Veritas Storage Foundation™ for Oracle RAC Installation and Configuration Guide

Linux for IBM System p

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Veritas Storage Foundation for Oracle RAC Installation and Configuration Guide

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Storage Foundation 5.0 for Oracle RAC

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Section I

SF Oracle RAC Concepts

Read this section to understand SF Oracle RAC product concepts.

Chapter 1

Introducing SF Oracle RAC

Veritas Storage Foundation for Oracle RAC (SF Oracle RAC) from Symantec provides a robust infrastructure for Oracle Real Application Clusters (RAC) that simplifies management of RAC databases. SF Oracle RAC integrates existing Veritas storage management and clustering technologies into a flexible solution for administrators.

About SF Oracle RAC

SF Oracle RAC is a storage management and clustering solution that enables you to:

- Create a standard approach toward application and database management in data centers. While other clusterware can only work with an Oracle database, SF Oracle RAC incorporates existing Veritas storage management and clustering technologies that provide flexible support for many types of applications and databases. Administrators can apply existing expertise of Veritas technologies toward this product.
- Set up an infrastructure for Oracle RAC that simplifies database management while fully integrating with Oracle Cluster Ready Services (CRS).
- Enhance scalability and availability with access to multiple RAC instances per database in a cluster.
- Back up and recover databases using volume-level and file system-level snapshot technologies. SF Oracle RAC enables full volume-level snapshots for off-host processing that reduce load on production systems, and file system-level snapshots that involve efficient backup and rollback processes.
- Prevent data corruption at the storage layer with robust split-brain protection.

- Increase scalability with high throughput and low latency technology for use by Oracle Cache Fusion.
- Share all types of files, in addition to Oracle database files, across nodes.
- Increase availability and performance with dynamic multipathing (DMP), which provides wide storage array support for protection from failures and performance bottlenecks in the HBAs and SAN switches.
- Model and test cluster configurations without affecting production systems using the simulator and fire drill clustering technologies.
- Optimize I/O performance through storage mapping technologies and tunable attributes.

How SF Oracle RAC works (high-level perspective)

Real Application Clusters (RAC) is a parallel database environment that takes advantage of the processing power of multiple computers. The Oracle database is the physical data stored in tablespaces on disk, while the Oracle instance is a set of processes and shared memory that provide access to the physical database. Specifically, the instance involves server processes acting on behalf of clients to read data into shared memory and make modifications to it, and background processes to write changed data to disk.

In traditional environments, only one instance accesses a database at a specific time. SF Oracle RAC enables all nodes to concurrently run Oracle instances and execute transactions against the same database. This software coordinates access to the shared data for each node to provide consistency and integrity. Each node adds its processing power to the cluster as a whole and can increase overall throughput or performance.

At a conceptual level, SF Oracle RAC is a cluster that manages applications (instances), networking, and storage components using resources contained in service groups. SF Oracle RAC clusters have many of the same properties as Veritas Cluster Server (VCS) clusters:

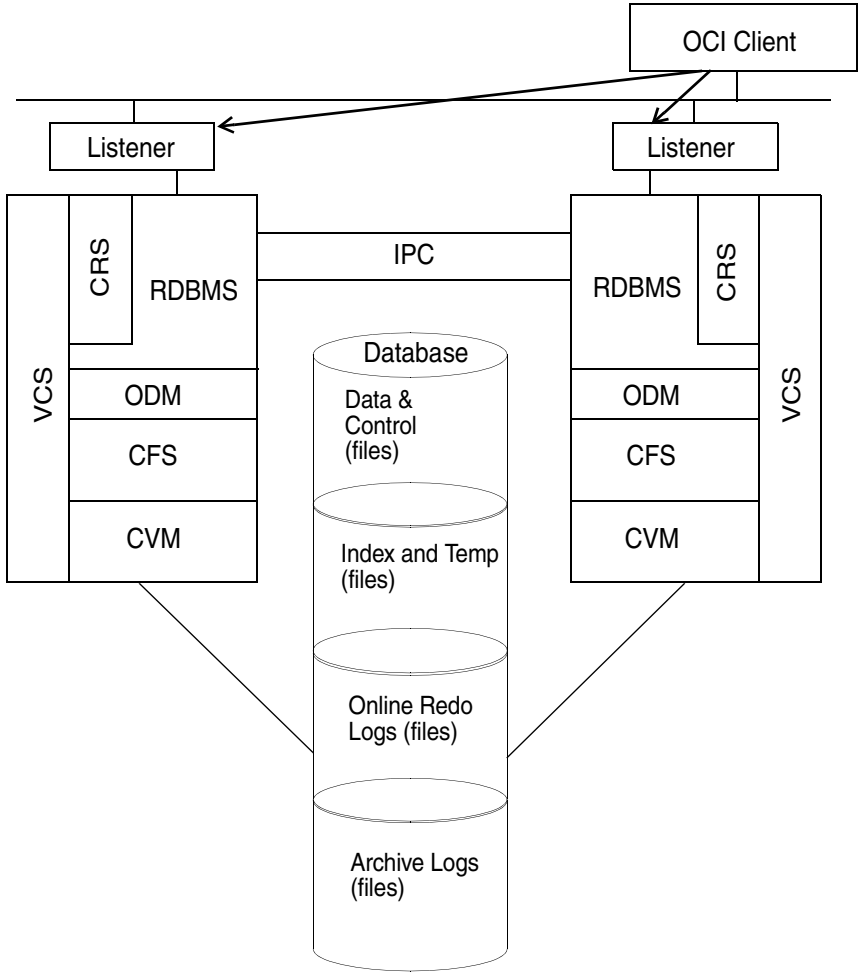
- Each node runs its own operating system.
- A cluster interconnect enables cluster communications.
- A public network connects each node to a LAN for client access.
- Shared storage is accessible by each node that needs to run the application.

SF Oracle RAC adds the following technologies, engineered specifically to improve performance, availability, and manageability of Oracle RAC environments, to a failover cluster environment:

- Cluster File System (CFS) and Cluster Volume Manager (CVM) technologies to manage multi-instance database access to shared storage.
- An Oracle Disk Manager (ODM) library to maximize Oracle disk I/O performance.
- Interfaces to Oracle clusterware (referred to as CRS—formerly Cluster Ready Services) and RAC for managing cluster membership and communication.

SF Oracle RAC provides an environment that can tolerate failures with minimal downtime and interruption to users. If a node fails as clients access the same database on multiple nodes, clients attached to the failed node can reconnect to a surviving node and resume access. Recovery after failure in the SF Oracle RAC environment is far quicker than recovery for a failover database because another Oracle instance is already up and running. The recovery process involves applying outstanding redo log entries from the failed node.

Figure 1-1 SF Oracle RAC architecture



Component products and processes of SF Oracle RAC

To understand how SF Oracle RAC manages database instances running in parallel on multiple nodes, review the architecture and communication mechanisms that provide the infrastructure for Oracle RAC. General highlights of the component products include:

- Cluster Volume Manager (CVM) -- Enables simultaneous access to shared volumes based on technology from Veritas Volume Manager (VxVM).
- Cluster File System (CFS) -- Enables simultaneous access to shared file systems based on technology from Veritas File System (VxFS).
- Database Accelerator -- Provides the interface with the Oracle Disk Manager (ODM) API.
- Cluster Server (VCS) -- Uses technology from Veritas Cluster Server to manage Oracle RAC databases and infrastructure components.
- RAC Extensions -- Manages cluster membership and communications between cluster nodes.

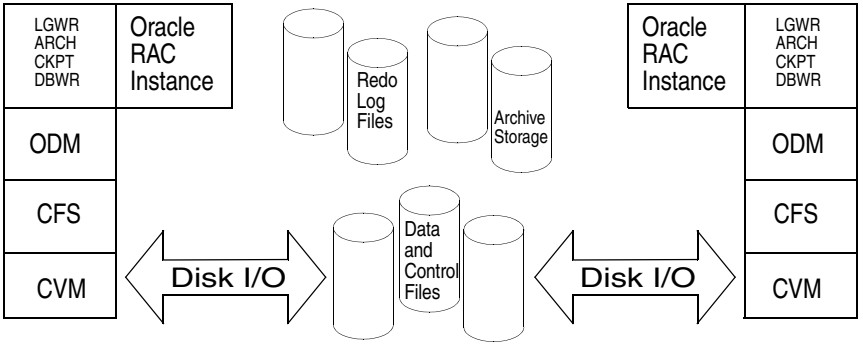
Communication infrastructure

To understand the communication infrastructure, review the data flow and communications requirements.

Data flow

The CVM, CFS, ODM, and Oracle RAC elements reflect the overall data flow, or data stack, from an instance running on a server to the shared storage. The various Oracle processes composing an instance -- such as DB Writers, Log Writer, Checkpoint, Archiver, and Server -- read and write data to the storage through the I/O stack in the diagram. Oracle communicates through the ODM interface to CFS, which in turn accesses the storage through the CVM.

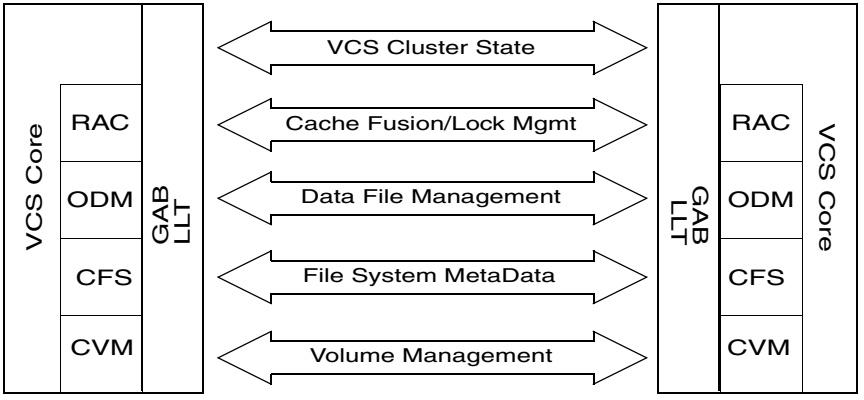
Figure 1-2 Data Flow



Communication requirements

End-users on a client system are unaware that they are accessing a database hosted by multiple instances. The key to performing I/O to a database accessed by multiple instances is communication between the processes. Each layer or component in the data stack must reliably communicate with its peer on other nodes to function properly. RAC instances must communication to coordinate protection of data blocks in the database. ODM processes must communicate to coordinate data file protection and access across the cluster. CFS coordinates metadata updates for file systems, while CVM coordinates the status of logical volumes and maps.

Figure 1-3 Communication between Nodes



Cluster interconnect communication channel

The cluster interconnect provides the communication channel for all system-to-system communication, in addition to communication between modules. Low Latency Transport (LLT) and Group Membership Services/Atomic Broadcast (GAB) make up the VCS communications package central to the operation of SF Oracle RAC. In a standard operational state, significant traffic through LLT and GAB results from Lock Management and Cache Fusion, while traffic for other data is relatively sparse.

Low Latency Transport

LLT provides fast, kernel-to-kernel communications and monitors network connections. LLT functions as a high performance replacement for the IP stack and runs directly on top of the Data Link Protocol Interface (DLPI) layer. The use of LLT rather than IP removes latency and overhead associated with the IP stack. The major functions of LLT are traffic distribution, heartbeats, and support for RAC Inter-Process Communications (VCSIPC).

Traffic distribution

LLT distributes (load-balances) internode communication across all available cluster interconnect links. All cluster communications are evenly distributed across as many as eight network links for performance and fault resilience. If a link fails, LLT redirects traffic to the remaining links.

Heartbeats

LLT is responsible for sending and receiving heartbeat traffic over network links. The Group Membership Services function of GAB uses heartbeats to determine cluster membership.

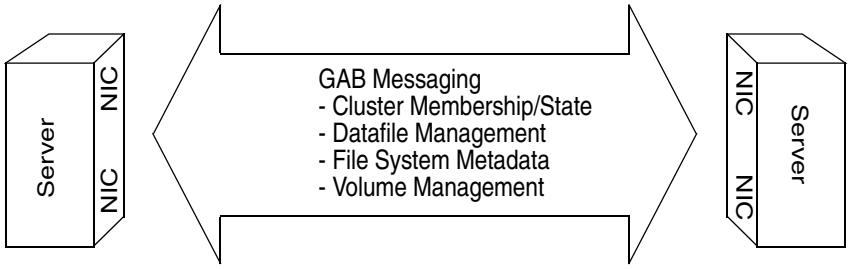
VCSIPC

RAC Inter-Process Communications (VCSIPC) uses the VCSIPC shared library for these communications. VCSIPC leverages all features of LLT and uses LMX, an LLT multiplexer, to provide fast data transfer between Oracle processes on different nodes.

Group Membership Services/Atomic Broadcast

The GAB protocol is responsible for cluster membership and cluster communications.

Figure 1-4 Group Membership Services/Atomic Broadcast



Cluster membership

At a high level, all nodes configured by the installer can operate as a cluster; these nodes form a cluster membership. In SF Oracle RAC, a cluster membership specifically refers to all systems configured with the same cluster ID communicating by way of a redundant cluster interconnect.

All nodes in a distributed system, such as SF Oracle RAC, must remain constantly alert to the nodes currently participating in the cluster. Nodes can leave or join the cluster at any time because of shutting down, starting up, rebooting, powering off, or faulting processes. SF Oracle RAC uses its cluster membership capability to dynamically track the overall cluster topology.

SF Oracle RAC uses LLT heartbeats to determine cluster membership:

- When systems no longer receive heartbeat messages from a peer for a predetermined interval, a protocol excludes the peer from the current membership.
- GAB informs processes on the remaining nodes that the cluster membership has changed; this action initiates recovery actions specific to each module. For example, CVM must initiate volume recovery and CFS must perform a fast parallel file system check.
- When systems start receiving heartbeats from a peer outside of the current membership, a protocol enables the peer to join the membership.

Cluster communications

GAB provides reliable cluster communication between SF Oracle RAC modules. GAB provides guaranteed delivery of point-to-point messages and broadcast messages to all nodes. Point-to-point messaging involves sending and acknowledging the message. Atomic-broadcast messaging ensures all systems within the cluster receive all messages. If a failure occurs while transmitting a broadcast message, GAB ensures all systems have the same information after recovery.

Low-level communication: Port relationship between GAB and processes

All processes in SF Oracle RAC use GAB for communication. Each process wanting to communicate with a peer process on other nodes registers with GAB on a specific port. This registration enables communication and notification of membership changes. For example, the VCS engine (High Availability Daemon or HAD) registers on port h. HAD receives messages from peer had processes on port h. HAD also receives notification when a node fails or when a peer process on port h becomes unregistered.

Some processes use multiple ports for specific communications requirements. For example, CVM uses multiple ports to allow communications by kernel and user-level functions in CVM independently.

Cluster Volume Manager

CVM is an extension of Veritas Volume Manager, the industry standard storage virtualization platform. CVM extends the concepts of VxVM across multiple nodes. Each node recognizes the same logical volume layout, and more importantly, the same state of all volume resources.

CVM supports performance-enhancing capabilities, such as striping, mirroring, and mirror break-off (snapshot) for off-host backup. You can use standard VxVM commands from one node in the cluster to manage all storage. All other nodes immediately recognize any changes in disk group and volume configuration with no interaction.

CVM architecture

CVM is designed with a “master and slave” architecture. One node in the cluster acts as the configuration master for logical volume management, and all other nodes are slaves. Any node can take over as master if the existing master fails. The CVM master exists on a per-cluster basis and uses GAB and LLT to transport its configuration data.

Just as with VxVM, the Volume Manager configuration daemon, `vxconfigd`, maintains the configuration of logical volumes. This daemon handles changes to the volumes by updating the operating system at the kernel level. For example, if a mirror of a volume fails, the mirror detaches from the volume and `vxconfigd` determines the proper course of action, updates the new volume layout, and informs the kernel of a new volume layout. CVM extends this behavior across multiple nodes and propagates volume changes to the master `vxconfigd`. (You must perform operator-initiated changes on the master node.) The `vxconfigd` process on the master pushes these changes out to slave `vxconfigd` processes, each of which updates the local kernel.

CVM does not impose any write locking between nodes. Each node is free to update any area of the storage. All data integrity is the responsibility of the upper application. From an application perspective, standalone systems access logical volumes in the same way as CVM systems.

CVM imposes a “Uniform Shared Storage” model. All nodes must connect to the same disk sets for a given disk group. Any node unable to detect the entire set of physical disks for a given disk group cannot import the group. If a node loses contact with a specific disk, CVM excludes the node from participating in the use of that disk.

CVM communication

CVM communication involves various GAB ports for different types of communication.

Port w

Most CVM communication uses port w for vxconfigd communications. During any change in volume configuration, such as volume creation, plex attachment or detachment, and volume resizing, vxconfigd on the master node uses port w to share this information with slave nodes.

When all slaves use port w to acknowledge the new configuration is the next active configuration, the master updates this record to the disk headers in the VxVM private region for the disk group as the next configuration.

Port v

CVM uses port v for kernel-to-kernel communication. During specific configuration events, certain actions require coordination across all nodes. An example of synchronizing events is a resize operation. CVM must ensure all nodes see the new or old size, but never a mix of size among members.

CVM also uses this port to obtain cluster membership from GAB and determine the status of other CVM members in the cluster.

Cluster File System

CFS enables you to simultaneously mount the same file system on multiple nodes and is an extension of the industry-standard Veritas File System. Unlike some other file systems that send data through another node to the storage, CFS is a true SAN file system. All data traffic takes place over the storage area network (SAN), and only the metadata traverses the cluster interconnect.

In addition to using the SAN fabric for reading and writing data, CFS offers storage checkpoints and rollback for backup and recovery.

CFS architecture

SF Oracle RAC uses CFS to manage a file system in a large database environment. Since CFS is an extension of VxFS, it operates in a similar fashion and caches metadata and data in memory (typically called buffer cache or vnode cache). CFS uses a distributed locking mechanism called Global Lock Manager (GLM) to ensure all nodes have a consistent view of the file system. GLM provides metadata and cache coherency across multiple nodes by coordinating access to file system metadata, such as inodes and free lists. The role of GLM is set on a per-file system basis to enable load balancing.

CFS involves a primary/secondary architecture. Though any node can initiate an operation to create, delete, or resize data, the GLM master node carries out the actual operation. After creating a file, the GLM master node grants locks for data coherency across nodes. For example, if a node tries to modify a row of a block in a file, it must obtain an exclusive lock to ensure other nodes that may have the same file cached have this cached copy invalidated.

SF Oracle RAC configurations minimize the use of GLM locking. Oracle RAC accesses the file system through the ODM interface and handles its own locking; only Oracle (and not GLM) buffers data and coordinates write operations to files. A single point of locking and buffering ensures maximum performance. GLM locking is only involved when metadata for a file changes, such as during create and resize operations.

CFS communication

CFS uses port f for GLM lock and metadata communication. Access to cluster storage in typical SF Oracle RAC configurations use CFS. Raw access to CVM volumes is also possible but not part of a common configuration. SF Oracle RAC configurations minimize the use of GLM locking except when metadata for a file changes.

Oracle Disk Manager

SF Oracle RAC requires Oracle Disk Manager (ODM), a standard API published by Oracle for support of database I/O. SF Oracle RAC provides a library for Oracle to use as its I/O library.

ODM architecture

When the Veritas ODM library is linked, Oracle is able to bypass all caching and locks at the file system layer and to communicate directly with raw volumes. The SF Oracle RAC implementation of ODM generates performance equivalent to performance with raw devices while the storage uses easy-to-manage file systems.

All ODM features can operate in a cluster environment. Nodes communicate with each other before performing any operation that could potentially affect another node. For example, before creating a new data file with a specific name, ODM checks with other nodes to see if the file name is already in use.

Veritas ODM performance enhancements

Veritas ODM enables performance benefits provided by Oracle Disk Manager:

- Locking for data integrity.
- Few system calls and context switches.
- Increased I/O parallelism.
- Efficient file creation and disk allocation.

Databases using file systems typically incur additional overhead:

- Extra CPU and memory usage to read data from underlying disks to the file system cache. This scenario requires copying data from the file system cache to the Oracle cache.
- File locking that allows for only a single writer at a time. Allowing Oracle to perform locking allows for finer granularity of locking at the row level.
- File systems generally go through a standard Sync I/O library when performing I/O. Oracle can make use of Kernel Async I/O libraries (KAIO) with raw devices to improve performance.

ODM communication - Port d

ODM uses port d to communicate with other ODM instances to support the file management features of Oracle Managed Files (OMF). OMF enables DBAs to set database parameters, such as the `init.ora` parameters for `db datafile`, `controlfile`, and `logfile` names, and for those structures to be named automatically. OMF allows for the automatic deletion of physical data files when DBAs remove tablespaces.

Veritas Cluster Server

VCS directs SF Oracle RAC operations by controlling the startup and shutdown of component layers and providing monitoring and notification of failure.

In a typical SF Oracle RAC configuration, the RAC service groups for VCS run as "parallel" service groups rather than "failover" service groups; in the event of a failure, VCS does not attempt to migrate a failed service group. Instead, the software enables you to configure the group to restart on failure.

VCS architecture

The High Availability Daemon (HAD) is the main VCS daemon running on each node. HAD tracks changes in the cluster configuration and monitors resource status by communicating with GAB and LLT. HAD manages all application services using agents, which are installed programs to manage resources (specific hardware or software entities).

The VCS architecture is modular for extensibility and efficiency. HAD does not need to know how to start up Oracle or any other application under VCS control. Instead, you can add agents to manage different resources with no effect on the engine (HAD). Agents only communicate with HAD on the local node, and HAD communicates status with HAD processes on other nodes. Because agents do not need to communicate across systems, VCS is able to minimize traffic on the cluster interconnect.

SF Oracle RAC provides specific agents for VCS to manage CVM, CFS, and Oracle agents.

VCS communication

SF Oracle RAC uses port h for HAD communication. Agents communicate with HAD on the local node about resources, and HAD distributes its view of resources on that node to other nodes through port h. HAD also receives information from other cluster members to update its own view of the cluster.

Cluster configuration files

VCS uses two configuration files in a default configuration:

- The `main.cf` file defines the entire cluster, including the cluster name, systems in the cluster, and definitions of service groups and resources, in addition to service group and resource dependencies.
- The `types.cf` file defines the resource types.

Additional files similar to `types.cf` may be present if you add agents. For example, SF Oracle RAC includes additional resource types files, such as `OracleTypes.cf` and `PrivNIC.cf`.

RAC extensions

Oracle RAC relies on several support services provided by VCS. Key features include Veritas Cluster Server Membership Manager (VCSMM) and Cluster Inter-Process Communication (VCSIPC), and LLT Multiplexer (LMX).

Veritas Cluster Server Membership Manager

To protect data integrity by coordinating locking between RAC instances, Oracle must know which instances actively access a database. Oracle provides an API called `skgxn` (system kernel generic interface node membership) to obtain information on membership. SF Oracle RAC implements this API as a library linked to Oracle/CRS after you install Oracle RAC. Oracle uses the linked `skgxn` library to make ioctl calls to VCSMM, which in turn obtains membership information for clusters and instances by communicating with GAB on port o.

Veritas Cluster Server Inter-Process Communication

To coordinate access to a single database by multiple instances, Oracle uses extensive communications between nodes and instances. Oracle uses Inter-Process Communications (VCSIPC) for Global Enqueue Service locking traffic and Global Cache Service cache fusion. SF Oracle RAC uses LLT to support VCSIPC in a cluster and leverages its high-performance and fault-resilient capabilities.

Oracle has an API for VCSIPC, System Kernel Generic Interface Inter-Process Communications (skgxp), that isolates Oracle from the underlying transport mechanism. As Oracle conducts communication between processes, it does not need to know how data moves between systems; the cluster implementer can create the highest performance for internode communications without Oracle reconfiguration.

LLT Multiplexer

Oracle instances use the `skgxp` library for interprocess communication. This interface enables Oracle to send communications between processes on instances.

SF Oracle RAC provides a library linked to Oracle at installation time to implement the `skgxp` functionality. This module communicates with the LLT Multiplexer (LMX) via `ioctl` calls.

LMX is a kernel module designed to receive communications from the `skgxp` module and pass them on to the correct process on the correct instance on other nodes. The LMX module "multiplexes" communications between multiple processes on other nodes. LMX leverages all features of LLT, including load balancing and fault resilience.

I/O fencing

I/O fencing is a mechanism to prevent uncoordinated access to the shared storage. This feature works even in the case of faulty cluster communications causing a split-brain condition.

Understanding Split Brain and the need for I/O fencing

To provide high availability, the cluster must be capable of taking corrective action when a node fails. In this situation, SF Oracle RAC configures its components to reflect the altered membership.

Problems arise when the mechanism that detects the failure breaks down because symptoms appear identical to those of a failed node. For example, if a system in a two-node cluster fails, the system stops sending heartbeats over the private interconnects and the remaining node takes corrective action. However, the failure of private interconnects (instead of the actual nodes) would present identical symptoms and cause each node to determine its peer has departed. This situation typically results in data corruption because both nodes attempt to take control of data storage in an uncoordinated manner.

In addition to a broken set of private networks, other scenarios can generate this situation. If a system is so busy that it appears to stop responding or "hang," the other nodes could declare it as dead. This declaration may also occur for nodes using hardware that supports a "break" and "resume" function. When a node drops to PROM level with a break and subsequently resumes operations, the other nodes may declare the system dead even though the system later returns and begins write operations.

SF Oracle RAC uses a technology called I/O fencing to remove the risk associated with split brain. I/O fencing allows write access for members of the active

cluster and blocks access to storage from non-members; even a node that is alive is unable to cause damage.

SCSI-3 Persistent Reservations

SCSI-3 Persistent Reservations (SCSI-3 PR) are required for I/O fencing and resolve the issues of using SCSI reservations in a clustered SAN environment. SCSI-3 PR enables access for multiple nodes to a device and simultaneously blocks access for other nodes.

