attribute list applies to all resources identified by the rqlist. Any errors for a resource are returned in the output out_reslist.

Parameters

- rqlist [in]: List of resource names to query
- nodename [in]: Query resources running only on the given node (optional, may be NULL)
- res_attrs [in]: List to specify the attributes to be returned for each resource
- res_flags [in]: Flags to restrict the resources being matched
- out_reslist [out]: List holding the returned resource information

Returns

- CLSCRS_STAT_SUCCESS if information is obtained for all input resources
- CLSCRS_STAT_FAIL if no information is available for atleast one resource

- CLSCRS_STAT_CONNECTION if there is an error communicating with the crsd process

Syntax

```
clscrs_stat(clscrs_splist *rqlist, oratext *nodename, uword res_flags, clscrs_
splist *res_attrs, clscrs_reslist *out_reslist);
```

Functions for Managing Resource Structures

This section describes functions for creating, managing, and destroying resources and the attributes associated with resources. The following structures are used in this section:

- clscrs_sp: This is a stringpair (sp) structure. It contains a name and a value string. The value may be NULL. It is created and destroyed and its contents can be examined and the value replaced. An sp may be a member of exactly one stringpair list (splist).
- clscrs_splist: A stringpair list (splist) is a list of zero or more stringpairs used in various contexts. Sometimes the list contains names and values, sometimes the list contains only names. The list is created and destroyed; members can be retrieved by name, added, deleted, replaced, and the list can be traversed with first and next operations.
- clscrs_res: This represents a resource abstraction that contains the name of a resource and additional data about the context in which it is used. Sometimes it contains resource attribute data and other times it contains status and return message about an operation. A resource may be in exactly one resource list.
- clscrs_reslist: A resource list is an abstraction used to contain information about zero or more resources. A resource list is created, appended, iterated over, and destroyed.

Export Operations

This section describes the following export operations:

- Stringpair Operations
- Splist Operations
- Resource Operations
- Resource List Operations

Stringpair Operations

This section describes stringpair operations.

clscrs_sp_set Change the value part of a stringpair. The new value may be NULL. After the call returns, the memory of the value can be recycled.

Parameters

- sp [in]: Stringpair to set the value for
- value [in]: Value component of the stringpair (may be NULL)

Returns

- clscrsretSUCC on success

- clscrsretBADARG if the sp argument is NULL

Syntax

```
clscrsret clscrs_sp_set(clscrs_sp *sp, const oratext *value);
```

clscrs_sp_get Get the name and value components of a stringpair.

Parameters

- sp [in]: Stringpair for which the name and value are being obtained
- name [out]: Name component of the stringpair
- value [out]: Value component of the stringpair (may be NULL)

Returns

- clscrsretSUCC on success
- clscrsretNOMEM if no memory can be allocated
- clscrsretBADARG if the sp argument is NULL

Syntax

```
clscrsret clscrs_sp_get(clscrs_sp *sp, oratext **name, oratext **value);
```

clscrs_sp_get_value Get the value component of a stringpair.

Parameters

- sp [in]: Stringpair for which the name and value are being obtained
- value [out]: Value component of the stringpair (may be NULL)

Returns

- clscrsretSUCC on success
- clscrsretBADARG if the sp argument is NULL

Syntax

```
clscrsret clscrs_sp_get_value(clscrs_sp *sp, oratext **value);
```

Splist Operations

This section describes the splist operations.

clscrs_splist_create Create a new stringpair list. The memory for the splist is allocated by the function.

Parameters

- ctx [in]: clscrs context
- splist [out]: The new stringpair list created

Returns

- clscrsretSUCC on success
- clscrsretNOMEM if no memory can be allocated
- clscrsretBADCTX if the context is NULL

Syntax

```
clscrsret clscrs_splist_create(clscrs_ctx *ctx, clscrs_splist **splist);
```

clscrs_splist_create_and_set Create a new stringpair list (`splist`) and set the name and value for the first stringpair in the list. The memory for the `splist` is allocated by the function.

Parameters

- `ctx [in]`: clscrs context
- `name [in]`: Name component of the stringpair
- `value [in]`: Value component of the stringpair (may be `NULL`)
- `sp [out]`: The new stringpair created

Returns

- `clscrsretSUCC` on success
- `clscrsretNOMEM` if no memory can be allocated
- `clscrsretBADCTX` if the context is `NULL`
- `clscrsretBADARG` if the name argument is `NULL`

Syntax

```
clscrsret clscrs_splist_create_and_set(clscrs_ctx *ctx, const oratext *name, const
oratext *value, clscrs_splist **splist);
```

clscrs_splist_append Add a new stringpair (`sp`) to a stringpair list (`splist`).

Parameters

- `splist [in]`: `splist` to add the new `{name, value}` stringpair.
- `name [in]`: Name component of the stringpair
- `value [in]`: Value component of the stringpair (may be `NULL`)

Returns

- `clscrsretSUCC` on success
- `clscrsretNOMEM` if no memory can be allocated
- `clscrsretBADARG` if the name argument is `NULL`

Syntax

```
clscrsret clscrs_splist_append(clscrs_splist *splist, const oratext *name, const
oratext *value);
```

clscrs_splist_first Get the first stringpair (`sp`) from a stringpair list (`splist`).

Parameters

- `name [in]`: `splist` to get the first `sp` from
- `sp [out]`: The first `sp` from the given `splist`

Returns

- `clscrsretSUCC` on success

- clscrsretBADARG if the splist is NULL
- clscrsretEMPTY if there are no stringpair elements in the splist

Syntax

```
clscrsret clscrs_splist_first(clscrs_splist *splist, clscrs_sp **sp);
```

clscrs_splist_next Get the current next stringpair (sp) from a stringpair list (splist). This function is called to iterate over the stringpairs in a splist.

Parameters

- name [in]: splist to get the next sp from
- sp [out]: The next sp {name, value} in the given splist

Returns

- clscrsretSUCC on success
- clscrsretBADARG if the splist is NULL
- clscrsretENDLIST if there are no more stringpair elements in the splist

Syntax

```
clscrsret clscrs_splist_next(clscrs_splist *splist, clscrs_sp **sp);
```

clscrs_splist_replace Replace the value for a stringpair (sp) in a stringpair list (splist).

Parameters

- splist [in]: Splist to add the new {name, value} stringpair.
- name [in]: Name for which the value is being replaced.
- value [in]: Replacement value for the name (may be NULL)

Returns

- clscrsretSUCC on successclscrsretBADARG if the name argument is NULL
- clscrsretBADARG if the name argument is NULL
- clscrsretBADARG if the name argument is NULL

Syntax

```
clscrsret clscrs_splist_replace(clscrs_splist *splist, const oratext *name, const
oratext *value);
```

clscrs_splist_delete_sp Delete a stringpair (sp) from a stringpair list (splist).

Parameters

- splist [in]: Splist from which to delete the {name, value} stringpair.
- splist [in]: Name to be deleted from the given splist.

Returns

- clscrsretSUCC on success
- clscrsretNONAME if there is no stringpair matching the given name
- clscrsretBADARG if the name argument is NULL

Syntax

```
clscrsret clscrs_splist_delete_sp(clscrs_splist *splist, const oratext *name);
```

clscrs_splist_find Find the value for a stringpair (`sp`) in a stringpair list (`splist`).

Parameters

- `splist [in]`: `Splist` to look into
- `name [in]`: Name for which the value is looked up
- `value [out]`: Value associated with the given name in the given `splist`

Returns

- `clscrsretSUCC` on success
- `clscrsretNONAME` if there is no stringpair matching the given name
- `clscrsretBADARG` if the name argument is `NULL`

Syntax

```
clscrsret clscrs_splist_find(clscrs_splist *splist, const oratext *name, oratext
**value);
```

clscrs_splist_count Count the number of stringpairs (`sp`) in a stringpair list (`splist`).

Parameters

- `splist [in]`: `Splist` to count the number of stringpairs.
- `count [out]`: The number of stringpairs in the given `splist`.

Returns

- `clscrsretSUCC` on success
- `clscrsretBADARG` if the splist is `NULL`

Syntax

```
clscrsret clscrs_splist_count(clscrs_splist *splist, ub4 *count);
```

clscrs_splist_destroy Free the memory for a stringpair list (`splist`).

Parameter

- `splist [in]`: `Splist` to destroy

Returns

- `clscrsretSUCC` on success

Syntax

```
clscrsret clscrs_splist_destroy(clscrs_splist **splist);
```

clscrs_res_create Create a new resource. The memory for the resource structure is allocated by the function. The memory is freed when a resource list (`clscrs_reslist`) is destroyed through `clscrs_reslist_destroy()`.

Parameters

- ctx [in]: clscrs context
- resname [in]: Name of the resource
- res [out]: The new resource created

Returns

- clscrsretSUCC on success
- clscrsretNOMEM if no memory can be allocated
- clscrsretBADCTX if the context is NULL
- clscrsretBADARG if the resource name is NULL

Syntax

```
clscrsret clscrs_res_create(clscrs_ctx *ctx, const oratext *resname, clscrs_res
**res);
```

clscrs_res_get_name Get the name of a resource.

Parameters

- res [in]: Resource for which the name is obtained
- name [out]: Name of the resource

Returns

- clscrsretSUCC on success
- clscrsretBADARG if the resource argument is NULL

Syntax

```
clscrsret clscrs_res_get_name(clscrs_res *res, oratext **name);
```

clscrs_res_set_attr Set a resource attribute for a resource.

Paramters

- res [in]: Resource for which the attribute is set
- attrname [in]: Name of the resource attribute
- value [in]: Value for the resource attribute (may be NULL)

Returns

- clscrsretSUCC on success
- clscrsretBADARG if the attribute name is NULL
- clscrsretNOMEM if no memory can be allocated

Syntax

```
clscrsret clscrs_res_set_attr(clscrs_res *res, const oratext *attrname, const
oratext *value);
```

clscrs_res_get_attr Get a resource attribute for a resource.

Parameters

- res [in]: Resource for which the attribute is obtained

- attrname [in]: Name of the resource attribute
- value [out]: Value for the resource attribute

Returns

- clscrsretSUCC on success
- clscrsretBADARG if the attribute name is NULL
- clscrsretNOMEM if no memory can be allocated

Syntax

```
clscrsret clscrs_res_get_attr(clscrs_res *res, const oratext *attrname, oratext
**value);
```

clscrs_res_get_attr_list Get the attribute list for a resource. The attribute list is a list of stringpairs. The client does not allocate the memory for attribute list.

Paramters

- res [in]: Resource for which the attribute list
- attrlist [out]: List of attributes for the given resource

Returns

- clscrsretSUCC on success
- clscrsretBADARG if the resource is NULL
- clscrsretNOMEM if no memory can be allocated
- clscrsretNOATTRS if there are no attributes set for the resource

Syntax

```
clscrsret clscrs_res_get_attr_list(clscrs_res *res, clscrs_splist **attrlist);
```

clscrs_res_set_attr_list Set the attribute list for a resource. The attribute list is a list of stringpairs. The list is created from the clscrs_splist_create call.

Parameters

- res [in]: Resource for which the attribute list is set
- attrlist [in]: List of attributes to be set for the given resource

Returns

- clscrsretSUCC on success
- clscrsretBADARG if the resource is NULL

Syntax

```
clscrsret clscrs_res_set_attr_list(clscrs_res *res, clscrs_splist *attrlist);
```

clscrs_res_attr_count Get the number of attributes for a resource.

Parameters

- res [in]: Resource for which number of attributes is obtained
- count [out]: Number of attributes for the given resource

Returns

- clscrsretSUCC on success
- clscrsretBADARG if the resource is NULL

Syntax

```
clscrsret clscrs_res_attr_count(clscrs_res *res, ub4 *count);
```

clscrs_res_get_op_status Get the status of an operation for a resource. The memory for the msg is allocated by the function.

Parameters

- res [in]: Resource for which the operation status is obtained
- status [out]: Status of an operation on the given resource
- msg [out]: Text message for the result of an operation on the resource

Returns

- clscrsretSUCC on success
- clscrsretNOMEM if no memory can be allocated
- clscrsretNOMSG if there is no msg available
- clscrsretBADARG if the resource is NULL

Syntax

```
clscrsret clscrs_res_get_op_status(clscrs_res *res, CLSCRS_STAT *status, oratext
**msg);
```

clscrs_res_get_registered Get the registration status of a resource.

Parameters

- res [in]: Resource for which the operation status is set
- registered [out]: Boolean indicating whether the resource is registered

Returns

- clscrsretSUCC on success
- clscrsretNOMEM if no memory can be allocated
- clscrsretBADARG if the resource is NULL

Syntax

```
clscrsret clscrs_res_get_registered(clscrs_res *res, boolean *registered);
```

clscrs_res_get_node_list Get the nodelist currently hosting the resource, or NULL if there is no host for the resource or there are no attributes. The caller need not allocate memory for the nodelist.

Parameters

- res [in]: Resource for which the nodelist is obtained
- nodelist [out]: Splist holding the node(s)

Returns

- clscrsretSUCC on success
- clscrsretBADARG if the resource is NULL

Syntax

```
clscrsret clscrs_res_get_node_list(clscrs_res *res, clscrs_splist **nodelist);
```

clscrs_res_destroy Free the memory for a resource.

Parameter

- res [in]: Resource for which the memory is freed

Returns

- clscrsretSUCC on success

Syntax

```
clscrsret clscrs_res_destroy(clscrs_res **res);
```

clscrs_reslist_create Create a new resource list. The memory for the resource list is allocated by the function.

Parameters

- ctx [in]: clscrs context
- reslist [out]: Resource list (empty) that is created

Returns

- clscrsretSUCC on success
- clscrsretNOMEM if no memory can be allocated
- clscrsretBADCTX if the context is NULL

Syntax

```
clscrsret clscrs_reslist_create(clscrs_ctx *ctx, clscrs_reslist **reslist);
```

clscrs_reslist_append Add a resource to a resource list.

Parameters

- reslist [in]: Resource list to add the resource to
- res [in]: Resource to add

Returns

- clscrsretSUCC on success
- clscrsretBADARG if reslist is NULL
- clscrsretRESEXISTS if the resource already exists in reslist

Syntax

```
clscrsret clscrs_reslist_append(clscrs_reslist *reslist, clscrs_res *res);
```

clscrs_reslist_first Get the first resource on a resource list.

Parameters

- `reslist [in]`: Resource list for which the first resource is obtained
- res [out]: The first resouce on the resource list

Returns

- `clscrsretSUCC` on success.
- `clscrsretBADARG` if reslist is `NULL`
- `clscrsretEMPTY` if there are no resources in the list

Syntax

```
clscrsret clscrs_reslist_first(clscrs_reslist *reslist, clscrs_res **res);
```

clscrs_reslist_next Get the current next resource from the resource list. This function is called to iterate over the resources in a resource list.

Parameters

- `reslist [in]`: Resource list for which the first resource is obtained
- `res [out]`: The next resouce on the resource list

Returns

- `clscrsretSUCC` on success
- `clscrsretBADARG` if reslist is `NULL`
- `clscrsretENDLIST` if there are no more resources in the list

Syntax

```
clscrsret clscrs_reslist_next(clscrs_reslist *reslist, clscrs_res **res);
```

clscrs_reslist_find Find a resource in a resource list.

Parameters

- `reslist [in]`: Resource list (empty) that is created
- `name [in]`: Name of the resource that is being obtained
- `res [out]`: The resouce corresponding to the given name

Returns

- `clscrsretSUCC` on success
- `clscrsretNORES` if the resource is not found
- `clscrsretBADARG` if reslist or name is `NULL`

Syntax

```
clscrsret clscrs_reslist_find(clscrs_reslist *reslist, const oratext *name,
clscrs_res **res);
```

clscrs_reslist_count Count the number of resources in a resource list.

Parameters

- `reslist [in]`: Resource list for which the count is obtained
- `count [out]`: Number of resources in the resource list

Returns

- clscrsretSUCC on success
- clscrsretBADARG if reslist is NULL

Syntax

```
clscrsret clscrs_reslist_count(clscrs_reslist *reslist, ub4 *count);
```

clscrs_reslist_delete_res Delete a resource from a resource list.

Parameters

- reslist [in]: Resource list from which to delete the resource
- name [in]: Name of the resource to delete

Returns

- clscrsretSUCC on success
- clscrsretBADARG if reslist or name is NULL
- clscrsretNORES if the resource is not in reslist

Syntax

```
clscrsret clscrs_reslist_delete_res(clscrs_reslist *reslist,
```

const oratext *name);

clscrs_reslist_destroy Free the memory for a resource list.

Parameters

- reslist [in]: Resource list for which the memory is to be freed

Returns

- clscrsretSUCC on success

Syntax

```
clscrsret clscrs_reslist_destroy(clscrs_reslist **reslist);
```

clscrs_get_error_message Retrieve the error message corresponding to the return codes from a clscrs API. The memory for the error message is allocated by the caller. If the buffer is not large enough, the length is returned in msg_len.

Parameters

- ctx [in]: clscrs context
- err_code [in]: Error code returned from the clscrs API
- msg [out]: Message corresponding to err_code
- msg_len [inout]: Length of the message buffer.

Returns

- clscrsretSUCC on success

Syntax

```
clscrsret clscrs_get_error_message(clscrs_ctx *ctx, clscrsret err_code, oratext
```

```
*msg, sb4 msg_len);
```

clscrs_get_fixed_attrlist

Get the list of attributes corresponding to an attribute group identifier.

Parameters

- `ctx [in]`: `clscrs` context
- `attrgrp [in]`: Attribute group that identifies a group of attributes
- `attrlist [out]`: List of attributes returned that corresponds to the attribute group

Returns

- `clscrsretSUCC` on success

Syntax

```
clscrs_splist* clscrs_get_fixed_attrlist(clscrs_ctx *ctx, clscrs_attr_grp
attrgrp);
```

Resource Operations

This section describes resource functions. The `clscrs_res` resource abstraction contains the name of a resource and additional data appropriate to the context in which it is used. Sometimes it carries status and error return information about an operations. Other times it contains attribute data as input to an operation. A resource may be in exactly one resource list. If so, its successor may be found with the `NEXT` operation.

CLSCRSRET clscrs_res_create(clscrs_cts *ctx, const oratext *resname, clscrs_res **res) Creates a single resource and fills in a handle to it. The `resname` must be provided, and cannot be `NULL`.

CLSCRSRET clscrs_res_get_name (clscrs_res *res, oratext **name); Returns a pointer to the name of a resource. The returned name pointer is only valid as long as the resource exists.

CLSCRSRET clscrs_res_get_op_status (clscrs_res *res, CLSCRS_STAT *stat, oratext **msg) If there is a valid operation error value in the resource, fill in the stat and the pointer to an error message and return `SUCCESS`. May fill in a `NULL` to the msg. If there is no valid operation status, returns `INVALID`.

clscrs_splist *clscrs_res_get_node_list(clscrs_res *res); Returns an `splist` holding the nodes currently hosting the resource, or `NULL` if there is no host for the resource or there are no attributes. The count of the list may obtained and the list iterated. The list is owned by the resource and will be destroyed when the resource is destroyed. This operation is a special case, interpreting the semantics of the attribute or attributes that may hold the current hosting member list. There is no specified ordering of the list.

CLSCRSRET clscrs_res_get_attr(clscrs_res *res, const oratext *attrname, oratext **value) ; Fills in a pointer to the value of the attribute with the given name and returns `SUCCESS` if found, or `FAILURE` if the name is not present in the attribute set of the resource, and `INVALID` if there is no attribute list in the resource. May assert if given an invalid resource handle.

CLSCRSRET clscrs_res_set_attr(clscrs_res *res, oratext *attrname, oratext *value) ; Sets the value of the attribute with the given name and returns `SUCCESS` or `FAILURE` if the name is not present in the attribute set of the resource. If the attribute already exists, then its current value will be replaced. On return, the memory for the name and value may be recycled.

CLSCRSRET clscrs_res_attr_count(clscrs_res *res, ub4 *count) Fill in the number of attributes that will be returned with a scan using an `attrIter`. Returns `SUCCESS` if there are attributes. If there are no attributes, returns `INVALID`, but still sets the count to zero.

CLSCRSRET clscrs_res_get_attr_list(clscrs_res *res, clscrs_splist **attrlist); Returns an `splist` for the attributes of the resource, allowing `next()` operations for a scan. The list is owned by the resource, which will destroy it when the resource is destroyed. Returns `SUCCESS` if there is an attribute list, or `INVALID` if there is not one in the resource. There is no specified ordering of the list.

Resource List Operations

This section describes the resource list operations. The `clscrs_reslist` resource list is an abstraction that contains information about zero or more resources. A list is created, appended, iterated over, and destroyed.

CLSCRSRET clscrs_reslist_create(clscrs_ctx *ctx, clscrs_reslist **reslist) Creates a resource list and fills a handle.

CLSCRSRET clscrs_reslist_count(clscrs_reslist *reslist, ub4 *count) Fills a count of the number of resources in a list.

CLSCRSRET clscrs_reslist_first(clscrs_reslist *reslist, clscrs_res **first) Fills a handle to the first resource in the list of resources. If the list is empty, fill in `NULL`.

CLSCRSRET clscrs_reslist_next(clscrs_reslist *reslist, clscrs_res **next) Fills a handle to the next resource in the list of resources. If the list is empty, fill in `NULL`.

CLSCRSRET clscrs_reslist_find(clscrs_reslist *reslist, const oratext *name, clscrs_res **res) Find a resource by name in a `reslist`, and fill in a handle to the one located. If the resource is not found, fill in `NULL`. Does an exact match lookup with no pattern matching.

clscrs_res *clscrs_reslist_destroy(clscrs_res *res) Delete a resource list and all of the resources that it currently contains.

C

Oracle Clusterware Messages

This appendix describes the Oracle Clusterware messages. The Oracle Clusterware commands and the Oracle Clusterware APIs are the primary sources of these error messages. The topic in this appendix is:

- CRS—Oracle Clusterware Messages

> **See Also:** *Oracle Database Platform Guide for Microsoft Windows (32-Bit)* for Windows-based messages and for all other messages refer search online at
>
> `http://tahiti.oracle.com`

CRS—Oracle Clusterware Messages

CRS-184: Cannot communicate with the CRS daemon.

Cause: The CRS daemon on the local node is either not running or there was an internal communication error with the CRS daemon.

Action: Check if the CRS daemon process is running on the local node.

CRS-210: Could not find resource '%s'.

Cause: An attempt was made to operate on a resource that is not registered.

Action: Check if the resource is registered using crs_stat.

CRS-211: Resource '%s' has already been registered.

Cause: An attempt was made to register a resource that is already registered.

Action: Check if the resource is registered using crs_stat.

CRS-213: Could not register resource '%s'.

Cause: There was an internal error while registering the resource.

Action: Check the CRS daemon log file.

CRS-214: Could not unregister resource '%s'.

Cause: There was an internal error while unregistering the resource.

Action: Check the CRS daemon log file.

CRS-215: Could not start resource '%s'.

Cause: There was an internal error while starting the resource.

Action: Check the CRS daemon log file.

CRS-216: Could not stop resource '%s'.

Cause: There was an internal error while stopping the resource.

Action: Check the CRS daemon log file.

CRS-217: Could not relocate resource '%s'.

Cause: There was an internal error while relocating the resource.

Action: Check the CRS daemon log file.

CRS-218: Could not restart the resource '%s' on the original node.

Cause: There was an internal error while restarting the resource.

Action: Check the CRS daemon log file.

CRS-219: Could not update resource '%s'.

Cause: There was an internal error while updating the resource.

Action: Check the CRS daemon log file.

CRS-220: Resource '%s' has invalid resource profile.

Cause: Invalid attributes in the resource profile.

Action: Run crs_profile -validate to identify the invalid attributes.

CRS-221: Resource '%s''s action script cannot be found.

Cause: The action script has been deleted from the file system.

Action: Run crs_stat -p to determine the action script location and to check for its existence.

CRS-223: Resource '%s' has placement error.

Cause: There was no host available to on which failover/start the resource based on the Placement Policy for the resource.

Action: Check the target host for the resource and restart the resource using the crs_start command.

CRS-230: Member '%s' is not in the cluster.

Cause: The hostname was not found in the cluster.

Action: Check the hostnames in the cluster.

CRS-232: Cluster member is down. Cannot perform operation.

Cause: The node on which CRS is attempting to start the resource is down.

Action: Start the node and retry the operation.

CRS-233: Resource or relatives are currently involved with another operation.

Cause: Another CRS daemon was operating on the same resource.

Action: Wait for a minute and try the command or operation again.

CRS-253: CRS configuration error, the CRS default directory is not set in OCR.

Cause: The OCR key which contains the user default CRS key is not initialised.

Action: Check the CRS configuration. If necessary reinstall CRS.

CRS-254: Authorization failure.

Cause: The user permissions were insufficient to operate on the resource.

Action: Check the permissions associated with the resource using crs_getperm.

CRS-255: CRSD is not running in privileged mode. Insufficient permissions to run this command.

Cause: The CRS daemon was not running as the privileged user.

Action: Check if the CRS daemon is running as root (Unix) or Administrator (Windows).

CRS-256: Username conflicts with the owner of the resource.

Cause: An attempt was made to give separate user level permissions for the owner of the resource.

Action: Check the owner of the resource and the user being given permissions.

CRS-257: Groupname conflicts with the primary group of the resource.

Cause: An attempt was made to give separate group level permissions for the primary group of the resource.

Action: Check the primary group of the resource and the group being given permissions.

CRS-258: Invalid ACL string format.

Cause: CRS-258: Invalid ACL string format.

Action: Check the syntax of the permission string (ACL).

CRS-259: Owner of the resource does not belong to the group.

Cause: The owner of the resource does not belong to the expected group.

Action: If this resource is owned by the root user, check if the root user belongs to the DBA group.

CRS-402: Could not make safe dir('%s').

Cause: Unable to create safe directory('%s').

Action: Please check if you have proper permissions and sufficient space on the disk to create the directory.

CRS-403: Could not chdir to safe dir('%s').

Cause: Unable to change directory to safe dir('%s').

Action: Please check if safe dir exists and if you have proper permissions.

CRS-413: Could not initialize the CSS context.

Cause: Unable to communicate with the cluster services.

Action: Verify that the CSS Daemon is properly configured and is running.

CRS-414: Could not establish EVM connection.

Cause: Unable to communicate with EVM daemon.

Action: Run the 'crsctl check evmd' command to determine whether EVM daemon is properly configured and is running.

CRS-451: CRS configuration error, unable to initialize OCR.

Cause: The OCR that contains information about the CRS configuration is unavailable.

Action: Check the CRS configuration. If necessary reinstall CRS.

CRS-452: CRS configuration error, unable to find CRSD Connection Information in OCR.

Cause: The OCR key which contains the user default CRSD connection is not initialised.

Action: Check the CRS configuration. If necessary reinstall CRS.

CRS-453: CRS configuration error, unable to find Instance Information in OCR.

Cause: The OCR key which contains the Instance's information is not initialised.

Action: Add the instance using srvctl.

CRS-471: Node number is not found.

Cause: Cluster Services is unable to retrieve the node name.

Action: Verify your cluster installation, including any vendor cluster ware. If necessary reinstall the cluster.

CRS-472: Node name is not found.

Cause: Cluster Services is unable to retrieve the node name.

Action: Verify your cluster installation, including any vendor cluster ware. If necessary reinstall the cluster.

CRS-1005: Failed to get required resources.

Cause: There was an internal error while evaluating the required resources for the subject resource.

Action: Check if the status of any resource is `UNKONOWN` using `crs_stat -t`.

CRS-1006: No more members to consider.

Cause: There was no host found on which to start the resource based on the placement policy.

Action: Check the placement policy and the required resources for the subject resource.

CRS-1007: Failed after successful dependency consideration.

Cause: There was no host found on which to start the resource based on the placement policy.

Action: Check the placement policy and the required resources for the subject resource.

CRS-1009: Resource '%s' is already running on member '%s'.

Cause: An attempt was made to start a resource on a host while it is already running on that host.

Action: This is an insignificant error. Check the operation being performed. 1011, 0, Trying to relocate to a dead member.

CRS-2001: User does not have permission to start CRSD.

Cause: Unable to start CRSD due to insufficient permissions.

Action: Start CRSD as a privileged user.

CRS-2007: Could not communicate with EVM.

Cause: Unable to communicate with EVM daemon.

Action: Run the 'crsctl check evmd' command to determine whether EVM daemon is properly configured and is running.

D

Oracle Cluster Registry Configuration Tool Command Syntax

This appendix describes the syntax of the Oracle Cluster Registry (OCR) tool, OCRCONFIG under the following topic:

- The OCR Configuration Tool Command Syntax and Options

The OCR Configuration Tool Command Syntax and Options

Use the `ocrconfig` command to perform OCR Configuration Tool operations with administrative privileges on UNIX-based systems or as a user with Administrator privileges on Windows-based systems. The `ocrconfig` command syntax is as follows where *`options`* is one of the verbs shown in the Option column of Table D–1:

```
ocrconfig -option
```

Table D–1 The ocrconfig Command Options

Option	Purpose
`-backuploc`	To change an OCR backup file location. For this entry, use a full path that is accessible by all of the nodes.
`-downgrade`	To downgrade an OCR to an earlier version.
`-export`	To export the contents of an OCR into a target file.
`-help`	To display help for the `ocrconfig` commands.
`-import`	To import the OCR contents from a previously *exported* OCR file.
`-overwrite`	To update an OCR configuration that is recorded on the OCR with the current OCR configuration information that is found on the node from which you are running this command.
`-repair`	To update an OCR configuration on the node from which you are running this command with the new configuration information specified by this command.
`-replace`	To add, replace, or remove an OCR location.
`-restore`	To restore an OCR from an automatically created OCR backup file.
`-showbackup`	To display the location, timestamp, and the originating node name of the backup files that Oracle created in the past 4 hours, 8 hours, 12 hours, and in the last day and week. You do not have to be the `root` user to execute the `-showbackup` option.
`-upgrade`	To upgrade an OCR to a later version.

For example, to export the OCR contents to a binary file, use the `ocrconfig` command with the following syntax where *`file_name`* is the file to which you want to export the OCR contents as follows:

```
ocrconfig -export file_name
```

E

Server Control Utility Reference

This chapter describes how to administer Oracle Real Application Clusters (Oracle RAC) databases and instances using the Server Control Utility (SRVCTL). The topics in this chapter include:

- Overview of SRVCTL for Administering Oracle Real Application Clusters
- SRVCTL Command Syntax and Options
- SRVCTL General Cluster Database Administration Tasks
- SRVCTL Cluster Database Configuration Tasks
- SRVCTL Node-Level Tasks
- SRVCTL Command Reference
- SRVCTL Commands

> **See Also:** Your platform-specific Oracle Real Application Clusters installation and configuration guide for information about using Database Configuration Assistant (DBCA)

Overview of SRVCTL for Administering Oracle Real Application Clusters

The Server Control (SRVCTL) utility is installed on each node by default. You can use SRVCTL to start and stop the database and instances, manage configuration information, and to move or remove instances and services. You can also use SRVCTL to add services. SRVCTL also manages configuration information.

Some SRVCTL operations store configuration information in the Oracle Cluster Registry (OCR). SRVCTL performs other operations, such as starting and stopping instances, by sending requests to the Oracle Clusterware process (CRSD), which then starts or stops the Oracle Clusterware resources.

To use SRVCTL, enter the `srvctl` command and its options in case sensitive syntax as described under the heading "SRVCTL Command Reference" on page E-3.

Guidelines for Using SRVCTL in Oracle Real Application Clusters

Guidelines for using SRVCTL are:

- To use SRVCTL to change your Oracle RAC database configuration, log in to the database as the `oracle` user. Members of the DBA group can start and stop the database.
- Only use the version of SRVCTL that is provided with Oracle Database 10*g* on Oracle RAC databases that are created or upgraded for Oracle Database 10*g*.

- Always use SRVCTL from the *Oracle_home* of the database that you are administering.
- SRVCTL does not support concurrent executions of commands on the same object. Therefore, only run one SRVCTL command at a time for each database, service, or other object.

Obtaining Command-Line Help for SRVCTL

To see help for all SRVCTL commands, from the command line enter:

```
srvctl -h
```

To see the command syntax and a list of options for each SRVCTL command, from the command line enter:

```
srvctl command (or verb) object (or noun) -h
```

To see the SRVCTL version number enter:

```
srvctl -V
```

> **Caution:** Although you may be able to cancel running SRVCTL commands by entering Control-C at the command line, you may corrupt your configuration data by doing this. You are strongly advised not to attempt to terminate SRVCTL in this manner.

SRVCTL Command Syntax and Options

SRVCTL commands, objects, and options are case sensitive. Database, instance, and service names are case insensitive and case preserving. SRVCTL interprets the following command syntax:

```
srvctl command object [options]
```

In SRVCTL syntax:

- `srvctl` is the command to start the SRVCTL utility.
- *command* is a verb such as `start`, `stop`, or `remove`.
- *object* is an object or target on which SRVCTL performs the command, such as *database* or *instance*. You can also use object abbreviations.
- *options* extend the use of a preceding command combination to include additional parameters for the command. For example, the `-i` option indicates that a comma-delimited list of instance names follows; sometimes the `-i` option only permits one value and not a list of names. The `-n` option indicates that a node name or a comma-delimited list of node names follows. SRVCTL prompts for user credentials when you use the `-q` option with any SRVCTL command.

> **Note:** Enclose comma-delimited lists in double-quote ("...,...") symbols.

SRVCTL Cluster Database Configuration Tasks

The database configuration tasks are:

- Add, modify, and delete **cluster database** configuration information.

- Add an instance or a service to, and delete an instance or service from the configuration of a **cluster** database.
- Move instances and services in a cluster database configuration and modify service configurations.
- Set and unset the environment for an instance or service in a cluster database configuration.
- Set and unset the environment for an entire cluster database in a cluster database configuration.

SRVCTL General Cluster Database Administration Tasks

The general database administration tasks are:

- Start and stop cluster databases
- Start and stop cluster database instances
- Start, stop, and relocate cluster database services
- Obtain statuses of cluster databases, cluster database instances, or cluster database services

SRVCTL Node-Level Tasks

The node-level tasks are:

- Adding and deleting node level applications.
- Setting and unsetting the environment for node-level applications.
- Administering node applications.
- Administering ASM instances.
- Starting and stopping a group of programs that includes virtual IP addresses, Listeners, Oracle Notification Services, and Oracle Enterprise Manager agents (for maintenance purposes).

SRVCTL Command Reference

This section presents the SRVCTL command reference:

- srvctl remove

SRVCTL Commands

This section summarizes the SRVCTL commands, objects, and options. Oracle recommends that you use DBCA to create your Oracle RAC database as well as your initial service configurations. This is because DBCA configures both the Oracle Clusterware resources and the Net Service entries for each service.

SRVCTL Commands Summary

Table E–1 summary the SRVCTL commands. Execute SRVCTL commands from the command line and specify one or more objects with the appropriate options for the command and its objects.

Table E–1 SRVCTL Commands Summary

Command	Description
srvctl add on page E-5	Adds the node applications, database, database instance, ASM instance, or service.
srvctl remove on page E-8	Removes the node applications, database, database instance, ASM instance, or service.
srvctl config on page E-8	Lists the configuration for the node applications, database, ASM instance, or service.
srvctl enable on page E-10	Enables the database, database instance, ASM instance, or service.
srvctl disable on page E-12	Disables the database, database instance, ASM instance, or service.
srvctl start on page E-14	Starts the node applications, database, database instance, ASM instance, or service.
srvctl stop on page E-17	Stops the node applications, database, database instance, ASM instance, or service.
srvctl modify on page E-17	Modifies the node applications, database, database instance, or service configuration.
srvctl relocate on page E-24	Relocates the service from one instance to another.
srvctl status on page E-25	Obtains the status of the node applications, database, database instance, ASM instance, or service.
srvctl getenv on page E-27	Displays the environment variable in the configuration for the node applications, database, database instance, or service.
srvctl setenv and unsetenv on page E-29	Sets and unsets the environment variable in the configuration for the node applications, database, database instance, or service.

SRVCTL Objects Summary

Table E–2 lists the SRVCTL objects for SRVCTL commands. Use the full name or the abbreviation for the purpose described.

Table E–2 SRVCTL Objects (Nouns) and Abbreviations

Object Noun Name	Abbreviation	Purpose
asm	asm	To add, configure, enable, start, obtain the status of, stop, disable, and remove ASM instances.
database	db	To add, configure, modify, manage environment variables for, enable, start, obtain the status of, stop, disable, and remove databases.
instance	inst	To add, configure, modify, manage environment variables for, enable, start, obtain the status of, stop, and remove database instances.
nodeapps	no abbreviation	To add, configure, modify, manage environment variables for, start, obtain the status of, stop, and remove node applications.
service	serv	To add, configure, modify, manage environment variables for, enable, start, obtain the status of, relocate, disable, stop, and remove services from your cluster database.

srvctl add

The SRVCTL `add` command adds the configuration and the Oracle Clusterware applications to the OCR for the cluster database, named instances, named services, or for the named nodes. To perform `srvctl add` operations, you must be logged in as the database administrator and be the Oracle account owner on UNIX-based systems, or you must be logged on as a user with Administrator privileges on Windows-based systems.

When adding an instance, the name that you specify with `-i` must match the `ORACLE_SID` parameter. The database name given with `-d db_unique_name` must match the `DB_UNIQUE_NAME` initialization parameter setting. If `DB_UNIQUE_NAME` is unspecified, then match the `DB_NAME` initialization parameter setting. The default setting for `DB_UNIQUE_NAME` uses the setting for `DB_NAME`. Also, the domain name given with `-m db_domain` must match the `DB_DOMAIN` setting.

Table E–3 srvctl add Summary

Command	Description
srvctl add database on page E-5	Adds a database and configuration.
srvctl add instance on page E-6	Adds one or more instances and configurations.
srvctl add service on page E-6	Adds services.
srvctl add nodeapps on page E-7	Adds node applications.
srvctl add asm on page E-8	Adds ASM instances.

srvctl add database

Adds a database configuration to your cluster database configuration.

Syntax and Options Use the `srvctl add database` command with the following syntax:

```
srvctl add database -d db_unique_name -o oracle_home [-m domain_name] [-p
spfile] [-A addr_str] [-r {PRIMARY |
PHYSICAL_STANDBY | LOGICAL_STANDBY}] [-s start_options] [-n db_name] - y database_
name [ automatic | manual ]
```

Table E–4 srvctl add database Options

Syntax	Description
`-d` *db_unique_name*	Unique name for the database.
`-o` *oracle_home*	The Oracle home for the database.
`-m` *domain_name*	The Domain for the database.
`-p` *spfile*	The server parameter file for the database.
`-A` *addr_str*	The database cluster alias (*name*|*ip*/netmask[/if1[|if2|...]]).
`-r {PRIMARY | PHYSICAL_STANDBY | LOGICAL_STANDBY}`	The role of the database (primary, physical standby, or logical standby).
`-s` *start_options*	Startup options for the database.
`-n` *db_name*	The name of the database, where it is different from the unique name given by the `-d` option.

Example An example of this command is:

```
srvctl add database -d crm -o /ora/ora10
```

srvctl add instance

Adds a configuration for an instance to your cluster database configuration.

Syntax and Options Use the `srvctl add instance` command with the following syntax:

```
srvctl add instance -d db_unique_name -i inst_name -n node_name
```

Table E–5 srvctl add instance Options

Option	Description
`-d` *db_unique_name*	Unique name for the database.
`-i` *inst_name*	The instance name.
`-n` *node_name*	The node name.

Examples Examples of this command are:

```
srvctl add instance -d crm -i  crm01 -n gm01
srvctl add instance -d crm -i  crm02 -n gm02
srvctl add instance -d crm -i  crm03 -n gm03
```

srvctl add service

Adds services to a database and assigns them to instances. If you have multiple instances of a cluster database on the same node, then always use only one instance on that node for all of the services that node manages. Also, you can use the `srvctl add service` command to configure the Transparent Application Failover (TAF) policy for a service.

See Also: Chapter 6 for more information about TAF policies

Syntax and Options Use the `srvctl add service` command with the following syntax:

```
srvctl add service -d db_unique_name -s service_name -r preferred_list
```

```
[-a available_list] [-P TAF_policy]
```

Table E–6 srvctl add service Options

Option	Description
`-d db_unique_name`	Unique name for the database.
`-s service_name`	The service name.
`-r preferred_list`	The list of preferred instances.
`-a available_list`	The list of available instances
`-P TAF_policy`	The TAF policy (`NONE`, `BASIC`, or `PRECONNECT`). The `BASIC` and `PRECONNECT` settings affect the content of the TNS string that Oracle generates.

Use the following syntax to add a new preferred or available instance to the service configuration:

```
srvctl add service -d db_unique_name -s service_name
-u [-r new_preferred_inst | -a new_available_inst]
```

Table E–7 srvctl add service Options for a New Instance

Option	Description
`-d db_unique_name`	Unique name for the database.
`-s service_name`	The service name.
`-u`	Update a new instance-to-service configuration.
`-r new_preferred_inst`	Name of the new preferred instance.
`-a new_available_inst`	Name of new available instance.

Examples Use this example syntax to add a named service to a database with preferred instances in list one and available instances in list two, using basic failover for the available instances:

```
srvctl add  service -d crm -s sales -r crm01,crm02 -a crm03
```

Use this example syntax to add a named service to a database with preferred instances in list one and available instances in list two, using preconnect failover for the available instances:

```
srvctl add  service -d crm -s sales -r crm01,crm02 -a crm03 -P Preconnect
```

srvctl add nodeapps

Adds a node application configuration to the specified node.

> **Note:** On UNIX-based systems, you must be logged in as `root` and on Windows-based systems, you must be logged in as a user with Administrator privileges to run this command.

Syntax and Options Use the `srvctl add nodeapps` command with the following syntax:

```
srvctl add nodeapps -n node_name -o oracle_home -A addr_str
```

Table E–8 srvctl add nodeapps Options

Option	Description
`-n node_name`	Node name.
`-o oracle_home`	Oracle home for the cluster database.
`-A addr_str`	The node level VIP address (*name*|*ip*/netmask[/if1[|if2|...]]).

Example An example of this command is:

```
srvctl add nodeapps -n crmnode1 -o /ora/ora10 -A 1.2.3.4/255.255.255.0
```

srvctl add asm

Adds a record for an ASM instance to the specified node.

Syntax and Options Use the `srvctl add asm` command with the following syntax:

```
srvctl add asm -n node_name -i asm_instance_name -o oracle_home
```

Table E–9 srvctl add asm Options

Option	Description
`-n node_name`	Node name.
`-i asm_instance_name`	The ASM instance name.
`-o oracle_home`	Oracle home for the cluster database.