SCSI-3 reservations are persistent across SCSI bus resets and support multiple paths from a host to a disk. In contrast, only one host can use SCSI-2 reservations with one path. If the need arises to block access to a device because of data integrity concerns, only one host and one path remain active. The requirements for larger clusters, with multiple nodes reading and writing to storage in a controlled manner, make SCSI-2 reservations obsolete.

SCSI-3 PR uses a concept of registration and reservation. Each system registers its own "key" with a SCSI-3 device. Multiple systems registering keys form a membership and establish a reservation, typically set to "Write Exclusive Registrants Only" or WERO. The WERO setting enables only registered systems to perform write operations. For a given disk, only one reservation can exist amidst numerous registrations.

With SCSI-3 PR technology, blocking write access is as simple as removing a registration from a device. Only registered members can "eject" the registration of another member. A member wishing to eject another member issues a "preempt and abort" command. Ejecting a node is final and atomic; an ejected node cannot eject another node. In SF Oracle RAC, a node registers the same key for all paths to the device. A single preempt and abort command ejects a node from all paths to the storage device.

Components of I/O fencing

Fencing in SF Oracle RAC involves coordinator disks and data disks. Each component has a unique purpose and uses different physical disk devices. The fencing driver, known as `vxfen`, directs CVM as necessary to carry out actual fencing operations at the disk group level.

Data disks

Data disks are standard disk devices for data storage and are either physical disks or RAID Logical Units (LUNs). These disks must support SCSI-3 PR and are part of standard VxVM or CVM disk groups.

CVM is responsible for fencing data disks on a disk group basis. Disks added to a disk group are automatically fenced, as are new paths discovered to a device.

Coordinator disks

Coordinator disks are three standard disks or LUNs set aside for I/O fencing during cluster reconfiguration. Coordinator disks do not serve any other storage purpose in the SF Oracle RAC configuration. Users cannot store data on these disks or include the disks in a disk group for user data. The coordinator disks can be any three disks that support SCSI-3 PR. Coordinator disks cannot be special devices that array vendors use. For example, you cannot use EMC gatekeeper devices as coordinator disks.

Symantec recommends using the smallest possible LUNs for coordinator disks. Because coordinator disks do not store any data, cluster nodes need only register with them and do not need to reserve them.

These disks provide a lock mechanism to determine which nodes get to fence off data drives from other nodes. A node must eject a peer from the coordinator disks before it can fence the peer from the data drives. This concept of racing for control of the coordinator disks to gain the ability to fence data disks is key to understanding prevention of split brain through fencing.

Dynamic Multipathing devices with I/O fencing

DMP allows coordinator disks to take advantage of the path failover and the dynamic adding and removal capabilities of DMP. You can configure coordinator disks to use Veritas Volume Manager Dynamic Multipathing (DMP) feature. Veritas Volume Manager DMP uses the ASL model for communicating with storage. As a result, DMP can discover devices and failover paths, and can issue other SCSI commands suitable for the unique characteristics of each array.

For more information on using DMP, see the *Veritas Volume Manager Administrator's Guide*.

Also see "Enabling fencing in the VCS configuration" on page 104.

I/O fencing operations

I/O fencing, provided by the kernel-based fencing module (`vxfen`), performs identically on node failures and communications failures. When the fencing module on a node is informed of a change in cluster membership by the GAB module, it immediately begins the fencing operation. The node attempts to eject the key for departed nodes from the coordinator disks using the preempt and abort command. When the node successfully ejects the departed nodes from the coordinator disks, it ejects the departed nodes from the data disks. In a split brain scenario, both sides of the split would race for control of the coordinator disks. The side winning the majority of the coordinator disks wins the race and fences the loser. The loser then panics and reboots the system.

I/O fencing communication

The vxfen driver connects to GAB port b to intercept cluster membership changes (reconfiguration messages). During a membership change, the fencing driver determines which systems are members of the cluster to allow access to shared disks.

After completing fencing operations, the driver passes reconfiguration messages to higher modules. CVM handles fencing of data drives for shared disk groups. After a node successfully joins the GAB cluster and the driver determines that a preexisting split brain does not exist, CVM can import all shared disk groups. The CVM master coordinates the order of import and the key for each disk group. As each slave joins the cluster, it accepts the CVM list of disk groups and keys, and adds its proper digit to the first byte of the key. Each slave then registers the keys with all drives in the disk groups.

Additional features of SF Oracle RAC

Additional SF Oracle RAC features include:

- The ability to back up and recover data at the volume and file system levels using Veritas Database Flashsnap and Veritas Storage Checkpoints.
- The ability to evaluate or troubleshoot I/O performance with Veritas Storage Mapping. You can access mapping information that allows for a detailed understanding of the storage hierarchy in which files reside.

Section II

Installing SF Oracle RAC

Install and configure SF Oracle RAC. After completing this process, proceed to the appropriate Oracle section for all Oracle-specific procedures.

Chapter 2

Preparing to install SF Oracle RAC

The following topics contain important planning information for installing SF Oracle RAC:

- "Overview of SF Oracle RAC installation and configuration tasks" on page 37
- "About SF Oracle RAC component features" on page 41
- "Typical SF Oracle RAC cluster setup" on page 48
- "SF Oracle RAC prerequisites" on page 61
- "Performing pre-installation tasks" on page 65
- "Gathering information to install and configure SF Oracle RAC" on page 69

Supported SF Oracle RAC installations work with Oracle 10g R2. The *Veritas Storage Foundation 5.0 for Oracle RAC Release Notes* provides details on SF Oracle RAC requirements.

Overview of SF Oracle RAC installation and configuration tasks

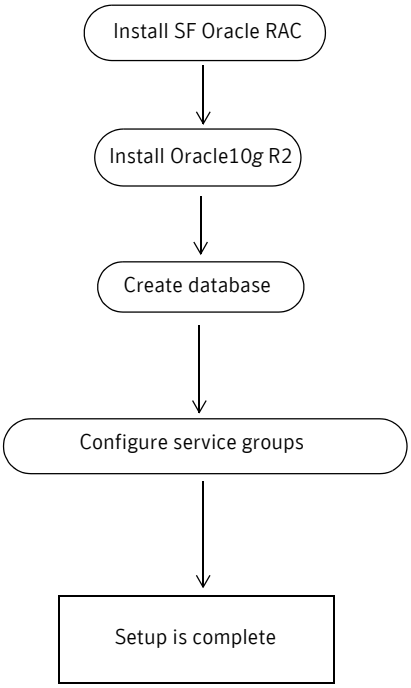
Phases involved in installing and configuring SF 5.0 Oracle RAC include:

- Preparing to install and configure SF Oracle RAC
- Installing SF Oracle RAC and configuring its components
- Installing Oracle RAC and creating Oracle RAC database
- Setting up VCS to manage RAC resources
- Setting up backup and recovery feature for SF Oracle RAC (optional)

For a high-level flow of the SF 5.0 Oracle RAC installation and configuration process:

See "High-level process of setting up SF Oracle RAC" on page 38.

Figure 2-1 High-level process of setting up SF Oracle RAC



Preparing to install and configure SF Oracle RAC

Before installing SF Oracle RAC, you must:

- Make sure you meet the installation requirements.
  See "SF Oracle RAC prerequisites" on page 61.
- Set up the basic hardware and plan your configuration.
  Details about supported hardware are on the support web site:
  http://www.symantec.com/enterprise/support/index.jsp
  See "Typical SF Oracle RAC cluster setup" on page 48.
- Perform the SF Oracle RAC pre-installation and pre-configuration tasks. Gather the required information to install and configure SF Oracle RAC.
  See "Performing pre-installation tasks" on page 65.

Setting umask for root user

Before installing SF Oracle RAC, set umask for root user to "0022" before installing SF Oracle RAC. Type:

```
# umask 0022
```

Installing SF Oracle RAC and configuring its components

Install SF Oracle RAC on clusters of up to eight nodes.

See "Installing and Configuring SF Oracle RAC Software" on page 79.

Installing and configuring SF Oracle RAC involves:

Installing SF Oracle RAC	Use the Veritas product installer or the installsfrac program. On each node, the interactive installer installs packages for: ■ Veritas Cluster Server (VCS) ■ Veritas Volume Manager (VxVM) ■ Veritas File System (VxFS) ■ Veritas High Availability Agent for Oracle ■ Other SF Oracle RAC modules
Performing system checks to configure SF Oracle RAC	Use the Veritas product installer or `installsfrac -configure` option of installsfrac program. The installer guides you to perform basic system checks.

Configuring SF Oracle RAC stack	Use the Veritas product installer or `installsfrac -configure` option of installsfrac program. After you perform basic system checks, you can configure the SF Oracle RAC components: ■ VCS ■ CVM, Veritas Volume Manager enabled for clusters ■ CFS, Veritas File System enabled for clusters The installer also starts the SF Oracle RAC processes.
Setting up I/O fencing	Manually configure I/O fencing feature for SF Oracle RAC: ■ Verify whether shared storage can support I/O fencing using vxfentsthdw script. ■ Set up coordinator disks for the I/O fencing feature into a disk group. ■ Set the UseFence=SCSI3 attribute in the configuration file. ■ Restart the processes.

Installing Oracle RAC and creating Oracle RAC database

After installing and configuring components of Storage Foundation for Oracle RAC, proceed to install Oracle RAC.

- Prepare to install Oracle RAC.
  See "Preparing to Install Oracle 10g RAC" on page 111.
- Install Oracle RAC.
  See "Installing Oracle 10g" on page 121.
- Create a raw database on raw volumes within a VxVM disk group or on a Veritas cluster file system.
  Numerous procedures exist for creating a database. If you decide to use the Oracle dbca utility, review the procedure to create a database.
  See "Creating a starter database" on page 277.

Setting up VCS to manage RAC resources

SF Oracle RAC provides the capability to completely automate the RAC environment. This capability ranges from enabling automatic control of the entire database environment to having VCS mount cluster file systems or enable CVM and CFS daemons. The user or DBA is free to choose the level of control and automation.

VCS uses the main.cf configuration file to manage resources in the cluster. The SF Oracle RAC installation process creates a basic VCS configuration file. After

installing Oracle and creating the database, you can modify the main.cf file on one of the cluster nodes to reflect the new resources and their configuration.

You can configure VCS service groups using the configuration wizard or manually.

See "Configuring Oracle 10g service groups" on page 133.

See "Sample VCS configuration files for SF Oracle RAC" on page 271.

Setting up backup and recovery feature for SF Oracle RAC (optional)

You can configure the following SF Oracle RAC optional features to back up and recover data at the volume and file system levels:

- Veritas Storage Checkpoint
  Allows efficient backup and recovery of Oracle RAC databases. This feature is available with SF Oracle RAC as part of the Veritas File System.
  See "Using Checkpoints and Storage Rollback with Storage Foundation for Oracle RAC" on page 175.
- Veritas Database FlashSnap
  Allows you to create a point-in-time copy of an Oracle RAC database for backup and off-host processing.
  See "Using database FlashSnap for backup and off-host processing" on page 191.
- Veritas Storage Mapping
  Allows you to evaluate or troubleshoot I/O performance. You can access mapping information that allows for a detailed understanding of the storage hierarchy in which files reside.
  Chapter 12, "Investigating I/O performance using storage mapping" on page 237

About SF Oracle RAC component features

Review the description of the optional features and decide the features that you want to configure with SF Oracle RAC:

- Symantec Product Authentication Service
- Veritas Cluster Management Console
- Notification for VCS events
- Typical SF Oracle RAC cluster setup

Note: To configure the optional features of the SF Oracle RAC components, make sure to install all packages when the installation program prompts you.

Symantec Product Authentication Service

The Symantec Product Authentication Service is a common Veritas feature that validates identities based on existing network operating system domains (such as NIS and NT) or private domains. The authentication service protects communication channels among Symantec application clients and services through message integrity and confidentiality services.

Before you install the authentication service, refer to the *Symantec Product Authentication Service Installation Guide* at the following location on the Veritas software disc:

distribution/authentication_service/docs/vxat_install.pdf.

Symantec Product Authentication Service secures communication using digital certificates for authentication and SSL to encrypt communication over the public network. You can configure SF Oracle RAC to use the Authentication Service to secure communication between the following:

- Cluster nodes and clients, including the VCS Java and the Web consoles
  You can set up Authentication Service for the cluster during the SF Oracle RAC installation and configuration process. If you want to enable Authentication Service after installation, refer to the *Veritas Cluster Server User's Guide*.
  See "Configuring the cluster in secure mode" on page 87
- Veritas Cluster Management Console Management Server and the centrally managed SF Oracle RAC clusters
  See "Veritas Cluster Management Console" on page 45.
- Veritas Storage Foundation Management Server and the centrally managed hosts
  See "Typical SF Oracle RAC cluster setup" on page 48.

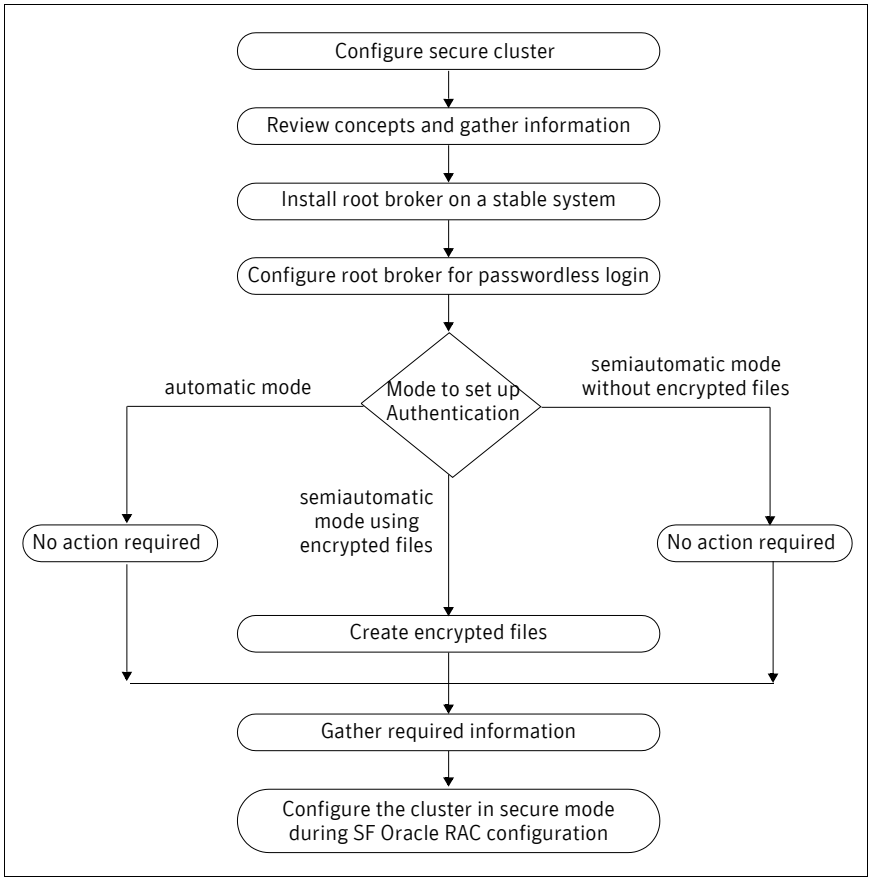
To configure the cluster in secure mode, SF Oracle RAC requires you to configure a system in your enterprise as root broker and all nodes in the cluster as authentication brokers.

- Root broker
  A root broker serves as the main registration and certification authority; it has a self-signed certificate and can authenticate other brokers. The root broker is only used during initial creation of an authentication broker.
- Authentication brokers

Authentication brokers serve as intermediate registration and certification authorities. Authentication brokers have certificates that are signed by the root. Each node in SF Oracle RAC cluster serves as an authentication broker.

Figure 2-2 depicts the flow of configuring SF Oracle RAC in secure mode.

Figure 2-2 Secure SF Oracle RAC cluster configuration flowchart



If you decide to enable the Authentication Service, the root broker administrator must perform the following preparatory tasks:

- Install the root broker on another stable system.
  The root broker is the main registration and certification authority and can serve multiple clusters. Symantec recommends that you install a single root broker on a utility computer such as an email server or domain controller, which can be highly available.

See "Installing root broker for Symantec Product Authentication Service" on page 52.

- Configure the root broker system for a passwordless login when you want to use the automatic mode.

The installsfrac program provides the following modes to configure Symantec Product Authentication Service:

- In the automatic mode, the installer configures Authentication Service automatically without any user intervention.
  You must provide the name of the root broker system.
- In the semiautomatic modes, the installer provides you an option to use encrypted files or answer the installer prompts to enable security. The semiautomatic mode requires the root broker administrator to set up the basic authentication environment and create principals for authentication brokers. You must complete the following preparatory tasks to configure security in the semiautomatic mode:

  With encrypted files
  - The root broker administrator must create an encrypted file for each node in the cluster.
    See "Creating encrypted files for Symantec Product Authentication Service" on page 53.
  - The root broker administrator must provide the encrypted files in a media or make it available on a shared location that you can access.
  - You must copy the encrypted files to a directory in the installation node. Make a note of the path of this encrypted files.

  Without encrypted files
  - You must gather the following information from the root broker administrator:
    Root broker name
    Root broker domain name
    Root broker port (Default is 2821)
    Authentication broker principal name for each node
    Authentication broker password for each Authentication broker
  - The root broker administrator must provide the root_hash file in a media or make it available on a shared location that you can access.
  - You must copy the root_hash file to a directory in the installation node. Make a note of the path of this root_hash file.

Refer to the *Symantec Product Authentication Service Administrator's Guide* for more information.

Note: Make sure that the system clocks of the Root Broker and Authentication Broker systems are in sync.

Veritas Cluster Management Console

Veritas Cluster Management Console is a high availability management solution that enables monitoring and administering SF Oracle RAC clusters from a single web console.

You can configure Cluster Management Console to manage a single cluster, multiple clusters, or both.

- If you want to use Cluster Management Console to manage multiple clusters, you must set up a management server.
- If you want to use the Cluster Management Console to manage a single cluster, choose the option to install the Cluster Management Console during SF Oracle RAC installation and configuration.

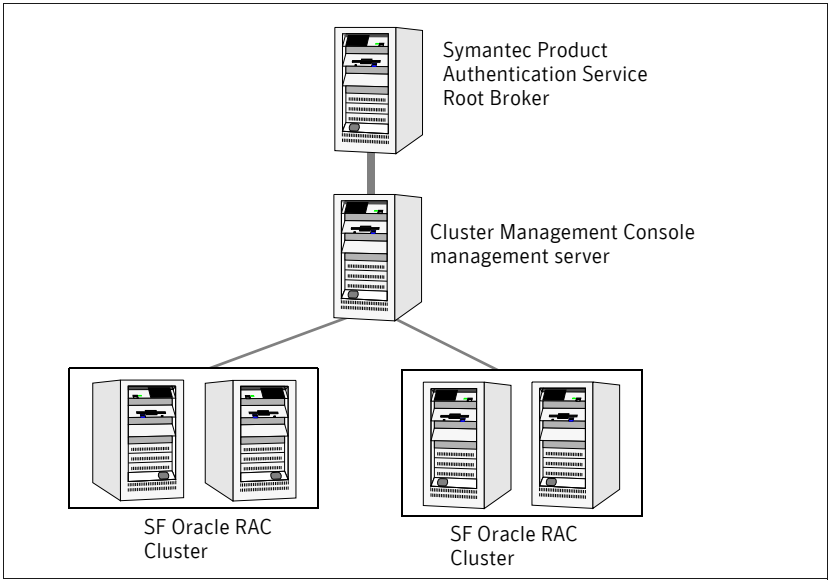
Operational mode	Configurational description
Local management of one cluster (single-cluster mode)	The Cluster Management Console is installed along with SF Oracle RAC on each node in the cluster and is configured for failover. It is integrated with SF Oracle RAC as part of the ClusterService service group. The Cluster Management Console offers robust cluster management capability and can be run from any supported Web browser on any system. See "Configuring the Cluster Management Console" on page 90.

Operational mode	Configurational description
Centralized, comprehensive, enterprise-wide administration of multiple clusters (multi-cluster mode)	One instance of the Cluster Management Console is installed outside all clusters on a standalone server. The console enables users to visually and intuitively input commands to the multi-cluster management engine, the *management server*. The management server initiates monitoring and management actions based upon those commands. The management server uses a database to store cluster configurations, cluster status, events, event policies, report jobs, report outputs, and more. See "Installing the management server for the Veritas Cluster Management Console" on page 55. If the management server and cluster nodes are separated by a firewall, a component called *cluster connector* is installed on each cluster node. Cluster connector enables communication with clusters through firewalls. Cluster connector also provides buffering for cluster data. If the console goes offline and then comes back online, it can retrieve data collected during the offline period from the cluster connector buffer. See "Configuring cluster connector" on page 89. The console offers additional capability for administering users, reports, events, and notification.

The configurational differences between the operational modes mean that you cannot switch a single Cluster Management Console installation from one mode to the other. The modes are also incompatible on the same system. Consequently, one system cannot offer both operational modes. However, the modes *can* co-exist in the same multi-cluster environment, with single-cluster-mode installations on SF Oracle RAC cluster nodes, and multi-cluster-mode installations on management server hosts. Such a deployment can be desirable if different IT administrators in your enterprise have different scopes of responsibility.

See *Veritas Cluster Server Centralized Management Guide* for more information.

Figure 2-3 Sample deployment for Veritas Cluster Management Console



Notification for VCS events

You have the option to configure SMTP email notification and SNMP trap notification of VCS events by the VCS Notifier component. Refer to the *Veritas Cluster Server User's Guide* for more information on SMTP and SNMP notification.

Typical SF Oracle RAC cluster setup

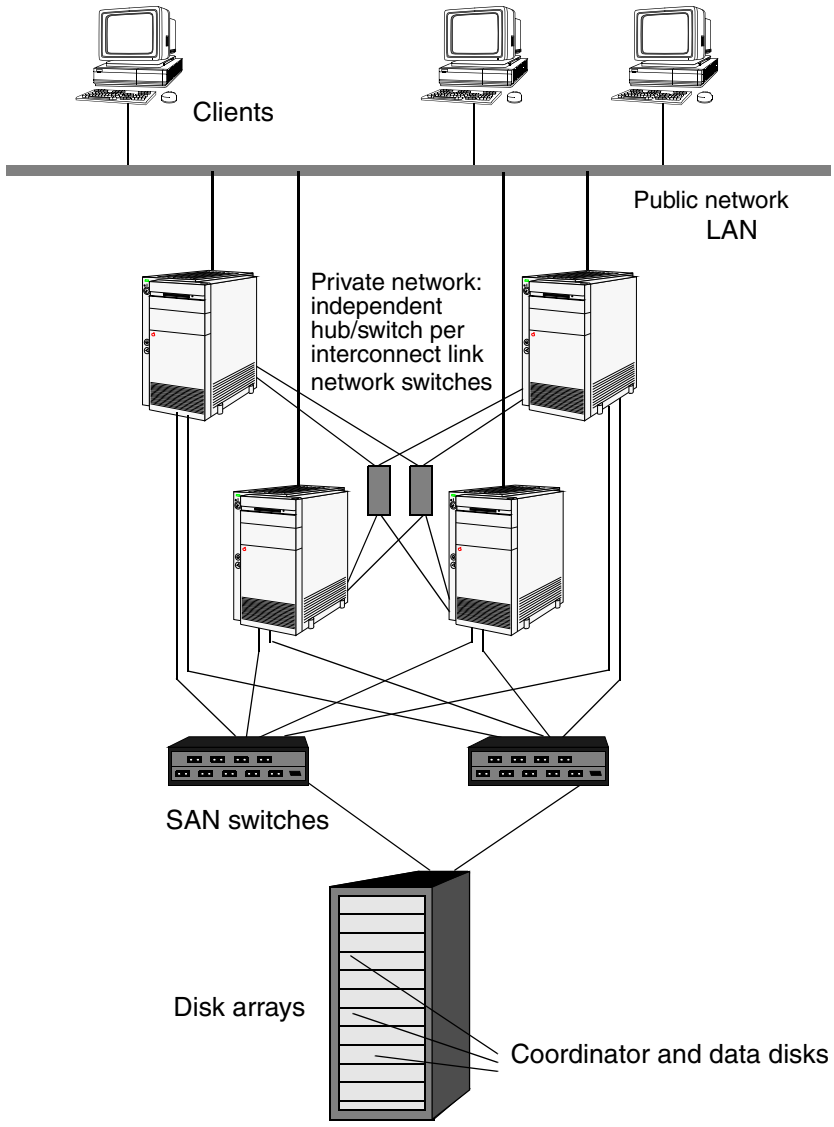
From a high-level, if you install SF Oracle RAC with Oracle10g and create a database, the SF Oracle RAC cluster typically has the following characteristics:

- Nodes connected by at least two VCS private network links using 100 Base T or Gigabit. Ethernet controllers on each system.
  For two-node clusters, cross-over Ethernet cables are acceptable. For three or more nodes, Ethernet switches can be used. Symantec recommends Gigabit Ethernet using enterprise-class switches for the private links. In either case, use a minimum of two switches to provide necessary redundancy. If multiple links are present on a single switch, such as cases where three or four links are configured, a separate VLAN must exist for each link. The use of multiple links on a single hub is not supported.
  Nodes are connected to shared storage devices through Fibre Channel switch. Symantec does not support the use of shared SCSI with the SF Oracle RAC product. For a complete list of supported Fibre Channel storage devices, see the current hardware compatibility list on the Symantec Support Web site.
  http://entsupport.symantec.com
- Nodes running Veritas Cluster Server (VCS), Veritas Volume Manager with cluster features (CVM), Veritas File System with cluster features (CFS), and Storage Foundation for Oracle RAC agents and components, including I/O fencing.
- Oracle RAC database is configured on the shared storage that is available to each node. The shared storage could be cluster file system or raw volumes. All shared storage, including coordinator disks, must support SCSI-3 PR.
- VCS is configured to enable agents to direct and manage the resources required by Oracle RAC. This configuration is required. The resources run in parallel on each system.

For a high-level view of an SF Oracle RAC configuration for a four-node cluster:

See "View of SF Oracle RAC Cluster" on page 49.

Figure 2-4 View of SF Oracle RAC Cluster



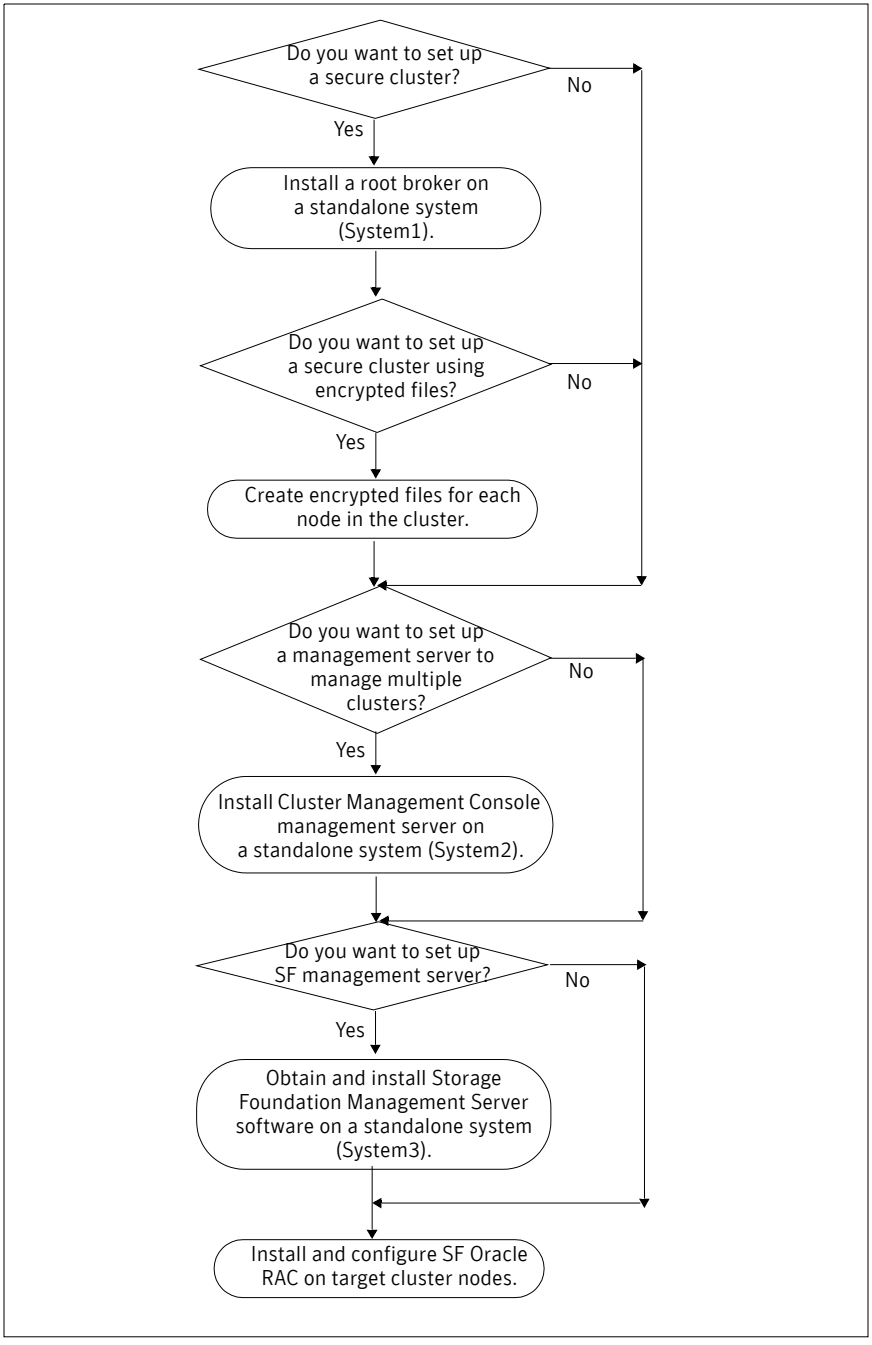
Preparing SF Oracle RAC cluster setup for optional features

After planning the SF Oracle RAC features that you want to configure, you must prepare to configure these features.

See "About SF Oracle RAC component features" on page 41.

Figure 2-5 on page 51 represents the major tasks and decisions required to install and configure SF Oracle RAC.

Figure 2-5 Workflow for fresh install of SF 5.0 Oracle RAC



Complete the following preparatory tasks based on the SF Oracle RAC features you want to configure:

- "Installing root broker for Symantec Product Authentication Service" on page 52
- "Creating encrypted files for Symantec Product Authentication Service" on page 53
- "Installing the management server for the Veritas Cluster Management Console" on page 55
- "Installing Veritas Storage Foundation Management Server" on page 61

Installing root broker for Symantec Product Authentication Service

Install the root broker only if you plan on using Symantec Product Authentication Service. The root broker administrator must install and configure the root broker before you configure the Authentication Service for SF Oracle RAC. Symantec recommends that you install the root broker on a stable system that is outside the cluster. You can install the root broker on an AIX, HP-UX, Linux, or Solaris system. See *Symantec Product Authentication Service Installation Guide* for more information. You can configure the Authentication Service during or after SF Oracle RAC installation.

See "Symantec Product Authentication Service" on page 42.

To install the root broker

1. Change to the directory where you can start the installsfrac program:
   ```
   # cd cluster_server
   ```
2. Start the Root Broker installation program:
   ```
   # ./installsfrac -security
   ```
3. Select to install the Root Broker from the three choices that the installer presents:
   ```
   [3] Install Symantec Product Authentication Service Root Broker.
   ```
4. Enter the name of the system where you want to install the Root Broker.
   ```
   Enter the system name on which to install Symantec Product
   Authentication Service: venus
   ```
5. Review the output as the installer:
   - checks to make sure that the SF Oracle RAC supports the operating system
   - verifies that you are installing from the global zone (only on Solaris)
   - checks if the system already runs the security package

6 Review the output as the installsfrac program checks for the installed packages on the system.
The installsfrac program lists the packages that will be installed on the system. Press Enter to continue.

7 Review the output as the installer installs the root broker on the system.

8 Enter **y** when the installer prompts you to configure the Symantec Product Authentication Service.

9 Enter a password for the root broker. Make sure the password contains a minimum of five characters.

10 Enter a password for the authentication broker. Make sure the password contains a minimum of five characters.

11 Press Enter to start the Authentication Server processes.

```
Do you want to start Symantec Product Authentication Service
processes now? [y,n,q] y
```

12 Review the output as the installer starts the Authentication Service.

13 If you plan to configure the Authentication Service during SF Oracle RAC installation, choose to configure the cluster in secure mode when the installer prompts you.
See "Configuring SF Oracle RAC Components" on page 85.

Creating encrypted files for Symantec Product Authentication Service

Create encrypted files only if you plan on choosing the semiautomatic mode that uses an encrypted file to configure the Authentication Service. The encrypted files must be created by the administrator on the root broker node. The administrator must create encrypted files for each node that would be a part of the cluster before you configure the Authentication Service for SF Oracle RAC. See *Veritas Cluster Server User's Guide* for more information. You can configure the Authentication Service during or after SF Oracle RAC installation.

See "Symantec Product Authentication Service" on page 42.

The example procedure assumes venus as the root broker node. The example procedure creates encrypted files for nodes galaxy and nebula that would form the SF Oracle RAC cluster rac_cluster101.

To create encrypted files

1 Determine the root broker domain name. Enter the following command on the root broker system:

```
venus> # vssat showalltrustedcreds
```

For example, the domain name would resemble
“Domain Name: root@venus.symantecexample.com” in the output.

2 For each node in the cluster, make sure that you have created an account on root broker system.

For example, to verify on node galaxy:

```
venus> # vssat showprpl --pdrtype root \
--domain root@venus.symantecexample.com --prplname galaxy
```

- If the output displays the principal account on root broker for the authentication broker on the node, then delete the existing principal accounts. For example:

```
venus> # vssat deleteprpl --pdrtype root \
--domain root@venus.symantecexample.com \
--prplname galaxy --silent
```

- If the output displays an error similar to “Failed To Get Attributes For Principal,” then the account for given authentication broker is not created on this root broker. Proceed to step 3 below.

3 Create a principal account for each authentication broker in the cluster. For example:

```
venus> # vssat addprpl --pdrtype root --domain \
root@venus.symantecexample.com --prplname galaxy \
--password password --prpltype service
```

You must use this password that you create in the input file for the encrypted file.

4 Make a note of the following information that is required for the input file for the encrypted file.

- hash - The root hash string that consists of 40 characters, as shown by the command:

```
venus> # vssat showbrokerhash
```

- identity - Authentication broker identity
  The value that you provide for **--prplname** in step 3 (for example, galaxy).
- password - Authentication broker password
  The value that you provide for **--password** in step 3.
- root_domain - Domain name of the root broker system
  The value that you determined in step 1.
- broker_admin_password - Authentication broker password for Administrator account on the node
  Provide a password of at least five characters long.

5 For each node in the cluster, create the input file for the encrypted file.

The installer presents the format of the input file for the encrypted file when you proceed to configure the Authentication Service using encrypted file. For example, the input file for authentication broker on galaxy would resemble:

```
[setuptrust]
broker=venus.symantecexample.com
hash=758a33dbd6fae751630058ace3dedb54e562fe98
securitylevel=high

[configab]
identity=galaxy
password=password
root_domain=vx:root@venus.symantecexample.com
root_broker=venus.symantecexample.com:2821
broker_admin_password=ab_admin_password
start_broker=true
enable_pbx=false
```

6 Back up these input files that you created for the authentication broker on each node in the cluster.
Note that for security purposes, the command to create the output file for the encrypted file deletes the input file.

7 For each node in the cluster, create the output file for the encrypted file from the root broker system using the following command.

```
RootBroker> # vssat createpkg --in /path/to/blob/input/file.txt
--out /path/to/encrypted/blob/file.txt --host_ctx AB-hostname
```

For example:

```
venus> # vssat createpkg --in /tmp/galaxy.blob.in \
--out /tmp/galaxy.blob.out --host_ctx galaxy
```

Note that this command creates a encrypted file even if you provide wrong password for “password=” entry, but the encrypted file will fail to install on authentication broker node.

8 After you complete creating output files for the encrypted file, you must copy these files to the installer node.

9 After you have created the encrypted file, you can start the SF Oracle RAC installation and choose to configure the cluster in secure mode.
See “Configuring SF Oracle RAC Components” on page 85.

Installing the management server for the Veritas Cluster Management Console

Install the Cluster Management Console management server only if you plan to centrally manage multiple clusters. Make sure you have a root broker in your domain. SF Oracle RAC clusters need not be secure to configure Cluster Management Console to manage multiple clusters.

See "Veritas Cluster Management Console" on page 45.

Install the Cluster Management Console management server and supporting components on a standalone system (outside any cluster but on the local network). Configure the management server to use a previously installed root broker or install and configure a root broker on the management server host.

You can install the management server on one of the following supported operating systems:

- Installing the management server on Solaris
- Installing the management server on Windows

Refer to the *Veritas Cluster Server Installation Guide* for supported software information for the Cluster Management Console.

Installing the management server on Solaris

You must install the management server on a system outside the cluster. This procedure follows a script of a successful installation. If at any step you experience a result other than the expected result that is documented here, you can click "n" to re-enter information. If you continue to have problems, click "q" to quit the installation and then verify the installation prerequisites.

To install the management server on Solaris

1. Insert the distribution media into the disc drive on the local system. At the command prompt, type the following command to run the setup program:

   ```
   ./installer -rsh
   ```

   The setup program (setup) presents copyright information followed by a menu titled, "Storage Foundation and High Availability Solutions 5.0".

2. Enter **i** to specify a task.

   ```
   Enter a Task: [I,C,L,P,U,D,Q,?] i
   ```

   Setup displays another menu that lists products that are available for installation.

3. Select the menu number that corresponds to Veritas Cluster Management Console.

   ```
   Select a product to install: [1-13,b,q]
   ```

   Setup presents a description of the product.

4. Enter **1** to select a product component.

   ```
   Enter '1' to install the Management Server, '2' to install the
   Cluster
   Connector: [1-2,q] (1) 1
   ```

   Setup presents a message stating that it will install the management server.

5. Enter **y** to verify that the information up to this point is correct.

   ```
   Is this information correct? [y,n,q] (y)
   ```

Setup performs an initial system check of the local system and checks for installed packages on the local system. If these checks are satisfactory, setup lists the packages to be installed.

```
Storage Foundation and High Availability Solutions 5.0
installer will install the following CMC packages:
VRTSat       Symantec Product Authentication Service
VRTSperl     Veritas Perl 5.8.8 Redistribution
VRTSdbms3    Symantec Shared DBMS
VRTSjre15    Veritas Java Runtime Environment Redistribution
VRTSweb      Veritas Java Web Server
VRTScmcm     Veritas Cluster Management Console
VRTScmcdc    Veritas Cluster Management Console Documentation
Press [Return] to continue:
```

6 Press Enter.

You may install Cluster Management Console packages without performing configuration. The setup program gives you the option to configure Cluster Management Console now, and provides instructions for configuring Cluster Management Console later.

7 Enter **y** to configure Cluster Management Console.

```
Are you ready to configure CMC? [y,n,q] (y)
```

8 Enter a unique management server display name, such as:

```
Enter a unique management server display name: [?]
mgmtserver1_sol9
```

9 Enter the network address used by the management server, such as:

```
Enter the network address used by the management server [b,?]
mgmtserver1.symantecexample.com
```

10 When prompted, enter a location for the management server database.

```
Enter the desired location of the database to be used by the
management server [b,?] (/opt/VRTScmc/db)
```

Setup repeats the management server display name, the management server network address, and the database location.

11 Enter **y** to verify that the information up to this point is correct.

```
Is this information correct? [y,n,q,b] (y)
```

Setup describes local user configuration and custom user configuration.

12 Configure a local user or a custom user as the initial management server administrator. This is the first user account that is enabled to log in to the Cluster Management Console.

Make your selection and then specify the following user authentication details:

- For a local user, setup assumes that the domain name is the name of the local system and that the domain type is unixpwd, or UNIX password.

When prompted for the initial management server user name, enter root or another administrator-level user for the local system.

- For a custom user, you must explicitly specify the domain name and the domain type along with the user name. Follow the three separate prompts to enter this user information.

```
Local User:
Configure a user on the local machine as the initial admin user.
Custom User:
Configure a user manually.
1)  Local User
2)  Custom User
Enter '1' to enter the name of a local user, '2' to set up a
custom user:
[1-2,q] (1) 1

Storage Foundation and High Availability Solutions 5.0
Local admin user selection:
To log in to the CMC Management Server, enter the name of a local
user to be set as the administrator. The domain and domain type
will be automatically selected for you.
Enter the initial management server user name: [b,?] (root)
Storage Foundation and High Availability Solutions 5.0
Management Server admin user verification:
Management Server User Name: root
```

13 Enter **y** to verify that the information up to this point is correct.

```
Is this information correct? [y,n,q,b] (y)
```

Setup describes a particular management server service account, which the management server uses for secure internal communications with cluster connector. This account is named CMC_CC@CMC_SERVICES.

14 Enter a password for the management server service account and confirm it at the next prompt.

```
Enter a password for the CMC service account:xxxxx
Confirm the password you entered for the CMC service
account:xxxxx
```

When you install and configure cluster connector, you must provide this same password for the CMC_CC@CMC_SERVICES account.

15 Specify whether or not you want the management server to use a remote root broker for user authentication.

If you have already configured a root broker in your network, Symantec recommends that you enter **y** to use that existing root. Specify the additional details for that remote root broker exactly as specified.

If you do not have a currently-configured root broker, enter **n** to install and configure a root broker on the management server host.

After you enter **y** or **n**, setup installs an authentication broker on the management server and configures it to use whichever root broker you selected. When finished, setup presents:

- Installation progress percentages
- Status for writing the management server configuration file
- Status for creating secure internal service accounts

16 Enter **y** to start Veritas Cluster Management Console processes now.

```
Do you want to start Veritas Cluster Management Console
processes now? [y,n,q,b] (y)
```

Setup presents startup progress percentages and, if successful, displays the following message:

```
Startup completed successfully on all systems.
```

17 Enter an encryption key of at least five characters.

```
Enter five or more characters to be used an encryption key: [b]
xxxxx
This key must be retained in a secure file and referenced using
the -enckeyfile option if the generated responsefile is to be
used again.
Press [Return] to continue:
```

18 Press Enter to continue.

Record the location that setup provides for the installation log files, summary file, and response file. Also ensure that you record the initial admin user information. You *must* use this account to log in to the Cluster Management Console for the first time.

Installing the management server on Windows

You must install the management server on a system outside all clusters. Windows Management Instrumentation (WMI) is a prerequisite for installing and using the management server and cluster connector.

To install WMI

1 Log on as a user that has administrator privileges on the system on which you want to install WMI.

2 On the **Start** menu, click **Settings**, and then click **Control Panel.**

3 In the **Control Panel** window, double-click **Add or Remove Programs**.

4 In the task pane, click **Add/Remove Windows Components**.

5 Click **Management and Monitoring Tools**, then click **Details**.

6 Ensure that the WMI Windows Installer Provider is checked, and then click **OK**.

7 Click **Next**.

8 If prompted, insert the Windows CD and click **OK**.

9 After installation is complete, click **Finish**.

10 Restart your computer.

To install the management server on Windows

1 On the distribution disc, locate the **\installer** directory.

2 Double-click the **setup** file.
Depending upon the operating system, you may or may not receive the following warning message:
```
The publisher could not be verified. Are you sure you want to
run this software?
```
If you receive this message, click **Run**.

3 In the Welcome to the Veritas Cluster Management Console Installation Manager dialog box, read the introduction and then click **Next**.

4 In the Installation and Configuration Options dialog box, click **Install a new management server on the local node**, and then click **Next**.

5 In the Management Server Installation Directory dialog box, leave the default installation path provided in the text box or click **Browse** to search for another installation location. Click **Next** to accept the path.

6 In the Management Server Information dialog box, enter the system name and IP address of the intended management server host.
You cannot change the port specification, 14145, but it is provided to help you to prevent port conflicts when configuring other software. The other ports used by the Cluster Management Console are 8181 (HTTP), 8443 (HTTPS), and 2994 (DBMS; this port can be shared with other Symantec products)

7 In the Database File Path box, leave the default database path provided or click **Browse** to search for another location for the database. Click **Next** to accept the path.

8 In the Services Account Password dialog box, enter a password for the user account that cluster connector uses for management server communications, and then click **Next**.
Record the password that you enter in a safe place. You must use it again whenever you install or configure cluster connector.

9 In the User Credential Confirmation dialog box, leave the automatically-detected user information provided or specify another user name, domain, and domain type.

This user becomes the initial management server user. You must provide the credentials entered at this step when logging in to the management server for the first time.

10 In the Summary dialog box, review the information you have specified and, if satisfactory, click **Next** to accept it and start the installation.
The Installing Veritas Cluster Management Console dialog box displays a progress bar and a status message window for the installation.

11 When you receive the following message, click **Next**:
`"Done deleting installation files from node...,"`

12 In the Completed the Symantec Veritas Cluster Management Console Installation Manager dialog box, review the information about how to connect to the management server and log in for the first time. Record this information in a safe place and then click **Finish**.

13 Note the log file locations. The installer creates log files at the following locations:

- Installation logs – `C:\Documents and Settings\All Users\Application Data\Veritas\Cluster Management Console`. The file names are Install_GUI_0.log and Install_MSI_0.log.
- Management server logs – `C:\Program Files\Veritas\Cluster Management Console\log`

Installing Veritas Storage Foundation Management Server

Obtain the Storage Foundation Management Server software and install SF Management software on a system outside the cluster. For information on ordering SF Management Server, visit:

www.symantec.com/enterprise/sfms

Refer to the Storage Foundation Management Server documentation for details.

SF Oracle RAC prerequisites

Verify the requirements for your configuration before installing SF Oracle RAC.

System requirements

Make sure that you have the correct equipment to install SF Oracle RAC.

Table 2-1

Item	Description
SF Oracle RAC systems	Two to eight systems with two or more CPUs at 2GHz or higher.
RAM	Each SF Oracle RAC system requires 2 GB or more of physical memory.
Network links	Two or more private links and one public link. Symantec recommends Gigabit Ethernet using enterprise-class switches for the private links.
DVD drive	One drive that is accessible to all nodes in the cluster.
Fibre channel or SCSI host bus adapters	SF Oracle RAC requires at least one built-in SCSI adapter per system to access the operating system disks, and at least one additional SCSI or Fibre Channel Host Bus Adapter per system for shared data disks.
Disks	Typical SF Oracle RAC configurations require that shared disks support applications that migrate between systems in the cluster. The SF Oracle RAC I/O fencing feature requires that all disks used as data disks or as coordinator disks must support SCSI-3 Persistent Reservations (PR). **Note:** The coordinator disk does not store data, so configure the disk as the smallest possible LUN on a disk array to avoid wasting space. "Checking shared disks for SCSI-3 support" on page 84
Disk space	SF Oracle RAC space requirement: ■ total: 2.6 G ■ `/opt`: 1.4 G ■ `/usr`: 200 KB ■ `/tmp`: 512 MB ■ `/var`: 32 MB ■ `/var/tmp`: 700 MB
Swap space	Two times the main memory.

Review the current compatibility list to confirm compatibility of your hardware:

http://entsupport.symantec.com/docs/286819

Software requirements

Software versions that SF 5.0 Oracle RAC supports include:

Oracle RAC	Oracle10*g* Release 2
Linux operating system	See "Supported operating systems" on page 64.
VCS, VxVM, VxFS	Use only versions of VCS, VxVM, and VxFS provided on the software disc. Remove other versions before you install the software from the SF Oracle RAC product disc.

To verify the latest information on support for Oracle database versions, see the Technical Support TechNote:

http://entsupport.symantec.com/docs/285834

Use a software combination supported for SF Oracle RAC:

Table 2-2 Supported versions of Oracle

Base Oracle Version	Latest Supported Oracle Version	RHEL 4.0 Update 4 ppc64	SLES9 SP3 ppc64
Oracle 10g Release 2 10.2.0.1	Oracle10*g* Release 2 10.2.0.3	Yes	Yes

The "Latest Supported Oracle Version" is always supported. For a fresh installation, you must upgrade the Oracle binaries to the "Latest supported Oracle version" before performing the database creation operation. This prevents potential problems due to an older Oracle version being incorrectly linked with the IPC library requirement for the newer version.

Supported operating systems

Within a cluster, all nodes must use the same operating system version and patch level. Run SF 5.0 Oracle RAC on these operating systems at the suggested patch levels.

- Install Linux operating systems. SF 5.0 Oracle RAC supports the following Linux operating systems and kernel binaries distributed by Red Hat and SUSE:

Table 2-3 Supported Linux architectures and kernels

Operating System	Architecture	Kernel
Red Hat Enterprise Linux 4 (RHEL 4) with Update 3 or 4	ppc64	2.6.9-34, 42 kernels on IBM System p servers (using IBM POWER5 processors). Later updates of RHEL4 are supported provided that Red Hat maintains kernel application binary interface (kABI) compatibility.
SUSE Linux Enterprise Server 9 (SLES 9) with Service Pack 3	ppc64	2.6.5-7.244 kernel on IBM System p servers (using IBM POWER5 processors). Later updates of SLES9 are supported provided that SuSE maintains kernel application binary interface (kABI) compatibility.

- For RHEL4, disable SELinux (Security Enhanced Linux) and Firewall during OS installation.
- For SLES9, do not use the auditing subsystem. ODM is not compatible with the auditing subsystem on SLES 9.
- Install Linux patches. No specific patches are required for SF Oracle RAC.

Performing pre-installation tasks

Complete these tasks before installing SF Oracle RAC:

- ✔ Obtaining license keys
- ✔ Synchronizing cluster nodes
- ✔ Setting up inter-system communication
- ✔ Setting up shared storage
- ✔ Setting up environment variables
- ✔ Configuring the I/O scheduler
- ✔ Configuring the SLES9 network
- ✔ Preparing information for the configuration phase of installsfrac.

Obtaining license keys

SF Oracle RAC includes a License Key certificate. The certificate specifies the product keys and the number of product licenses purchased. A single key enables you to install the product on the number and type of systems for which you purchased the license. A key may enable the operation of more products than are specified on the certificate; however, you are legally limited to the number of product licenses purchased.

The product installation procedure includes instructions on how to activate the key. If you encounter problems while licensing this product, visit the Symantec support website at:

http://www.symantec.com/enterprise/support/assistance_care.jsp

The VRTSvlic package enables product licensing. After the VRTSvlic is installed, the following commands and their manual pages are available on the system:

vxlicinst	Installs a license key for a Symantec product
vxlicrep	Displays currently installed licenses
vxlictest	Retrieves features and their descriptions encoded in a license key

Even though other products are included on the enclosed software discs, you can only install the Symantec software products for which you have purchased a license.

Synchronizing cluster nodes

Symantec requires all cluster nodes have the same time. If you do not run the Network Time Protocol (NTP) daemon, make sure to synchronize the time settings on each node.

On RHEL4, use the `rdate` command on each system to synchronize with the NTP server:

```
# rdate -s timesrv
```

On SLES9, use the `yast` command on each system to synchronize with the NTP server:

```
# yast ntp-client
```

Setting up inter-system communication

If you configured `ssh` (SSH client) for the cluster nodes, the installation program can install SF Oracle RAC as long as `ssh` commands between nodes can execute without password prompting and confirmation.