Example An example of this command is:

```
srvctl add asm -n crmnode1 -i asm1 -o /ora/ora10
```

srvctl config

The SRVCTL `config` command displays the configuration stored in the OCR.

Table E–10 srvctl config Summary

Command	Description
srvctl config database on page E-8	Displays the configuration information of the cluster database.
srvctl config service on page E-9	Displays the configuration information for the services.
srvctl config nodeapps on page E-9	Displays the configuration information for the node applications.
srvctl config asm on page E-10	Displays the configuration for the ASM instances on the node.
srvctl config listener on page E-10	Displays a list of configured Listeners that are registered with Oracle Clusterware on a given node.

srvctl config database

Displays the configuration for an Oracle RAC database or lists all configured databases.

Syntax and Options Use the `srvctl config database` command with the following syntax:

```
srvctl config database [-d db_unique_name [-a] [-t]]
```

Table E–11 srvctl config database Options

Option	Description
`-d db_unique_name`	Unique name for the database
`-a`	Additional attributes
`-t`	Display sample TNS entries

Examples An example of this command to list all database is:

```
srvctl config database
```

An example of this command to show sample TNS entries for a specific database is:

```
srvctl config database -d db_erp
```

srvctl config service

Displays the configuration for a service.

Syntax and Options Use the `srvctl config service` command with the following syntax:

```
srvctl config service -d db_unique_name [-s service_name] [-a]
```

Table E–12 srvctl config service Options

Option	Description
`-d db_unique_name`	Unique name for the database.
`-s service_name`	Service name.
`-a`	Additional attributes.

Example An example of this command is:

```
srvctl config service -d crm -s crm
```

> **Note:** If you do not specify `-s service`, then SRVCTL displays all services for the specified cluster database.

srvctl config nodeapps

Displays the configuration for node applications.

Syntax and Options Use the `srvctl config nodeapps` command with the following syntax:

```
srvctl config nodeapps -n node_name [-a] [-g] [-s] [-l]
```

Table E–13 srvctl config nodeapps Option

Option	Description
`-n node_name`	Node name.
`-a`	VIP configuration.
`-g`	GSD configuration.
`-s`	ONS configuration.
`-l`	Listener configuration.

Example An example of this command is:

```
srvctl config nodeapps -n mynode1
```

srvctl config asm

Displays the configuration for the ASM instances.

Syntax and Options Use the `srvctl config asm` command with the following syntax:

```
srvctl config asm -n node_name
```

The only option available for this command is `-n` to specify the node name.

Example An example of this command is:

```
srvctl config asm -n mynode1
```

srvctl config listener

Displays a list of configured Listeners that are registered with Oracle Clusterware on a given node.

Syntax and Options Use the `srvctl config listener` command with the following syntax:

```
srvctl config listener -n node_name
```

The only option available for this command is `-n` to specify the node name.

Example An example of this command is:

```
srvctl config listener -n mynode1
```

srvctl enable

The SRVCTL `enable` command enables the named object so that it can run under Oracle Clusterware for automatic startup, failover, or restart. The Oracle Clusterware application supporting the object may be up or down to use this function. `Enable` is the default value. If the object is already enabled, then the command is ignored. Enabled objects can be started, and disabled objects cannot be started.

Table E–14 srvctl enable Summary

Command	Description
srvctl enable database on page E-11	Enables the database.
srvctl enable instance on page E-11	Enables the instance.
srvctl enable service on page E-11	Enables a service.
srvctl enable asm on page E-12	Enables an ASM instance.

srvctl enable database

Enables the Oracle Clusterware resources for a database and enables the database's instances if the database was previously disabled.

Syntax and Options Use the `srvctl enable database` command with the following syntax:

```
srvctl enable database -d db_unique_name
```

The only option available for this command is `-d` to specify the database name.

Example An example of this command is:

```
srvctl enable database -d crm
```

srvctl enable instance

Enables an instance for Oracle Clusterware. If all instances are disabled, then enabling an instance also enables the database.

Syntax and Options Use the `srvctl enable instance` command with the following syntax:

```
srvctl enable instance -d db_unique_name -i inst_name_list
```

Table E–15 srvctl enable instance Option

Option	Description
`-d db_unique_name`	Unique name for the database
`-i inst_name_list`	Comma-delimited list of instance names.

Example An example of this command is:

```
srvctl enable instance  -d crm -i "crm1,crm2"
```

srvctl enable service

Enables a service for Oracle Clusterware. Enabling an entire service also affects the enabling of the service over all of the instances by enabling the service at each one. When the entire service is already enabled, an srvctl enable service operation does not affect all of the instances and enable them. Instead, this operation returns an error. Therefore, you cannot always use the entire set of service operations to manipulate the service indicators for each instance.

Syntax and Options Use the `srvctl enable service` command with the following syntax:

```
srvctl enable service -d db_unique_name {-s service_name_list | -s service_name -i
inst_name}
```

Table E–16 srvctl enable service Options

Option	Description
`-d db_unique_name`	Unique name for the database.
`-s service_name_list`	Comma-delimited list of service names.
`-s service_name`	Single service name.
`-i inst_name`	Instance name.

Examples The following example globally enables a service:

```
srvctl enable service -d crm -s crm
```

The following example enables a service to use a preferred instance:

```
srvctl enable service -d crm -s crm -i crm1
```

srvctl enable asm

Enables an ASM instance.

Syntax and Options Use the `srvctl enable asm` command with the following syntax:

```
srvctl enable asm -n node_name [-i asm_inst_name]
```

Table E–17 srvctl enable asm Option

Option	Description
`-n node_name`	Node name
`-i inst_name`	ASM instance name.

Example An example of this command is:

```
srvctl enable asm -n crmnode1 -i asm1
```

srvctl disable

Disables a specified object (cluster database, database instance, ASM instance, or service). SRVCTL `disable` is intended to be used when an object is to be repaired or is down for maintenance to prevent inappropriate automatic restarts. When you issue the `disable` command, the object is disabled and unavailable to run under Oracle Clusterware for automatic startup, failover, or restart. If you specify `-i instance_name`, then SRVCTL only disables the service from running on the specified instance.

Table E–18 srvctl disable Summary

Command	Description
srvctl disable database on page E-13	Disables the cluster database

Table E–18 (Cont.) srvctl disable Summary

Command	Description
srvctl disable instance on page E-13	Disables an instance
srvctl disable service on page E-13	Disables a service
srvctl disable asm on page E-14	Disables an ASM instance

srvctl disable database

Disables a cluster database and its instances.

Syntax and Options Use the `srvctl disable database` command with the following syntax:

```
srvctl disable database -d db_unique_name
```

The only option available for this command is `-d` to specify the database name.

Example An example of this command is:

```
srvctl disable database -d mybd1
```

srvctl disable instance

Disables an instance. If the instance that you disable with this command is the last enabled instance, then this operation also disables the database.

Syntax and Options Use the `srvctl disable instance` command with the following syntax:

```
srvctl disable instance -d db_unique_name -i inst_name_list
```

Table E–19 srvctl disable instance Options

Option	Description
`-d db_unique_name`	Unique name for the database.
`-i inst_name_list`	Comma-delimited instance names.

Example An example of this command is:

```
srvctl disable instance -d crm -i "crm1,crm3"
```

srvctl disable service

Disables a service. Disabling an entire service affects all of the instances, disabling each one. When the entire service is already disabled, an srvctl disable service operation on the entire service affect all of the instances and disable them; it just returns an error. This means that you cannot always use the entire set of service operations to manipulate the service indicators for each instance.

Syntax and Options Use the `srvctl disable service` command with the following syntax:

```
srvctl disable service -d db_unique_name {-s service_name_list | -s service_name
-i inst_name}
```

Table E–20 srvctl disable service Options

Option	Description
`-d db_unique_name`	Unique name for the database.
`-s service_name_list`	Comma-delimited service names.
`-s service_name`	Single service name.
`-i inst_name`	Instance name.

Examples The following example globally disables two services:

```
srvctl disable service -d crm -s crm,marketing
```

The following example disables a service running on the preferred named instance and results in running a service on one less instance:

```
srvctl disable service -d crm -s crm -i crm1
```

srvctl disable asm

Disables an ASM instance.

Syntax and Options Use the `srvctl disable asm` command with the following syntax:

```
srvctl disable asm -n node_name [-i asm_inst_name]
```

Table E–21 srvctl disable asm Option

Option	Description
`-n node_name`	Node name
`-i inst_name`	ASM instance name.

Example An example of this command is:

```
srvctl disable asm -n crmnode1 -i asm1
```

srvctl start

Starts Oracle Clusterware enabled, non-running applications for the database, all or named instances, all or named service names, or node-level applications. For the `start` command, and for other operations that use a connect string, if you do not provide a connect string, then SRVCTL uses "/ as sysdba" to perform the operation. To run such operations, the owner of the `oracle` binary executables must be a member of the OSDBA group, and users running the commands must be in the OSDBA group also.

Table E–22 srvctl start Summary

Command	Description
srvctl start database on page E-15	Starts the cluster database and its instances
srvctl start instance on page E-15	Starts the instance
srvctl start service on page E-16	Starts the service

Table E–22 (Cont.) srvctl start Summary

Command	Description
srvctl start nodeapps on page E-16	Starts the node applications
srvctl start asm on page E-16	Starts ASM instances
srvctl start listener on page E-17	Starts the specified Listener or Listeners.

srvctl start database

Starts a cluster database and its enabled instances.

Syntax and Options Use the `srvctl start database` command with the following syntax:

```
srvctl start database -d db_unique_name [-o start_options] [-c connect_str | -q]
```

Table E–23 srvctl start database Options

Option	Description
`-d db_unique_name`	Unique name for the database.
`-o start_options`	Options for startup command (for example: `open`, `mount`, or `nomount`)
`-c connect_str`	Connect string (default: `/ as sysdba`)
`-q`	Prompt for user credentials connect string from standard input.

Example An example of this command is:

```
srvctl start database -d crm -o open
```

srvctl start instance

Starts instances in the cluster database.

Syntax and Options Use the `srvctl start instance` command with the following syntax:

```
srvctl start instance -d db_unique_name -i inst_name_list [-o start_options] [-c
connect_str | -q]
```

Table E–24 srvctl start instance Options

Option	Description
`-d db_unique_name`	Unique name for the database.
`-i inst_name_list`	Comma-delimited instance names.
`-o start_options`	Options for startup command (for example: open, mount, or nomount).
`-c connect_str`	Connect string (default: / as sysdba).
`-q`	Prompt for user credentials connect string from standard input.

Example An example of this command is:

```
srvctl start instance -d crm -i "crm1,crm4"
```

srvctl start service

Starts a service or multiple services on the specified instance. The `srvctl start service` command will fail if you attempt to start a service on an instance if that service is already running on its maximum number of instances, that is, its number of preferred instances. You may move a service or change the status of a service on an instance with the srvctl modify service and srvctl relocate service commands described on on page E-22 and on page E-25 respectively.

Syntax and Options Use the `srvctl start service` command with the following syntax:

```
srvctl start service -d db_unique_name [-s service_name_list [-i inst_name]]
[-o start_options] [-c connect_str | -q]
```

Table E–25 srvctl start service Options

Option	Description
`-d db_unique_name`	Unique name for the database
`-s service_name_list`	Comma-delimited service names; the service name list is optional and if not provided, the SRVCTL starts all of the database's services
`-i inst_name`	Instance name
`-o start_options`	Options to startup command (for example: open, mount, or nomount)
`-c connect_str`	Connect string (default: / as sysdba)
`-q`	Query connect string from standard input

Examples The following example starts named service names. If the instances that support these services, including available instances that the service uses for failover, are not running but are enabled, then they are started:

```
srvctl start service -d crm -s crm
```

The following example starts a named service on a specified instance:

```
srvctl start service -d crm -s crm -i crm2
```

srvctl start nodeapps

Starts node-level applications on a particular node.

Syntax and Options Use the `srvctl start nodeapps command` with the following syntax:

```
srvctl start nodeapps -n node_name
```

The only option available for this command is `-n` to specify the node name.

Example An example of this command is:

```
srvctl start nodeapps -n mynode1
```

srvctl start asm

Starts an ASM instance.

Syntax and Options Use the `srvctl start asm` command with the following syntax:

```
srvctl start asm -n node_name [-i asm_inst_name] [-o start_options] [-c connect_
str | -q]
```

Table E–26 srvctl start asm Option

Option	Description
-n node_name	Node name
-i inst_name	ASM instance name.
-o *start_options*	Options to startup command, for example `open`, `mount`, or `nomount`.
-c *connect_string*	Connect string where the default is forward slash (`/`).
-q	Query connect string from standard input.
-h	Display help.

Examples An example of this command to start a single ASM instance is:

```
srvctl start asm -n crmnode1 -i asm1
```

An example to start all ASM instances on a node is:

```
srvctl start asm -n crmnode2
```

srvctl start listener

Starts the default Listener known as *node_name*, or the Listeners represented in a given list of Listener names, that are registered with Oracle Clusterware on the given node.

Syntax and Options Use the `srvctl start listener` command with the following syntax:

```
srvctl start listener -n node_name [-l listener_name_list]
```

Example An example of this command is:

```
srvctl start listener -n mynode1
```

srvctl stop

Stops the Oracle Clusterware applications for the database, all or named instances, all or named service names, or node level applications. Only the Oracle Clusterware applications that are starting or running are stopped. Objects running outside of Oracle Clusterware are not stopped. Stops node-level applications and all dependent Oracle Clusterware applications on the node.

You should disable an object that you intend to remain stopped after you issue a SRVCTL stop command. Refer to the SRVCTL `disable` command starting with srvctl disable database on page E-13.

Note: If the object is stopped and is not disabled, then it can restart as a result of another planned operation. That is, the object will *not* restart as a result of a failure. Oracle recommends that you disable an object that should remain stopped after you issue a `stop` command.

Table E–27 srvctl stop Summary

Command	Description
srvctl stop database on page E-18	Stops the cluster database
srvctl stop instance on page E-18	Stops the instance
srvctl stop service on page E-19	Stops the service
srvctl stop nodeapps on page E-19	Stops the node-level applications
srvctl stop asm on page E-20	Stops ASM instances
srvctl stop listener on page E-20	Stops the specified Listener or Listeners.

srvctl stop database

Stops a database, its instances, and its services.

Syntax and Options Use the `srvctl stop database` command with the following syntax:

```
srvctl stop database -d db_unique_name [-o stop_options] [-c connect_str | -q]
```

Table E–28 srvctl stop database Options

Option	Description
`-d db_unique_name`	Unique name for the database
`-o stop_options`	`shutdown` command options (for example: normal, transactional, immediate, or abort)
`-c connect_str`	Connect string (default: / as sysdba)
`-q`	Prompt for user credentials connect string from standard input

Example An example of this command is:

```
srvctl stop database -d crm
```

srvctl stop instance

Stops instances and stops all enabled and non-running services that have these instances as either preferred or available instances.

Syntax and Options Use the `srvctl stop instance` command with the following syntax:

```
srvctl stop instance -d db_unique_name -i inst_name_list [-o stop_options] [-c
connect_str | -q]
```

Table E–29 srvctl stop instance Options

Option	Description
-d *db_unique_name*	Unique name for the database
-i *inst_name_list*	Comma-delimited instance names
-o *stop_options*	Options for shutdown command (for example: normal, transactional, immediate, or abort)
-c *connect_str*	Connect string (default: / as sysdba)
-q	Query connect string from standard input

Example An example of this command is:

```
srvctl stop instance -d crm -i crm1
```

srvctl stop service

Stops one or more services globally across the cluster database, or on the specified instance.

Syntax and Options Use the `srvctl stop service` command with the following syntax:

```
srvctl stop service -d db_unique_name [-s service_name_list [-i inst_name]]
[-c connect_str | -q] [-f]
```

Table E–30 srvctl stop service Options

Option	Description
-d *db_unique_name*	Unique name for the database
-s *service_name_list*	Comma-delimited service names; if you do not provide a service name list, then SRVCTL stops all services on the database
-i *inst_name*	Instance name
-c *connect_str*	Connect string (default: / as sysdba)
-q	Query connect string from standard input
-f *force*	Force SRVCTL to stop the service; this causes SRVCTL to disconnect all of the sessions transactionally, causing the sessions using the service to reconnect to another instance

Examples The following example stops a service globally across a cluster database:

```
srvctl stop service -d crm -s crm
```

The following example stops a service on a specified instance:

```
srvctl stop  service -d crm -s crm -i crm2
```

srvctl stop nodeapps

Stops node-level applications on a particular node.

Syntax and Options Use the `srvctl stop nodeapps` command with the following syntax:

```
srvctl stop nodeapps -n node_name
```

The only option for this command is the `-n` option, which specifies the node name.

Example An example of this command is:

```
srvctl stop nodeapps -n mynode1
```

srvctl stop asm

Stops an ASM instance.

Syntax and Options Use the `srvctl stop asm` command with the following syntax:

```
srvctl stop asm -n node_name [-i inst_name] [-o stop_options] [-c connect_str |
-q]
```

Table E–31 srvctl stop asm Option

Option	Description
-n node_name	Node name.
-i inst_name	ASM instance name.
-o *stop_options*	Options for shutdown command, for example, `normal`, `transactional`, `immediate`, or `abort`.
-c *connect_string*	Connect string where the default is forward slash (`/`).
-q	Query connect string from standard input.
-h	Display help.

Example An example of this command is:

```
srvctl stop asm -n crmnode1 -i asm1
```

srvctl stop listener

Stops the default Listener known as *node_name*, or the Listeners represented in a given list of Listener names, that are registered with Oracle Clusterware on the given node.

Syntax and Options Use the `srvctl stop listener` command with the following syntax:

```
srvctl stop listener -n node_name [-l listener_name_list]
```

Example An example of this command is:

```
srvctl stop listener -n mynode1
```

srvctl modify

Enables you to modify the instance configuration without removing and adding Oracle Clusterware resources. Using `modify` preserves the environment in the OCR configuration that would otherwise need to be re-entered. The configuration description is modified in the OCR configuration, and a new Oracle Clusterware

profile is generated and registered. The change takes effect when the application is next restarted.

Table E–32 srvctl modify Summary

Command	Description
srvctl modify database on page E-21	Modifies the configuration for a database.
srvctl modify instance on page E-21	Modifies the configuration for an instance.
srvctl modify service on page E-22	Modifies the configuration for a service.
srvctl modify nodeapps on page E-24	Modifies the configuration for a node application.

srvctl modify database

Modifies the configuration for a database.

Syntax and Options Use the `srvctl modify database` command with the following syntax:

```
srvctl modify database -d db_unique_name [-n db_name] [-o oracle_home] [-m domain_
name] [-p spfile] [-r {PRIMARY | PHYSICAL_STANDBY | LOGICAL_STANDBY}] [-s start_
options] [-y {AUTOMATIC | MANUAL}]
```

Table E–33 srvctl modify database Options

Option	Description
`-d db_unique_name`	Unique name for the database.
`-n db_name`	Name of the database, where it is different from the unique name given by -d option.
`-o oracle_home`	Oracle home for cluster database.
`-m domain_name`	Domain for cluster database.
`-p spfile`	Server parameter file for cluster database.
`-r role [PRIMARY | PHYSICAL_STANDBY | LOGICAL_STANDBY]`	Role of the database (primary, physical standby, or logical standby)
`-s start_options`	Startup options for the database.
`-y`	Management policy for the database, either `automatic` or `manual`.
`-h`	Print usage.

Example The following example changes the role of a database to a logical standby:

```
srvctl modify database -d crm -r logical_standby
```

srvctl modify instance

Modifies the configuration for a database instance from its current node to another node or changes the dependency between and ASM instance and a database instance.

Syntax and Options Use the `srvctl modify instance` command with the following syntax:

```
srvctl modify instance -d db_unique_name -i inst_name {-n node_name | -s asm_
instance_name | -r}
```

Table E–34 srvctl modify instance Options

Option	Description
`-d db_unique_name`	Unique name for the database.
`-i inst_name`	Database instance name.
`-n node_name`	Node name.
`-s asm_instance_name`	ASM instance dependency to database instance.
`-r`	Remove ASM instance dependency from database instance.

Examples An example of this command to relocate a database instance is:

```
srvctl modify instance -d crm -i crm1 -n my_new_node
```

The following example of this command establishes a dependency between an ASM instance and a database instance:

```
srvctl modify instance -d crm -i crm1 -s asm1
```

srvctl modify service

Moves a service member from one instance to another. Additionally, this command changes which instances are to be the preferred and the available instances for a service. This command supports some online modifications to the service, for example:

- When a service configuration is modified so that a new preferred or available instance is added, the running state of the existing service is not affected. However, the newly added instances will not automatically provide the service, until a srvctl start service command is issued as described on page E-16.
- When there are available instances for the service, and the service configuration is modified so that a preferred or available instance is removed, the running state of the service may change unpredictably:
  - The service is stopped and then removed on some instances according to the new service configuration.
  - The service may be running on some instances that are being removed from the service configuration.
  - These services will be relocated to the next "free" instance in the new service configuration.

As a result of these considerations, when the online service is being modified, users may experience a brief service outage on some instances even if the instances are not being removed. Or users may experience a brief service outage on instances that are being removed from the service.

Important: Oracle recommends that you limit configuration changes to the minimum requirement and that you not perform other service operations while the online service modification is in progress.

Syntax and Options Use the `srvctl modify service` command with the following syntax:

```
srvctl modify service -d db_unique_name -s service_name -i old_inst_name
-t new_inst_name [-f]
```

Table E–35 srvctl modify service Options for an Available Instance

Option	Description
`-d db_unique_name`	Unique name for the database.
`-s service_name`	Service name.
`-i old_inst_name`	Old instance name.
`-t new_inst_name`	New instance name.
`-f`	Disconnect all sessions during stop or relocate service operations.

You can also use the `srvctl modify service` command to change an available instance to a preferred instance as follows:

```
srvctl modify service -d db_unique_name -s service_name -i avail_inst_name -r [-f]
```

Table E–36 srvctl modify service Options for Changing an Available Instance to Preferred

Option	Description
`-d db_unique_name`	Unique name for the database.
`-s service_name`	Service name.
`-i avail_inst_name`	Instance name.
`-r`	Upgrade instance to preferred.
`-f`	Disconnect all sessions during stop or relocate service operations.

Examples An example of moving a service member from one instance to another is:

```
srvctl modify service -d crm -s crm -i crm1 -t crm2
```

An example of changing an available instance to a preferred instance is:

```
srvctl modify service -d crm -s crm -i crm1 -r
```

To change the status of multiple instances, you can use the `srvctl modify service` command to list which instances are to be the preferred and which are to be the available instances for a service as follows:

```
srvctl modify service -d db_unique_name -s service_name -n -i pref_inst_list [-a
avail_inst_list] [-f]
```

Table E–37 srvctl modify service Options for Changing Instances between Preferred and Available status

Option	Description
`-d db_unique_name`	Unique name for the database.
`-s service_name`	Service name.

Table E–37 (Cont.) srvctl modify service Options for Changing Instances between Preferred and Available status

Option	Description
`-n`	Uses only the instances named for this service (unnamed instances already assigned to the service are removed).
`-i avail_inst_name`	List of preferred instances.
`-a avail_inst_list`	List of available instances.
`-f`	Disconnect all sessions during stop or relocate service operations.

Example An example of this command to exchange a preferred and available instance is:

```
srvctl modify service -d crm -s crm -n -i crm1 -a crm2
```

srvctl modify nodeapps

Applies a new Oracle home or virtual IP address to nodeapps.

Syntax and Options Use the `srvctl modify nodeapps` command with the following syntax:

```
srvctl modify nodeapps -n node_name [-o oracle_home] [-A new_vip_address]
```

Table E–38 srvctl modify nodeapps Option

Option	Description
`-n node_name`	Node name.
`-o oracle_home`	Oracle home for the cluster database.
`-A new_vip_address`	The node level VIP address (*name*|*ip*/netmask[/if1[|if2|...]]).

Example An example of this command is:

```
srvctl modify nodeapps -n mynode1 -A 100.200.300.40/255.255.255.0/eth0
```

srvctl relocate

Relocates the named service names from one named instance to another named instance. The `srvctl relocate` command works on only one source instance and one target instance at a time, relocating a service from a single source instance to a single target instance. The target instance must be on the preferred or available list for the service. The relocated service is temporary until you modify the configuration. The srvctl modify command described on page E-24 permanently changes the service configuration.

Table E–39 srvctl relocate Summary

Command	Description
srvctl relocate service on page E-25	Relocates the named service names from one named instance to another named instance

srvctl relocate service

Temporarily relocates a service member to run on another instance.

Syntax and Options Use the `srvctl relocate service` command with the following syntax:

```
srvctl relocate service -d db_unique_name -s service_name -i old_inst_name -t new_
inst_name [-f]
```

Table E–40 srvctl relocate service Options

Option	Description
`-d db_unique_name`	Unique name for the database.
`-s service_name`	Service name.
`-i old_inst_name`	Old instance name.
`-t new_inst_name`	New instance name.
`-f`	Disconnect all sessions during stop or relocate service operations.

Example To temporarily relocate a named service member from `crm1` to `crm3`:

```
srvctl relocate service -d crm -s crm -i crm1 -t crm3
```

srvctl status

Displays the current state of a named database, instances, services, or node applications.

Table E–41 srvctl status Summary

Command	Description
srvctl status database on page E-25	Obtains the status of a database.
srvctl status instance on page E-26	Obtains the status of a instance.
srvctl status service on page E-26	Obtains the status of services.
srvctl status nodeapps on page E-27	Obtains the status of node applications.
srvctl status asm on page E-27	Obtains the status of ASM instances.

srvctl status database

Obtains the status of instances and their services.

Syntax and Options Use the `srvctl status database` command with the following syntax:

```
srvctl status database -d db_unique_name [-f] [-v]
```

Table E–42 srvctl status database Options

Option	Description
`-d db_unique_name`	Unique name for the database
`-f`	Include disabled applications

Table E–42 (Cont.) srvctl status database Options

Option	Description
-v	Verbose output

Example An example of this command is:

```
srvctl status database -d crm -v
```

srvctl status instance

Obtains the status of instances.

Syntax and Options Use the `srvctl status instance` command with the following syntax:

```
srvctl status instance -d db_unique_name -i inst_name_list [-f] [-v]
```

Table E–43 srvctl status instance Options

Option	Description
-d *db_unique_name*	Unique name for the database
-i *inst_name_list*	Comma-delimited list of instance names
-f	Include disabled applications
-v	Verbose output

Example An example of this command is:

```
srvctl status instance -d crm -i "crm1,crm2" -v
```

srvctl status service

Obtains the status of a service.

Syntax and Options Use the `srvctl status service` command with the following syntax:

```
srvctl status service -d db_unique_name -s service_name_list [-f] [-v] [-S] level
```

Table E–44 srvctl status service Options

Option	Description
-d *db_unique_name*	Unique name for the database
-s *service_name_list*	Comma-delimited list of service names
-f	Include disabled applications
-v	Verbose output
-S	

Example The following example obtains the status of a named service globally across the database:

```
srvctl status service -d crm -s crm -v
```

srvctl status nodeapps

Obtains the status of node applications on a particular node.

Syntax and Options Use the `srvctl status nodeapps` command with the following syntax:

```
srvctl status nodeapps -n node_name
```

The only option available for this command is `-n` to specify the node name.

Example An example of this command to obtain the status of all nodes supporting database applications is:

```
srvctl status nodeapps -n mynode1
```

srvctl status asm

Obtains the status of an ASM instance.

Syntax and Options Use the `srvctl status asm` command with the following syntax:

```
srvctl status asm -n node_name
```

The only option available for this command is `-n` to specify the node name.

Example An example of this command is:

```
srvctl status asm -n crmnode1
```

srvctl getenv

Gets and displays values for the environment from the configuration file. Use SRVCTL with the `set`, `get`, and `unset` environment configuration verbs to administer the environment configurations for databases, instances, services, and node applications.

Table E–45 srvctl getenv Summary

Command	Description
srvctl getenv database on page E-27	Gets the cluster database environment values.
srvctl getenv instance on page E-28	Gets the instance environment values.
srvctl getenv service on page E-28	Gets the service environment values.
srvctl getenv nodeapps on page E-29	Gets the node application environment values.

srvctl getenv database

Displays the cluster database environment values.

Syntax and Options Use the `srvctl getenv database` command with the following syntax:

```
srvctl getenv database -d db_unique_name [-t name_list]
```

Table E–46 srvctl getenv database Options

Options	Description
-d *db_unique_name*	Unique name for the database
-t *name_list*	Names of environment variables

Example The following example gets the environment configuration for a cluster database:

```
srvctl getenv database -d crm
```

srvctl getenv instance

Gets the values for an instance environment configuration.

Syntax and Options Use the `srvctl getenv instance` command with the following syntax:

```
srvctl getenv instance -d db_unique_name -i inst_name [-t name_list]
```

Table E–47 srvctl getenv database Options

Options	Description
-d *db_unique_name*	Unique name for the database
-i *inst_name*	Instance name
-t name_list	Names of environment variables

Example The following example sets the environment configuration for an instance:

```
srvctl getenv instance -d -crm -i instance1
```

srvctl getenv service

Gets the values for a service environment configuration.

Syntax and Options Use the `srvctl getenv service` command with the following syntax:

```
srvctl getenv service -d db_unique_name -s service_name [-t name_list]
```

Table E–48 srvctl getenv service Options

Options	Description
-d *db_unique_name*	Unique name for the database
-s *service_name*	Service name
-t *name_list*	Names of environment variables

Example The following example lists all environment variables for a service:

```
srvctl getenv service -d crm -s crm
```

srvctl getenv nodeapps

Gets the environment variables for the node application configurations.

Syntax and Options Use the `srvctl getenv nodeapps` command with the following syntax:

```
srvctl getenv nodeapps -n node_name [-t name_list]
```

Table E–49 srvctl getenv nodeapps Options

Options	Description
`-n node_name`	Node name
`-t name_list`	Names of environment variables

Example The following example lists all environment variables for the node applications:

```
srvctl getenv nodeapps -n crmnode1
```

srvctl setenv and unsetenv

The `setenv` command sets values for the environment in the configuration file. The `unsetenv` command unsets values for the environment in the configuration file.

Table E–50 srvctl setenv and unsetenv Summary

Command	Description
srvctl setenv database on page E-29	Administers cluster database environment configurations
srvctl setenv instance on page E-30	Administers instance environment configurations
srvctl setenv service on page E-30	Administers service environment configurations
srvctl setenv nodeapps on page E-31	Administers node application environment configurations
srvctl unsetenv database on page E-31	Unsets the cluster database environment configuration
srvctl unsetenv instance on page E-31	Unsets instance environment configurations
srvctl unsetenv service on page E-32	Unsets service environment configurations
srvctl unsetenv nodeapps on page E-32	Unsets node application environment configurations

srvctl setenv database

Administers cluster database environment configurations.

Syntax and Options Use the `srvctl setenv database` command with the following syntax:

```
srvctl setenv database -d db_unique_name {-t name=val[,name=val,...] | -T
name=val}
```

Table E–51 srvctl setenv database Options

Options	Description
`-d db_unique_name`	Unique name for the database.
`-t =,...nameval`	Names and values of environment variables.

Table E–51 (Cont.) srvctl setenv database Options

Options	Description
`-T name=val`	Enables single environment variable to be set to a value that contains commas or other special characters.

Example The following example sets the language environment configuration for a cluster database:

```
srvctl setenv database -d crm -t LANG=en
```

srvctl setenv instance

Administers instance environment configurations.

Syntax and Options Use the `srvctl setenv instance` with the following syntax:

```
srvctl setenv instance -d db_unique_name [-i inst_name] {-t
name=val[,name=val,...] | -T name=val}
```

Table E–52 srvctl setenv instance Options

Options	Description
`-d db_unique_name`	Unique name for the database.
`-i inst_name`	Instance name.
`-t =,...nameval`	Names and values of environment variables.
`-T name=val`	Enables single environment variable to be set to a value that contains commas or other special characters.

Example The following example sets the environment configuration for an instance:

```
srvctl setenv instance -d -crm -i instance1 -t LANG=EN
```

srvctl setenv service

Administers service environment configurations.

Syntax and Options Use the `srvctl setenv service` command with the following syntax:

```
srvctl setenv service -d db_unique_name [-s service_name] {-t
name=val[,name=val,...] | -T name=val}
```

Table E–53 srvctl setenv service Options

Options	Description
`-d db_unique_name`	Unique name for the database.
`-s service_name`	Service name.
`-t =,...nameval`	Names and values of environment variables.
`-T name=val`	Enables single environment variable to be set to a value that contains commas or other special characters.

Example To set all environment variables for a service:

```
srvctl setenv service -d crm -s crm -t CLASSPATH=/usr/local/jdk/jre/rt.jar
```

srvctl setenv nodeapps

Sets the environment variables for the node application configurations.

Syntax and Options Use the `srvctl setenv nodeapps` command as follows:

```
srvctl setenv nodeapps -n node_name {-t name=val[,name=value,...] | -T name=value}
```

Table E–54 srvctl setenv nodeapps Options

Options	Description
`-n node_name`	Node name.
`-t =,...nameval`	Names and values of environment variables.
`-T name=val`	Enables single environment variable to be set to a value that contains commas or other special characters.

Example To set an environment variable for a node application:

```
srvctl setenv nodeapps -n crmnode1 -t CLASSPATH=/usr/local/jdk/jre/rt.jar
```

srvctl unsetenv database

Unsets the cluster database environment configurations.

Syntax and Options Use the `srvctl unsetenv database` command as follows:

```
srvctl unsetenv database -d db_unique_name -t name_list
```

Table E–55 srvctl unsetenv database Options

Options	Description
`-d db_unique_name`	Unique name for the database.
`-t name_list`	Names of environment variables.

Example The following example unsets the environment configuration for a cluster database environment variable:

```
srvctl unsetenv database -d crm -t CLASSPATH
```

srvctl unsetenv instance

Unsets instance environment configurations.

Syntax and Options Use the `srvctl unsetenv instance` command as follows:

```
srvctl unsetenv instance -d db_unique_name [-i inst_name] -t name_list
```

Table E–56 srvctl unsetenv instance Options

Options	Description
`-d db_unique_name`	Unique name for the database.
`-i instance_name`	Instance name.
`-t name_list`	Names of environment variables.

Example The following example unsets the environment configuration for an instance:

```
srvctl unsetenv instance -d -crm -i instance1 -t CLASSPATH
```

srvctl unsetenv service

Unsets service environment configurations.

Syntax and Options Use the `srvctl unsetenv service` command as follows:

```
srvctl unsetenv service -d db_unique_name [-s service_name] -t name_list
```

Table E–57 srvctl unsetenv service Options

Options	Description
`-d db_unique_name`	Unique name for the database.
`-s service_name`	Service name.
`-t name_list`	Names of environment variables.

Example To unset an environment variables for a service:

```
srvctl unsetenv service -d crm -s crm -t CLASSPATH
```

srvctl unsetenv nodeapps

Unsets the environment configuration for the node application configurations.

Syntax and Options Use the `srvctl unsetenv nodeapps` command as follows:

```
srvctl unsetenv nodeapps -n node_name -t name_list
```

Table E–58 srvctl unsetenv nodeapps Options

Options	Description
`-n node_name`	Node name.
`-t name=val`	Names and values of environment variables.

Example The following example unsets the environment configuration for a node's node applications:

```
srvctl unsetenv nodeapps -n crmnode1 -t name_list
```

srvctl remove

Removes the configuration, the Oracle Clusterware applications for the node (including the virtual IP address, the Oracle Enterprise Manager agent, the GSD, and the Listeners), the database, named instances, or the named services from the cluster database. Environment settings for the object are also removed.

If you do not use the force flag (`-f`), then Oracle prompts you to confirm whether to proceed. If you use the force (`-f`) option, then the remove operation proceeds without prompting and continues processing even when it encounters errors. Even when the Oracle Clusterware resources cannot be removed, the OCR configuration is removed, so that the object now appears not to exist, but there are still Oracle Clusterware resources. Use the `-f` option with extreme caution because this could result in an inconsistent OCR.

To use the `remove` verb, you must first stop the node applications, database, instance, or service for which you are specifying `srvctl remove`. Oracle recommends that you perform a disable operation before using this command, but this is not required. You must stop the target object before running the `srvctl remove` command. The srvctl stop command is described on page E-17.

Table E–59 srvctl remove Summary

Command	Description
srvctl remove database on page E-33	Removes a database and configuration.
srvctl remove instance on page E-33	Removes one or more instances and configurations.
srvctl remove service on page E-34	Removes services.
srvctl remove nodeapps on page E-34	Removes node applications.
srvctl remove asm on page E-35	Removes ASM instances

srvctl remove database

Removes a database configuration.

Syntax and Options Use the `srvctl remove database` command with the following syntax:

```
srvctl remove database -d db_unique_name [-f]
```

Table E–60 srvctl remove database Options

Options	Description
`-d` *`db_unique_name`*	Unique name for the database.
`-f`	Force remove.

Example An example of this command is:

```
srvctl remove database -d crm
```

srvctl remove instance

Removes the configurations for an instance.

Syntax and Options Use the `srvctl remove instance` command with the following syntax:

```
srvctl remove instance -d db_unique_name -i inst_name [-f]
```

Table E–61 srvctl remove instance Options

Options	Description
`-d db_unique_name`	Unique name for the database.
`-i inst_name`	Instance name.
`-f`	Force remove.

Example An example of this command is:

```
srvctl remove instance -d crm -i crm01
```

srvctl remove service

Removes the configuration for a service.

Syntax and Options Use the `srvctl remove service` command as follows:

```
srvctl remove service -d db_unique_name -s service_name [-i inst_name] [-f]
```

Table E–62 srvctl remove service Options

Options	Description
`-d db_unique_name`	Unique name for the database.
`-s service_name`	Service name.
`-i inst_name`	Instance name.
`-f`	Force remove.

Examples An example of this command is:

```
srvctl remove service -d crm -s sales
```

The following example removes the services from specific instances:

```
srvctl remove service -d crm -s sales -i crm01,crm02
```

srvctl remove nodeapps

Removes the node application configuration from the specified node. You must have full administrative privileges to run this command. On UNIX-based systems, you must be logged in as `root` and on Windows-based systems, you must be logged in as a user with Administrator privileges.

Syntax Use the `srvctl remove nodeapps` command as follows:

```
srvctl remove nodeapps -n node_name_list [-f]
```

Table E–63 srvctl remove nodeapps Options

Options	Description
`-n node_name_list`	Node name or a comma-delimited list of node names.

Table E–63 (Cont.) srvctl remove nodeapps Options

Options	Description
`-f`	Force remove.

Example An example of this command is:

```
srvctl remove nodeapps -n "mynode1,mynode2,mynode3"
```

srvctl remove asm

Removes an ASM instance.

Syntax and Options Use the `srvctl remove asm` command with the following syntax:

```
srvctl remove asm -n node_name [-i asm_inst_name]
```

Table E–64 srvctl remove asm Option

Option	Description
`-n` *node_name*	Node name
`-i` *asm_inst_name*	ASM instance name.

Example An example of this command is:

```
srvctl remove asm -n crmnode1 -i asm1
```

F

Oracle Real Application Clusters Tools Messages

This appendix describes the Oracle Real Application Clusters (Oracle RAC) management tools messages. The messages in this appendix appear alphabetically by group. The topics in this appendix are:

> **See Also:** *Oracle Database Platform Guide for Microsoft Windows (32-Bit)* for Windows-based messages and for all other messages refer search online at
>
> `http://tahiti.oracle.com`

Overview of Oracle Real Application Clusters-Specific Messages

Within Oracle Database 10*g*, Oracle RAC messages use the same ORA prefix and reside in the same `e*.msg` files as single-instance Oracle database messages. Additionally, some Oracle RAC messages are issued by the single-instance Oracle database. These messages appear online by way of a Tahiti error message search as described in the Oracle database documentation in the Preface of this book under the heading "Related Documents" on page -xiv.

Prefixes and Message Codes for Oracle RAC-Specific Messages

Message prefixes indicate where to find information about the messages in this chapter. In addition, the prefixes indicate which Oracle RAC component issued the messages.

Types of Oracle Real Application Clusters Messages and Related Files

The Oracle RAC high availability and **cluster database** management tools use the following syntax for internal messages:

```
PRKx-0000: Cause description "variable" text {variable} text {variable}
```

A message might appear as follows:

```
PRKC-1022 "Could not get "node name" for node {0} in {1}"
```

The variables in the previous example represent numbers, names, and character strings for objects in the physical or logical cluster and the cluster database. you can ignore empty variables.

PRKA—Cluster Node Applications Messages

PRKA-2001: GSD already exists

Cause: An attempt was made to create the Global Services Daemon (GSD) application while there is a running GSD application.

Action: Stop and remove the running GSD and create the GSD application again using the 'srvctl add nodeapps' command.

PRKA-2002: Listener already exists

Cause: An attempt was made to create a Listener application while there is a running Listener application.

Action: Stop and remove the running Listener and create the Listener application again using the 'srvctl add nodeapps' command.

PRKA-2003: EM Agent already exists

Cause: An attempt was made to create an Agent application while there is a running Agent application.

Action: Stop and remove the running Agent and create the Agent application again using the 'srvctl add nodeapps' command.

PRKA-2004: No database found for the cluster.

Cause:

Action:

PRKA-2005: Netmasks are different for starting and ending IP addresses

Cause: Invalid range of VIP addresses specified for the cluster.

Action: Check if the starting and ending addresses in the VIP range belong to the same netmask.

PRKA-2006: Invalid VIP address range

Cause: Invalid range of VIP addresses specified for the cluster.

Action: Check if the starting address is less than ending address.

PRKA-2007: Empty VIP address range

Cause: Invalid range of VIP addresses specified for the cluster.

Action: Enter valid non-null VIP address range.

PRKA-2008: No VIP address is available in the VIP pool

Cause: No IP addresses are available for use in the range of IP addresses that you specified earlier.

Action: Check the VIP address pool to ensure that you are using valid VIP addresses.

PRKA-2009: VIP address is not found

Cause: IP address is not found.

Action: Enter valid VIP address.

PRKA-2010: VIP address already exists

Cause: An attempt was made to create a Virtual IP while there is a running Virtual IP application.

Action: Stop and remove the running Virtual IP application and create the Virtual IP application using the 'srvctl add nodeapps' command.

PRKA-2011: Remote command failed - not used?

Cause: The command failed to execute on remote node.

Action: Check the command for syntax and semantics and reissue the command.