If you did not configure `ssh`, enable each node to have remote `rsh` access to the other nodes during installation and disk verification.

Setting up shared storage for I/O fencing

You need to set up shared storage so that it is visible to the SCSI layer from all the nodes in the cluster. The shared storage that you add for use with SF Oracle RAC software must support SCSI-3 persistent reservations, a functionality that enables the use of I/O fencing.

For troubleshooting, see “Shared disks not visible” on page 265.

Setting up environment variables

Set up the PATH and MANPATH variables prior to installing SF Oracle RAC.

Setting the PATH Variable

The installation and other commands are located in various directories. If necessary, add these directories to your PATH environment variable on each system:

For Bourne Shell (`sh` or `ksh`), type:

```
# PATH=/usr/sbin:/sbin:/usr/bin:/usr/lib/vxvm/bin:\
/opt/VRTSvxfs/sbin:/opt/VRTSvcs/bin:/opt/VRTS/bin:\
/opt/VRTSvcs/rac/bin:/opt/VRTSob/bin:$PATH; export PATH
```

For C Shell (`csh`), type:

```
# setenv PATH /usr/sbin:/sbin:/usr/bin:/usr/lib/vxvm/bin:\
/opt/VRTSvxfs/sbin:/opt/VRTSvcs/bin:/opt/VRTS/bin:\
```

```
/opt/VRTSvcs/rac/bin:/opt/VRTSob/bin:$PATH
```

For `root` user, do not define paths to a cluster file system in the `LD_LIBRARY_PATH` variable. For example, define `$ORACLE_HOME/lib` in `LD_LIBRARY_PATH` for user `oracle` only.

The path defined as `/opt/VRTSob/bin` is optional unless you choose to install Veritas Enterprise Administrator.

Setting the MANPATH Variable

Set the MANPATH variable to enable viewing manual pages.

For the Bourne Shell (`bash`, `sh` or `ksh`), type:

```
# export MANPATH=$MANPATH:/opt/VRTS/man
```

For the C Shell (`csh`), type:

```
# setenv MANPATH $MANPATH:/opt/VRTS/man
```

Some terminal programs may display garbage characters while viewing man pages. This issue can be resolved by setting the following environment variable: LC_ALL=C

Configuring the I/O scheduler

Symantec recommends using the Linux 'deadline' I/O scheduler for database workloads. Please configure your system to boot with the '`elevator=deadline`' argument to select the 'deadline' scheduler. See:

- http://www.redhat.com/f/pdf/rhel4/RHEL4WhatsNewPdf.pdf
- http://www.novell.com/products/linuxenterpriseserver/sles9_whatsnew.pdf

To determine whether a system is using the deadline scheduler:

Look for "`elevator=deadline`" in `/proc/cmdline`.

To configure a system to use the deadline scheduler

1. Include the `elevator=deadline` parameter in the boot arguments of the GRUB or ELILO configuration file. The location of the appropriate configuration file depends on the system's architecture and Linux distribution. For ppc64, the configuration file is `/boot/grub/menu.lst`
   - For GRUB configuration files, add the `elevator=deadline` parameter to the `kernel` command. For example, change:
   - For GRUB configuration files, add the `elevator=deadline` parameter to the `kernel` command. For example, change:

     ```
     title RHEL AS 4 smp
         root (hd1,1)
         kernel /boot/vmlinuz-2.6.9-11.ELsmp ro root=/dev/sdb2
         initrd /boot/initrd-2.6.9-11.ELsmp.img
     ```

To:

```
title RHEL AS 4 smp
    root (hd1,1)
    kernel /boot/vmlinuz-2.6.9-11.ELsmp ro
        root=/dev/sdb2 \ elevator=deadline
    initrd /boot/initrd-2.6.9-11.ELsmp.img
```

- A setting for the `elevator` parameter is always included by SUSE in its ELILO and GRUB configuration files. In this case, change the parameter from `elevator=cfq` to `elevator=deadline`.

2 Reboot the system once the appropriate file has been modified. See the operating system documentation for more information on I/O schedulers.

Configuring the SLES9 network

Before installing SF Oracle RAC on SLES9, some network configuration is required on SLES9.

To configure a SLES9 network for SF Oracle RAC

1 If it is not already set to yes, set `HOTPLUG_PCI_QUEUE_NIC_EVENTS` in `/etc/sysconfig/hotplug` to "yes":

```
HOTPLUG_PCI_QUEUE_NIC_EVENTS=yes
```

2 Make sure that all ethernet devices are brought online at boot time by including them as `MANDATORY_DEVICES`. This ensures that LLT interfaces are available before configuration.

For example:

```
# grep MANDATORY_DEVICES /etc/sysconfig/network/config
MANDATORY_DEVICES="eth-id-00:04:23:a5:99:bc
eth-id-00:04:23:a5:99:bd eth-id-00:30:6e:4a:62:50
eth-id-00:30:6e:4a:63:5d"
```

Each entry in the `MANDATORY_DEVICES` list is of the form `eth-id-<macaddress>`.

Make the appropriate entries in this list using the mac addresses of the interfaces present.

3 To ensure that the interface name to MAC address mapping remains the same across reboots, Symantec requires that `PERSISTENT_NAME` entries be added to the configuration files for all the network interfaces, including those that are not currently used:

- Run:
  `ifconfig -a`.
- For each ethernet interface displayed:
  - If it does not already exist, create a file named:
    `/etc/sysconfig/network/ifcfg-eth-id-<mac>`

where <mac> is the hardware address of that interface. Make sure that <mac> contains lower case characters.
If a file named ifcfg-eth0 exists then delete it.

- Add the following line at the end of this file:-

```
PERSISTENT_NAME=<ethX>
```

where ethX is the interface name for this interface.

- Example:

Enter: ifconfig -a

```
eth0      Link encap:Ethernet  HWaddr 00:02:B3:DB:38:FE
    inet addr:10.212.99.30  Bcast:10.212.99.25
        Mask:255.255.254.0
    inet6 addr: fe80::202:b3ff:fedb:38fe/64 Scope:Link
 UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
 RX packets:453500 errors:0 dropped:0 overruns:0 frame:0
    TX packets:8131 errors:0 dropped:0 overruns:0
        carrier:0
    collisions:0 txqueuelen:1000
    RX bytes:35401016 (33.7 Mb)  TX bytes:999899 (976.4
        Kb)
    Base address:0xdce0 Memory:fcf20000-fcf40000
```

If it does not already exist, create a file named:

```
/etc/sysconfig/network/ifcfg-eth-id-00:02:b3:db:38:fe
```

Add to the end of this file the following line:

```
PERSISTENT_NAME=eth0
```

- Repeat this procedure for all interfaces displayed by ifconfig -a.

Gathering information to install and configure SF Oracle RAC

The SF Oracle RAC installation and configuration program prompts you for information about some SF Oracle RAC components. The program provides default values for some information, which you can choose to use. Keep the following required information at hand.

Information to install SF Oracle RAC rpms

- System names on which to install SF Oracle RAC
  Example: **galaxy**, **nebula**
- License keys
  License keys could be one of the following types:
  - Valid license keys for each system in the cluster
  - Valid site license key

- Valid demo license key

  See "Obtaining license keys" on page 65.

- Do you want to install required SF Oracle RAC rpms or all SF Oracle RAC rpms?

  Install only the required rpms if you do not want to configure any optional components or features.

  Default option is to install all rpms.

Information to configure Veritas Cluster Server component

- Name of the cluster
  The name must begin with a letter of the alphabet (a-z, A-Z) and contain only the characters a through z, A through Z, and 1 through 0, hyphen (-), and underscore (_).
  Example: **rac_cluster101**
- Unique ID number for the cluster
  Number in the range of 0-65535. Within the site containing the cluster, each cluster must have a unique ID.
  Example: **101**
- Device names of the NICs used by the private networks among systems
  Do not enter the network interface card that is used for the public network.
  Example: **eth2, eth3**
  The interface names associated with each NIC for each network link must be the same on all nodes.

Information to configure SF Oracle RAC clusters in secure mode

- Which mode do you want to choose to configure Authentication Service?
  The installer provides you the following three modes to configure Authentication Service in the SF Oracle RAC clusters:
  - automatic mode
  - semiautomatic mode using encrypted files
  - semiautomatic mode without using encrypted files

  Default option is automatic mode.
  See "Symantec Product Authentication Service" on page 42.
- Host name of the Symantec Product Authentication Service Root Broker System
  Example: **venus**

Information to add SF Oracle RAC users

You need add SF Oracle RAC users now if you configured SF Oracle RAC cluster in secure mode.

- User name
  Example: **smith**
- User password
  Enter the password at the prompt.

- User privilege
  Users have three levels of privileges: A=Administrator, O=Operator, or G=Guest.
  Example: **A**

Information to configure Cluster Management Console cluster connector

- Management Server network address for Cluster Management Console
  Example: **mgmtserver1.symantecexample.com**
- Cluster Management Console service account password
  You must have set this account password while installing the management server.
- Root hash of the management server
  You can use `vssat showbrokerhash` command and copy the root hash of the management server.

Information to configure Cluster Management Console

- Name of the public NIC for each node in the cluster
  The device name for the NIC that provides public network access.
  Example: **eth0**
- Virtual IP address of the NIC for Cluster Management Console (CMC)
  This virtual IP address becomes a resource for use by the ClusterService group that includes the CMC. The “Cluster Virtual IP address” can fail over to another cluster system, making the Web Console highly available.
  Example: **10.10.12.1**
- Netmask for the virtual IP address
  The subnet used with the virtual address.
  Example: **255.255.240.0**

Information to configure SMTP email notification

- Domain-based address of the SMTP server
  The SMTP server sends notification email about the events within the cluster.
  Example: **smtp.symantecexample.com**
- Email address of each SMTP recipient to be notified
  Example: **john@symantecexample.com**

- Minimum severity of events for SMTP email notification
  Events have four levels of severity: I=Information, W=Warning, E=Error, and S=SevereError.
  Example: **E**

Information to configure SNMP trap notification

- Port number for the SNMP trap daemon
  Default port number is 162.
- Machine name for each SNMP console
  Example: **saturn**
- Minimum severity of events for SNMP trap notification
  Events have four levels of severity: I=Information, W=Warning, E=Error, and S=SevereError.
  Example: **E**

Information to configure Cluster Volume Manager

- CVM cluster reconfiguration timeout in seconds
  Default is 200.

Information to configure I/O fencing

- Name of three disks that will form the coordinator disk group
  Example: **sda, sdb, sdc**
- DMP nodes names for each disk in the coordinator disk group (if using DMP)
  Example: **/dev/vx/dmp**

Enclosure-based disk names

Typically, disks on UNIX systems use device names, such as `/dev/sdz` to identify disks on the system. With VxVM, choose whether to use the enclosure-based naming scheme, which makes disk arrays more recognizable.

Starting SF Oracle RAC processes

You have the option of starting the SF Oracle RAC processes during the installation procedure.

Default disk group

As some VxVM commands require a disk group be specified, the installation enables you to register the name of the default VxVM disk group (which can be created later) on each eligible cluster system. Setting up a default disk group is optional.

In VxVM 4,0 and higher, commands that affect the contents of a disk group require you to specify a disk group using the `-g` option. If you specify a disk group in the *VXVM_DEFAULTDG* environment variable, or you configure the default disk group, you do not need to use the `-g` option for disk group operations on that disk group.

About CVM and CFS in an SF Oracle RAC environment

You can review concepts on CVM, CFS, and Oracle before installing SF Oracle RAC to better understand the overall setup and configuration of the product.

About CVM

Review CVM configuration differences from VxVM and CVM recovery operations. For introductory information on CVM, see “Cluster Volume Manager” on page 25.

CVM configuration differences

CVM configuration differs from VxVM configuration in these areas:

- Configuration commands occur on the master node.
- Disk groups are created (could be private) and imported as shared disk groups.
- Disk groups are activated per node.
- Shared disk groups are automatically imported when CVM starts.

CVM recovery

When a node leaves a cluster, it can leave some mirrors in an inconsistent state. The membership change is communicated through GAB to the `vxconfigd` daemon, which automatically calls the `vxrecover` utility with the `-c` option when necessary.

CVM supports both the FastResync option and dirty region logging (DRL) as optional features to improve resynchronization performance. FastResync

improves performance when reorganizing volumes (moving, splitting, and joining disk groups). This is useful when performing off-host processing. DRL speeds up resynchronization after a node failure.

Special considerations exist when using the DRL in an SF Oracle RAC environment. As in a non-clustered environment, the DRL in clusters exists on a log subdisk in a mirrored volume. The size of the DRL in clusters is typically larger than in non-clustered systems. The log size depends on the volume size and the number of nodes. The `vxassist` command automatically imports a sufficiently large DRL.

You can reimport a private disk group as a shared disk group but the DRL for any mirrored volume in the disk group is probably too small to accommodate maps for all the cluster nodes. Adding nodes to the cluster can also result in too small a log size. In this situation, VxVM marks the log invalid and performs full volume recovery instead of using DRL.

About CFS

Review CFS File System benefits, CFS configuration differences from VxFS and CFS recovery operations. For introductory information on CFS, see “Cluster File System” on page 27.

CFS file system benefits

Many features available in VxFS do not come into play in an SF Oracle RAC environment because ODM handles such features. CFS adds such features as high availability, consistency and scalability, and centralized management to VxFS. Using CFS in an SF Oracle RAC environment provides these benefits:

- Increased manageability, including easy creation and expansion of files. Without a file system, you must provide Oracle with fixed-size partitions. With CFS, you can grow file systems dynamically to meet future requirements.
- Less prone to user error. Raw partitions are not visible and administrators can compromise them by mistakenly putting file systems over the partitions. Nothing exists in Oracle to prevent you from making such a mistake.
- Data center consistency. If you have raw partitions, you are limited to a RAC-specific backup strategy. CFS enables you to implement your backup strategy across the data center.

CFS configuration differences

The first node to mount a CFS file system as shared becomes the primary node for that file system. All other nodes are “secondaries” for that file system.

Use the `fsclustadm` command from any node to view which node is primary and set the CFS primary node for a specific file system.

Mount the cluster file system individually from each node. The -o cluster option of the mount command mounts the file system in shared mode, which means you can mount the file system simultaneously on mount points on multiple nodes.

When using the `fsadm` utility for online administration functions on VxFS file systems, including file system resizing, defragmentation, directory reorganization, and querying or changing the largefiles flag, run `fsadm` from the primary node. This command fails from secondaries.

CFS recovery

The `vxfsckd` daemon is responsible for ensuring file system consistency when a node crashes that was a primary node for a shared file system. If the local node is a secondary node for a given file system and a reconfiguration occurs in which this node becomes the primary node, the kernel requests `vxfsckd` on the new primary node to initiate a replay of the intent log of the underlying volume. The `vxfsckd` daemon forks a special call to `fsck` that ignores the volume reservation protection normally respected by `fsck` and other VxFS utilities. `vxfsckd` can check several volumes at once if the node takes on the primary role for multiple file systems.

After a secondary node crash, no action is required to recover file system integrity. As with any crash on a file system, internal consistency of application data for applications running at the time of the crash is the responsibility of the applications.

Coordinating CVM and CFS configurations

After installing SF Oracle RAC, a VCS cluster attribute (`HacliUserLevel`) is set to give root the ability to run commands on remote systems by way of the cluster interconnect. CFS takes advantage of this mechanism to enable you to perform file system operations requiring the primary node be initiated on secondary nodes and carried out on the primary node transparently.

If you reset this attribute, be aware of which node is the primary for certain file system operations and perform those tasks from that node. Unlike a non-RAC environment, you cannot run a sequence of VxVM and VxFS commands, such as resizing a volume and a file system, on the same node unless it is both the CVM master and CFS primary node.

About shared disk groups

This section highlights general information to refer to when dealing with disk groups and volumes. Refer to the Veritas Volume Manager documentation for complete details on creating and managing shared disk groups.

Viewing information on a disk group

To display information about a specific disk group, type:

```
vxdg list disk_group
```

Checking the connectivity policy on a shared disk group

By default, the connectivity policy for a shared disk group is set to “global.” This setting protects against possible data corruption and causes all nodes to detach from the disk group when any node reports a disk failure for that disk group.

The output of the `vxdg list shared_disk_group` command includes the following line:

```
detach-policy: global
```

To change the connectivity policy for a disk group from “local” to “global,” type:

```
# vxedit -g shared_disk_group set diskdetpolicy=global
shared_disk_group
```

Determining whether a node is CVM master or slave

To determine whether a node is the CVM master or slave, type:

```
# vxdctl -c mode
```

On `nebula`, which is the slave, the output shows:

```
mode: enabled: cluster active - SLAVE
master: galaxy
```

On `galaxy`, which is the master, the output shows:

```
mode: enabled: cluster active - MASTER
master:galaxy
```

Deporting and importing shared disk groups

Shared disk groups in an SF Oracle RAC environment are configured for “Autoimport” at the time of CVM startup. If the user manually deports the shared disk group on the CVM master, the disk group is deported on all nodes. To reimport the disk group, the user must import the disk group as a shared group from the CVM master.

To deport a shared disk group, use the following command on the CVM master:

```
vxdg deport shared_disk_group
```

To import a shared disk group, use the following command on the CVM master:

```
vxdg -s import shared_disk_group
```

To import a disk group as a standalone disk group, deport it from the CVM master and use the following command on any node:

```
vxdg -C import shared_disk_group
```

To reimport a disk group as a shared disk group, deport it from the standalone node and use the following command on the CVM master node:

```
vxdg -C -s import shared_disk_group
```

Reviewing limitations of shared disk groups

The cluster functionality of VxVM (CVM) does not support RAID-5 volumes or task monitoring for shared disk groups in a cluster. These features can function in private disk groups attached to specific nodes of a cluster. Online relayout is available provided it does not involve RAID-5 volumes.

Note: The default disk group, defined when the vxinstall program is run, is a private group that cannot be shared in a cluster.

CVM only provides access to raw device; it does not support shared access to file systems in shared volumes unless you install and configure the appropriate software, such as CFS.

About raw volumes versus CFS for data files

Keep these points in mind about raw volumes and CFS for data files:

- If you use file-system-based data files, the file systems containing these files must be located on shared disks. Create the same file system mount point on each node.
- If you use raw devices, such as VxVM volumes, set the permissions for the volumes to be owned permanently by the database account. For example, type:

  ```
  # vxedit -g dgname set group=dba owner=dba mode 660 \
      /dev/vx/rdsk/dgname/volume_name
  ```

  VxVM sets volume permissions on import. The VxVM volume, and any file system that is created in it, must be owned by the Oracle database account.

Chapter 3

Installing and Configuring SF Oracle RAC Software

After reviewing the requirements and planning information, use this chapter to install and configure SF Oracle RAC on clean systems. For planning information:

See "Preparing to install SF Oracle RAC" on page 37.

High-level objectives and required tasks to complete each objective:

✔ "Installing the software" on page 79

✔ "Performing basic system checks" on page 81

✔ "Configuring SF Oracle RAC Components" on page 85

✔ "Starting SF Oracle RAC processes" on page 95

✔ "Performing post-installation tasks" on page 96

✔ "Setting up I/O fencing" on page 98

Installing the software

To install the SF Oracle RAC software, you may use the Symantec common product installer with the `-installonly` option or the `installsfrac` script with `-installonly` option.

The common product installer offers a high-level approach to installing multiple products along with Symantec Product Authentication Service, Veritas Cluster Management Console, and Veritas Central Management Server. Each of these products and features are covered in depth in their respective product guides.

The common product installer is the recommended method to license and install the product. The installer also enables you to configure the product, verify pre-installation requirements, and view the product's description. At most

points during an installation, you can type **b** ("back") to return to a previous section of the installation procedure. The back feature of the installation scripts is context-sensitive, so it returns to the beginning of a grouped section of questions. If an installation procedure hangs, use **Control–c** to stop and exit the program. There is a short delay before the script exits.

The `installsfrac -installonly` script offers a more direct approach to specifically installing SF Oracle RAC. The script takes the user only through the installation of packages.

Note: If you have obtained a Veritas product from an electronic download site, the single product download files do not contain the `installer` installation script, so you must use the product installation script to install the product. For example, if you download Veritas Storage Foundation for Oracle RAC, use the `installsfrac` script instead of the `installer` script.

Note: Configuring the software with the `installsfrac -configure` script occurs *after* you install the product and run required system checks.

To install SF Oracle RAC

1. Insert the disc containing the Veritas SF Oracle RAC software in a disc drive connected to one of the nodes for installation.
2. Log in as `root` user.
3. Enter:
   ```
   # mount /mnt/cdrom
   ```
4. Navigate to the directory containing the installation program:
   - For RHEL 4.0 on ppc64:
     ```
     # cd
     /mnt/cdrom/rhel4_ppc64/storage_foundation_for_oracle_rac
     ```
   - For SLES9 on ppc64:
     ```
     # cd
     /mnt/cdrom/sles9_ppc64/storage_foundation_for_oracle_rac
     ```
5. Start the `installsfrac` script:
   ```
   # ./installsfrac -installonly
   ```
   By default, the installsfrac program uses SSH for remote communication. However, to use RSH, specify the -rsh option with the installsfrac program.
   ```
   # ./installsfrac -rsh -installonly
   ```
6. Enter the names of the nodes separate by spaces where you want to install the software:

```
Enter the system names separated by spaces on which to
install SFRAC: galaxy nebula
```

7 After the script verifies that the local node running the script can communicate with remote nodes and that `VRTScpi` and `VRTSvlic` are present on each node, enter the license key for SF Oracle RAC.
You can also enter keys for other products:

```
Enter a SFRAC license key for galaxy:
XXXX-XXXX-XXXX-XXXX-XXXX-XXXX-XXX
XXXX-XXXX-XXXX-XXXX-XXXX-XXXX-XXX successfully registered on
on galaxy
SFRAC license registered on galaxy

Do you want to enter another license key for galaxy?
[y,n,q,?] (n)
```

8 Respond to the script as it verifies system requirements and installs the software. If requirements for installation are not met, the utility stops and indicates the actions required to proceed with the process.

- The script determines if any rpms are already installed.
- The script checks whether the required operating system patches are installed. The installer notes missing patches and recommends to stop the installation and install them.
  See "Software requirements" on page 63.
- The script checks for the required file system space.
- The script checks for the presence of processes that could conflict with the installation.

9 At the conclusion of the installation, the installer displays information about where to find installation log files:

```
...
Installing SFRAC: 100%

Installation completed successfully on all systems Installation
log files, summary file, and response file are saved at:
        /opt/VRTS/install/logs/installsfrac-lB2coI
```

Performing basic system checks

While some system checks are required prior to configuring SF Oracle RAC, other checks are optional or needed only when troubleshooting an issue. Use the SF Oracle RAC configuration program initially to check:

- Setup for LLT (optional): verifies the private interfaces on all nodes have the same settings for media speed and jumbo frames on the link.
- Shared disks for I/O fencing (required at this point)

Running an optional system check for LLT

Run this check to ensure the proper setup of LLT.

To run an optional system check for LLT

1. Log in as `root` user.
2. Navigate to the directory containing the installation program:
   - For RHEL 4.0 on ppc64:
     ```
     # cd
     /mnt/cdrom/rhel4_ppc64/storage_foundation_for_oracle_rac
     ```
   - For SLES9 on ppc64:
     ```
     # cd
     /mnt/cdrom/sles9_ppc64/storage_foundation_for_oracle_rac
     ```
3. Launch the SF Oracle RAC configuration menu:
   ```
   # ./installsfrac -configure
   ```
   By default, the installsfrac program uses SSH for remote communication. However, to use RSH, specify the -rsh option with the installsfrac program.
   ```
   # ./installsfrac -rsh -configure
   ```
4. Enter the system names.
   ```
   Enter the system names separated by spaces on whcih to configure
   SFRAC: galaxy nebula
   ```
5. From the main menu, select **Check systems for SFRAC **INSTRUCTIONS ONLY ****.
6. Select **Check LLT links **INSTRUCTIONS ONLY****.
7. The installer lists the conditions for LLT links for each of the cluster systems and shows example commands for checking and changing settings. You must log in to each cluster system to make the checks. For example:
   ```
   ........................................
   Before continuing, login to all cluster nodes and check LLT
   links.Each LLT link must:
       * Not share a subnet with other LLT links on that system.
       * Have speed and autonegotiate settings matching the switch
       port
       * Have same jumbo frame settings
       * Must have unique MAC addresses

   Example:
       /sbin/ethtool -a eth1 #to query speed and autonegotiate
       /sbin/ethtool -a eth1 #to query jumbo frames
   ........................................................
   ```

Auto-negotiation, media speed, and jumbo frame settings on private NICs

For optimal LLT (Low Latency Transport) communication among the cluster nodes, the interface cards on each node must use the same media speed settings. Also, the settings for switches or hubs used for the interconnects must match that of the interface cards. Incorrect settings can cause poor network performance or even network failure.

Guidelines for Auto-negotiation, media speed, and jumbo frame settings for LLT interconnects:

- If you have hubs or switches for LLT interconnects, we recommend using the Auto_Negotiation media speed setting on each Ethernet card on each node.
- If you have hubs or switches for LLT interconnects and you do not use the Auto_Negotiation media speed setting, set the hub or switch port to the same setting as that used for the cards on each node.
- If you use directly connected Ethernet links (using crossover cables), set the media speed to the highest value common to both cards, typically 100_Full_Duplex.
- Settings on Ethernet cards for jumbo frames must match that of the switches or hubs. Symantec does not recommend use of jumbo frames in an SF Oracle RAC environment.
- Symantec does not recommend using dissimilar network cards for private links.

Displaying and setting the Ethernet media speed

The following paragraphs describe displaying information about the current settings for interface cards and how to modify them if necessary.

To display and set the Ethernet auto-negotiation setting and the media speed

1. Use the command ethtool <device_name> to display Ethernet card speed settings. For example:

   ```
   # ethtool eth2
   ```

   Check the displayed settings against the recommendations.

   See “Auto-negotiation, media speed, and jumbo frame settings on private NICs” on page 83.

2. The following examples show how to make changes to the settings:

   ```
   # ethtool -s eth2 autoneg on
   # ethtool -s eth2 speed 1000
   # ethtool -s eth2 duplex full
   ```

   Refer to the ethtool manual page for details

Checking shared disks for SCSI-3 support

The shared storage for SF Oracle RAC must support SCSI-3 persistent reservations to enable I/O fencing. SF Oracle RAC uses two types of shared storage:

- Data disks that store shared data
- Coordinator disks that act as a global lock during membership changes. Coordinator disks are small LUNs (typically three per cluster)

When to check the shared disks for SCSI-3 support

You can choose to verify that the disks you plan to use for shared data storage or for coordinator disks at this time, before you configure the SF Oracle RAC components, or later, after configuring the components. In either case, review the guideline included in the installer and refer to the procedures in the section "Setting up I/O fencing" on page 98.

If you test the disks now and discover that the disks are not SCSI3 compliant, you can delay the configuration tasks until you obtain and verify compliant disks.

If, however, you have high confidence that the disks you plan to use are compliant, you can skip testing now and proceed with the configuration SF Oracle RAC components. You can test the storage later.

Checking that disks support SCSI-3 involves:

- Reviewing the guidelines for checking the disks
- Verifying that nodes have access to the same disk
- Using the `vxfentsthdw` utility to perform the check

Viewing guidelines for checking SCSI-3 support

Use the SF Oracle RAC configuration program to review this system check for SCSI support.

To view guidelines for checking SCSI-3 support

1. Log in as `root` user.
2. Navigate to the directory containing the installation program:
   - For RHEL 4.0 on ppc64:

     ```
     # cd
     /mnt/cdrom/rhel4_ppc64/storage_foundation_for_oracle_rac
     ```

   - For SLES9 on ppc64:

     ```
     # cd
     /mnt/cdrom/sles9_ppc64/storage_foundation_for_oracle_rac
     ```

3 Start the `installsfrac` script:

```
# ./installsfrac -configure
```

By default, the installsfrac program uses SSH for remote communication. However, to use RSH, specify the -rsh option with the installsfrac program.

```
# ./installsfrac -rsh -configure
```

4 From the main menu, select **Check systems for SFRAC**.

5 Select **Check I/O fencing disks**.

6 Review the brief overview on testing disks for SCSI-3 compliance. If you desire to test the disks at this time, proceed to "Setting up I/O fencing" on page 98 and use the procedures:

- "Verifying the nodes see the same disk" on page 98
- "Testing the disks using the vxfentsthdw script" on page 99

Configuring SF Oracle RAC Components

The `installsfrac -configure` script prompts you for information necessary to set up and configure the cluster. You can also set up optional features including Symantec Authentication Services, Cluster Management Console, SMTP and SNMP notification, Storage Foundation Management Server, and various options for Veritas Volume Manager. Details on all of these products and features are in their respective product guides and may require initial setup using the Symantec product installer menu.

Tasks for configuring the cluster may include:

- "Configuring the cluster"
- "Configuring the cluster in secure mode"
- "Adding SF Oracle RAC users"
- "Configuring cluster connector"
- "Configuring the Cluster Management Console"
- "Configuring SMTP email notification"
- "Configuring SNMP trap notification"
- "Setting permissions for database administration"
- "Configuring the cluster volume manager"

Configuring the cluster

Enter a cluster name and ID to perform the basic cluster configuration.

To configure the cluster

1. If you ran the `installsfrac -installonly` utility earlier, or if you ran the `installsfrac` utility but declined to configure SF Oracle RAC at that point, start the `installsfrac -configure` script:
   - Log in as `root` user.
   - Navigate to the directory containing the installation program:
     - For RHEL 4.0 on ppc64:

       ```
       # cd
       /mnt/cdrom/rhel4_ppc64/storage_foundation_for_oracle_rac
       ```

     - For SLES9 on ppc64:

       ```
       # cd
       /mnt/cdrom/sles9_ppc64/storage_foundation_for_oracle_rac
       ```

   - Start the configuration:

     ```
     # ./installsfrac -configure
     ```

     By default, the installsfrac program uses SSH for remote communication. However, to use RSH, specify the -rsh option with the installsfrac program.

     ```
     # ./installsfrac -rsh -configure
     ```

   - Enter the system names, separated by spaces, on which to configure SF Oracle RAC.
2. From the main menu, select **Configure SFRAC.**
3. Select **Configure VCS, CVM and CFS.**
4. Enter the cluster details.
   - Enter the unique cluster name. For example, type:

     ```
     rac_cluster101
     ```

   - Enter the unique cluster ID between 0-65535. For example, type:

     ```
     101
     ```

   - Enter the NICs for private heartbeat links. `eth0` is typically the network interface card for only the public network. In this example, `eth1` and `eth2` are the private heartbeat NICs on all nodes.

     Note: Oracle RAC requires the use of the same heartbeat interfaces on all hosts in the cluster.

     ```
     Discovering NICs on galaxy ... discovered eth0 eth0 eth2
         eth3 eth4
     ```

```
Enter the NIC for the first private heartbeat NIC on
    galaxy: [b,?] eth1
Would you like to configure a second private heartbeat
    link? [y,n,q,b,?] (y)
Enter the NIC for the second private heartbeat link on
    galaxy: [b,?] eth2
Would you like to configure a third private heartbeat
    link? [y,n,q,b,?] (n)
Are you using the same NICs for private heartbeat links
    on all systems? [y,n,q,b,?] (y)
```

You may use NICs with different device names on some nodes. If necessary, indicate the NICs are different when prompted.

- Verify the summary information.

5 Choose to configure SF Oracle RAC with Symantec Product Authentication Service, an option that encrypts all inter-node communication and verifies users with security credentials. See "Configuring the cluster in secure mode" on page 87.

If you decline to set up these services, specify whether you want to set the user name and password for the Administrator, and whether you want to add another user to the cluster.

Go to "Adding SF Oracle RAC users" on page 88.

Configuring the cluster in secure mode

Before you configure a cluster in a secure mode, make sure you have installed a root broker on another stable system. Also, make sure you meet the requirements for automatic or semiautomatic mode of configuration.

See "Symantec Product Authentication Service" on page 42.

To configure the cluster in secure mode

1 Choose whether to configure SF Oracle RAC to use Symantec Product Authentication Service.

- If you want to configure Authentication Service, make sure that you have installed the root broker, and answer **y**.
- If you decline to configure Authentication Service, answer **n** and proceed to adding SF Oracle RAC users.

  See "Adding SF Oracle RAC users" on page 88.

```
Would you like to configure VCS to use Symantec Security
Services? [y,n,q] (n) y
```

2 Select one of the options to configure security.

```
Select the Security option you would like to perform [1-3,q,?]
```

Based on the mode of configuration you want to use, enter one of the following:

Option	Tasks
1. Automatic configuration	Enter the name of the root broker system when prompted. Requires remote access to the root broker. Review the output as the installer verifies communication with the root broker system, checks vxatd process and version, and checks security domain.
2 . Semi-automatic using encrypted files	Enter the path of the file for each node when prompted.

3. Semi-automatic entering authentication information at installer prompts	Enter the following root broker information as the installer prompts you:
	`Enter root Broker name:`
	`venus.symantecexample.com`
	`Enter root broker FQDN: [b] (symantecexample.com)` **`symantecexample.com`**
	`Enter root broker domain: [b] (root@venus.symantecexample.com)`
	`root@venus.symantecexample.com`
	`Enter root broker port: [b] (2821)` **`2821`**
	`Enter path to the locally accessible root hash [b] (/var/tmp/installvcs-1Lcljr/root_hash)`
	`/root/root_hash`
	Enter the following authentication broker information as the installer prompts you for each node:
	`Enter authentication broker principal name on north [b] (north.symantecexample.com)`
	`north.symantecexample.com`
	`Enter authentication broker password on north:`
	`Enter authentication broker principal name on south [b] (south.symantecexample.com)`
	`south.symantecexample.com`
	`Enter authentication broker password on south:`

3 After configuring the cluster in secure mode, proceed to configure the Cluster Management Console cluster connector.
See “Configuring cluster connector” on page 89.

Adding SF Oracle RAC users

If you have enabled Symantec Product Authentication Service, you need not add SF Oracle RAC users. Proceed to configure the Cluster Management Console.

Otherwise, on systems operating under an English locale, you can add SF Oracle RAC users at this time.

"Configuring the cluster in secure mode" on page 87

"Configuring cluster connector" on page 89

To add SF Oracle RAC users

1. Review the required information to add SF Oracle RAC users.
2. Reset the password for the Admin user, if necessary.
3. To add a user, enter **y** at the prompt.
4. Enter the user's name, password, and level of privileges.

```
Enter the user name: [?] smith
Enter New Password:*******

Enter Again:*******
Enter the privilege for user smith (A=Administrator, O=Operator,
G=Guest): [?] a
```

5. Enter **n** at the prompt if you have finished adding users.

```
Would you like to add another user? [y,n,q] (n)
```

6. Review the summary of the newly added users and confirm the information.

Configuring cluster connector

If you configured the Cluster Management Console management server to centrally manage this cluster, you can now configure cluster connector for the buffering feature. If a firewall exists between the management server and this cluster, then you must configure cluster connector to enable centralized management. Make sure you meet the prerequisites to configure cluster connector.

See "Veritas Cluster Management Console" on page 45.

To configure cluster connector

1. Review the information to configure Cluster Management Console.
2. Choose whether to configure cluster connector or not. Do one of the following:
   - To configure cluster connector on the systems, press Enter.

     ```
     Do you want this cluster to be managed by a management
     server? Enter 'y' if you have set up a management server.
     [y,n,q] (y) y
     ```

   - To skip configuring cluster connector and advance to configuring Cluster Management Console for local cluster management, enter **n**.

     See "Configuring the Cluster Management Console" on page 90.

3 Review the required information to configure cluster connector.

4 Enter the Management Server network address for Cluster Management Console.

```
Enter the network address used by the management server [?]
(north) mgmtserver1.symantecexample.com
```

5 Verify and confirm the management server information.

6 Enter the following information that is required to securely communicate with the management server.

- Password for the service account that is created during the management service installation
- Hash of Cluster Management Console management server's root broker

7 Verify and confirm the information.

Configuring the Cluster Management Console

If you want to locally manage this cluster, then you must configure the Cluster Management Console. Note that this cluster can also be a part of the centrally managed clusters.

See "Veritas Cluster Management Console" on page 45.

To configure the Cluster Management Console

1 Review the required information to configure the Cluster Management Console.

2 Choose whether to configure the Cluster Management Console or not. Do one of the following:

- To configure the Cluster Management Console on the systems, press **Enter**.

  ```
  Do you want to configure the Cluster Management Console
  [y,n,q](y)
  ```

- To skip configuring the Cluster Management Console and advance to configuring SMTP, enter **n**.

  See "Configuring SMTP email notification" on page 91.

3 Confirm whether you want to use the discovered public NIC on the first system. Do one of the following:

- If the discovered NIC is the one to use, press **Enter**.
- If you want to use a different NIC, type the name of a NIC to use and press **Enter**.

4 Confirm whether you want to use the same public NIC on all nodes. Do one of the following:

- If all nodes use the same public NIC, enter **y**.
- If unique NICs are used, enter **n** and enter a NIC for each node.

5 Enter the virtual IP address for the Cluster Management Console.

```
Enter the Virtual IP address for Cluster Management Console:
[b,?] 10.10.12.1
```

6 Confirm the default netmask or enter another one:

```
Enter the netmask for IP 10.10.12.1: [b,?] (255.255.240.0)
```

7 Verify and confirm the Cluster Management Console information.

Configuring SMTP email notification

You can choose to configure SF Oracle RAC to send event notifications to SMTP e-mail services. You need to provide the SMTP server name and e-mail addresses of people to be notified. Note that it is also possible to configure notification after installation.

To configure SMTP email notification

1 Review the required information to configure the SMTP email notification.

2 Specify whether you want to configure the SMTP notification. Do one of the following:

- To configure SMTP notification, press Enter.

  ```
  Do you want to configure SMTP notification? [y,n,q] (y) y
  ```

- To skip configuring SMTP notification and advance to configuring SNMP notification, enter **n**.

  See "Configuring SNMP trap notification" on page 92.

3 Provide information to configure SMTP notification.

- Enter the SMTP server's host name.

  ```
  Enter the domain-based hostname of the SMTP server
  (example: smtp.yourcompany.com): [b,?]
  smtp.symantecexample.com
  ```

- Enter the email address of each recipient.

  ```
  Enter the full email address of the SMTP recipient
  (example: user@yourcompany.com): [b,?]
  admin@symantecexample.com
  ```

- Enter the minimum security level of messages to be sent to each recipient.

  ```
  Enter the minimum severity of events for which mail should be
  sent to ozzie@example.com  [I=Information, W=Warning,
  E=Error, S=SevereError]: [b,?] i
  ```

4 Add more SMTP recipients, if necessary.

- If you want to add another SMTP recipient, enter **y** and provide the required information at the prompt.

```
Would you like to add another SMTP recipient? [y,n,q,b] (n) y

Enter the full email address of the SMTP recipient
(example: user@yourcompany.com): [b,?]
harriet@symantecexample.com

Enter the minimum severity of events for which mail should be
sent to harriet@example.com  [I=Information, W=Warning,
E=Error, S=SevereError]: [b,?] E
```

- If you do not want to add, answer **n**.

```
Would you like to add another SMTP recipient? [y,n,q,b] (n)
```

5 Verify and confirm the SMTP notification information.

Configuring SNMP trap notification

You can choose to configure SF Oracle RAC to send event notifications to SNMP management consoles. You need to provide the SNMP management console name to be notified and message severity levels. Note that it is also possible to configure notification after installation.

To configure the SNMP trap notification

1 Review the required information to configure the SNMP notification feature of SF Oracle RAC.

2 Specify whether you want to configure the SNMP notification. Do one of the following:

- To configure SNMP notification, press Enter.

```
Do you want to configure SNMP notification? [y,n,q] (y)
```

3 Provide information to configure SNMP trap notification.

- Enter the SNMP trap daemon port.

```
Enter the SNMP trap daemon port: [b,?] (162)
```

- Enter the SNMP console system name.

```
Enter the SNMP console system name: [b,?] system2
```

- Enter the minimum security level of messages to be sent to each console.

```
Enter the minimum severity of events for which SNMP traps
should be sent to saturn [I=Information, W=Warning, E=Error,
S=SevereError]: [b,?] E
```

4 Add more SNMP consoles, if necessary.

- If you want to add another SNMP console, enter **y** and provide the required information at the prompt.

```
Would you like to add another SNMP console? [y,n,q,b] (n) y
Enter the SNMP console system name: [b,?] jupiter
Enter the minimum severity of events for which SNMP traps
should be sent to jupiter [I=Information, W=Warning,
E=Error, S=SevereError]: [b,?] i
```

- If you do not want to add, answer **n**.

```
Would you like to add another SNMP console? [y,n,q,b] (n)
```

5 Verify and confirm the SNMP notification information.

Setting permissions for database administration

After SF Oracle RAC is installed, the default settings allow only the superuser to access the /opt/VRTSdbed folder. If you want database administrators (DBAs) to access SF Oracle RAC components, you must set the required permissions. You can skip setting the database administration permission and advance to configuring the cluster volume manager.

See "Configuring the cluster volume manager" on page 93.

To set permissions for database administration

1 Review the required information to set up the permissions for database administration.

2 Specify whether you want to add single user access, group access, or both on each of the nodes as the installer prompts.

- Provide information if you want to add single user access.

```
Do you want to add single user access on galaxy [y,n,q,?]
   (y)
Enter login account name for DBA user: dba
```

- Provide information if you want to add group access.

```
Do you want to add group access on galaxy [y,n,q,?] (y)
Enter group name for DBA users: oper
```

Configuring the cluster volume manager

Cluster volume manager configuration tasks include:

- Setting up naming scheme
- Setting up default disk group

Setting up naming scheme

Disks on Linux systems typically use device names such as /dev/rdsk/sd*n* to identify disks on the system. It is possible to use the VxVM enclosure-based naming scheme, which allows disk arrays to be more readily recognizable.

Dynamic Multipathing (DMP) is a prerequisite for enclosure-based naming schemes. Refer to the Veritas Volume Manager documentation for details on this scheme.

To set up the naming scheme

1 If you want to set up the enclosure-based naming scheme, enter **y**.

```
Do you want to set up the enclosure-based naming scheme?
[y,n,q,?] (n)
```

2 Specify if you want to use the new naming scheme for all eligible systems.

```
Do you want to use the enclosure-based naming scheme for all of
the eligible systems? [y,n,q,?] (y)
```

Setting up default disk group

If applicable, set up the default disk group. Because some VxVM commands require that a disk group be specified, the installer enables you to register the name of a default VxVM disk group on each eligible node. Note that you can create the default disk group later.

1 If you want to set up a default disk group, enter **y**.

```
Do you want to set up a system wide default disk group?
[y,n,q,?] (y) y

Which disk group? [<group>,list,q,?] xyz_dg
```

2 If you specified setting up a default disk group, review the setup output.

```
Volume Manager default disk group setup and daemon startup

Setting default diskgroup to xyz_dg on north ......... Done
Starting vxrelocd on nebula ......................... Started
Starting vxcached on nebula ......................... Started
Starting vxconfigbackupd on nebula .................. Started
.
.
```

Starting the VAILAgent

You must start the VAILAgent to access array discovery service for deep mapping. After starting the agent, this service for deep mapping becomes accessible across the domain. Refer to the Veritas Volume Manager documentation for more information.

To start the VAILAgent

1 When the configuration prompts you, confirm the fully qualified host names of the cluster nodes.

```
Is the fully qualified hostname of system "galaxy" =
"galaxy.example.com"? [y,n,q] (y)
Is the fully qualified hostname of system "nebula" =
"nebula.example.com"? [y,n,q] (y)
```

2 Review the output as the program verifies communication with the remote nodes.

About Veritas Storage Foundation Management Server

Veritas Storage Foundation Management Server by Symantec (SF Management Server) ties together Storage Foundation product offerings to ensure that hosts in your data center use storage as efficiently as possible. You can use it to centrally monitor, visualize, and manage Storage Foundation hosts and generate reports about the hosts and the storage resources they consume.

Note: You are prompted to set up an optional SF Management Server managed host during SF Oracle RAC installation. After reviewing the description of SF Management Server, answer **n** to the prompt:
Enable Storage Foundation Management Server Management? [y,n,q] (y) **n**

SF Management Server is not available on the Storage Foundation and High Availability Solutions release. For information on ordering SF Management Server, visit:

www.symantec.com/enterprise/sfms

Refer to the Storage Foundation Management Server documentation for details on enabling centrally managed Storage Foundation hosts in an SF Oracle RAC environment.

Starting SF Oracle RAC processes

After configuring the cluster and optional features, start SF Oracle RAC to complete the installation.

To start SF Oracle RAC processes

1 Confirm that you desire to start the SF Oracle RAC processes when you see:

```
Do you want to start Veritas Storage Foundation for Oracle RAC
processes now? [y,n,q] (y) y
```

2 The installer configures CFS agents for SF Oracle RAC.

3 At the end of the product installation, the utility creates informational files and indicates where they are stored:

```
Configuration log files, summary file, and response file are
saved at:
        /opt/VRTS/install/logs/installsfrac-DzQaFO
```

- A log file containing executed system commands and output.
- A response file used with the `-responsefile` option of the installer.
- A summary file containing the output of the installation scripts.

Performing post-installation tasks

Perform these tasks after installing SF Oracle RAC:

- ✔ Verifying GAB port membership.
- ✔ Setting up I/O fencing.
- ✔ Verifying the fencing GAB port membership.
- ✔ Reimporting new disk groups.
- ✔ Verifying the CVM group is online.

Verifying GAB port membership

Use GAB port membership as a method of determining if a specific component of the SF Oracle RAC stack is operating properly and communicating with its peers. The output below shows the common ports in use in a functional SF Oracle RAC environment before fencing is configured. Each line lists a GAB port, such as port `a`, a generation number determining a startup time, such as `gen 4a1c0001`, and a membership showing which LLT node IDs are participating, such as `membership 01`. In the first line of the output below, each node (0 and 1) has membership with the GAB utility that uses port `a`.

- To view GAB port membership, type:

  ```
  # /sbin/gabconfig -a
  ```

  The output resembles this information:

  ```
  GAB Port Memberships
  ===============================================================
  Port a gen 4a1c0001 membership 01
   Port b gen ada40d01 membership 01
  Port d gen 40100001 membership 01
  Port f gen f1990002 membership 01
  Port h gen d8850002 membership 01
  Port o gen f1100002 membership 01
  Port v gen 1fc60002 membership 01
  Port w gen 15ba0002 membership 01
  ```

The software configures the ports in the list for these functions:

Port	Function
a	GAB
b	I/O fencing
d	ODM (Oracle Disk Manager)
f	CFS (Cluster File System)
h	VCS (Veritas Cluster Server: High Availability Daemon)
o	VCSMM driver
v	CVM (Cluster Volume Manager)
w	`vxconfigd` (module for CVM)

Setting up I/O fencing

The shared storage for SF Oracle RAC must support SCSI-3 persistent reservations to enable I/O fencing. To review general guidelines on the process of checking disks in the SF Oracle RAC configuration menu, see "Viewing guidelines for checking SCSI-3 support" on page 84.

SF Oracle RAC involves two types of shared storage: data disks to store shared data, and coordinator disks, which are small LUNs (typically three per cluster), to control access to data disks by the nodes. Both data disks and the disks used as coordinator disks must be SCSI-3 compliant.

Setting up I/O fencing involves:

1. Adding data disks and coordinator disks, verifying the systems see the same disks
2. Testing data disks and coordinator disks for SCSI-3 compliance
3. Configuring coordinator disks
4. Enabling I/O fencing in the VCS configuration.

- If you are installing SF Oracle RAC and want to check the disks for SCSI-3 compliance before you configure the SF Oracle RAC components, use the procedures:
  - "Verifying the nodes see the same disk" on page 98
  - "Testing the disks using the vxfentsthdw script" on page 99
- If you have already tested that some or all the disks you have added are SCSI-3 compliant and have configured SF Oracle RAC components, go to the procedure "Configuring coordinator disks" on page 101.

Verifying the nodes see the same disk

A disk or LUN that supports SCSI-3 persistent reservations requires that two nodes have simultaneous access to the same disks.

To verify node access to the same disk

1. Use the following command to list the disks:
   ```
   fdisk -l
   ```
2. Use the `vxdisk scandisks` command to scan all disk drives and their attributes, update the VxVM device list, and reconfigure DMP with the new devices. For example, type:
   ```
   # vxdisk scandisks
   ```
   See the Veritas Volume Manager documentation for details on adding and configuring disks.
3. Initialize the disks as VxVM disks using one of these methods:

- Use the interactive `vxdiskadm` utility. When prompted, Symantec recommends specifying that the disk support Cross-platform Data Sharing (CDS) format.
- Use the `vxdisksetup` command. This example specifies the CDS format:

  `vxdisksetup -i device_name format=cdsdisk`

  For example:

  ```
  # vxdisksetup -i sdr format=cdsdisk
  ```

4 To confirm whether a disk or LUN supports SCSI-3 persistent reservations, two nodes must have simultaneous access to the same disks. Because a shared disk is likely to have a different name on each node, check the serial number to verify the identity of the disk. Use the `vxfenadm` command with the `-i` option to verify the same serial number for the LUN is generated on all paths to the LUN.

For example, an EMC array is accessible by the `/dev/sdz` path on node A and the `/dev/sdaa` path on node B.

From node A, type:

```
# vxfenadm -i /dev/sdz
Vendor id       : EMC
Product id      : SYMMETRIX
Revision        : 5567
Serial Number   : 42031000a
```

Expect the same serial number details to appear when you enter the equivalent command on node B using the `/dev/sdaa` path.

On a disk from another manufacturer, Hitachi Data Systems, the output is different and may resemble:

```
# vxfenadm -i /dev/sdz
Vendor id       : HITACHI
Product id      : OPEN-3
Revision        : 0117
Serial Number   : 0401EB6F0002
```

Refer to the `vxfenadm`(1M) manual page for more information.

Testing the disks using the vxfentsthdw script

Before using the `vxfentsthdw` utility to test the shared storage arrays support SCSI-3 persistent reservations and I/O fencing, make sure to test disks serving as coordinator disks (see "Configuring coordinator disks" on page 101). Keep in mind that the tests overwrite and destroy data on the disks unless you use the `-r` option. Review these guidelines on testing support for SCSI-3:

- Verify the connection of the shared storage to two of the nodes on which you installed SF Oracle RAC.

- To ensure both nodes are connected to the same disk during the test, use the `vxfenadm -i diskpath` command to verify the disk serial number.
  See "Verifying the nodes see the same disk" on page 98.
- The two nodes must have `ssh` (default) or `rsh` communication. If you use `rsh`, launch the vxfentsthdw utility with the `-n` option.
  See "Setting up inter-system communication" on page 66.
- The `vxfentsthdw` utility has additional options suitable for testing many disks. You can test disks without destroying data using the `-r` option. The options for testing disk groups (`-g`) and disks listed in a file (`-f`) are described in detail:
  See "vxfentsthdw options and methods" on page 302.

To run the vxfentsthdw utility

Make sure system-to-system communication is functioning properly before performing this step.

See "Setting up inter-system communication" on page 66.