PRKA-2012: Failed to get the VIP address range configuration from the OCR

Cause: There might not be any IP address ranges in the OCR or it is possible that an OCR error occurred while retrieving the VIP address range.

Action: Refer to the OCR logs for detailed error information.

PRKA-2013: Failed to add the VIP address range configuration to the OCR

Cause: An OCR error occurred while adding the VIP address range into the OCR.

Action: Refer to the OCR logs for detailed error information.

PRKA-2014: Failed to remove the VIP address range configuration from the OCR

Cause: An OCR error occurred while adding the VIP address range into the OCR.

Action: Refer to the OCR logs for detailed error information.

PRKA-2015: Invalid node name

Cause: The node name that you entered does not belong to the cluster.

Action: Enter a node that belongs to the cluster.

PRKA-2016: Invalid listener name

Cause: The listener name entered is invalid.

Action: Correct the listener name.

PRKA-2017: There are no IP addresses in the specified range. Make sure to specify the correct range for the IP addresses.

Cause:

Action: Specify valid range for IP addresses.

PRKA-2018: Virtual IP can only be created or removed by the system privilege user.

Cause: Only users with administrative privileges can configure Virtual IPs on the system.

Action: Verify the privileges of the user who is attempting to create or remove the VIP address.

PRKA-2019: Error executing command \"{0}\". File is missing.

Cause:

Action:

PRKC—Cluster Command Messages

PRKC-1023: Invalid IP address format: {0}

Cause: The given IP address does not adhere to the IP address format standard.

Action: Use the correct IP address format.

PRKC-1024: Invalid netmask: {0}

Cause: The given netmask format does not adhere to the format standard.

Action: Change the netmask format to a valid netmask format.

PRKC-1025: Failed to create a file in directory {0}

Cause: Might be due to insufficient permission or due to insufficient disk space.

Action: Check the permission on the directory and available space.

PRKC-1026: Failed doing I/O to file {0}

Cause: Might be due to insufficient permission or due to insufficient disk space or network issue.

Action: Check the permission on the directory and available space. Make sure the storage medium is accessible.

PRKC-1027: Error checking existence of file {0} on {1}

Cause: Might be due to an improper user equivalence configuration or due to insufficient permissions on the parent directory.

Action: Verify that user equivalence is correctly configured and that the directory has read and execute permissions.

PRKC-1028: Error checking write permission for directory {0} on {1}

Cause: Might be due to an improper user equivalence configuration or due to insufficient permissions on the parent directory.

Action: Verify that user equivalence is correctly configured and that the directory has read and execute permissions.

PRKC-1029: Failed to get modification time for file {0} on node {1}, [2]

Cause: Might be due to an improper user equivalence configuration or due to insufficient permissions on the parent directory.

Action: Verify that user equivalence is correctly configured and that the directory has read and execute permissions.

PRKC-1030: Error checking accessibility for node {0}, {1}

Cause: Might be due to a network issue or to an improper user equivalence setup.

Action: Check node reachability between the local and the remote nodes and make sure user equivalence is correctly configured.

PRKC-1031: Error checking free space for {0} on {1}

Cause: Might be due to a network issue or to an improper user equivalence setup.

Action: Check node reachability between the local and the remote nodes and make sure that user equivalence is correctly configured.

PRKC-1032: Directory {0} does not exist

Cause: The specified directory does not exist.

Action: Make sure that the specified directory exists. Use an absolute path for the directory.

PRKC-1033: Executable {0} does not exist

Cause: The specified executable does not exist.

Action: Verify the existence of the executable before retrying.

PRKC-1034: No local node name found for host {0}

Cause: The local node may not be part of the cluster or an error may have occurred while retrieving the local node name.

Action: Check CRS logs in ORA_CRS_HOME/log/<hostname> and OCR logs in ORA_CRS_HOME/srvm/log.

PRKC-1035: Node names for this cluster could not be retrieved

Cause: An error occurred while retrieving node names from the cluster.

Action: Check CRS logs in ORA_CRS_HOME/log/<hostname> and OCR logs in ORA_CRS_HOME/srvm/log.

PRKC-1036: CRS_HOME name passed to the method was null

Cause: The CRS home name cannot be null.

Action: Pass non-null CRS_HOME to the method.

PRKC-1037: Error removing files listed in {0} from node {1}

Cause: Might be due to an improper user equivalence configuration or due to insufficient permissions.

Action: Verify that user equivalence is correctly configured and that the mentioned files have the correct permissions.

PRKC-1038: Error copying files listed in {0} to node {1}

Cause: Might be due to an improper user equivalence configuration or due to insufficient permissions.

Action: Verify that user equivalence is correctly configured and that the mentioned files have the correct permissions.

PRKC-1039: Error creating directories listed in {0} on node {1}

Cause: Might be due to an improper user equivalence configuration or due to insufficient permissions.

Action: Verify that user equivalence is correctly configured and that the mentioned files have the correct permissions.

PRKC-1040: Remote Shell is not known yet.

Cause: User equivalence is not yet configured.

Action: Configure user equivalence.

PRKC-1041: Remote Copy command is not known yet.

Cause: User equivalence is not yet configured.

Action: Configure user equivalence.

PRKC-1042: The Remote Shell {0} requested by client is not recognized

Cause: The system does not recognize the given remote shell command.

Action: Use ssh or rsh as the remote shell.

PRKC-1043: The Remote Copy command {0} requested by client is not recognized

Cause: The system does not recognize the given remote copy command.

Action: Use scp or rcp for remote copy.

PRKC-1044: Failed to check remote command execution setup for node {0} using shells {1} and {2}

Cause: Could not find the remote shell commands {1} and {2} on node {0}.

Action: Configure user equivalence. Use environment variables to pass remote shell commands.

PRKC-1045: Node name is null

Cause: Node name received is null.

Action: Pass non-null node name to method/command.

PRKC-1046: The file list passed to the method was null

Cause: The list of files obtained is null.

Action: Pass non-null file list to method.

PRKC-1047: The directory list passed to the method was null

Cause: The list of directories obtained is null.

Action: Pass non-null directory list to method.

PRKC-1048: {0} is not supported on Windows platform

Cause: Unsupported operation.

Action: Do not attempt {0} on Windows.

PRKC-1049: CRS is not supported in version {0}. It is supported from version {1} onwards

Cause: Unsupported operation.

Action: Upgrade to version {1} before attempting CRS commands.

PRKC-1050: EVM is not supported in version {0}. It is supported from version {1} onwards

Cause: Unsupported operation.

Action: Upgrade to version {1} before attempting to use EVM.

PRKC-1051: Invalid data to set for registry key {0}.

Cause: Data validation failed for registry operation.

Action: Check data passed as value for registry key {0}.

PRKC-1052: Invalid data type for registry key {0}.

Cause: Data validation failed for registry key {0}.

Action: Check data type of value for registry key {0}.

PRKC-1053: Error returned from node {0} is \"{1}\"

Cause:

Action: Contact your customer support representative.

PRKC-1054: Node {0} is not accessible

Cause: Might be due to a network issue or due to an improper user equivalence configuration.

Action: Contact your network or system administrator to verify connectivity and the health of node {0}.

PRKC-1055: Directory name passed was null

Cause:

Action: Ensure non-null directory name is passed to command.

PRKC-1056: Failed to get the hostname for node {0}

Cause: Unable to fetch the hostname.

Action: Check hostname of node {0}.

PRKC-1057: The computername and hostname do not match for node {0}. Make sure that they match.

Cause:

Action: Contact your network or computer administrator to reconfigure the computer name and/or the hostname before re-attempting the operation.

PRKC-1058: The hostname registry key {0} has an empty value on node {1}

Cause: Null value was passed for the registry key {0}.

Action: Contact your customer service representative.

PRKC-1059: The computername registry key {0} has an empty value on node {1}

Cause: Null value was passed for the registry key {0}.

Action: Contact your customer service representative.

PRKC-1060: Cluster misconfigured on node \"{0}\", \"{1}\" property in {2} does not match with configured data in Oracle Cluster Registry

Cause: Improper setup for the cluster.

Action: Contact your customer service representative.

PRKC-1061: Failed to list contents of the directory {0}

Cause: Might be due to insufficient permission.

Action: Check the permission and the contents of directory {0}.

PRKC-1062: Node list is null

Cause: The node list is null.

Action: Pass non-null node list to method/command.

PRKC-1063: Node list {0} contained {1} nodes, minimum number of nodes required is {2}

Cause:

Action: Modify nodelist to contain appropriate number of nodes before retrying method/command.

PRKC-1064: Node list {0} contained {1} nodes whereas the cluster has {2} nodes

Cause: The node list that is configured for the cluster does not match the given node list.

Action: Modify the nodelist to contain {2} nodes.

PRKC-1065: Nodes {0} do not belong to this cluster

Cause: The provided nodes are not configured for the cluster.

Action: Remove the invalid nodes that do not belong to cluster.

PRKC-1066: Failed to retrieve node number for node \"{0}

Cause: Cluster was not properly setup.

Action: Check CRS logs for detailed error information.

PRKC-1067: File name is null

Cause:

Action: Change file name to non-null value and retry method invocation.

PRKC-1068: Failed to get private interconnect node name for node {0}, {1}

Cause: Cluster was not properly setup.

Action: Check logs for detailed error information.

PRKC-1069: Failed to get sub keys of \"{0}\" registry key, {1}

Cause: Either the parent or the sub-key does not exist.

Action: Contact your customer service representative.

PRKC-1070: Failed to get sub keys of \"{0}\" registry key on node \"{1}\", {2}

Cause: Either the parent or the sub-key does not exist.

Action: Contact your customer service representative.

PRKC-1071: Nodes \"{0}\" did not respond to ping in \"{1}\" seconds, {2}

Cause: The node might be down or there could be a network outage.

Action: Contact your network administrator to verify connectivity between the specified nodes.

PRKC-1072: Invalid node \"{0}\" specified for checking the result of operation

Cause: Node name validation for the operation failed.

Action: Check the value of node {0}. Specify valid values for the nodes.

PRKC-1073: Failed to transfer directory \"{0}\" to any of the given nodes \"{1}\". {2}

Cause: Could not copy the directory \"{0}\" to any of the given nodes \"{1}\".

Action: Verify that user equivalence is properly configured. Check the log files for details.

PRKC-1074: Error on node {0}:{1}

Cause:

Action: Contact your customer support representative.

PRKC-1075: User equivalence does not exist with nodes \"{0}\", {1}

Cause: User equivalence was not configured.

Action: Contact your system administrator to verify user equivalence between the specified nodes.

PRKC-1076: Oracle Home is null

Cause:

Action: Contact your customer support representative.

PRKC-1077: List file {0} has the following invalid files:{1}

Cause: Filename validation failed for the given files.

Action: Remove invalid entries from list file.

PRKC-1078: Failed to transfer directories listed in \"{0}\" to any of the given nodes \"{1}\": {2}

Cause: Could not copy the directory \"{0}\" to any of the given nodes \"{1}\".

Action: Verify that user equivalence is properly configured. Check the log files for details.

PRKC-1079: {0} is not contained within an Oracle Home

Cause:

Action: Use {0} contained within an Oracle home.

PRKC-1080: Failed to transfer file \"{0}\" to any of the given nodes \"{1}\". {2}

Cause: Could not copy the file \"{0}\" to any of the given nodes \"{1}\".

Action: Verify that user equivalence is properly configured. Check the log files for details.

PRKC-1081: Failed to transfer listed files in \"{0}\" to any of the given nodes \"{1}\". {2}

Cause: Could not copy the files \"{0}\" to any of the given nodes \"{1}\".

Action: Verify that user equivalence is properly configured. Check the log files for details.

PRKC-1082: Failed to create listed directory in \"{0}\" to any of the given nodes \"{1}\". {2}

Cause: Could not create the directory \"{0}\" to any of the given nodes \"{1}\".

Action: Verify that user equivalence is properly configured. Verify the permissions for the parent directory on the given nodes.

PRKC-1083: Failed to remove listed directory in \"{0}\" to any of the given nodes \"{1}\". {2}

Cause: Could not remove the directory \"{0}\" to any of the given nodes \"{1}\".

Action: Verify that user equivalence is properly configured. Verify the permissions for the parent directory on the given nodes.

PRKC-1084: Failed to create path \"{0}\" in any of the given nodes \"{1}\". {2}

Cause: Could not create the path \"{0}\" to any of the given nodes \"{1}\".

Action: Verify that user equivalence is properly configured. Verify the permissions for the parent directory on the given nodes.

PRKC-1085: Failed to retrieve Oracle private name for node \"{0}\"

Cause: Cluster is not properly configured.

Action: Check whether node {0} is part of the cluster. If so, contact your customer support representative. If not, correct node name.

PRKC-1086: Unknown path type \"{0}\" specified for path \"{1}\" existence check

Cause: Unknown path type.

Action: Specify a valid path type for the path existence check.

PRKC-1087: Failed to retrieve virtual IP for node \"{0}\"

Cause: Cluster is not properly configured.

Action: Check whether node {0} is part of the cluster. If so, contact your customer support representative. If not, correct node name.

PRKC-1088: Failed to recursively list files from the directories specified in file: {0}

Cause: File access issue.

Action: Verify that the files exist and make sure that the files permissions are correct.

PRKC-1089: List file {0} is empty

Cause: An empty list file was passed to a transfer/copy command.

Action: Edit the contents of the list file before reattempting the command.

PRKC-1090: Failed to update environment on nodes \"{0}\", {1}

Cause: Might be due to improper privilege.

Action: Check user privilege on nodes \"{0}\".

PRKC-1091: The include list file passed is null

Cause:

Action: Pass non-null include file list to retry command/method.

PRKC-1092: Failed to retrieve the location of votedisks: {0}

Cause: Node name passed to command is not part of cluster.

Action: Invalid node name passed to command. Use a name for a node that is part of the cluster.

PRKC-1093: Failed to retrieve the version of crs software on node \"{0}\" : {1}

Cause: Cluster is not setup properly.

Action: Contact your customer support representative.

PRKC-1094: Failed to retrieve the active version of crs: {0}

Cause: Cluster is not setup properly.

Action: Contact your customer support representative.

PRKC-1095: OLE initialization or OCX load error while registering OCX library on nodes \"{0}\", {1}

Cause: Cluster is not setup properly.

Action: Contact your customer support representative.

PRKC-1096: Failed to do node reboot on nodes \"{0}\", {1}

Cause: Cluster is not setup properly.

Action: Contact your customer support representative.

PRKC-1097: PRKC- The file, \"{0}\" is not an OCX

Cause: Cluster is not setup properly.

Action: Contact your customer support representative.

PRKC-1098: Failed to create new listfile with proper UNC path from the path specified in file: {0}

Cause: Internal error.

Action: Contact your customer support representative.

PRKC-1099: The host names or IP addresses passed as an argument are null

Cause:

Action: Pass non-null arguments for hostnames or IP addresses.

PRKC-1100: The network port {0} is already in use

Cause: Preoccupied network port {0}.

Action: Free port {0} for use by CRS infrastructure.

PRKC-1101: The network port {0} is not available for use.

Cause: The port {0} might be used by another application.

Action: Make port {0} available for use.

PRKC-1102: CSS is not configured with local-only OCR on node \"{0}\"

Cause: CSS is not configured to run in a stand alone environment.

Action: Follow the documentation to setup CSS properly.

PRKC-1102: CSS is not configured with local-only OCR on node \"{0}\"

Cause: CSS is not configured to run in a standalone environment.

Action: Follow the documentation to setup CSS properly.

PRKC-1103: Failed to check CSS status for any of the given nodes \"{0}\", {1}

Cause: CSS might be down. User equivalence might not be set or there could be a network issue.

Action: Check the logs to see details.

PRKC-1104: Property, \"{0}\" is not found in file \"{1}\"

Cause: File \"{1}\" does not contain the property \"{0}\".

Action: Check the file '{1}'.

PRKC-1105: Failed to retrieve the local CSS home for node \"{0}\"

Cause: Cluster is not setup properly.

Action: Contact your customer support representative.

PRKC-1106: Failed to remove file \"{0}\" on node \"{1}\", {2}

Cause: Could not remove the file \"{0}\" on node \"{1}\".

Action: Verify that user equivalence is properly configured. Verify the permissions for the parent directory as well as for the file on the given nodes.

PRKC-1107: Failed to create symbolic link from file \"{0}\" to \"{1}\" on node \"{2}\", {3}

Cause: Could not create symbolic link.

Action: Verify that user equivalence is properly configured. Verify the permissions for the parent directory as well as for the file on the given nodes.

PRKC-1108: Failed to copy file \"{0}\" on node \"{1}\" to file \"{2}\" on node \"{3}\", {4}

Cause: Could not copy the file \"{0}\" on node \"{1}\".

Action: Verify that user equivalence is properly configured. Verify the permissions for the parent directory as well as for the file on the given nodes.

PRKC-1109: Failed to move file \"{0}\" to file \"{1}\" on node \"{2}\", {3}

Cause: Could not move the file \"{0}\" to file \"{1}\" on node \"{2}\".

Action: Verify that user equivalence is properly configured. Verify the permissions for the parent directory as well as for the file on the given nodes.

PRKC-1110: Failed to create directory \"{0}\" on node \"{1}\", {2}

Cause: Could not create the directory \"{0}\" on node \"{1}\".

Action: Verify that user equivalence is properly configured. Check the log files for details.

PRKC-1111: Failed to remove directory \"{0}\" on node \"{1}\", {2}

Cause: Could not remove the directory \"{0}\" on node \"{1}\".

Action: Verify that user equivalence is properly configured. Check the log files for details.

PRKC-1112: Failed to list contents of directory \"{0}\" on node \"{1}\", {2}

Cause: Could not read the directory \"{0}\" on node \"{1}\".

Action: Verify that user equivalence is properly configured. Check the log files for details.

PRKC-1113: Directory \"{0}\" does not exist on node \"{1}\"

Cause: The mentioned directory does not exist.

Action: Check for existence of directory {0}. Use absolute path for the directory.

PRKC-1114: Registry key name is null

Cause:

Action: Correct registry key name passed to command.

PRKC-1115: Registry subkey name is null

Cause:

Action: Correct registry subkey name passed to command.

PRKC-1116: Failed to create registry subkey \"{0}\" under key \"{1}\" on node \"{2}\", [3]

Cause: Registry operation failed.

Action: See logs for detail.

PRKC-1117: Failed to delete registry subkey \"{0}\" under key \"{1}\" on node \"{2}\", [3]

Cause: Registry operation failed.

Action: See logs for detail.

PRKC-1118: Failed to check existence of registry key \"{0}\" on node \"{1}\", [2]

Cause: Registry operation failed.

Action: See logs for detail.

PRKC-1119: Failed to set data for value \"{0}\" of registry key \"{1}\" on node \"{2}\", [3]

Cause: Registry operation failed.

Action: See logs for detail.

PRKC-1120: Failed to retrieve data for value \"{0}\" of registry key \"{1}\" on node \"{2}\", [3]

Cause: Registry operation failed.

Action: See logs for detail.

PRKC-1121: Failed to delete value \"{0}\" of registry key \"{1}\" on node \"{2}\", [3]

Cause: Registry operation failed.

Action: See logs for detail.

PRKC-1122: Service name is null

Cause: Empty service name provided.

Action: Reattempt the command with a non-null service name.

PRKC-1123: Failed to create service \"{0}\" on node \"{1}\", [2]

Cause:

Action: Please refer to logs for detailed error information.

PRKC-1124: Failed to create service dependency between services \"{0}\" and \"{1}\" on node \"{2}\", [3]

Cause:

Action: Please refer to logs for detailed error information.

PRKC-1125: Failed to start service \"{0}\" on node \"{1}\", [2]

Cause:

Action: Please refer to logs for detailed error information.

PRKC-1126: Failed to stop service \"{0}\" on node \"{1}\", [2]

Cause:

Action: Please refer to logs for detailed error information.

PRKC-1127:Failed to delete service \"{0}\" on node \"{1}\", [2]

Cause:

Action: Please refer to logs for detailed error information.

PRKC-1128: Invalid Interface type {0} is specified as an argument.

Cause:

Action: Correct interface type before retrying command.

PRKC-1129: Invalid IP address type {0} is specified as an argument.

Cause:

Action: Change IP address type before reattempting command.

PRKC-1130: Version argument is null.

Cause:

Action: Correct version argument and retry method invocation.

PRKC-1131: Failed to set user permissions on path {0} on nodes {1}, [{2}]

Cause: Might be due to improper user equivalence setup.

Action: Verify that user equivalence is correctly configured.

PRKC-1132: Failed to set administrator permissions on path {0} on nodes {1}, [{2}]

Cause: Might be due to improper user equivalence setup.

Action: Verify that user equivalence is correctly configured.

PRKC-1133: Names of services on which this service \"{0}\" is dependent on is null.

Cause:

Action: Invalid dependency list passed to method. Correct dependency list and retry command.

PRKC-1134: Failed to remove service dependency between services \"{0}\" and \"{1}\" on node \"{2}\", [3]

Cause:

Action: Refer to logs for detailed error information.

PRKC-1135: Registry key name {0} is not valid, it must be fully defined registry key path

Cause: Invalid registry key format.

Action: Provide valid registry key path.

PRKD—Global Services Daemon Messages

PRKD-3000: Failed to initialize and register with clusterware

Cause: This can occur if cluster synchronization services was not functioning properly.