1. From one node, start the utility.
   - If you use `ssh` for communication:
     ```
     # /opt/VRTSvcs/vxfen/bin/vxfentsthdw
     ```
   - If you use `rsh` for communication:
     ```
     # /opt/VRTSvcs/vxfen/bin/vxfentsthdw -n
     ```
2. After reviewing the overview and warning about overwriting data on the disks, confirm to continue the process and enter the node names.
   ```
   ******** WARNING!!!!!!!! ********
   THIS UTILITY WILL DESTROY THE DATA ON THE DISK!!
   Do you still want to continue : [y/n] (default: n) y
   Enter the first node of the cluster: galaxy
   Enter the second node of the cluster: nebula
   ```
3. Enter the name of the disk you are checking. For each node, the disk may be known by the same name.
   ```
   Enter the disk name to be checked for SCSI-3 PGR on node galaxy
   in the format: /dev/sdx
   /dev/sdr
   Enter the disk name to be checked for SCSI-3 PGR on node nebula
   in the format: /dev/sdx
   Make sure it's the same disk as seen by nodes galaxy and nebula
   /dev/sdr
   ```
   Regardless if the disk names are identical, the names must refer to the same physical disk to facilitate the testing.
4. After performing the check, make sure the `vxfentsthdw` utility reports the disk is ready for I/O fencing on each node.

5 Run the `vxfentsthdw` utility for each disk you intend to verify.

Note: If you have checked disks before configuring SF Oracle RAC components, return to "Configuring SF Oracle RAC Components" on page 85 to continue.

If disks cannot be successfully verified

If the `vxfentsthdw` utility cannot successfully verify that the storage devices can support SCSI-3 PR, you may need to remove keys that are written to the disk during the testing. For troubleshooting:

See "Removing existing keys from disks" on page 259.

Note: SF Oracle RAC I/O fencing and EMC together do not support the use of gate keeper devices as coordinator disks. Such administrative devices are intended for EMC use only.

Configuring coordinator disks

I/O fencing requires coordinator disks that are configured in a disk group and accessible to each node. These disks enables the `vxfen` driver to resolve potential split-brain conditions and prevent data corruption. For a description of I/O fencing and the role of coordinator disks:

See "I/O fencing" on page 31

Because coordinator disks are not used to store data, configure them as the smallest possible LUN on a disk array to avoid wasting space. Symantec recommends using hardware-based mirroring for coordinator disks.

Review these requirements and make sure you already added and initialized disks for use as coordinator disks:

- Use an odd number of coordinator disks with a minimum of three coordinator disks. This requirement ensures a majority of disks can be achieved.
- Each of the coordinator disks uses a physically separate disk or LUN.
- Use, if possible, coordinator disks that exist on different disk arrays.
- Initialize each disk as a VxVM disk. Symantec recommends the default CDS format.
  See "Initializing disks as VxVM disks" on page 301.
- Test to verify that the coordinator disks support SCSI-3 persistent reservations.
  See "Testing the coordinator disk group with vxfentsthdw -c" on page 102.

- Configure the coordinator disks in a disk group (for example, `vxfencoorddg`). Set the coordinator attribute when creating the disk group to prevent the disks in the group from being used for other purposes.
  See "Creating the coordinator disk group (vxfencoorddg)" on page 102.

Configuring coordinator disks involves three phases:

- Creating `vxfencoorddg`, the coordinator disk group
- Testing the coordinator disk group with the `vxfentsthdw -c` utility
- Creating the `vxfendg` file

Coordinator attribute

SF Oracle RAC uses a "coordinator" attribute for disk groups. The `vxfen` driver uses this attribute to prevent the reassignment of coordinator disks to other disk groups. The procedure that follows includes the setting of this attribute.

Refer to the Veritas Volume Manger documentation for more information on the coordinator attribute.

Creating the coordinator disk group (vxfencoorddg)

From one node, create a disk group named `vxfencoorddg`. This group must contain an odd number of disks or LUNs and a minimum of three disks.

For example, assume the disks have the device names `/dev/sdx, /dev/sdy`, and /dev/sdz.

To create the coordinator disk group

1 On any node, create the disk group by specifying the device name of the disks:

```
# vxdg -o coordinator=on init vxfencoorddg sdx sdy sdz
```

Testing the coordinator disk group with vxfentsthdw -c

Review these requirements before testing the coordinator disk group (`vxfencoorddg`) with the `vxfentsthdw` utility:

- The `vxfencoorddg` disk group is accessible from two nodes.
- The two nodes must have `rsh` permission set such that each node has root user access to the other. Temporarily modify the `/.rhosts` file to enable cluster communications for the `vxfentsthdw` utility, placing a "+" character in the first line of the file. You can also limit the remote access to specific systems. Refer to the manual page for the `/.rhosts` file for more
- To ensure both nodes are connected to the same disks during the testing process, use the `vxfenadm -i` *`diskpath`* command to verify the serial number. See "Verifying the nodes see the same disk" on page 98.

In the procedure, the vxfentsthdw utility tests the three disks one disk at a time from each node. From the galaxy node, the disks are:

/dev/sdz, /dev/sdaa, /dev/sdab

From the nebula node, the same disks are seen as:

/dev/sdz, /dev/sdaa, /dev/sdab

To test the coordinator disk group

1. Use the vxfentsthdw command with the -c option. For example, type:

   ```
   # /opt/VRTSvcs/vxfen/bin/vxfentsthdw -c vxfencoorddg
   ```

2. Enter the nodes you are using to test the coordinator disks.
3. Review the output to ensure the tests are successful. After testing all disks in the disk group, the vxfencoorddg disk group is ready for use.
   If a disk in the coordinator disk group fails verification, complete these operations:
   - Use the vxdiskadm utility to remove the failed disk or LUN from the vxfencoorddgdisk group. Refer to the Veritas Volume Manager documentation.
   - Add a new disk to the node, initialize it, and add it to the coordinator disk group. See "Creating the coordinator disk group (vxfencoorddg)" on page 102.
   - Test the disk group again. See "Testing the coordinator disk group with vxfentsthdw -c" on page 102.

If you need to replace a disk in an active coordinator disk group, refer to the topic in the troubleshooting section.

See "Adding or removing coordinator disks" on page 262.

Creating the vxfendg file

After setting up and testing the coordinator disk group, configure it for use.

To create the vxfendg file

1. Deport the disk group:

   ```
   # vxdg deport vxfencoorddg
   ```

2. Import the disk group with the -t option to avoid automatically importing it when the nodes restart:

   ```
   # vxdg -t import vxfencoorddg
   ```

3. Deport the disk group. This operation prevents the coordinator disks from serving other purposes:

   ```
   # vxdg deport vxfencoorddg
   ```

4. On all nodes, type:

```
# echo "vxfencoorddg" > /etc/vxfendg
```

Do no use spaces between the quotes in the “vxfencoorddg” text.

This command creates the `/etc/vxfendg` file, which includes the name of the coordinator disk group.

Enabling fencing in the VCS configuration

Enabling fencing involves editing the UseFence attribute in the VCS configuration file (`main.cf`), verifying the configuration file syntax, copying the `main.cf` to other nodes, setting the contents of the vxfenmode file (DMP or raw), and restarting the fencing driver and VCS.

To enable I/O fencing

1. Save the existing VCS configuration file, `/etc/VRTSvcs/conf/config/main.cf`:

   ```
   # haconf -dump -makero
   ```

2. Stop VCS on all nodes with the command:

   ```
   # hastop -all
   ```

3. On *each* node, enter the following command:

   ```
   # /etc/init.d/vxfen stop
   ```

4. Make a backup copy of the `main.cf` file:

   ```
   # cd /etc/VRTSvcs/conf/config
   # cp main.cf main.orig
   ```

5. On one node, use `vi` or another text editor to edit the `main.cf` file. Modify the list of cluster attributes by adding the `UseFence` attribute and assigning its value of `SCSI3`:

   ```
   cluster rac_cluster1 (
       UserNames = { admin = "cDRpdxPmHpzS." }
       Administrators = { admin }
       HacliUserLevel = COMMANDROOT
       CounterInterval = 5
       UseFence = SCSI3
       )
   ```

6. Save and close the file.

7. Verify the syntax of the `/etc/VRTSvcs/conf/config/main.cf` file:

   ```
   # hacf -verify /etc/VRTSvcs/conf/config
   ```

8. Using `rcp` or another utility, copy the VCS configuration file from a node (for example, `galaxy`) to the remaining cluster nodes. On each remaining node, type:

   ```
   # rcp galaxy:/etc/VRTSvcs/conf/config/main.cf
     /etc/VRTSvcs/conf/config
   ```

9 Depending on whether you want to use the DMP configuration or the raw device configuration, use one of the following commands:

- For DMP configuration (preferred):

  ```
  # cp /etc/vxfen.d/vxfenmode_scsi3_dmp /etc/vxfenmode
  ```

- For raw device configuration:

  ```
  # cp /etc/vxfen.d/vxfenmode_scsi3_raw /etc/vxfenmode
  ```

Enter the command on all cluster systems.

10 On *each* node enter the sequence of commands that resembles the following example in which the DMP device is configured:

```
# /etc/init.d/vxfen start
# /opt/VRTS/bin/hastart
```

11 Review the /etc/vxfentab file.

On each node, the list of coordinator disks is in the /etc/vxfentab file. The same disks may appear using different names on each node.

On one node, for raw disks, an example /etc/vxfentab file resembles:

```
/dev/rdsk/c1t1d0s2
/dev/rdsk/c2t1d0s2
/dev/rdsk/c3t1d0s2
/dev/rhdisk75
/dev/rhdisk76
/dev/rhdisk77
/dev/sdz
/dev/sdaa
/dev/sdab
```

For DMP disks, the file /etc/vxfentab file resembles:

```
/dev/vx/rdmp/c1t1d0s2
/dev/vx/rdmp/c2t1d0s2
/dev/vx/rdmp/c3t1d0s2
/dev/vx/rdmp/rhdisk75
/dev/vx/rdmp/rhdisk76
/dev/vx/rdmp/rhdisk77
/dev/vx/rdmp/sdz
/dev/vx/rdmp/sdaa
/dev/vx/rdmp/sdab
```

If you must remove or add disks in an existing coordinator disk group, see the procedure in the troubleshooting chapter.

See “Adding or removing coordinator disks” on page 262.

Note: Based on the contents of the `/etc/vxfendg` file, the `rc` script creates the `/etc/vxfentab` file for use by the `vxfen` driver when the system starts. `/etc/vxfentab` invokes the `vxfenconfig` command, which configures the `vxfen` driver to start and use the coordinator disks listed in `/etc/vxfentab`. `/etc/vxfentab` is a generated file; do not modify this file

Verifying the fencing GAB port

After configuring fencing and starting VCS, CVM, and CFS on each node, use the gabconfig command to verify that all nodes appear in GAB port `b` membership.

- To verify GAB port membership for fencing, type:

  ```
  # /sbin/gabconfig -a
  ```

  Review the output for port `b`:

  ```
  GAB Port Memberships
  ===================================================================
  Port a gen 4a1c0001 membership 01
  Port b gen g8ty0002 membership 01
  Port d gen 40100001 membership 01
  Port f gen f1990002 membership 01
  Port h gen d8850002 membership 01
  Port o gen f1100002 membership 01
  Port v gen 1fc60002 membership 01
  Port w gen 15ba0002 membership 01
  ```

Verifying the CVM group is online

On all nodes, type:

```
# hagrp -state cvm
```

to verify that the `cvm` group is ONLINE.

Verifying I/O fencing configuration

Verify from the vxfenadm output that the SCSI-3 disk policy reflects the configuration in the /etc/vxfenmode file.

To verify I/O fencing configuration

- On one of the nodes, type:

```
# vxfenadm -d

I/O Fencing Cluster Information:
================================

Fencing Protocol Version: 201
Fencing Mode: SCSI3
Fencing SCSI3 Disk Policy: raw
Cluster Members:

    * 0 (north)
    1 (south)

RFSM State Information:
    node   0 in state  8 (running)
    node   1 in state  8 (running)
```

Section II

Setting up SF Oracle RAC with Oracle 10g

After installing and configuring SF Oracle RAC, use the following procedures to install and configure Oracle 10*g*:

Chapter 4

Preparing to Install Oracle 10g RAC

After setting up SF Oracle RAC, prepare to install Oracle10g. You can install the software on shared storage or locally on each node. Make sure to review the Oracle installation manuals before installing Oracle 10g.

This chapter contains the topics:

About Oracle 10g RAC in an SF Oracle RAC environment

Review the information on infrastructure requirements and Oracle RAC in an SF Oracle RAC environment.

Oracle RAC infrastructure requirements

Oracle RAC requires a cluster infrastructure that deals with these aspects:

- Shared concurrent access to storage
  - ODM support
  - ODM-compliant cluster file system
  - Cluster-volume management
- Cluster membership management
  - Tracking current members
  - Joining systems

    - Leaving systems
- Communications channels between systems
    - Inter-instance messaging
    - Cluster state
    - Cache fusion

Oracle RAC in a Veritas SF Oracle RAC environment

Veritas SF Oracle RAC provides all software infrastructure components for Oracle RAC. Multiple systems running database instances provide access to the same physical database on behalf of multiple clients. Multiple instances accessing the same data provide increased scalability by spreading the load across systems, and they provide increased availability. Multiple instances also increase the need for coordination. Instances must coordinate access to data to ensure one instance does not overwrite or corrupt data. For a view of the overall environment:

See "How SF Oracle RAC works (high-level perspective)" on page 18.

About the location of ORACLE_HOME

Before installing Oracle binaries (ORACLE_HOME) locally on each system or on a cluster file system on shared storage as described in "Installing Oracle 10g" on page 121, consider these points:

- Local installations provide a comfort level using traditional installation methods and the possibility of improved protection against a single point of failure.
- CFS installations provide a single Oracle installation to manage, regardless of number of nodes. This scenario offers a necessary reduction in storage requirements and easy addition of nodes.

Select the location based on your high availability requirements. Symantec and Oracle generally recommend using local installations.

Performing pre-installation operations

Performing pre-installation operations involves manual and automated tasks from the SF Oracle RAC configuration program. Before installing Oracle 10*g* you must perform the following tasks if you have not already performed them:

- Setting Oracle user
- Setting up Oracle user equivalence for RSH and RCP

- Configuring private IP addresses for CRS
- Creating public virtual IP addresses for use by Oracle
- Creating disk groups, volumes, and mount points
- Identifying required directories for CRS and Oracle

Using the SF Oracle RAC configuration program

The Oracle installation requires some preparation such as creating the Oracle user and group ID, creating disk groups, volumes, and mount points, and configuring private IP addresses for CRS. You can perform tasks in the configuration program sequentially at one time, or you can access the program for individual tasks later.

To perform pre-installation tasks in the configuration menu

1. Launch the SF Oracle RAC configuration program. As root user on any one system, enter:

   ```
   # cd /opt/VRTS/install
   # installsfrac -configure
   ```

   By default, the installsfrac program uses SSH for remote communication. However, to use RSH, specify the -rsh option with the installsfrac program.

   ```
   # ./installsfrac -rsh -configure
   ```

2. Enter the system names, separated by spaces.
3. From the configuration program menu, select **Prepare to install Oracle**. From this menu, you can choose to perform all installation tasks, or to perform specific tasks.

Setting Oracle user

Configure the Oracle user and group settings in the SF Oracle RAC configuration program.

To set Oracle user

1. Access the SF Oracle RAC configuration program if you are not currently using it.

   See "Using the SF Oracle RAC configuration program" on page 113.

2. Select **Create userid and group id for Oracle** from the configuration menu and provide the required information.
   - Make sure that the user and group IDs are unused on all the nodes in the cluster.

- Refer to Oracle documentation for information on creating the `oinstall` (Oracle Inventory), `dba` and `oper` groups, and the `oracle` user.

3 Enter Oracle UNIX user and primary group information:

```
Enter Oracle UNIX user name: [b] oracle
Enter Oracle UNIX user id (numerical): [b] 1001
Enter Oracle UNIX user home dir: [b] /opt/oracle
Enter Oracle UNIX group name: [b] (oinstall) oinstall
Enter Oracle UNIX group id (numerical): [b] 101
```

Note: The set of Oracle user IDs and group IDs in each cluster configuration must be the same.

4 The installer verifies that the specified `userid` does not exist on any of the systems in the cluster and then creates it. Enter **y** to create the oracle user with the information provided.

5 Enter the information to create secondary groups, "dba" and "oper":

```
Do you want to create secondary groups for Oracle user? [y,n,q]
(y)
Enter Oracle UNIX secondary group name: [b] dba
Enter Oracle UNIX secondary group id (numerical): [b] 102
Group dba does not exist on any node. Do you want to create it
with the information provided [y,n,q] (y)
    Creating group dba on galaxy ... Done
    Adding Oracle user (oracle) to group (dba) on galaxy ... Done
    Creating group dba on nebula ... Done
    Adding Oracle user (oracle) to group (dba) on nebula ... Done
```

6 You must first enable RSH access for the newly created “oracle” user.

7 After creating the secondary groups, the installer proceeds to verify RSH access for "oracle" user. Leave the installer at this prompt and proceed to setup RSH access. You can return to this installer session after setting up oracle user equivalance.
See “Setting up Oracle user equivalence for RSH and RCP” on page 114.

Setting up Oracle user equivalence for RSH and RCP

To set up Oracle user equivalence for RSH and RCP

1 Access the SF Oracle RAC configuration program even if you are currently using it and open another terminal session as `root` user.
See “Using the SF Oracle RAC configuration program” on page 113.

2 As `root` user on each system, edit /etc/hosts.equiv file and add entries similar to the following:

```
galaxy oracle
```

```
nebula oracle
```

3 On each system, set the password for the “oracle” user:

```
[root@galaxy /]# passwd oracle
Changing password for "oracle"
oracle's New password:
Re-enter oracle's new password:
```

4 On each system, login as user "oracle" and change the passwd.

```
[root@galaxy /]# su - oracle
$ passwd
Changing password for "oracle"
oracle's New password:
Re-enter oracle's new password:
```

5 On each system, as user “oracle”, verify “rsh” access:

```
$ rsh galaxy date
Mon Apr 24 10:02:45 PDT 2006
$ rsh nebula date
Mon Apr 24 10:02:45 PDT 2006
```

You can now create the secondary groups for Oracle.

See “Setting Oracle user” on page 113.

Verifying RSH access for Oracle user

To verify RSH access for "oracle" user

1 Return to the installer session the end of “To set Oracle user” on page 113.

2 At the installer prompt, answer "y" to verify "RSH" accessibility.

3 Quit the installation program.

Configuring private IP addresses for CRS

The CRS daemon requires a private IP address on each node to enable communications and heartbeating. After confirming the values, the installer adds a new section in the VCS configuration file (`main.cf`) for the PrivNIC resource in the CVM group.

To add private IP addresses to /etc/hosts

1 Log in to each system as root

2 Add the following entries to the /etc/hosts file:

```
192.168.12.1    galaxy_priv
192.168.12.2    nebula_priv
```

To configure private IP addresses for CRS

1 Access the SF Oracle RAC configuration program if you are not currently using it.
See "Using the SF Oracle RAC configuration program" on page 113.

2 Select **Configure private IP addresses for CRS** from the configuration menu.

3 Enter the private IP address information for each host.

```
Enter the private IP for galaxy: [b] 192.168.12.1
    Checking 192.168.12.1 in /etc/hosts on galaxy..... exists
    Discovering NICs on galaxy ..... discovered eth0 eth1 eth2

Enter the NIC 1 for private network for galaxy (x if done): [b]
eth1
Enter the NIC 2 for private network for galaxy (x if done): [b]
eth2
Enter the NIC 3 for private network for galaxy (x if done): [b] x
Enter the private IP for nebula: [b] 192.168.12.2
    Checking 192.168.12.2 in /etc/hosts on nebul ..... exists
    Discovering NICs on nebula ..... discovered eth0 eth1 eth2
Enter the NIC 1 for private network for nebula (x if done): [b]
eth1
Enter the NIC 2 for private network for nebula (x if done): [b]
eth2
Enter the NIC 3 for private network for nebula (x if done): [b] x
Enter the netmask for private network: [b] 255.255.240.0
```

Note: The private IP addresses of all nodes should be on the same physical network in the same IP subnet.

4 Confirm the private IP address information.

5 After the private IP address is configured, you can exit the installer by entering **q** or continue with your configuration.

To verify the private NIC address configuration

1 Verify that the PrivNIC resource, ora_priv, shows up in VCS main.cf:

```
PrivNIC ora_priv (
    Critical = 0
     Device @galaxy = { eth1 = 0, eth2 = 1 }
     Device @nebula = { eth1 = 0, eth2 = 1 }
     Address @galaxy = "192.168.12.1"
     Address @nebula = "192.168.12.2"
     NetMask = "255.255.240.0"
     )
```

2 Verify that the "ora_priv" resource is online on all systems in the cluster:

```
# hares -state ora_priv
#Resource    Attribute        System     Value
```

```
ora_priv       State           galaxy   ONLINE
ora_priv       State            nebula ONLINE
```

3 On each system, check the output of “ifconfig”

```
# ifconfig -a
```

4 From each system, ping the private IP addresses:

```
# ping 192.168.12.2
PING 192.168.12.2 (192.168.12.2): 56 data bytes
64 bytes from 192.168.12.2: icmp_seq=0 ttl=255 time=0 ms
64 bytes from 192.168.12.2: icmp_seq=1 ttl=255 time=0 ms
# ping 192.168.12.1
PING 192.168.12.1 (192.168.12.1): 56 data bytes
64 bytes from 192.168.12.1: icmp_seq=0 ttl=255 time=0 ms
64 bytes from 192.168.12.1: icmp_seq=1 ttl=255 time=0 ms
```

Creating public virtual IP addresses for use by Oracle

Oracle requires one virtual public network address for the Oracle listener process on each node.

Before starting the Oracle installation, you must create virtual IP addresses for each node. An IP address and an associated host name should be registered in the domain name service (DNS) for each public network interface.

To obtain public virtual IP addresses for use by Oracle

1 Obtain one virtual IP per node.

2 Add entry for the virtual IP and virtual public name in the `/etc/hosts` file, for all nodes.

3 Register with DNS.

Example:

```
10.10.11.1 galaxy_pub
10.10.11.2 nebula_pub
```

Creating disk groups, volumes, and mount points

To create disk groups, volumes, and mount points for Oracle, review these guidelines. Before you install the Oracle Cluster Ready Services (CRS) and Oracle 10g binaries, you must create storage space for these installations. You need to provide storage for:

- The home directories, CRS_HOME and ORACLE_HOME, for CRS and Oracle binaries. See “Identifying required directories for CRS and Oracle” on page 118.

- The volumes for Oracle Cluster Registry (OCR) and the VOTE-disk. The volumes should reside on raw device, or in directories in shared disk groups. See “Creating OCR and VOTE-disk volumes” on page 119.

Note: The displayed task to create CVM volumes or a directory on CFS for database file storage is covered later in “Creating the Oracle database” on page 132.

Identifying required directories for CRS and Oracle

Identify the directories required for installing Oracle and CRS software:

Directory	Component
/app	Mountpoint for Oracle/CRS binaries
/app/crshome	CRS_HOME
/app/oracle	ORACLE_BASE
/app/oracle/home	ORACLE_HOME
/oradata	Mountpoint for Oracle database

Preparing $CRS_HOME and $ORACLE_HOME on each node

To create a file system on local storage for Oracle/CRS binaries (/app), perform the following steps:

1. As root user, first create a VxVM local diskgroup, orabindg_*hostname*:
   ```
   # vxdg init orabindg_galaxy Disk_1
   ```
2. Create a volume, orabinvol_*hostname*:
   ```
   # vxassist -g orabindg_galaxy make orabinvol_galaxy 12G
   ```
3. Create directory, /app
   ```
   # mkdir /app
   ```
4. Create a filesystem with this volume, orabinvol_*hostname*
   ```
   # mkfs -t vxfs  /dev/vx/dsk/orabindg/orabinvol
   ```
5. Mount /app
   ```
   # mount -t vxfs /dev/vx/dsk/orabindg/orabinvol /app
   ```
6. Add an entry for this filesystem in /etc/fstab.
   ```
   /dev/vx/dete/orabindg/orabinvol
   /app
   vxfs
   ```

```
defaults 01
```

To prepare $CRS_HOME on each node, perform the following steps:

1. On each system, log in as "root".
2. Create the directory for CRS_HOME:
   ```
   #mkdir -p /app/crshome
   ```
3. Change ownership and permissions
   ```
   #chown -R oracle:oinstall /app/crshome
   #chmod -R 775 /app/crshome
   ```

To prepare $ORACLE_BASE on each node, perform the following steps:

1. On each system, log in as "root".
2. Create the directory for ORACLE_BASE:
   ```
   #mkdir -p /app/oracle
   ```
3. Change ownership and permissions
   ```
   #chown -R oracle:oinstall /app/oracle
   #chmod -R 775 /app/oracle
   ```

To prepare $ORACLE_HOME on each node, perform the following steps:

1. On each system, log in as "root".
2. Create the directory for ORACLE_HOME:
   ```
   #mkdir -p /app/oracle/orahome
   ```
3. Change ownership and permissions
   ```
   #chown -R oracle:oinstall /app/oracle/orahome
   #chmod -R 775 /app/oracle/orahome
   ```

Creating OCR and VOTE-disk volumes

The installation of CRS requires predefined locations for the OCR and VOTE-disk components. After you create volumes, you can add them to the VCS configuration to make them highly available.

To create raw volumes for OCR and VOTE disks

1. As root user, from the CVM master, create a shared VxVM diskgroup
   ```
   # vxdg -s init ocrvotedg Disk_2
   ```
2. As root user, from CVM master, create volume(s) for ocr and voting disk.

   Note: For 10gR2, you need to create raw volumes for ocr as well as voting disk.