Action: Check the state of your clusterware by running olsnodes from ORA_CRS_HOME/bin. It should list the nodes in the cluster.

PRKD-3001: Ready to receive client requests

Cause: Global Services Daemon is ready.

Action: No action needed at this time.

PRKE—Global Services Daemon Controller Utility Messages

PRKE-1008: Failed to get list of active nodes from clusterware

Cause: Not operating in cluster mode, failure to load srvm libraries, failure to initialize clusterware context.

Action: Verify the health of the Oracle Clusterware by running the "lsnodes" command to obtain a list of the active nodes in the cluster. Also verify the presence of the SRVM libraries in the load library path. If the active node list is correct and the SRVM libraries are in the load path, then contact your customer support representative.

PRKE-1009: Failed to start GSD on local node

Cause: GSD is already running on the local node, or GSD could not be started because of some other reason.

Action: Run "srvctl status" to check if a daemon is already running on the local node. If a daemon is not running on local node, please contact your customer support representative to check for the other reasons for failure.

PRKE-1010: Failed to stop GSD on local node

Cause: GSD is not running on the local node, or GSD could not shutdown gracefully.

Action: Run "srvctl status" to check if a GSD is running on the local node. If a GSD is running, please contact your customer support representative to check for other reasons for failure.

PRKE-1011: Failed to get status of GSD on local node

Cause: Failure to get the list of active nodes from the cluster, or failure to query the list of live daemons from the clusterware.

Action: Run "lsnodes" to check the health of the clusterware. If the clusterware is working fine, check for the presence of srvm libraries in the load library path. If the libraries are present, please contact your customer support representative for further assistance.

PRKH—Server Manager (SRVM) Messages

PRKH-1000: Unable to load the SRVM HAS shared library

Cause: The system cannot find, or load the srvm has shared library.

Action: Check your system's library load path. Verify that the library exists, and that the libraries it depends on are readable and are in the load path.

PRKH-1001: HASContext Internal Error

Cause: An unexpected internal error has occurred while attempting to communicate with CRS.

Action: Contact Oracle support.

PRKH-1002: Internal HASContext Error: JNI Native Call Failure

Cause: An unexpected internal error has occurred while executing native code from java.

Action: Contact Oracle support.

PRKH-1003: Failed to allocate memory in native layer:

Cause: The SRVM framework was unable to allocate memory.

Action: Your system is running low on memory. Check the memory and swap space, resolve the problem and retry.

PRKH-1004: Failed to execute remote join cluster alias {0} for nodes:

Cause: Unable to execute a join cluster alias operation on another node.

Action: Check the failed nodes. Verify that the system can execute remote commands on those nodes. Check the cluster alias and its related functionality.

PRKH-1005: Failed to execute remote leave cluster alias {0} for nodes:

Cause: Unable to execute a leave cluster alias operation on another node.

Action: Check the failed nodes. Verify that the system can execute remote commands on those nodes. Check the cluster alias and its related functionality.

PRKH-1006: The following nodes are either not active or not configured:

Cause: The system was unable to find a node requested.

Action: Please check the node list supplied and verify that the node is available and configured.

PRKH-1007: Exception Caused by:

Cause: The current exception was caused by another earlier exception.

Action: Examine all of the nested exceptions to determine the root cause of the error.

PRKH-1008: Internal HASContext Error: Argument {0} must be set.

Cause: Internal software error.

Action: Contact Oracle support.

PRKH-1009: CRS HOME must be defined in the environment or in the Oracle Cluster Registry

Cause: The system is unable to determine the ORA_CRS_HOME for this CRS installation.

Action: Check that the Oracle Cluster Registry is properly configured and available to this node.

PRKH-1010: Unable to communicate with CRS services

Cause: The system is unable to communicate with the Oracle Clusterware services.

Action: Check that all of the CRS daemons are running and are properly configured. Verify that the current program is attempting to communicate with the correct CRS daemons.

PRKH-1011: Process does not have sufficient privileges to perform the requested operation. {0}

Cause: The user running the current operation is not permitted to execute a given operation.

Action: Check other messages in the error stack to determine which operation failed. Verify that you are running the operation as the correct user.

PRKH-1012: Unable to find or resolve user {0}

Cause: The system was unable to find the username supplied.

Action: Check the username and try again.

PRKH-1013: The oracle home {0} does not exist

Cause: The system was unable to find the oracle home supplied.

Action: Check the full path of the oracle home and try again.

PRKI—Cluster Pre-Install Messages

PRKI-2059 Unable to copy files to the nodes

Cause: Lack of permission to create destination file or copy file to the destination location.

Action: Verify permission to create the destination file. Also, please make sure that the destination file is not currently in use.

PRKI-2060 Unable to create service on the nodes

Cause: Lack of permission to create the service, or service already exists.

Action: Verify that you have the permission to create a service on the destination node or nodes. Also, verify that the service does not already exist.

PRKI-2061 Unable to start service on the nodes

Cause: Service is not created, service is already running, service marked for deletion, service could not be started properly.

Action: Try to start the service manually from the service control panel and check the Windows Error message that it gives.

PRKI-2061 Unable to start service on the nodes

Cause: This could be because of several possible problems: the service is not created, the service is already running, the service is marked for deletion, or the service could not be started properly.

Action: Try to start the service manually from the service control panel and check the Windows error message that it gives.

PRKI-2064 Unable to update registry entries on the nodes

Cause: Lack of permission to modify registry entries on the nodes, error while updating the registries.

Action: Verify permission to modify registry entries.

PRKI-2066 Unable to find an Oracle disk partition. Please exit from the wizard, create Oracle partitions and try again.

Cause: Absence of Oracle disk partition, failure to load OLM dll.

Action: Verify that OLM dll (oobjlib.dll) is present in the load path. Also, verify that the Oracle disk partitions are present by going to the Disk Administrator and looking for the partitions.

PRKI-2114 Cannot collect and verify hardware information for all the nodes. Press abort to exit the wizard or ignore to continue.

Cause: Failure to connect to the remote nodes while adding a node to a cluster. Failure to collect VIA information if VIA was chosen.

Action: If you are trying to add a node to an existing cluster, then attempt to map a drive letter to a drive on each of the remote nodes (using commands such as "net use"). Also, verify that the you have permission to start a temporary service on the remote nodes to collect VIA information, in case your system uses VIA.

PRKI-2116 Cannot connect to remote drive on node {0}

Cause: Failure to connect to remote node.

Action: Try to map a driver letter from the local node to the remote node using commands such as "net use".

PRKI-2119 Unable to delete files on {0}. Install may not succeed if files are not deleted

Cause: Files that you are trying to delete do not exist or are currently being used.

Action: If the files you are trying to delete do not exist, ignore this error. If the files you are trying to delete are currently being used, then stop the processes that are using the files and retry.

PRKI-2120 Unable to delete service {0} on {1}. Install may not succeed if services are not deleted

Cause: Service does not exist, or service could not be deleted.

Action: Check the service control panel to see if the service exists. If the service does not exist, ignore this error. If the service exists, try to delete it from the command line using utilities like "net" and "sc". If this fails, check the Windows error message returned by these commands.

PRKN—Server Manager (SRVM) System Library Messages

PRKN-1008: Unable to load the shared library "{0}" or a dependent library, from {1}={2} [{3}]

Cause: The SRVM framework was unable to load a shared library to perform native operations.

Action: Make sure that the library in question is installed and in a location where it can be loaded. Check the environment setting that determines shared library loading on your platform.

PRKN-1009: Native System Internal Error

Cause: An unexpected internal error occurred while attempting to execute a native operation from Java.

Action: Contact Oracle Support.

PRKN-1010: This system is not properly configured as a cluster

Cause: SRVM was unable to find the system libraries which are required in order to use the system as a cluster.

Action: Verify that the Oracle Clusterware installation succeeded and attempt to execute the 'srvctl status' command to obtain more diagnostic information.

PRKN-1011: Failed to retrieve value for "{0}" under registry key "{1}" on node "{2}", {3}

Cause: There was a problem accessing the Windows registry key.

Action: Open the Windows Registry editor on the node and verify that the Registry key exists and that it contains the subkey.

PRKO—Server Control (SRVCTL) Utility Messages

PRKO-2001: "Invalid command line syntax"

Cause: An invalid SRVCTL command line was entered.

Action: Use -h SRVCTL command line option to find out the correct command line syntax and re-enter the command.

PRKO-2002: "Invalid command line option: "

Cause: An invalid SRVCTL command line option was entered.

Action: Use -h SRVCTL command line option to find out the correct command line syntax and re-enter the command.

PRKO-2003: "Invalid command line option value: "

Cause: An invalid SRVCTL command line option value was entered.

Action: Use -h SRVCTL command line option to find out the correct command line syntax and re-enter the command.

PRKO-2004: "Repetition of command line option: "

Cause: Duplicate SRVCTL command line option was entered.

Action: Eliminate the duplicate and re-enter the command.

PRKO-2005: "Application error: Failure in getting Cluster Database Configuration for: "

Cause: An error occurred when getting Cluster Database configuration for the named database.

Action: Make sure that the database has been configured in Cluster Database Configuration Repository; make sure that GSDs are running on each node in the cluster.

PRKO-2005: "Application error: Failure in getting Cluster Database Configuration for: "

Cause: An error occurred when getting Cluster Database configuration for the named database.

Action: Verify that the database has been configured in the Oracle Cluster Registry; make sure that the GSDs are running on each node in the cluster.

PRKO-2006: "Invalid node name: "

Cause: An invalid node name was entered.

Action: Use the correct node name. A valid node name should match the output from 'lsnodes' and must not contain domain name.

PRKO-2007: "Invalid instance name: "

Cause: An invalid instance name was entered.

Action: Use the correct instance name for the database. Run the 'srvctl config database -d <db_name>' command to identify all instances of the database in the Oracle Cluster Registry.

PRKO-2008: "Invalid connect string: "

Cause: An invalid connect string was entered.

Action: Use the correct connect string syntax: <user>/<password>[as <role>].

PRKO-2009: "Invalid name/value string: "

Cause: An invalid environment name/value pair was entered during SRVCTL setenv command.

Action: Make sure that the correct name/value string format is used: <name>=<value>.

PRKO-2010: "Error in adding instance to node: "

Cause: An error occurred when adding instance to the Oracle Cluster Registry.

Action: Use the 'srvctl config database -d <db_name>' command to check if the database has been configured in the Oracle Cluster Registry; make sure that the GSDs are running on each node in the cluster.

PRKO-2011: "Error in removing instance: "

Cause: An error occurred when removing an instance from the Oracle Cluster Registry.

Action: Use the 'srvctl config database -d <db_name>' command to check if the database and instance have been configured in the Oracle Cluster Registry; make sure that the GSDs are running on each node in the cluster.

PRKO-2012: "Error in moving instance to node: "

Cause: An error occurred when changing the instance and node mapping in the Oracle Cluster Registry.

Action: Use the 'srvctl config database -d <db_name>' command to check if the database and instance have been configured in the Oracle Cluster Registry; make sure that the GSDs are running on each node in the cluster.

PRKO-2013: "Error in setting env: "

Cause: An error occurred when setting environment variables for a database or an instance.

Action: Use 'srvctl config database -d <db_name>' command to check if the database and/or the instance have been configured in the Oracle Cluster Registry; make sure that the GSDs are running on each node in the cluster.

PRKO-2014: "Error in unsetting env: "

Cause: An error occurred when unsetting environment variables for a database or an instance.

Action: Use the 'srvctl getenv' command to check if the environment variable exists for the database or instance; make sure that the database and/or the instance have been configured in the Oracle Cluster Registry; make sure that the GSDs are running on each node in the cluster.

PRKO-2015: "Error in checking condition of instance on node: "

Cause: Could not get status information of an instance.

Action: Use the 'srvctl config database -d <db_name>' command to check if the instance has been configured in the Oracle Cluster Registry; make sure that the GSDs are running on each node in the cluster.

PRKO-2016: "Error in checking condition of listener on node: "

Cause: Could not get status information of a listener.

Action: Check if the listener has been configured in the listener configuration file and if the database instance on the node is listed in SID_NAME in the listener configuration; make sure that GSDs are running on each node in the cluster.

PRKO-2017: "Service {0} is not supported on instance {1}."

Cause: The named instance is not configured in the service configuration.

Action: In service related operations, make sure that you operate on the instances that are configured for the service.

PRKO-2018: "Mutual exclusive command line options -c and -q cannot be used at the same time."

Cause: Both command line option -c and -q are specified on the command line.

Action: Use either one of the options, but not both.

PRKO-2019: Cannot change management policy when database is disabled. Either remove -y option or enable database before before running this command

Cause: The database resource attributes cannot be changed when it is in online state.

Action: Stop the database using the 'srvctl stop database' command and then re-run the command to change the policy.

PRKO-2101: "Instance is disabled: "

Cause: The instance is disabled and cannot be started.

Action: Enable the instance before starting.

PRKO-2102: "Service {0} is not supported on instance {1}."

Cause: The named instance is not configured in the service configuration.

Action: In service related operations, make sure you operate on the instances that are configured for the service.

PRKO-2104: "Error in checking condition of service: "

Cause: There is a problem with the CRS daemon, or the service resource is in an unknown state.

Action: Check whether the daemon is up and listening to the port that SRVCTL is communicating with. Check the service resource status.

PRKO-2105: "Error in checking condition of VIP on node: "

Cause: There is a problem with the CRS daemon, or the VIP resource is in an unknown state.

Action: Check whether the daemon is up and listening to the port that SRVCTL is communicating with. Check the VIP resource status.

PRKO-2106: "Error in checking condition of GSD on node: "

Cause: There is a problem with the CRS daemon, or the VIP resource is in an unknown state.

Action: Check whether the daemon is up and listening to the port that SRVCTL is communicating with. Check the VIP resource status.

PRKO-2108: "Node applications are still running on node: "

Cause: Node applications are running on the node.

Action: Stop the node applications before removing them.

PRKO-2109: "Invalid address string: "

Cause: Invalid address string.

Action: Use the correct format for address string.

PRKO-2112: "Some or all node applications are not removed successfully on node: "

Cause: There was a problem when removing the node applications.

Action: Details of the problem are given in the text.

PRKO-2113: "Instance {0} is already a preferred instance for service {1}."

Cause: The instance is configured as a preferred instance for the service.

Action: Pick another instance to configure.

PRKO-2114: "Instance {0} is already an available instance for service {1}."

Cause: The instance is configured as an available instance for the service.

Action: Select another instance to configure.

PRKO-2115: "Cannot remove node-level applications on node {0}, because a listener application exists. Remove the listener application first, then re-run this command."

Cause: A listener application exists.

Action: Remove the listener application first, then re-run this command.

PRKO-2116: "Error in checking condition of ONS daemon on node: "

Cause: There is a problem with the CRS daemon, or the ONS resource is in an unknown state.

Action: Check if the daemon is up and listening to the port that SRVCTL is communicating with. Check the ONS resource status.

PRKO-2117: "This command should be executed as the system privilege user."

Cause: User did not login as the system privilege user.

Action: Login as system privilege user and re-try.

PRKO-2118: "Error in checking condition of ASM instance {0} on node {1}."

Cause: There is a problem with the CRS daemon, or the ASM resource is in an unknown state.

Action: Check if the daemon is up and listening to the port that SRVCTL is communicating with. Check the ASM resource status.

PRKO-2119: "Error in checking enable/disable status of ASM instance {0} on node {1}."

Cause: There was some problem when checking the status of the ASM instance.

Action: Make sure that the Oracle Cluster Registry is functioning and that the CRS daemon is running.

PRKO-2120: "The internal database service {0} cannot be managed with srvctl."

Cause: The internal database service is not supposed to be a highly available service.

Action: Do not operate on the internal database service.

PRKP—Cluster Database Management Messages

PRKP-1000 "Cannot retrive configuration for cluster database {0}"

Cause: The cluster database configuration cannot be retrieved from the repository. This can occur either because the database was never registered, or because the repository itself has not been created.

Action: Check if the database has been configured by printing a list of all cluster databases using 'srvctl config'. If the repository has not been created, use 'srvconfig -init' to create it.

PRKP-1001 "Error starting instance {0} on node {1}"

Cause: The instance could not be started using the SQL*Plus startup command.

Action: Try starting the named instance manually using SQL*Plus to see why it failed.

PRKP-1002 "Error stopping instance {0} on node {1}"

Cause: The SQL*Plus shutdown command returned an error while stopping the instance.

Action: Try stopping the named instance manually using SQL*Plus to see why it failed.

PRKP-1003 "Startup operation partially failed"

Cause: Some components of the cluster database could not be started.

Action: See earlier error message for details.

PRKP-1004 "Shutdown operation partially failed"

Cause: Some components of the cluster database reported errors while being stopped.

Action: See earlier error messages for details.

PRKP-1005 "Failed to start up cluster database {0}"

Cause: The cluster database could not be started.

Action: See earlier error messages for details.

PRKP-1006 "Failed to shut down cluster database {0}"

Cause: The cluster database reported errors while being shut down.

Action: See earlier error messages for details.

PRKP-1007 "Failed to start all the listeners associated with all the instances of cluster database {0}"

Cause:

Action: Contact your customer support representative.

PRKP-1008 "Failed to start listeners associated with instance {0} on node {1}"

Cause:

Action: Contact your customer support representative.

PRKP-1009 "Failed to stop all the listeners associated with all the instances of cluster database {0}"

Cause: Either the listener name associated with an instance could not be determined, or "lsnrctl stop" failed for a listener.

Action: Verify that listener.ora contains a SID_LIST entry for each instance of the named database, and that the lsnrctl stop command succeeds for those listeners.

PRKP-1010 "Failed to stop all the listeners associated with instance {0} on node{1}"

Cause: Either the listener name associated with an instance could not be determined, or "lsnrctl stop" failed for a listener.

Action: Verify that listener.ora contains a SID_LIST entry for each instance of the named database, and that the lsnrctl stop command succeeds for those listeners.

PRKP-1011 "Failed to get all the listeners associated with instance {0} on node{1}"

Cause: The listener name associated with an instance could not be determined.

Action: Ensure that listener.ora contains a SID_LIST entry for the named instance.

PRKP-1012 "Invalid environment variable {0} setting for cluster database {1}"

Cause: The argument to the -t option is not of the form <name>=<value> or it contains special characters.

Action: Ensure that the -t option has an argument of the form <name>=<value>. Enclose the argument to the -t flag in quotes.

PRKP-1013 "{0}: undefined environment variable for cluster database {1}"

Cause: The named environment variable is not defined for the named cluster database.

Action: Set a value for the variable with "srvctl set env".

PRKP-1014 "{0}: undefined environment variable for instance {1} of cluster database {2}"

Cause: The named environment variable is not defined for the given instance.

Action: Set a value for the variable with "srvctl set env".

PRKP-1015 "{0}: undefined environment variable"

Cause: The named environment variable is not defined.

Action: Set a value for the named environment variable with "srvctl set env".

PRKP-1016 "Database {0} already enabled"

Cause: An attempt was made to enable a database that is already enabled.

Action: No action required.

PRKP-1017 "Instance {0} already enabled."

Cause: An attempt was made to enable an instance that is already enabled.

Action: No action required.

PRKP-1018 "Service {0} already enabled."

Cause: An attempt was made to enable a service that is already enabled.

Action: No action required.

PRKP-1019 "Database {0} already disabled."

Cause: An attempt was made to disable a database that is already disabled.

Action: No action required.

PRKP-1020 "Instance {0} already disabled."

Cause: An attempt was made to disable an instance that is already disabled.

Action: No action required.

PRKP-1021 "Service {0} already disabled."

Cause: An attempt was made to disable a service that is already disabled.

Action: No action required.

PRKP-1022 "The database {0} is still running."

Cause: An attempt was made to delete a database that is still running.

Action: Stop the database using 'srvctl stop database' before deleting the database.

PRKP-1023 "The instance {0} is still running."

Cause: An attempt was made to delete an instance that is still running.

Action: Stop the instance using 'srvctl stop instance' before deleting the instance.

PRKP-1024 "The service {0} is still running."

Cause: An attempt was made to delete a service that is still running.

Action: Stop the service using 'srvctl stop service' before deleting the service.

PRKP-1025 "The service {0} does not exist."

Cause: An attempt was made to operate on a non-configured service.

Action: Check if the service is configured through 'srvctl status service'.

PRKP-1026 "No instance found for database {0}."

Cause: An attempt was made to operate on a non-configured instance.

Action:

PRKP-1027 "Instance {0} is not found for database {1}."

Cause: An attempt was made to operate on a non-configured instance.

Action: Check if the instance is configured through 'srvctl config instance'.

PRKP-1028 "No preferred instance(s) for service {0}."

Cause: An attempt was made to create a service without preferred instances.

Action: Supply preferred instances for the service through 'srvctl create service'.

PRKP-1029 "Failed to register the service {0}."

Cause: Internal error.

Action: Contact support.

PRKP-1030 "Failed to start the service {0}."

Cause: Internal error.

Action: Contact support.

PRKP-1031 "Failed to stop the service {0}."

Cause: Internal error.

Action: Contact support.

PRKP-1032 "Cannot start the disabled service {0}."

Cause: Internal error.

Action: Contact support.

PRKP-1033 "Cannot relocate service {0} from instance {1} to instance {2}."

Cause: Internal error.

Action: Contact support.

PRKP-1034 "{0}: undefined environment variable for node {1}."

Cause: Internal error.

Action: Contact support.

PRKP-1035 "Invalid environment variable {0} setting for node {1}."