   ```
   # vxassist -g ocrvotedg make ocrvol 400M
   # vxassist -g ocrvotedg make vdrvol 400M
   ```

3 For raw volumes, also need to change permissions as follows.

```
#vxedit -g ocvotedg set user=oracle group=oinstall mode=660
ocrvol
#vxedit -g ocvotedg set user=oracle group=oinstall mode=660
vdvol
```

4 Verify that the VCS resources and ocrvote_voldg, are ONLINE on all systems in the cluster.

```
#hares -state ocrvote_voldg
```

It is mandatory to follow the instructions given in Oracle release notes for "Linux on POWER" from the following site: http://otn.oracle.com

Please refer to the following sections from the above release notes:

1 Interim Fix for the IBM XL C/C++ Advanced Edition V7.0 for Linux Runtime Environment Component

2 Relink of Database 10g Release 2 Fails

Chapter 5

Installing Oracle 10g

After installing SF Oracle RAC and preparing to install Oracle 10g R2, proceed to install the Oracle 10g R2 software.

Installing Oracle10g R2 in an SF Oracle RAC environment involves these tasks:

- ✔ "Installing CRS" on page 121
- ✔ "Installing Oracle 10g database software" on page 125
- ✔ "Completing post-installation operations" on page 127

Installing CRS

The CRS software is installed on each node in the location created in "Preparing $CRS_HOME and $ORACLE_HOME on each node" on page 118.

To install CRS

1. Make sure that the Oracle installer is in a directory that is writable. If you are using the CD-ROM, make sure that the Oracle installation files are copied locally.
   By default, the installsfrac utility uses ssh for remote communication. However, rsh can be used in place of ssh by using the "-rsh" option with the installsfrac utility.
2. On the same node where you have set the environment variables, execute the following command as root:
   ```
   # cd /opt/VRTS/install
   # ./installsfrac -configure
   ```
   The installer will display the copyright message.
3. When the installer prompts, enter the system names separated by spaces on which to configure Storage Foundation for Oracle RAC. For the installation example used in this procedure:
   ```
   galaxy nebula
   ```

```
The installer checks both systems for communication and creates
a log directory on the second system in
/var/tmp/installsfracxxxxxxxxxx, where xxxx represents the
timestamp.
```

4 When the initial system check is successfully completed, press Enter to continue.

5 The installer proceeds to verify the license keys. When the licenses are successfully verified, press Enter to continue.

6 Following the instructions presented, navigate to the Main Menu and select Install or relink Oracle. Some choices for installing and configuring may vary, depending on the operating system you are running.

7 In the Choose Oracle version menu, select the appropriate version of Oracle (10gR2).

8 In the Choose task menu, select the task Install Oracle Clusterware (CRS).

9 In the Set DISPLAY dialog, enter the value for DISPLAY. The value of DISPLAY variable should be <ip-address-of-the-machine>: 0 .

10 Enter Oracle user and group information.

- In the Oracle Username dialog, enter Oracle Unix User Account when prompted. The installer checks for the user on all systems.
- In the Oracle Groupname dialog, enter Oracle Inventory group when prompted. The installer checks for group existence on all systems.
- Press Enter to continue.

11 In the CRS Install Image dialog, enter the absolute path of CRS install image when prompted. The installer validates the CRS installer. Press Enter to continue.

12 In the Oracle base directory dialog, enter the location of base of the Oracle directory structure for OFA compliant databases. The installer validates the Oracle Base Directory. If the directory doesn't exist, installer prompts for the creation of oracle base directory on all nodes. Choose option 'y' to create oracle base directory on all nodes.

13 Press Enter to continue.

14 In the CRS Home directory dialog, enter absolute path of CRS home directory when prompted. Installer validates the CRS home directory. If the directory doesn't exist, installer prompts for the creation of the directory on all nodes. Choose option 'y' to create oracle base directory on all nodes.

15 Press Enter to continue.

16 The Installer prints the CRS installation information for verification. If the information displayed by the installer is correct choose option “y” otherwise choose option “n”.

Example:

```
Oracle environment information verification
Oracle Unix User: oracle
Oracle Unix Group: oinstall
Oracle Clusterware (CRS) Installation Path:
/orcl/10gR2/CRS/Disk1
Oracle Clusterware (CRS) Home: /app/oracle/crshome
Oracle Release: 10.2
Oracle Base: /app/oracle
Is this information correct? [y,n,q] (y)
```

17 Press Enter to continue.

The SF Oracle RAC installer invokes the Oracle Universal Installer (OUI) for Oracle CRS Installer.

To install Oracle 10.2.0.1 CRS using the Oracle interface

1 When the Oracle Universal Installer (OUI) for Oracle CRS appears, specify the name for the install and CRS_HOME and click Next.

2 The host name for the local node is displayed with default string (-priv and -vip) appended to its private name and virtual name.

- Modify it as needed to put the correct private and virtual name for the local node.
- Add other cluster nodes using the Add option. While adding new nodes, specify private and virtual names for each. The nodes must be added in the same order in which they are configured for Storage Foundation for Oracle RAC (the node order present in /etc/llthosts), otherwise after Oracle installation, you may observe that original node ordering (present in /etc/llthosts) is missing.
- After adding all the cluster nodes click Next.

3 Choose the external redundancy option. Specify the OCR shared raw volume name with an absolute path, for example the /dev/vx/rdsk/ocrdg/ocrvol raw volume, and click Next.

4 Choose the external redundancy option. Specify CSS (Vote disk) shared raw volume name with an absolute path, for example the /dev/vx/rdsk/ocrdg/vdvol raw volume, and click Next. The installer proceeds with the CRS installation and sets the CRS parameters.

5 When prompted at the end of the CRS installation, run the $CRS_HOME/root.sh file on each cluster node in the same order as mentioned by Oracle CRS Installer.

Note: Do not click OK in the $CRS_HOME/root.sh window until after you run the VIPCA utility.

6 Run the VIPCA utility in $CRS_HOME/bin from the first node in the cluster.

7 Click OK in the $CRS_HOME/root.sh window after you run the VIPCA utility.

8 Exit the CRS Installer after running root.sh and continue with installsfrac -configure for the Oracle 10g binaries installation

Installing Oracle 10g database software

Note: Please refer to the Oracle OTN site specified within the section "Creating OCR and VOTE-disk volumes" on page 119 and follow the instructions before proceeding.

After installing the CRS component, install the Oracle database software.

To install Oracle Database Software

1. Login as root user on any system and invoke the `installsfrac` utility to bring up the menu:

   ```
   #cd /opt/VRTS/install
   #./installsfrac -configure (if ssh is setup)
   #./installsfrac -rsh -configure (if ssh is not setup)
   ```

2. Navigate to the "Main Menu" and select "Install and Relink Oracle".
   See "Using the SF Oracle RAC configuration program" on page 113.
3. In the Choose Oracle version menu, select the appropriate version of Oracle (10gR2).
4. In the Choose task menu, select "Install Oracle RDBMS server."
5. In the Set DISPLAY dialog, enter the value for DISPLAY. The value of DISPLAY variable should be <ip-address-of-the-machine>: 0 .
6. Enter Oracle user and group information.
   - In the Oracle Username dialog, enter Oracle Unix User Account when prompted. The installer checks for the user on all systems.
   - In the Oracle Groupname dialog, enter Oracle Inventory group when prompted. The installer checks for group existence on all systems.
   - Press Enter to continue.
7. In the Database Install Image dialog, specify the location of Oracle Database Software install image.
   Example: /orcl/10201/database
8. In the Oracle base directory dialog, specify the base of the Oracle directory structure for OFA compliant databases.
   Example: /app/oracle
9. In the CRS Home directory dialog, specify the directory containing Oracle CRS Software.
   Example: /app/crshome
10. In the Database home directory dialog, specify the directory containing Oracle Database Software.

Example: /app/oracle/orahome

11 The installer prints the oracle environment information for verification. If the information displayed by the installer is correct choose option “y” otherwise choose option “n.”

Oracle 10g R2 example:

```
Oracle environment information verification
Oracle Unix User: oracle
Oracle Unix Group: onstall
Oracle Clusterware (CRS) Installation Path:
/orcl/10201/crs/Disk1
Oracle Clusterware (CRS) Home: /app/oracle/crshome
Oracle Release: 10.2
Oracle Base: /app/oracle
Oracle Home: /app/oracle/dbhome
RDBMS Installation Path: /orcl/10201/db/Disk1
Is this information correct? [y,n,q] (y)
```

Press Enter to continue.

The SF Oracle RAC installer invokes the Oracle User Interface (OUI) for Database Software Installation.

To install the Oracle 10.2.0.1 database binaries using the Oracle interface

1 The installer invokes the Oracle Database Installer. When the Oracle Database Installer appears, specify the file locations and click Next.

2 Select all nodes in the cluster and click Next.

3 Choose the installation type. The installer verifies that the requirements are all met.

4 Provide OSDBA and OSOPER group for UNIX Oracle users when prompted.

5 When prompted to create the database, select the “No” option.

6 Install the binaries now.

7 The installer prompts you to run $ORACLE_HOME/root.sh on each node. The installer confirms when installation is successful. Exit the Oracle 10g Installer and return to installsfrac -configure.

8 The installer will ask "Do you wish to link Oracle now?". Proceed to "Completing Post Install Operations for 10gR2".

9 Proceed to the post-installation steps.

See “Completing post-installation operations” on page 127.

Verifying the Oracle CRS and Oracle 10g Installation

To verify that the installations of the Oracle CRS and Oracle 10g have succeeded, issue the command described below from any node in the cluster. The output should show processes running on all nodes, as in the following example:

```
# $CRS_HOME/bin/crs_stat
        NAME=ora.galaxy.vip
        TYPE=application
        TARGET=ONLINE
        STATE=ONLINE on galaxy

        NAME=ora.galaxy.gsd
        TYPE=application
        TARGET=ONLINE
        STATE=ONLINE on galaxy

        NAME=ora.galaxy.ons
        TYPE=application
        TARGET=ONLINE
        STATE=ONLINE on galaxy

        NAME=ora.nebula.vip
        TYPE=application
        TARGET=ONLINE
        STATE=ONLINE on nebula

        NAME=ora.nebula.gsd
        TYPE=application
        TARGET=ONLINE
        STATE=ONLINE on nebula

        NAME=ora.nebula.ons
        TYPE=application
        TARGET=ONLINE
        STATE=ONLINE on nebula
```

Completing post-installation operations

After installing the Oracle software, complete these operations:

- Adding Oracle 10g R2 patches
- Relinking the SF Oracle RAC libraries to Oracle
- Creating the Oracle database
- Configuring the Oracle Service Group in a VCS Configuration

Adding Oracle 10g R2 patches

Use the following procedures to add Oracle 10g R2 patches to your node if you have installed Oracle, but have not yet configured Oracle in your cluster. To install Oracle 10g R2 patch software, you must have installed Oracle 10g R2 software.

Applying Oracle 10.2.0.3 patch set

Your cluster should be in following state:

- Oracle CRS version 10.2.0.1 up and running
- Oracle database version 10.2.0.1 installed
- SF Oracle RAC installer (installsfrac –configure galaxy nebula) is waiting on question to stop crs.

If you are continuing in the installer, you are prompted to link Oracle after installing Oracle 10.2.0.1. Normally Oracle needs to be linked to SF Oracle RAC Libraries, for which it is mandatory to stop CRS.

To bring the configuration to the desired Oracle patch level:

- Quit the SF Oracle RAC installer for now:
  press ‘q’ when prompted to link Oracle.
- Patch the Oracle installation:
  See “To apply Oracle 10.2.0.3 patch set” on page 128.
- Invoke the SF Oracle RAC installer to relink Oracle:
  See “Relinking the SF Oracle RAC libraries to Oracle” on page 129.

To apply Oracle 10.2.0.3 patch set

1. Refer to Oracle 10.2.0.3 Patch note to apply 10.2.0.3 patch set to Oracle CRS and database.
2. Invoke the SF Oracle RAC installer to relink Oracle:
   See “Relinking the SF Oracle RAC libraries to Oracle” on page 129.

Relinking the SF Oracle RAC libraries to Oracle

After installing the Oracle base software or Oracle patches, use the configuration program to relink SF Oracle RAC libraries to Oracle.

The following Oracle libraries are replaced during relinking phase:

Under $CRS_HOME:

lib/libskgxn2.so with /usr/lib64/libvcsmm.so

lib/libskgxp10.so with /opt/VRTSvcs/rac/lib/libskgxp10_ver25_64.so

lib32/libskgxn2.so with /usr/lib/libvcsmm.so

Under $ORACLE_HOME:

lib/libskgxn2.so with /usr/lib64/libvcsmm.so

lib/libskgxp10.so with /opt/VRTSvcs/rac/lib/libskgxp10_ver25_64.so

lib/libodm10.so with /usr/lib64/libodm.so

Relinking for Oracle 10.2.0.3

To relink the SF Oracle RAC libraries to Oracle 10.2.0.3

1. Go to /opt/VRTS/install on one node and run following command.
   ```
   # ./installsfrac -configure galaxy nebula
   ```
2. Press Enter till you reach Main Menu. Select Option 4 which is for Relink of oracle.
3. Press Enter to go to “Choose Oracle Version” Menu.
4. Select option 1, which is for Oracle10gR2.
5. You are asked to “Choose Task”. Select “Relink oracle.”
6. Press Enter.
7. Enter the necessary values for linking oracle with SF Oracle RAC libraries. Verify the list of all values when prompted.
   To correct values, go back and modify as needed. Once all correct values are displayed in list, Press ‘y’ to confirm.
8. The installer validates oracle home, node list and necessary permissions for user name and group. Then, it asks confirmation for stopping crs as “Do you want to continue with stopping crs?”. Press ‘y’ to stop crs. Installer stops crs as follows.
   ```
   Stopping CRS on node1 using: /etc/init.d/init.crs stop ……..
   Done
   Stopping CRS on node2 using: /etc/init.d/init.crs stop ……..
   Done
   Checking files ……. Done
   Oracle relinking done successfully
   ```

9 The installer displays LLT and CRS node numberings.

```
Checking for node numbering differences .....................
Done
NODE NAME LLT NODE ID CRS NODE ID
galaxy  0   1
nebula  1   2
Node numbering of LLT and CRS is different. It will be fixed.
This step is mandatory for SF Oracle RAC to function.
```

10 Press [Enter] to continue.

11 If LLT and CRS node numberings are not same, then Oracle may not detect some nodes and may detect some nodes in a wrong manner. This step ensures that the two numberings are same. Press Enter to continue.

```
Replacing node membership pattern in
/etc/VRTSvcs/conf/config/main.cf on
all the nodes ... Done
NodeId attribute has been changed only for CVMCluster resource
in
/etc/VRTSvcs/conf/config/main.cf to conform to Oracle's node
numbering
scheme, but if you have any other resource which uses NodeId as
an
attribute, you must change that manually in
/etc/VRTSvcs/conf/config/main.cf file before starting vcs.
Replacing node membership pattern in /etc/llthosts on all the
nodes .. Done
```

Press [Enter] to continue:

12 The installer prompts you to stop the whole Storage Foundation for Oracle RAC stack and provides the required commands.

```
Use the commands to stop the Storage Foundation for Oracle RAC
stack.
Before finishing Oracle 10g Release 2 installation, the SF
Oracle RAC stack needs to be shutdown on all the nodes using the
following steps.
Commands to shutdown the stack :
1) Stop database, crs.
2) Unmount all VxFS mounts, stop volumes and deport diskgroups.
3) Stop DBAC with commands :
/etc/init.d/vcsmm stop (Do not use vcsmmconfig -U);
/etc/init.d/lmx stop
4) Stop ODM and GMS with commands :
/etc/init.d/vxodm stop; /etc/init.d/vxgms stop
5) Stop VCS with command :
/opt/VRTSvcs/bin/hastop -local
6) /opt/VRTS/bin/fsclustadm cfsdeinit
7) Stop GLM with command :
/etc/init.d/vxglm stop
8) Stop/Kill the following processes if they are running :
had, hashadow, CmdServer
```

```
9) Stop VXFEN with command :
/etc/init.d/vxfen stop (Do not use vxfenconfig -U)
10) Stop GAB with command :
/etc/init.d/gab stop
11) Stop LLT with command :
/etc/init.d/llt stop
Press [Enter] to continue:
Please remember that you should not use "vcsmmconfig -U" and
"vxfenconfig -U" for unconfiguring vcsmm and vxfen respectively.
For stopping vcsmm and vxfen, please use:
$ /etc/init.d/vcsmm stop
$ /etc/init.d/vxfen stop
```

13 If the Storage Foundation for Oracle RAC stack does not stop, messages appear checking the status, confirming that Storage Foundation for Oracle RAC is not down and some components are still up. You are prompted to bring the stack down or to reboot. The required commands to bring the stack down are provided again. You are prompted:

```
Do you want to continue to bring down SFRAC components? [y,n,q]
(y)
You can enter N and safely ignore the step of stopping Storage
Foundation for Oracle RAC stack. On selecting N,the installer
displays the following message:
You must manually reboot all the nodes at the same time for the
new membership to take effect. To achieve simultaneous reboot of
nodes, please shutdown all the nodes at the same time. Now start
them only after all are in shutdown state. This step is critical
for avoiding those situations where some nodes are running with
old membership and the rest with new membership.
WARNING: If VxFEN has problems coming up after the reboot, SCSI3
PGR registration keys should be fixed using
/opt/VRTSvcs/vxfen/bin/vxfenclearpre command.
Refer to SF Oracle RAC Installation and configuration guide page
#86  for more
information.
Press [Enter] to continue:
This step ensures that all the cluster nodes start with new node
IDs on next
boot. In installsfrac -configure, press Enter to continue. The
success of
the configuration is reported. The configuration summary is
saved at:
/opt/VRTS/install/logs/installsfracxxxxxxxxxx.summary
The installsfrac log is saved at:
/opt/VRTS/install/logs/installsfracxxxxxxxxxx.log
```

14 If you were able to stop SF Oracle RAC stack successfully, then you do not need to reboot the nodes to start SF Oracle RAC stack. Start the SF Oracle RAC stack on all the nodes using the following steps:

```
1) Start LLT with command :
/etc/init.d/llt start
```

```
2) Start GAB with command :
/etc/init.d/gab start
3) Start VXFEN with command :
/etc/init.d/vxfen start
4) Start DBAC with commands :
/etc/init.d/vcsmm start; /etc/init.d/lmx start
5) Start GMS and ODM with commands :
/etc/init.d/vxgms start; /etc/init.d/vxodm start
6) Start vcs with command:
/etc/init.d/vcs start
7) Import all previously imported diskgroups and start all
volumes.
Mount all VxFS mounts that were previously mounted.
8) Start crs and then start database (If any).
```

15 Then, using Oracle utilities create Listener and Database appropriately. You may refer to “Creating a starter Database” for database creation.

Creating the Oracle database

Create the Oracle database on shared storage. Use you own tools or refer to Appendix B, “Creating a starter database” for guidelines on using the Oracle `dbca` (Database Creation Assistant) tool to create a database on shared raw VxVM volumes or shared VxFS file systems.

Configuring the Oracle Service Group in a VCS Configuration

After you install Oracle10g and create a database, make the proper modifications in the VCS configuration file. Refer to “Configuring Oracle 10g service groups” on page 133 for details on configuring service groups in an Oracle 10g environment.

Chapter 6

Configuring Oracle 10g service groups

After you have installed Oracle and created your database, you can set up VCS to automate the Oracle RAC environment:

- About VCS service group for Oracle 10g dependencies
- Configuring CVM and Oracle Service Groups
- Location of VCS log files

About VCS service group for Oracle 10g dependencies

Review the information on how to set up VCS to automate the Oracle 10g RAC environment and how VCS manages resources within a cluster.

VCS service group dependencies are based on whether you use the VCS Oracle agent or not. The following figures illustrate the dependencies.

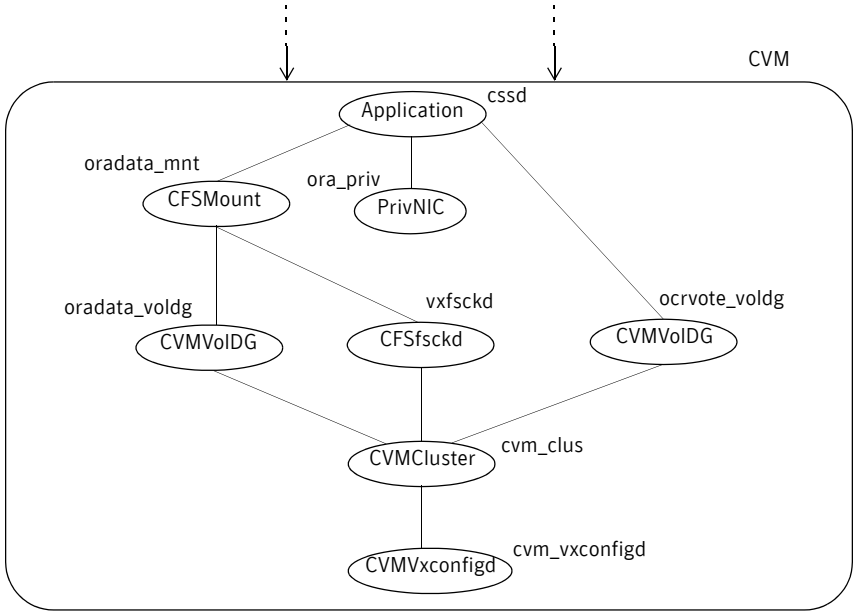
- In a configuration without the VCS Oracle agent, CRS controls the database.

See "Configuration without the Oracle agent" on page 134.

- In a configuration with the VCS Oracle agent, VCS controls the Oracle database. An online local firm dependency exists between the Oracle group and the CVM group. For more details on service group dependencies, refer to the *Veritas Cluster Server User's Guide*.

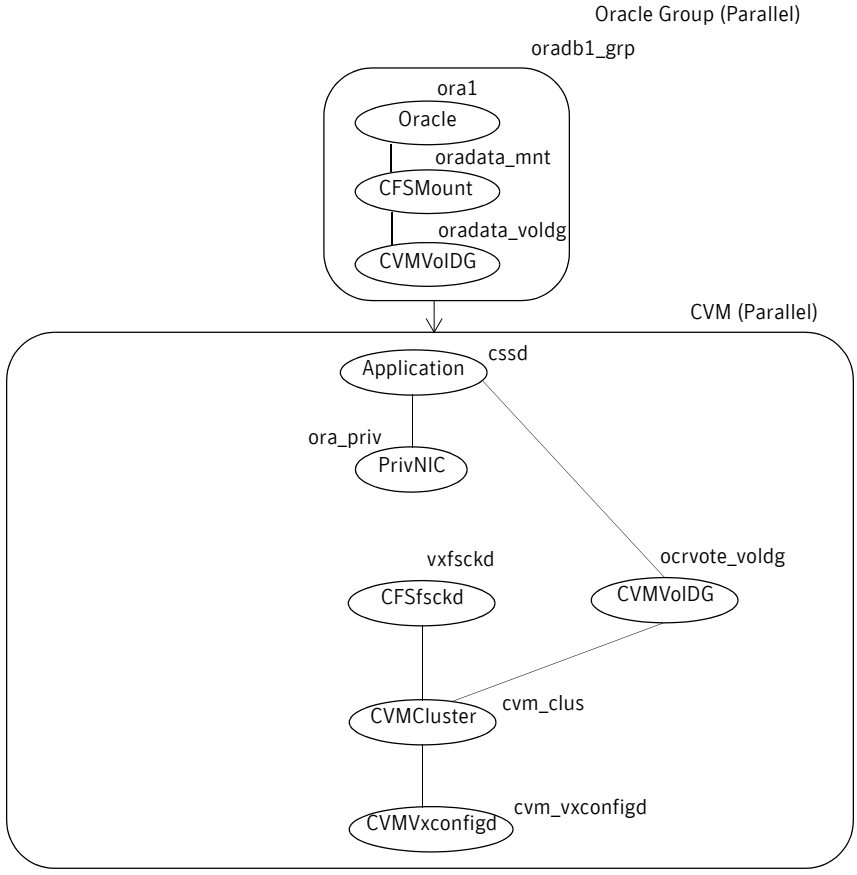
See "Configuration with the Oracle agent" on page 135.

Figure 6-1 Configuration without the Oracle agent



A sample main.cf file (Oracle 10g configuration without the Oracle agent) is displayed in Appendix A, "Sample VCS configuration files for SF Oracle RAC" on page 272.

Figure 6-2 Configuration with the Oracle agent



A sample main.cf file (Oracle 10g configuration with the Oracle agent) is displayed in Appendix A, "Sample VCS configuration files for SF Oracle RAC" on page 274.

Configuring CVM and Oracle Service Groups

The CVM and Oracle service groups can be configured using the following two methods:

- By editing the VCS configuration file, main.cf, to define the service groups; see "Location of VCS log files" on page 146.
- By using a configuration wizard for Oracle RAC; see "Creating service groups using the configuration wizard" on page 137.

Configuring CVM Service Group for Oracle 10*g* Manually

This section describes how to manually edit the `main.cf` file to configure the CVM and Oracle service groups.

To configure CVM service group for Oracle 10*g* manually

1. Log in to one system as `root`.
2. Save your existing configuration to prevent any changes while you modify `main.cf`:

   ```
   # haconf -dump -makero
   ```

   If the configuration is not writable, a warning appears: "Cluster not writable." You may safely ignore the warning.
3. Make sure VCS is not running while you edit `main.cf` by using the `hastop` command to stop the VCS engine on all systems and leave the resources available:

   ```
   # hastop -all -force
   ```
4. Make a backup copy of the main.cf file:

   ```
   # cd /etc/VRTSvcs/conf/config
   # cp main.cf main.orig
   ```
5. Using `vi` or another text editor, edit the `main.cf` file, modifying the `cvm` service group and creating `Oracle` service groups using the sample main.cf as a guideline.

Sample main.cf for *Oracle 10g*

This section provides the following sample files:

- "Oracle 10g configuration without Oracle agent" on page 272
- "Oracle 10g configuration with Oracle agent" on page 274

When you finish configuring the CVM and Oracle service groups by editing the `main.cf` file, verify the new configuration.