Cause:

Action: Contact support.

PRKP-1036 "Failed to unregister HA resource {0}."

Cause:

Action: Contact support.

PRKP-1037 "Failed to create cluster database {0}."

Cause:

Action: Contact support.

PRKP-1038 "Invalid instance {0} specified for the Service {1}."

Cause:

Action: Contact support.

PRKP-1039 "operation result is null"

Cause:

Action: Contact support.

PRKP-1041: "Failed to reload all the listeners associated with cluster database {0}"

Cause:

Action: Refer to CRS logs for detailed error information.

PRKP-1042: "Failed to reload all the listeners associated with instance {0} on node{1}"

Cause:

Action: Refer to CRS logs for detailed error information.

PRKP-1043: "Failed to reload listeners on node {0}"

Cause:

Action: Refer to CRS logs for detailed error information.

PRKP-1044 "Failed to enable the database {0}."

Cause:

Action: Contact support.

PRKP-1045 "Failed to disable the database {0}."

Cause:

Action: Contact support.

PRKP-1046 "Failed to enable the instance {0}."

Cause:

Action: Contact support.

PRKP-1048 "Failed to change configuration for service {0}."

Cause:

Action: Contact support.

PRKP-1049 "{0}: undefined environment variable for service {1} of cluster database {2}"

Cause: The environment variable is not defined for the service.

Action: No action required.

PRKP-1050 "Failed to remove the service {0}."

Cause: There was a problem while executing the crs_unregister command.

Action: Verify whether the crs_unregister command succeeds in unregistering a CRS resource.

PRKP-1051 "Failed to remove the service {0} on instance {1}."

Cause: There was a problem while executing the crs_unregister command.

Action: Verify whether the crs_unregister command succeeds in unregistering a CRS resource.

PRKP-1052 "Failed to enable the service {0}."

Cause: There was a problem while executing the crs_register command.

Action: Verify whether the crs_register command succeeds in registering a CRS resource.

PRKP-1053 "Failed to disable the service {0}."

Cause: There was a problem while executing the crs_register command.

Action: Verify whether the crs_register command succeeds in registering a CRS resource.

PRKP-1054 "Failed to enable the service {0} on instance {1}."

Cause: There was a problem while executing the crs_register command.

Action: Verify whether the crs_register command succeeds in registering a CRS resource.

PRKP-1055 "Failed to disable the service {0} on instance {1}."

Cause: There was a problem while executing the crs_register command.

Action: Verify whether the crs_register command succeeds in registering a CRS resource.

PRKP-1056 "Failed to get the status of the resource {0}."

Cause: There was a problem while executing the crs_stat command.

Action: Verify whether the crs_stat command gives the status of the CRS resources registered.

PRKP-1057 "Failed to set the environment for service {0}."

Cause: There was a problem while accessing the OCR.

Action: Check whether the OCR is accessible by executing a srvctl config command.

PRKP-1058 "Failed to unset the environment for service {0}."

Cause: There was a problem while accessing the OCR.

Action: Check whether the OCR is accessible by executing the srvctl config command.

PRKP-1059 "Failed to get the environment for service {0}."

Cause: There was a problem while accessing the OCR.

Action: Check whether the OCR is accessible by executing the srvctl config command.

PRKP-1060 "Failed to get CRS home."

Cause: Internal error.

Action: Contact support.

PRKP-1061 "Failed to modify the database {0}. "

Cause: Internal error.

Action: Contact support.

PRKP-1062 "Service {0} is already running."

Cause: Attempted to start a service that is already running.

Action: None required.

PRKP-1063 "Service {0} is already stopped."

Cause: Attempted to stop a service that is already stopped.

Action: None required.

PRKP-1064 "Service {0} is already running on instance {1}."

Cause: Attempted to start a service on an instance where it is already running.

Action: None required.

PRKP-1065 "Service {0} is already stopped on instance {1}."

Cause: Attempted to stop a service on an instance where it is already stopped.

Action: None required.

PRKP-1066 "Instance {0} is not an available instance for service {1}."

Cause:

Action: Contact support.

PRKP-1067 "Instance {0} is the last available instance for service {1}. Try modify service instead."

Cause:

Action: Contact support.

PRKP-1068 "Cannot stop the critical instance {0} in critical standby database {1} because it would result in a shutdown of the primary database."

Cause: Attempted to stop the critical instance in a critical standby database while the primary database is running.

Action: Do not stop the critical instance in a critical standby database while the primary database is running.

PRKP-1069 "Failed to change domain of the database {0} to {1}, because this domain name is already used by service {2} configured under the database."

Cause: Attempted to change the database domain when there are services configured with this domain.

Action: Do not change the database domain when there are services configured with that domain.

PRKP-1070 "Service name {0} contains illegal characters."

Cause: Invalid characters have been specified in the service name given.

Action: Supply a name for the service with the character set [a-zA-Z0-9_.].

PRKP-1071: "Database unique name or instance name {0} contains illegal characters {1}."},

Cause:

Action: Correct db/instance name before retrying method/command.

PRKP-1072 "Failed to create service {0} for database {1}, because the specified service domain name is the same as the database domain {2}."

Cause:

Action:

PRKP-1073 "Cannot create database {0} because a database named {1} already exists."

Cause: Attempted to create a database that already exists.

Action: Choose a different name for the database being created.

PRKP-1074 "Failed to relocate a service resource to instance {0} during modifying service configuration for service {1}."

Cause: Internal error.

Action: Contact support.

PRKP-1075 "Instance {0} is the last preferred instance for service {1}."

Cause: Internal error.

Action: Contact support

PRKP-1076: Instance name passed to the method is null

Cause: The Oracle instance SID that you are passing to this API cannot be null.

Action: Make sure that the Oracle instance is configure before this call. Check client specific error message for details.

PRKP-1077: Oracle home is null for the cluster database {0}

Cause: Oracle home specified cannot be null.

Action: Make sure Oracle home is properly set. Check client specific error message for more details.

PRKP-1078: Failed to retrieve \"{0}\" attribute value from \"{1}\" file, {2}"

Cause: An error occurred while retrieving CRS attribute value because of some CRS/OCR error.

Action: Refer to CRS or OCR logs in CRS home/log/<hostname> for detailed error information.

PRKP-1079: Cannot start service {0} on disabled database {1}

Cause: Service cannot be started on a database which is already disabled.

Action: Enable the database using 'srvctl enable database' before re-attempting command.

PRKP-1080: "Cannot start service {0} on disabled instance {1}."

Cause: Service cannot be started in an instance which is already disabled.

Action: Enable the instance using 'srvctl enable instance' before attempting to start the service.

PRKP-1081: Database name passed to the method is null

Cause: The database name cannot be null to perform the operation.

Action: Verify the database name that you are using and retry the command

PRKP-1082: Instance \"{0}\" does not exist in database \"{1}\"

Cause: The configuration information for this instance may not exist in the OCR, or the instance was never configured.

Action: Verify the instance name that you are using before retrying the command. Alternatively, verify the instances that are configured with a database by running the command 'srvctl config database -d <database>'.

PRKP-1083: The service {0} already exists.

Cause: You cannot have multiple database services with same name.

Action: Make sure you use unique service names for each database.

PRKP-1084: Database \"{0}\" cannot have more than \"{1}\" services

Cause: The database supports only 115 user services. You cannot configure more than 115 services.

Action: If you must add this service, then remove some of the unused services using the command 'srvctl removes services' before adding any new services.

PRKR—Cluster Registry Messages

PRKR-1001 "cluster database {0} does not exist"

Cause: The cluster database was never configured in the OCR.

Action: Check if the database has been configured by printing a list of all cluster databases using 'srvctl config'.

PRKR-1002 "cluster database {0} already exists"

Cause: An attempt was made to configure a cluster database that already exists in the OCR.

Action: Check if the database has already been configured by printing a list of all cluster databases using 'srvctl config'.

PRKR-1003 "instance {0} does not exist"

Cause: The named instance is not configured in the OCR.

Action: Use srvctl options to check if the instance was configured in the OCR.

PRKR-1004 "instance {0} already exists"

Cause: The named instance is already configured in the OCR.

Action: Use srvctl options to check if the instance has already been configured in the OCR.

PRKR-1005 "adding of cluster database {0} configuration failed, {1}"

Cause: An error occurred while attempting to add the cluster database configuration information to the OCR.

Action: Verify whether the OCR is accessible by using an 'ocrcheck' or 'srvctl config' command.

PRKR-1006 "deleting of cluster database {0} configuration failed, {1}"

Cause: Same as PRKR-1005.

Action: See earlier error messages.

PRKR-1007 "getting of cluster database {0} configuration failed, {1}"

Cause: Same as PRKR-1005.

Action: See earlier error messages.

PRKR-1008 "adding of instance {0} on node {1} to cluster database {2} failed, {3}"

Cause: Same as PRKR-1005.

Action: See earlier error messages.

PRKR-1009 "deleting of instance {0} from cluster database {1} failed, {2}"

Cause: Same as PRKR-1005.

Action: See earlier error messages.

PRKR-1010 "moving of instance {0} to node {1} of cluster database {2} failed, {3}"

Cause: Same as PRKR-1005.

Action: See earlier error messages.

PRKR-1011 "renaming of instance {0} to instance {1} of cluster database {2} failed, {3}"

Cause: Same as PRKR-1005.

Action: See earlier error messages.

PRKR-1016 "reading of cluster database {0} configuration failed, {1}, {2}"

Cause: Same as PRKR-1005.

Action: See earlier error messages.

PRKR-1017 "writing of cluster database {0} configuration failed, {1}, {2}"

Cause: Same as PRKR-1005.

Action: See earlier error messages.

PRKR-1018 "reading of directory failed, {0}, {1}"

Cause: Internal error.

Action: Contact your customer support representative.

PRKR-1019 "writing of directory failed, {0}, {1}"

Cause: Internal error.

Action: Contact your customer support representative.

PRKR-1020 "reading of version information failed, {0}, {1}"

Cause: Same as PRKR-1005.

Action: See earlier error messages.

PRKR-1021 "writing of version information failed, {0}, {1}"

Cause: Same as PRKR-1005.

Action: See earlier error messages.

PRKR-1022 "raw device {0} contains incompatible version, {1} != {2}"

Cause: An attempt was made to use an incompatible version of the OCR.

Action: Contact your customer support representative.

PRKR-1023 "file {0} does not exist"

Cause: The named file did not exist.

Action: Check if the file exists.

PRKR-1024 "file {0} does not have {1} permissions"

Cause: The named file did not have the specified permission.

Action: Try changing the permission on the file to the specified permission.

PRKR-1025 "file {0} does not contain property {1}"

Cause: The file did not contain the specified property.

Action: Contact your customer support representative.

PRKR-1026 "property {0} not set in file {1}"

Cause: The file did not contain the specified property.

Action: Contact your customer support representative.

PRKR-1027 "failed to retrieve list of cluster databases"

Cause: Same as PRKR-1005.

Action: See earlier error messages.

PRKR-1028 "raw device {0} is invalid\n[HINT: initialize raw device by using \"srvconfig\" tool]"

Cause: The cluster registry was never initialized.

Action: Use srvconfig -init to initialize the cluster registry.

PRKR-1038 "invalid argument {0} specified to -init option"

Cause:

Action:

PRKR-1039 "invalid option {0} specified"

Cause: The specified option was invalid.

Action: Check usage.

PRKR-1040 "missing <file> argument for {0} option"

Cause: The specified option was invalid for srvconfig.

Action: Check usage for details.

PRKR-1045 "raw device version \"{0}\""

Cause: Attempted to retrieve the version of the cluster registry.

Action: No action is required.

PRKR-1046 "srvconfig detected valid raw device \"{0}\"\n[HINT: please specify -init -f option to forcefully initialize it]"

Cause: A valid cluster registry was detected.

Action: No action is required.

PRKR-1047 "raw device {0} is in use by daemon(s) on node(s) {1}"

Cause: An attempt was made to initialize the OCR while the Global Services Daemons were up on one or more nodes in the cluster.

Action: Stop all of the Global Services Daemons on all of the nodes in the cluster by running the 'srvctl stop' command on every node. Try the 'srvconfig -init' operation again.

PRKR-1050 "file {0} creation in {1} directory failed, check permissions, etc."

Cause: Attempted to create a file in a directory which did not exist or which d id not have the right permissions.

Action: Create the directory if it did not exist or change the permission of the directory.

PRKR-1051 "file {0} does not contain an entry for dbname {1}"

Cause: Internal error.

Action: Contact your customer support representative.

PRKR-1052 "file name {0} is not of <cluster database name>.conf form"

Cause: An attempt was made to register a cluster database in the OCR and the file argument passed was not of the <cluster database name>.conf form.

Action: Refer to the usage of the srvconfig command for more information.

PRKR-1053 "invalid range {0} specified in node_list = {1}"

Cause:

Action: Contact your customer support representative.

PRKR-1054 "invalid parameter {0} specified in inst_oracle_sid = {1}"

Cause: Extra number of arguments provided to srvconfig.

Action: See usage of srvconfig for details.

PRKR-1055 "invalid extra arguments {0} specified to {1} option"

Cause: Provided invalid arguments to srvconfig.

Action: See usage of srvconfig for details.

PRKR-1056 "invalid registry entry {0} found, should be of form {1}"

Cause: Detected an invalid registry entry while attempting to add a 8.1.7 or earlier version of Oracle Parallel Server in the OCR.

Action: Contact your customer support representative.

PRKR-1057 "environment variable does not exist"

Cause: Attempted to retrieve non existing environment variable.

Action: Set the environment variable.

PRKR-1058 "Service {0} does not exist in cluster database {1}."

Cause: The named service is not configured in the OCR.

Action: Use srvctl options to check whether the service was configured in the OCR.

PRKR-1059 "Node {0} does not exist."

Cause: Node applications for the named node are not configured in the OCR.

Action: Use srvctl options to check whether the node applications were configured for the given node in the OCR.

PRKR-1060 "Failed to add configuration for node {0}"

Cause:

Action: Contact your customer support representative.

PRKR-1061 "Failed to run remote command to get node configuration for node {0}"

Cause: An internal error occurred while retrieving the configuration for the given node.

Action: Contact your customer support representative.

PRKR-1062 "Failed to find configuration for node {0}"

Cause:

Action: Contact your customer support representative.

PRKR-1063 "VIP {0} is already existing"

Cause:

Action: Contact your customer support representative.

PRKR-1064 "SRVM configuration operation failed due to Oracle Cluster Registry error :"

Cause: Error occurred while accessing the Oracle Cluster Registry.

Action: Contact your customer support representative.

PRKR-1066 "cluster database domain does not match"

Cause:

Action: Contact your customer support representative.

PRKR-1067 "Failed to get environment for cluster database {0}, {1}"

Cause: Unable to retrieve the environment configuration for the given cluster database from the OCR.

Action: Use the ocrdump utility to check whether the environment was configured for the given cluster database in the OCR.

PRKR-1068 "Failed to get environment for instance {1} of cluster database {0}, {2}"

Cause: Unable to retrieve the environment configuration for the given instance from the OCR.

Action: Use ocrdump to check if environment was configured for the given instance in the OCR.

PRKR-1069 "Failed to set environment for cluster database {0}, {1}"

Cause: Unable to update the environment configuration for the given cluster database in the OCR.

Action: Contact your customer support representative.

PRKR-1070 "Failed to set environment for instance {1} of cluster database {0}, {2}"

Cause: Unable to update the environment configuration for the given instance to the OCR.

Action: Contact your customer support representative.

PRKR-1071 "Failed to unset environment for cluster database {0}, {1}"

Cause: Unable to update the environment configuration for the given cluster database in the OCR.

Action: Contact your customer support representative.

PRKR-1072 "Failed to unset environment for instance {1} of cluster database {0}, {2}"

Cause: Unable to update the environment configuration for the given instance in the OCR.

Action: Contact your customer support representative.

PRKR-1073 "\n########## Configuration of nodeapps follows ##########\n"

Cause:

Action: Contact your customer support representative.

PRKR-1074 "\n########## Configuration of vip_range follows ##########\n"

Cause:

Action: Contact your customer support representative.

PRKR-1075 "Insufficient privileges for doing this operation"

Cause: User did not have sufficient privileges when running this command.

Action: Execute this command as a privileged user.

PRKR-1076 "This command cannot run when the RAC daemons (crsd, evmd, ocssd) are running. Make sure the daemons are not running before invoking this command"

Cause: The RAC daemons were running when this command was invoked.

Action: Make sure that the RAC daemons have been stopped before running this command.

PRKR-1077 "One or more arguments passed to the function are not valid"

Cause: One or more invalid arguments were passed to the given method.

Action: Contact your customer support representative.

PRKR-1078 "Database {0} cannot be administered using current version of srvctl. Instead run srvctl from {1}"

Cause: Using incorrect SRVCTL version.

Action: Contact your customer support representative.

PRKR-1079 "Failed to initialize the Oracle Cluster Registry"

Cause: Failed to initialize the Oracle Cluster Registry.

Action: Contact your customer support representative.

PRKS—Automatic Storage Management Messages

PRKS-1000: "ASM instance "{0}" already exists on node "{1}"

Cause: An attempt was made to add configuration information for an ASM instance on the node where it already exists.

Action: Check whether the ASM instance was configured on the node using 'srvctl config asm -n <node>' before adding the configuration for it.

PRKS-1001: ASM instance "{0}" does not exist on node "{1}"

Cause: The configuration for the ASM instance does not exist on the node.

Action: Check whether the ASM instance was configured on the node using 'srvctl config asm -n <node>' before performing the operation.

PRKS-1002: Failed to create CRS profile for ASM instance "{0}" on node "{1}", [{2}]

Cause: 'crs_stat -p' command failed for the ASM instance resource on the node.

Action: Contact Oracle Support.

PRKS-1003: Failed to register CRS resource for ASM instance "{0}" on node "{1}", [{2}]

Cause: crs_register command failed for ASM instance resource on the node.

Action: Contact Oracle Support.

PRKS-1004: Failed to unregister CRS resource for ASM instance "{0}" on node "{1}", [{2}]" }

Cause: A crs_unregister command failed for the ASM instance resource on the node.

Action: Check if there is a database instance that is dependent upon the ASM instance on the node by running the command crs_stat -p ora.<db>.<inst>.inst and see if ASM instance resource name appears in the required resources for the database instance. Remove the database instance's required resource dependency on the ASM instance by running a 'srvctl modify asm' command before retrying this operation.

PRKS-1005: Failed to create CRS resource for ASM instance "{0}" on node "{1}", [{2}]

Cause: crs_register command failed for the ASM instance resource on the node.

Action: Contact Oracle Support.

PRKS-1006: ASM instance "{0}" is already running on node "{1}".

Cause: An attempt was made to start a running ASM instance on the node.

Action: None.

PRKS-1007: ASM instance "{0}" is still running on node "{1}".

Cause: An attempt was made to remove the configuration for a running ASM instance on the node.

Action: Stop the ASM instance using 'srvctl stop asm -n <node> -i <inst>' command before performing the remove operation.

PRKS-1008: ASM instance "{0}" is not running on node "{1}".

Cause: An attempt was made to stop a non-running ASM instance on the node.

Action: None.

PRKS-1009: Failed to start ASM instance "{0}" on node "{1}", [{2}]

Cause: crs_start failed for the ASM instance resource on the node, may be due to invalid startup credentials or missing parameter file.

Action: Check if VIP resource is online on the node and then try to startup the ASM instance using SQL*Plus to get more diagnostic information.

PRKS-1010: Failed to start ASM instances "{0}" on node "{1}", [{2}]

Cause: See above.

Action: See above.

PRKS-1011: Failed to check status of ASM instance "{0}" on node "{1}", [{2}]

Cause: crs_stat failed for the ASM instance resource on the node.

Action: Contact Oracle Support.

PRKS-1012: Failed to stop ASM instance "{0}" on node "{1}", [{2}]"

Cause: The crs_stop command failed for the ASM instances on the node. This may be due to a CRS resource dependency or because the user has invalid credentials for stopping ASM instances.

Action: Determine whether there are database instances that depend on the ASM instance on the node by running the crs_stat -p ora.<db>.<inst>.inst command. If ASM instance resource names appear in the required resources for the database instance, then stop the database instances first using the 'srvctl stop instance' command. Do this before retrying the ASM instance stop operation or try to stop the ASM instance using SQL*Plus to obtain more diagnostic information.

PRKS-1013: Failed to stop ASM instances "{0}" on node "{1}", [{2}]"

Cause: See above.

Action: See above.

PRKS-1014: Failed to enable CRS resource for ASM instance "{0}" on node "{1}", [{2}]

Cause: Failed to set the enable flag of the ASM instance configuration in the OCR.

Action: Verify that the OCR is accessible by running the 'srvctl config ' command.

PRKS-1015: Failed to enable CRS resources for ASM instances "{0}" on node "{1}", [{2}]"

Cause: See above for each ASM instance.

Action: Check whether the OCR is accessible by running the 'srvctl config ' command.

PRKS-1016: Failed to disable CRS resource for ASM instance "{0}" on node "{1}", [{2}]"

Cause: Failed to reset the enable flag of the ASM instance configuration in the OCR.

Action: Verify that the OCR is accessible by running the 'srvctl config ' command.

PRKS-1017: Failed to disable CRS resources for ASM instances "{0}" on node "{1}", [{2}]"

Cause: See above for each ASM instance.

Action: Verify that the OCR is accessible by running the 'srvctl config ' command.

PRKS-1019: Cannot create CRS dependency between database instance "{0}" configured on node "{1}" and ASM instance "{2}" configured on node "{3}".

Cause: An attempt was made to create a CRS dependency between a database instance and an ASM instance that is configured on a different node.

Action: Make sure that the database instance and the ASM instance are on the same node before creating a CRS dependency between them.

PRKS-1020: Failed to create CRS dependency between database instance "{0}" and ASM instance "{1}", [{2}]

Cause: 'crs_register -u' failed to create CRS dependency between the database instance and the ASM instance on the node.

Action: Contact Oracle support.

PRKS-1021: Failed to remove CRS dependency between database instance "{0}" and ASM instance "{1}", [{2}]

Cause: 'crs_register -u' command failed to remove CRS dependency between the database instance and the ASM instance on the node.

Action: Contact Oracle Support.

PRKS-1022: Failed to remove CRS dependency between database instance "{0}" and ASM instances "{1}", [{2}]

Cause: See above.

Action: See above.

PRKS-1023: Failed to remove CRS resource for ASM instance "{0}" on node "{1}", [{2}]

Cause: crs_unregister command failed to unregister CRS resource for the ASM instances on the node.

Action: Contact Oracle Support.

PRKS-1026: ASM Configuration for node "{0}" does not exist in cluster registry."

Cause: An attempt was made to retrieve names of ASM instances configured on the node without configuring any ASM instance on it.

Action: First configure ASM instance using 'srvctl add asm' on the node command before executing the get configuration operation.

PRKS-1027: Configuration for ASM instance "{0}" does not exist in cluster registry."

Cause: An attempt was made to retrieve node name for a given ASM instance name which is not configured on any cluster nodes.

Action: First configure ASM instance using 'srvctl add asm' command before executing the get configuration operation.

PRKS-1028: Configuration for ASM instance "{0}" on node "{1}" does not exist in cluster registry.

Cause: An attempt was made to retrieve configuration for the ASM instance on the node name where it was not configured.

Action: Use "srvctl config asm -n <node>' command to determine the ASM instance names configured on it and then pass one of these names as "-i <inst>" argument to 'srvctl config asm' command.

PRKS-1029: Client version "{0}" is not compatible with ASM instance configuration version "{1}" in cluster registry.

Cause: Version of the client that tried to retrieve ASM instance configuration is not compatible with ASM instance configuration version.

Action: Make sure client version is compatible with ASM instance configuration version before accessing it.

PRKS-1030: Failed to add configuration for ASM instance "{0}" on node "{1}" in cluster registry, [{2}]

Cause: Failed to add the configuration information for the ASM instance in the OCR.

Action: Verify that the OCR is accessible by executing 'srvctl config ' command.

PRKS-1031: "Failed to retrieve configuration for ASM instance "{0}" on node "{1}" from cluster registry, [{2}]

Cause: Failed to retrieve the configuration information for the ASM instance from the OCR.

Action: Verify that the OCR is accessible by executing 'srvctl config ' command.

PRKS-1032: Failed to modify configuration for ASM instance "{0}" on node "{1}" in cluster registry, [{2}]

Cause: Failed to modify the configuration information for the ASM instance on the node in the OCR.

Action: Verify that the OCR is accessible by executing 'srvctl config ' command.

PRKS-1033: Failed to remove configuration for ASM instance "{0}" on node "{1}" from cluster registry, [{2}]

Cause: Failed to remove the configuration information for the ASM instance from the OCR.

Action: Verify that the OCR is accessible by executing 'srvctl config ' command.

PRKS-1034: Failed to remove configuration for ASM instances "{0}" on node "{1}" from cluster registry, [{2}]"

Cause: See above.

Action: See above.

PRKS-1035: Failed to retrieve ORACLE_HOME value for ASM instance "{0}" on node "{1}" from cluster registry, [{2}]

Cause: Failed to retrieve the ORACLE_HOME from the ASM instance configuration in the OCR.

Action: Verify that the OCR is accessible by executing 'srvctl config ' command.

PRKS-1036: VIP resource for ASM instance node "{0}" does not exist."

Cause: The VIP resource for the node does not exist; it is a required resource for the ASM instance configuration on the node.

Action: Configure the VIP resource for the node using the 'srvctl add nodeapps' command as a privileged user before adding configuration for the ASM instance.

PRKS-1037: Failed to check existence of VIP resource for ASM instance node "{0}", [{1}]

Cause: 'crs_stat ora.<node>.vip' failed to check status of the VIP resource for the node.

Action: Contact Oracle Support.

PRKU—Command-Line Parser Utility Messages

PRKU-1000: "Exception Caused by: "

Cause: The current exception was caused by another earlier exception.

Action: Examine all of the nested exceptions to determine the root cause of the error.

PRKU-1001: "The parameter {0} is required."

Cause: The parameter specified is required by a command line utility.

Action: Supply the parameter specified.

PRKU-1002: "Unexpected argument {0}."

Cause: The argument specified is not needed or not understood by this utility.

Action: Verify the arguments on the command you are executing.

PRKU-1003: "The parameter {0} requires an argument."

Cause: The parameter specified must be accompanied by an argument.

Action: Verify the arguments on the command you are executing.

PRKV—Virtual IP Configuration Assistant Messages

PRKV-1013 "A network interface is required"

Cause: You did not provide a network interface for configuring the virtual IP address.

Action: When running VIPCA in GUI mode, select a suitable network interface from the list. When running VIPCA in silent mode, provide a suitable interface using the '-interfaces' option.

PRKV-1014 "Enter a valid IP address for the node \"{0}\"."

Cause: You did not enter an IP address to be configured as a virtual IP for the node.

Action: Enter an unused IP address to be used for configuring the virtual IP address.

PRKV-1015 "Enter a valid subnet mask for the IP address \"{0}\"."

Cause: You did not enter an IP netmask for the IP address.

Action: Enter a netmask for the IP address.

PRKV-1016 "IP address \"{0}\" is invalid. Enter a valid IP address."

Cause: IP address entered is invalid.

Action: Enter a valid IP address in standard IEEE format.

PRKV-1017 "IP address \"{0}\" does not exist. Enter a valid IP address."

Cause: IP address cannot be resolved in the network.

Action: Add an IP address in DNS or /etc/hosts so it can be resolved.

PRKV-1018 "IP address \"{0}\" has invalid format. Enter a valid IP address."

Cause: IP address is not in standard IEEE format.

Action: Enter a valid IP address in IEEE format.

PRKV-1019 "Netmask entered \"{0}\" has invalid format. Enter a valid netmask."

Cause: Netmask entered in not in standard IEEE format.

Action: Enter a valid IP netmask in IEEE format.

PRKV-1039 "IP address \"{0}\" has already been used. Enter an unused IP address."

Cause: The IP address entered is already used by another node as a virtual IP address.

Action: Enter an unused IP address.

PRKV-1059: "Invalid node name \"{0}\" entered in an input argument."

Cause: The IP address entered is already used by another node as a virtual IP address.

Action: Enter an unused IP address.

PRKV-1060: "Virtual IP address is not entered for node \"{0}\". Enter a valid virtual IP address."

Cause:

Action: Enter a valid virtual IP address for node {0} before re-attempting the command.

PRKV-1061 "Invalid IP address \"{0}\" entered in an input argument."

Cause:

Action: Enter valid IP address in place of {0} before reattempting command.

PRKV-1062 "Invalid netmask \"{0}\" entered in an invalid argument."

Cause:

Action: Enter valid netmask in place of {0} before reattempting command.

PRKV-1063 "Insufficient privileges."

Cause:

Action: Contact your system administrator to grant the appropriate privileges to you so that you can perform the required operations.

PRKV-1064 "Failed to obtain handle to CRS.

Cause:

Action: Refer to CRS logs for detailed error information.

PRKV-1065 "Host IP address \"{0}\" cannot be used as virtual IP for the node \"{1}\". Enter a different IP address.

Cause:

Action: Change IP address {0} before reattempting command.

PRKV-1066 "Host IP address \"{0}\" of cluster node \"{1}\" cannot be used as virtual IP for the node \"{2}\". Enter a different IP address."

Cause:

Action: Change IP address {0} before reattempting command.

PRKV-1070: Different interface names entered as an input for each node. Specify same set of interfaces for each node in the cluster.

Cause: The nodes in a cluster should use the same set of public interfaces for configuring a Virtual IP.

Action: Make sure that you have public interfaces on each node of the cluster and that their names and subnets match.

PRKV-1072: Invalid syntax used for option \"nodevips\". Check usage (vipca -help) for proper syntax.

Cause: The syntax argument value specified for option “nodevips” is invalid.

Action: Run “vipca -help” to see the syntax in which nodevips option value should be specified.

PRKV-1073: "Node names \"{0}\" are duplicated in an input argument."

Cause: The node names entered an input VIPCA command line should be unique.

Action: Remove duplicate node names from VIPCA command line and rerun the command.

PRKV-1073: "Node names \"{0}\" are duplicated in an input argument."

Cause: The node names that you enter as input to the VIPCA command line should be unique.

Action: Remove duplicate node names from the VIPCA command line and rerun the command.

PRKV-1074: The given interface(s), \"{0}\" is not public. Public interfaces should be used to configure virtual Ips.

Cause: The interface that you have specified as input is not a public interface. The Oracle Clusterware uses public interfaces for configuring VIPs.

Action: Find a public interface on your system with a name and subnet that matches all of the nodes of the cluster and specify this interface as an argument to VIPCA.

Glossary

Automatic Workload Repository (AWR)

A built-in repository that exists in every Oracle Database. At regular intervals, the Oracle Database makes a snapshot of all of its vital statistics and workload information and stores them in the AWR.

cache coherency

The synchronization of data in multiple caches so that reading a memory location through any cache will return the most recent data written to that location through any other cache. Sometimes called cache consistency.

Cache Fusion

A diskless cache coherency mechanism in Oracle Real Application Clusters that provides copies of blocks directly from a holding instance's memory cache to a requesting instance's memory cache.

cluster

A set of interconnected instances that cooperates to perform the same task.

cluster file system

A distributed file system that is a cluster of servers that collaborate to provide high performance service to their clients. Cluster file system software deals with distributing requests to storage cluster components.

cluster database

The generic term for a Oracle Real Application Clusters database.

CRSD - Oracle Clusterware Daemon

The primary Oracle Clusterware process.

Cluster Synchronization Services (CSS)

An Oracle Clusterware component that discovers and tracks the membership state of each node by providing a common view of membership across the cluster. CSS also monitors process health, specifically the health of the database instance. The Global Enqueue Service Monitor (LMON), a background process that monitors the health of the cluster database environment and registers and de-registers from CSS. See also, OCSSD.

Cluster Verification Utility (CVU)

A tool that verifies a wide range of Oracle RAC-specific components such as shared storage devices, networking configurations, system requirements, Oracle Clusterware, groups, and users.

CRSD

A UNIX-based process that performs high availability recovery and management operations such as maintaining the OCR. Also manages application resources and runs as `root` user (or by a user in the `admin` group on Mac OS X-based systems) and restarts automatically upon failure.

Distributed Transaction Processing (DTP)

The paradigm of distributed transactions, including both XA-type externally coordinated transactions, and distributed-SQL-type (database links in Oracle) internally coordinated transactions.

Enterprise Manager Configuration Assistant (EMCA)

A graphical user interface-based configuration assistant that you can use to configure Enterprise Manager features.

Event Manager (EVM)

The background process that publishes Oracle Clusterware events. EVM scans the designated callout directory and runs all scripts in that directory when an event occurs.

Event Manager Daemon (EVMD)

A UNIX-based event manager daemon that starts the `racgevt` process to manage callouts.

Fast Application Notification (FAN)

Applications can use FAN to enable rapid failure detection, balancing of connection pools after failures, and re-balancing of connection pools when failed components are repaired. The FAN notification process uses system events that Oracle publishes when cluster servers become unreachable or if network interfaces fail.

Fast Connection Failover

Fast Connection Failover provides high availability to FAN integrated clients, such as clients that use JDBC, OCI, or ODP.NET. If you configure the client to use fast connection failover, then the client automatically subscribes to FAN events and can react to database `UP` and `DOWN` events. In response, Oracle gives the client a connection to an active instance that provides the requested database service.

General Parallel File System (GPFS)

General Parallel File System (GPFS) is a shared-disk IBM file system product that provides data access from all of the nodes in a homogenous or heterogeneous cluster.

forced disk write

In Real Application Clusters, a particular data block can only be modified by one instance at a time. If one instance modifies a data block that another instance needs, then whether a forced disk write is required depends on the type of request submitted for the block.

Global Cache Service (GCS)

Process that implement Cache Fusion. It maintains the block mode for blocks in the global role. It is responsible for block transfers between instances. The Global Cache Service employs various background processes such as the Global Cache Service Processes (LMSn) and Global Enqueue Service Daemon (LMD).

Global Cache Service Processes (LMSn)

Processes that manage remote messages. Oracle RAC provides for up to 10 Global Cache Service Processes. The number of LMSn varies depending on the amount of messaging traffic among nodes in the cluster.

Global Cache Service (GCS) resources

Global resources that coordinate access to data blocks in the buffer caches of multiple Oracle RAC instances to provide cache coherency.

global database name

The full name of the database that uniquely identifies it from any other database. The global database name is of the form database_name.database_domain—for example: OP.US.ORACLE.COM

global dynamic performance views (GV$)

Dynamic performance views storing information about all open instances in a Real Application Clusters cluster. (Not only the local instance.) In contrast, standard dynamic performance views (V$) only store information about the local instance.

Global Enqueue Service (GES)

A service that coordinates enqueues that are shared globally.

Global Enqueue Service Daemon (LMD)

The resource agent process that manages requests for resources to control access to blocks. The LMD process also handles deadlock detection and remote resource requests. Remote resource requests are requests originating from another instance.

Global Enqueue Service Monitor (LMON)

The background LMON process monitors the entire cluster to manage global resources. LMON manages instance deaths and the associated recovery for any failed instance. In particular, LMON handles the part of recovery associated with global resources. LMON-provided services are also known as Cluster Group Services.

Global Services Daemon (GSD)

A component that receives requests from SRVCTL to execute administrative job tasks, such as startup or shutdown. The command is executed locally on each node, and the results are returned to SRVCTL. by default.

High Availability Cluster Multi-Processing (HACMP)

High Availability Cluster Multi-Processing is an IBM AIX-based high availability cluster software product. HACMP has two major components: high availability (HA) and cluster multi-processing (CMP).

Oracle Hardware Assisted Resilient Data (HARD)

The Oracle Hardware Assisted Resilient Data (HARD) Initiative prevents data corruptions. The HARD initiative uses Oracle data validation algorithms inside storage devices to prevent writing corrupted data to permanent storage.

high availability

Systems with redundant components that provide consistent and uninterrupted service, even in the event of hardware or software failures. This involves some degree of redundancy.

instance

For an Oracle RAC database, each node within a cluster usually has one instance of the running Oracle software that references the database. When a database is started, Oracle allocates a memory area called the System Global Area (SGA) and starts one or more Oracle processes. This combination of the SGA and the Oracle processes is called an instance. Each instance has unique Oracle System Identifier (sid), instance name, rollback segments, and thread ID.

instance membership recovery

The method used by Oracle RAC guaranteeing that all cluster members are functional or active. IMR polls and arbitrates the membership. Any members that do not show a heartbeat by way of the control file or who do not respond to periodic activity inquiry messages are presumed terminated.

instance name

Represents the name of the instance and is used to uniquely identify a specific instance when clusters share common services names. The instance name is identified by the INSTANCE_NAME parameter in the instance initialization file, initsid.ora. The instance name is the same as the Oracle System Identifier (sid).

instance number

A number that associates extents of data blocks with particular instances. The instance number enables you to start up an instance and ensure that it uses the extents allocated to it for inserts and updates. This will ensure that it does not use space allocated for other instances.

interconnect

The communication link between nodes.

Logical Volume Manager (LVM)

A generic term that describes UNIX-based subsystems for online disk storage management.

Inter-Process Communication (IPC)

A high-speed operating system-dependent transport component. The IPC transfers messages between instances on different nodes. Also referred to as the interconnect.

Master Boot Record (MBR)

A program that executes when a computer starts. Typically, the MBR resides on the first sector of a local hard disk. The program begins the startup process by examining the partition table to determine which partition to use for starting the machine. The MBR program then transfers control to the boot sector of the startup partition, which continues the startup process.

Network Attached Storage (NAS)

Storage that is attached to a server by way of a network.

Network Time Protocol (NTP)

An Internet standard protocol, built on top of TCP/IP, that ensures the accurate synchronization to the millisecond of the computer clock times in a network of computers.

Network Interface Card (NIC)

A card that you insert into a computer to connect the computer to a network.

node

A node is a machine on which an instance resides.

Oracle Cluster File System (OCFS)

The Oracle proprietary cluster file system software that is available for Linux and Windows-based platforms.

Oracle Cluster Registry (OCR)

The Oracle RAC configuration information repository that manages information about the cluster node list and instance-to-node mapping information. The OCR also manages information about Oracle Clusterware resource profiles for customized applications.

Object Link Manager (OLM)

The Oracle interface that maps symbolic links to logical drives and displays them in the OLM graphical user interface.

OCSSD

A UNIX-based process that manages the Cluster Synchronization Services (CSS) daemon. Manages cluster node membership and runs as `oracle` user; failure of this process results in cluster restart.

Oracle Interface Configuration Tool (OIFCFG)

A command-line tool for both single-instance Oracle databases and Oracle RAC databases that enables you to allocate and de-allocate network interfaces to components, direct components to use specific network interfaces, and retrieve component configuration information. The Oracle Universal Installer (OUI) also uses OIFCFG to identify and display available interfaces.

Oracle Notification Services (ONS)

A publish and subscribe service for communicating information about all FAN events.

OPROCD

A UNIX-based process monitor for a cluster. Note that this process will only appear on platforms that do not use vendor clusterware with Oracle Clusterware.

Oracle Clusterware

Oracle-provided clusterware that manages cluster database processing including node membership, group services, global resource management, and high availability functions.

Oracle Universal Installer (OUI)

A tool to install Oracle Clusterware, the Oracle relational database software, and the Oracle Real Application Clusters software. You can also use the Oracle Universal Installer to launch the Database Configuration Assistant (DBCA).

raw device

A disk drive that does not yet have a file system set up. Raw devices are used for Oracle Real Application Clusters since they enable the sharing of disks. See also raw partition.

raw partition

A portion of a physical disk that is accessed at the lowest possible level. A raw partition is created when an extended partition is created and logical partitions are assigned to it without any formatting. Once formatting is complete, it is called a cooked partition. See also raw device.

Recovery Manager (RMAN)

An Oracle tool that enables you to back up, copy, restore, and recover datafiles, control files, and archived redo logs. It is included with the Oracle server and does not require separate installation. You can invoke RMAN as a command line utility from the operating system (O/S) prompt or use the GUI-based Enterprise Manager Backup Manager.

Runtime Connection Load Balancing

Connection pool load balancing enables Oracle to make intelligent service connection decisions based on the connection pool that provides the optimal service for the requested application based on current workloads. The JDBC, ODP.NET, and OCI clients are integrated with the load balancing advisory; you can use any of these three client environments to provide connection pool load balancing.

scalability

The ability to add additional nodes to Real Application Clusters applications and achieve markedly improved scale-up and speed-up.

Secure Shell (SSH)

A program for logging into a remote computer over a network. You can use SSH to execute commands on a remote machine and to move files from one machine to another. SSH uses strong authentication and secure communications over insecure channels.

Server Control (SRVCTL) Utility

Server Management (SRVM) comprises the components required to operate Oracle Enterprise Manager in Oracle Real Application Clusters. The SRVM components, such as the Intelligent Agent, Global Services Daemon, and SRVCTL, enable you to manage cluster databases running in heterogeneous environments through an open client/server architecture using Oracle Enterprise Manager.

services

Entities that you can define in Oracle RAC databases that enable you to group database workloads and route work to the optimal instances that are assigned to offer the service.

shared everything

A database architecture in which all instances share access to all of the data.

singleton services

Services that run on only one instance at any one time. By defining the Distributed Transaction Property (DTP) property of a service, you can force the service to be a singleton service.

split brain syndrome

Where two or more instances attempt to control a cluster database. In a two-node environment, for example, one instance attempts to manage updates simultaneously while the other instance attempts to manage updates.

system identifier (SID)

The Oracle system identifier (SID) identifies a specific instance of the running Oracle software. For a Real Application Clusters database, each node within the cluster has an instance referencing the database.

thread

Each Oracle instance has its own set of online redo log groups. These groups are called a thread of online redo. In single-instance Oracle Database environments, each database has only one thread that belongs to the instance accessing it. In Real Application Clusters environments, each instance has a separate thread, that is, each instance has its own online redo log. Each thread has its own current log member.

thread number

The number of the redo thread to be used by an instance as specified by the THREAD initialization parameter or the THREAD clause in the ALTER DATABASE ADD LOGFILE statement. You can use any available redo thread number but an instance cannot use the same thread number as another instance.

transparent application failover (TAF)

A runtime failover for high-availability environments, such as Real Application Clusters and Oracle Real Application Clusters Guard, TAF refers to the failover and re-establishment of application-to-service connections. It enables client applications to automatically reconnect to the database if the connection fails, and optionally resume a SELECT statement that was in progress. This reconnect happens automatically from within the Oracle Call Interface (OCI) library.

voting disk

A file that manages information about node membership.

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