To save and check the configuration

1. Save and close the `main.cf` file.
2. Verify the syntax of the file `/etc/VRTSvcs/conf/config/main.cf`:
   ```
   # cd /etc/VRTSvcs/conf/config
   # hacf -verify .
   ```
3. Start the VCS engine on one system:
   ```
   # hastart
   ```
4. Type the command `hastatus`:
   ```
   # hastatus
   ```
5. When "`LOCAL_BUILD`" is listed in the message column, start VCS on the other system:
   ```
   # hastart
   ```
6. Verify that the service group resources are brought online. On one system, enter:
   ```
   # hagrp -display
   ```

To verify the state of newly added resources

1. Use `hargrp -state` to check status of the `cvm` group.
2. Use `hargrp -state` to check status of resources.

To restart the cluster nodes

A restart is required to make sure that CRS and Oracle RAC database instances use Symantec libraries.

1. Stop CRS using `/etc/init.d/init.crs stop` on all nodes.
2. Stop VCS using `/opt/VRTSvcs/bin/hastop -local` on all nodes.
3. Restart all nodes.

Modifying the VCS configuration

For additional information and instructions on modifying the VCS configuration by editing the `main.cf` file, refer to the *VERITAS Cluster Server User's Guide.*

Creating service groups using the configuration wizard

You can use a configuration wizard to configure the VCS service groups for Storage Foundation for Oracle RAC environment. The wizard enables you to modify the CVM service group to include the CRS resources. To monitor the

Oracle database using the Oracle Agent provided by VCS, you must edit the `main.cf` manually after you finish running the wizard. See "Location of VCS log files" on page 146 for details.

Before Starting the Wizard

Before starting the Wizard, you can verify that your Oracle installation can be configured. Review the requirements listed below. Also, you need to provide the wizard information as it proceeds. Make sure you have that information at hand.

Prerequisites

- Oracle RAC instances and listeners must be running on all cluster nodes.
- The database files of all instances must be on a cluster file system.

  Note: The Wizard does not support using the same file system for the Oracle binary and Oracle datafiles.

- The OCR file and VOTE file location must be on a raw volume.
- Each Oracle instance must be associated with a listener.

  Note: The RAC configuration wizard requires that for the default listener, the listener parameter file, listener.ora, must reside in $ORACLE_HOME/network/admin. No such restriction applies for non-default listeners.

- The IP addresses and host names specified in the files listener.ora and tnsnames.ora must be the same.
- Virtual IPs required for CRS must be up.

Information Required From the User

- RAC database instances to be configured
- NICs for Private NIC resource
- Registry and vote disk location for CRS

Establishing graphical access for the wizard

The configuration wizard requires graphical access to the VCS systems where you want to configure service groups. If your VCS systems do not have monitors, or if you want to run the wizards from a remote HP system, do the following:

To establish graphical access from a remote system

1. From the remote system, (`jupiter`, for example), run `xhost +`
   ```
   # xhost +
   ```
2. Complete one of the following operations (depending on your shell):
   - If you are running `ksh`, run this step on one of the systems where the wizard will run (for example, `jupiter`):
     ```
     # export DISPLAY=jupiter:0.0
     ```
   - If you are running `csh`, run this step
     ```
     # setenv DISPLAY jupiter:0.0
     ```
3. Verify the DISPLAY environment variable is updated:
   ```
   # echo $DISPLAY
   jupiter:0.0
   ```
4. Make sure to set the JRE_HOME variable to `/opt/VRTSjre/jre1.4`. If VRTSjre1.4 is not installed, the hawizard exits after displaying an error message.

Creating service groups using the configuration wizard

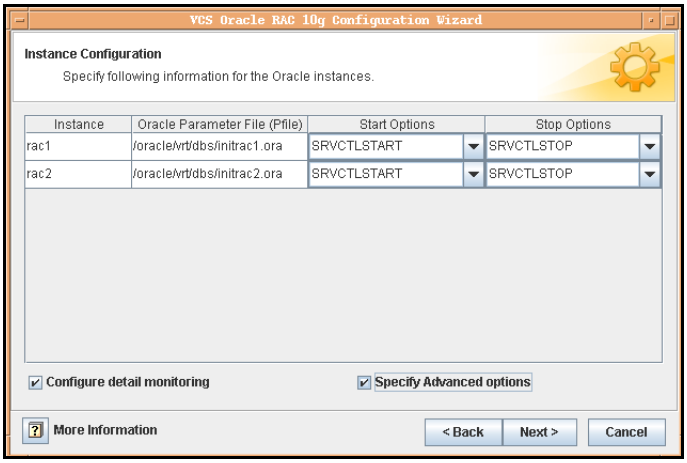
Start the configuration wizard for Oracle RAC at the command-line.

To create service groups using the configuration wizard

1. Log on to one of your VCS systems as superuser.
2. Start the configuration wizard.
   ```
   # /opt/VRTSvcs/bin/hawizard rac10g
   ```
3. Read the information on the Welcome screen.
   - If your configuration does not meet the requirements, click **Cancel** to stop the wizard. Start the wizard again after taking the necessary steps to meet the requirements.
   - If your configuration meets the requirements, click **Next**. The wizard begins discovering the current Oracle RAC information before proceeding.

     If the wizard does not find all databases and listeners running on all nodes in the cluster, it halts with an error, indicating the problem. Click **Cancel**, and start the wizard again after you correct the problem.
4. In the Wizard Options dialog box, select the **Create RAC Service Group** option.
5. Enter a name for the RAC service group in the **Service group name** box and click **Next**.
6. In the Database Selection dialog box, select a database and click **Next**.

7 In the Instance Configuration dialog box, specify information for all instances of the database you selected.



Specify the following information for each Oracle instance that is displayed and click **Next**:

Oracle Parameter File (Pfile) Verify the location of the Oracle Parameter File.

Edit the information if necessary.

Start Options Choose the Start options, if desired. Default is STARTUP_FORCE.

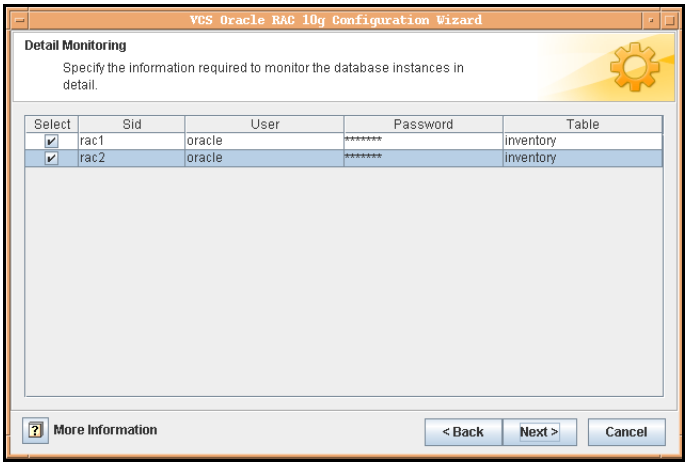
Stop Options Choose the Stop options, if desired. Default is IMMEDIATE.

Configure detail monitoring Select the check box if you want to monitor the database in detail.

If you want to enable Detail Monitoring, be sure you have previously set up the database table, user, and password for the agent to use during monitoring.

Specify Advanced Options Select the check box to enter advanced configuration information for the database instances.

8 If you chose to monitor the database in detail, the Detail Monitoring dialog box is displayed.



Specify the following information for the database instances that you want the agent to monitor in detail and click **Next**:

Select Select the check box corresponding to the database to be monitored in detail.

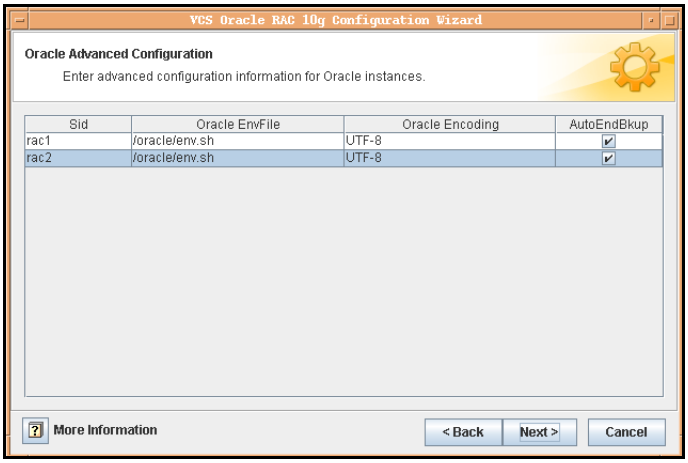
User Enter a valid user name for the database that the Oracle agent uses to log in to monitor the health of the database.

Password Enter a valid password for the database user.

Note: Do not encrypt passwords when entering them through the Agent Configuration Wizard; the wizard takes care of encrypting passwords.

Table Enter the name of a table that will be queried to validate the status of the database.

9 If you chose to specify advanced options, the Oracle Advanced Configuration dialog box is displayed.



Specify the following information for the Oracle instances that you want to configure advanced attributes and click **Next**:

Oracle EnvFile Enter the location of the Oracle Envfile, the source file used by the agent entry point scripts.

Oracle Encoding Enter the operating system encoding that corresponds to Oracle encoding for the displayed Oracle output.

The encoding value must match the encoding value used by the Netlsnr configuration.

AutoEndBkup Select the check box, if desired.

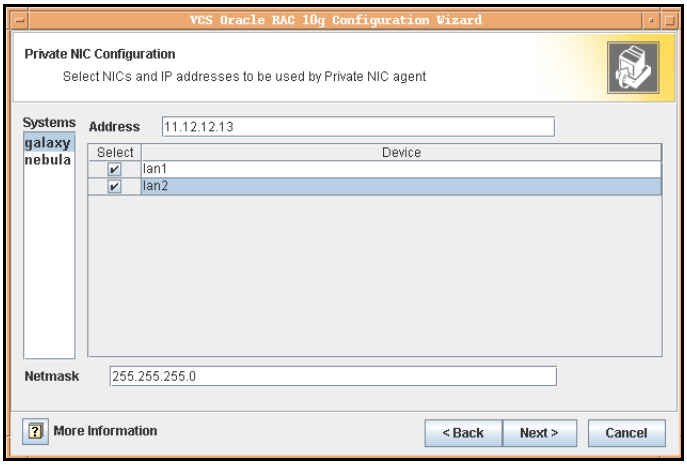
Specifies that data files in the database are taken out of the backup mode when instance is brought online.

Refer to the *Veritas High Availability Agent for Oracle Installation and Configuration Guide* for a complete description of these attributes.

10 In the Monitor option Configuration dialog box, specify the monitor option for the Oracle instances, and click **Next**.

The default monitor option is **Process check**.

11 In the Private NIC Configuration dialog box, specify the NIC and IP address for Private NIC agent.



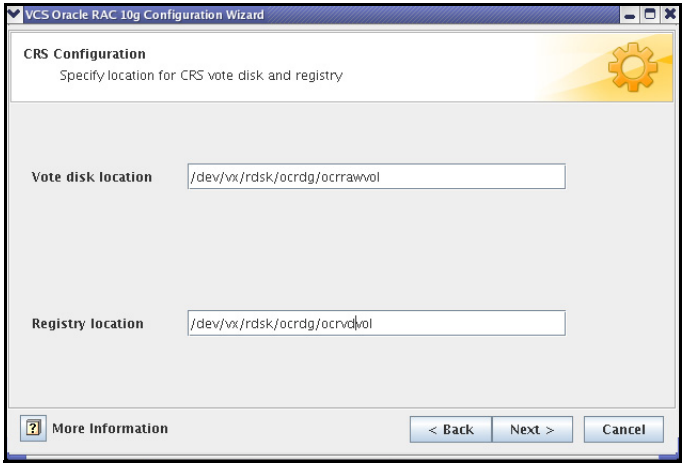
Specify the following information for each node in the cluster and click **Next**:

Address	Enter the private IP address that is used by Oracle 10*g* CRS.
Select	Select the checkbox against the network cards in the **Device** column. This NIC will be used by the PrivNIC agent.
Netmask	Enter the netmask.

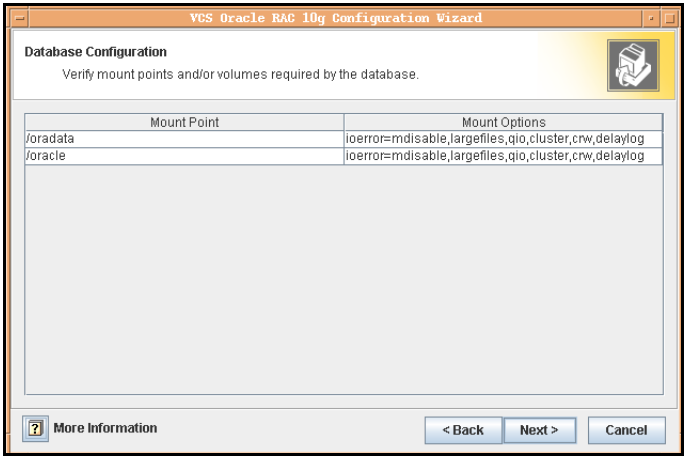
12 In the CRS Configuration dialog box, specify the location for CRS vote disk and OCR registry.

Enter the raw volume location for the CRS vote disk and registry. Example vote disk location:

- /dev/vx/rdsk/crs_oradg/crsvol

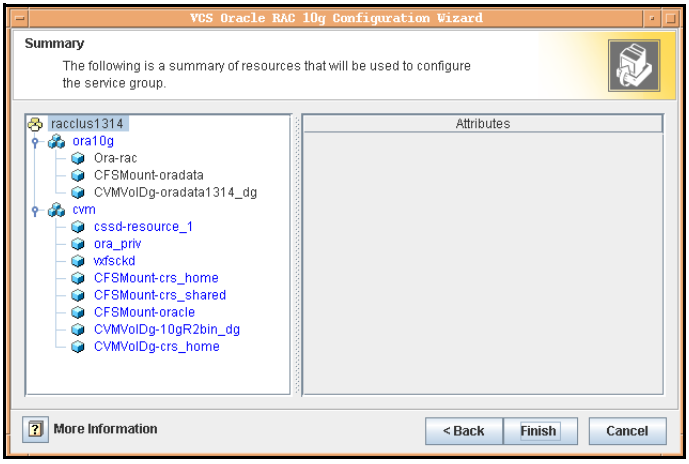


13 In the Database Configuration dialog box, verify the mount point of the database that the wizard displays. Confirm or modify the mount options displayed and click **Next**.
Note that the wizard discovers the mount point if the database is installed on a cluster file system. If the database exists on raw volumes, the wizard discovers the volumes.



14 In the Service Group Summary dialog, review your configuration.

Click on a resource to view its attributes and their configured values in the **Attributes** box.



- Click a resource within the service group to display its attributes and their values.

  For example, if you click on the name of the cssd application resource, cssd-resource, the wizard displays details of the cssd application resource.

  Attributes for the CFSMount resource show dependencies.

  The NetLsnr resource is configured as part of the CVM service group. The CVM service group also contains other resources, which may not be displayed by the wizard because the wizard does not control them.
- Change names of resources, if desired; the wizard assigns unique names to resources based on their respective name rules.

  To edit a resource name, select the resource name and click on it, press Enter after editing each attribute.

15 Review your configuration and click **Finish**.

The wizard starts running commands to create the Oracle RAC service group. Various messages indicate the status of these commands.

16 In the Completing the Oracle Configuration wizard dialog box, select the **Bring the service group online** check box to bring the service group online on the local system.

17 Click **Close**.

The wizard creates the Oracle RAC service group in your cluster and adds the Netlsnr resource to the CVM configuration.

Location of VCS log files

On all cluster nodes, look at the log files for any errors or status messages:

```
/var/VRTSvcs/log/engine_A.log
```

When large amounts of data are written, multiple log files may be required. For example, `engine_B.log`, `engine_C.log`, and so on, may be required. The `engine_A.log` contains the most recent data.

Chapter 7

Adding and removing cluster nodes for Oracle 10g

A cluster running Veritas *Storage Foundation for Oracle RAC* can have as many as eight systems. If you have a multi-node cluster running Oracle 10g, you can add or remove a node:

Adding a node to an Oracle 10g cluster

The examples used in these procedures describe adding one node to a two-system cluster.

Checking system requirements for new node

Ensure that the new systems meet all requirements for installing and using Storage Foundation for Oracle RAC.

- ✔ The new system must have the identical operating system and patch level as the existing systems.
- ✔ Use a text window of 80 columns minimum by 24 lines minimum; 80 columns by 24 lines is the recommended size for the optimum display of the `installsfrac` script.
- ✔ Verify that the file `/etc/fstab` contains only valid entries, each of which specifies a file system that can be mounted.

Physically adding a new system to the cluster

The new system must have the identical operating system and patch level as the existing systems. When you physically add the new system to the cluster, it must have private network connections to two independent switches used by the cluster and be connected to the same shared storage devices as the existing nodes. Refer to the *Veritas Cluster Server Installation Guide*.

After installing Storage Foundation for Oracle RAC on the new system and starting VxVM, the new system can access the same shared storage devices. The shared storage devices, including coordinator disks, must be exactly the same among all nodes. If the new node does not see the same disks as the existing nodes, it will be unable to join the cluster.

Installing Storage Foundation for Oracle RAC on the new system

Read the pre-installation instructions in this guide before proceeding.

To install Storage Foundation for Oracle RAC without configuration

1. Log in as root on one of the systems for installation.
2. Install the Veritas Storage Foundation for Oracle RAC software as described in Chapter 2, "Preparing to install SF Oracle RAC" on page 37 and Chapter 3, "Installing and Configuring SF Oracle RAC Software" on page 79 of this guide, but run the product installation script instead of the generic `installer` script. Enter the following command from the top-level directory of the mounted disc:

   ```
   # ./installsfrac -installonly [-rsh]
   ```

   The `-installonly` option is required to perform the installation without configuring the software. The `-rsh` option is required if you are using the remote shell (RSH) rather than the secure shell (SSH) to install the software simultaneously on several systems.

Note: If remote shell (RSH) or secure shell (SSH) is configured correctly, you can run this command on a single node to install the software on all nodes in the cluster.

3 After the initial system checks are complete, press **Return** to start the requirements checks.

4 Enter the licenses when prompted.

5 After the requirements checks are complete, press **Return** to start installing the packages. If you are installing multiple nodes, you have the option of installing them simultaneously. You will be prompted after the installation is complete.

6 When installation is complete, note the locations of the summary, log, and response files indicated by the installer.

Note: Ignore the message advising that you must run `installsfrac -configure`. When adding a node to a cluster running Storage Foundation for Oracle RAC, you must manually configure the system using the following procedure.

Starting Volume Manager

As you run the utility, answer **n** to prompts about licensing. You installed the appropriate license when you ran the `installsfrac` utility.

To start Volume Manager

1 Run the installer:

```
# vxinstall
```

2 Enter **n** when prompted to select enclosure-based naming for all disks.

3 Enter **n** to set up a systemwide disk group for the system. The installation completes.

4 Verify that the daemons are up and running. Enter the command:

```
# vxdisk list
```

The output should display the shared disks without errors.

Configuring LLT, GAB, VCSMM, and VXFEN drivers

To configure LLT, GAB, VCSMM, and VXFEN drivers

1 On the new system, modify the file `/etc/sysctl.conf` to set the shared memory and other parameter required by Oracle; refer to the documentation: B10766-01, *Oracle 10g Installation Guide,* for details. The value of the shared memory parameter is put to effect when the system restarts.

Note: This does not apply for SUSE.

2 Edit the file `/etc/llthosts` on the two existing systems. Using `vi` or another text editor, add the line for the new node to the file. The file should resemble:

```
1 galaxy
2 nebula
3 saturn
```

3 Copy the `/etc/llthosts` file from one of the existing systems over to the new system. The `/etc/llthosts` file must be identical on all nodes in the cluster.

4 Create an `/etc/lltab` file on the new system. For example:

```
set-node saturn
set-cluster 101
link eth1 eth-[MACID for eth1] - ether - -
link eth2 eth-[MACID for eth2] - ether - -
```

The second line, the cluster ID, must be the same as in the existing nodes.

5 Use `vi` or another text editor to create the file `/etc/gabtab` on the new system. It should resemble the following example:

```
/sbin/gabconfig -c -nN
```

Where *N* represents the number of systems in the cluster. For a three-system cluster, *N* would equal 3.

6 Edit the `/etc/gabtab` file on each of the existing systems, changing the content to match the file on the new system.

7 If you are adding the new node to a single node cluster, then fencing must be enabled and configured on the original node before proceeding to step 8. See "Setting up I/O fencing" on page 98.

8 Set up the `/etc/vcsmmtab` and `/etc/vxfendg` files on the new system by copying them from one of the other existing nodes:

```
# scp galaxy:/etc/vcsmmtab /etc
# scp galaxy:/etc/vxfendg /etc
```

9 Run the commands to start LLT and GAB on the new node:

```
# /etc/init.d/llt start
# /etc/init.d/gab start
```

10 On the new node, start the VXFEN, VCSMM, and LMX drivers. Remove the `/etc/vxfenmode file` to enable fencing. Use the commands in the order shown:

```
# rm /etc/vxfenmode
# /etc/init.d/vxfen start
# /etc/init.d/vcsmm start
# /etc/init.d/lmx start
```

11 Copy /etc/vxfenmode file from any existing cluster node.

12 On the new node, start the GMS and ODM drivers. Use the commands in the order shown:

```
# /etc/init.d/odm start
```

13 On the new node, verify that the GAB port memberships are a, b, d, and o. Run the command:

```
# /sbin/gabconfig -a
GAB Port Memberships
```

Preparing to add a node

Before configuring using the Oracle Add Node procedure, you must obtain IP addresses and configure CVM.

To prepare for installing Oracle

1 Obtain two IP addresses:

- one IP address for the private interconnect, which should be non-routable
- one public IP address to be plumbed as alias against the host interface, which *must* be on the same subnet as the system network interface

2 Create a local group and local user for Oracle. Be sure to assign the same group ID, user ID, and home directory as exists on the systems in the current cluster.

```
# groupadd -g 1000 oinstall
# groupadd -g 1001 dba
# groupadd -g 1002 oper
# useradd -g dba -u 1001 -d /lhome/oracle oracle
```

3 Create a password for the user oracle:

```
# passwd oracle
```

4 Create the directory structure for all shared mount points as defined in the `main.cf` configuration file. Include the Oracle OCR and Vote disk mount point if on the file system, the Oracle binaries if on CFS, and the Oracle

database. The directory structure must be same as defined on the systems in the current cluster.

Example of mount point for Oracle binaries

```
# mkdir-p /app/oracle/orahome
```

Example of mount point for Oracle database:

```
# mkdir –p /oradata
```

5 Change ownership and group to Oracle user.

```
# chown –R oracle:oinstall app/oracle
# chown –R oracle:oinstall app/crshome
# chown –R oracle:oinstall oradata
```

Configuring CVM

As root user, execute the following on the CVM master node only.

To configure the CVM group in the main.cf file

1 Determine the CVM master node:

```
# vxdctl –c mode
```

2 Make a backup copy of the `main.cf` file.

```
# cd /etc/VRTSvcs/conf/config
# cp main.cf main.cf.2node
```

3 Use the commands to reconfigure the CVM group. On the CVM master node, execute:

```
# haconf -makerw
# hasys -add saturn
# hares -local ora_priv Device
# hagrp -modify cvm SystemList -add saturn 2
# hagrp -modify cvm AutoStartList -add saturn
# hares -modify ora_priv Device -add eth1 0 -sys saturn
# hares -modify ora_priv Device -add eth2 1 -sys Saturn
# hares -modify ora_priv Address “192.11.12.10” -sys saturn
# hares -modify cvm_clus CVMNodeId -add saturn 3
# haconf -dump -makero
```

4 Verify the syntax of main.cf file:

```
# hacf –verify .
```

5 Stop the VCS engine on all systems, leaving the resources available.

```
# hastop –all –force
```

6 Copy the new version of the `main.cf` to each system in the cluster including the newly added system.

```
# rcp (or scp) main.cf  nebula:/etc/VRTSvcs/conf/config
# rcp (or scp) main.cf  saturn:/etc/VRTSvcs/conf/config
```

In the example, galaxy is the system where `main.cf` is edited; it does not need a copy.

7 Start VCS on the CVM master.

```
# hastart
```

8 Verify the CVM group has come online.

```
# hastatus -sum
```

9 To enable the existing cluster to recognize the new node, execute on the current node:

```
# /etc/vx/bin/vxclustadm -m vcs -t gab reinit
# /etc/vx/bin/vxclustadm nidmap
```

10 Repeat steps 7 through 9 on each system in the existing cluster.

11 Start CVM on the newly added node.

- Determine the node ID:

```
# cat /etc/llthost
```

- Verify this host ID is seen by the GAB module.

```
# gabconfig -a
```

- Start the VCS engine.
  - If on the newly added node ports f, u, v, or w were present before `hastart`, then the newly added node must be rebooted to properly start the VCS:

```
# shutdown -r
```

  - If on the newly added node ports f, u, v, or w were not present before `hastart`, then use the following command to start VCS:

```
# hastart
```

12 Verify the CVM group has come online on the newly added node.

```
# hastatus -sum
```

Using the Oracle add node procedure

For the Oracle procedure for adding a node, see:

Metalink Article 270512.1, Adding a Node to a 10g RAC Cluster

In this procedure, Oracle copies the CRS_HOME and ORACLE_HOME from an existing node in the cluster.

Sample main.cf for adding an Oracle 10g node

Changes to the sample `main.cf` for adding a node are highlighted in red.

```
include "types.cf"
include "CFSTypes.cf"
include "CVMTypes.cf"
include "OracleTypes.cf"
include "PrivNIC.cf"

cluster ora_cluster (
        UserNames = { admin = dOPhOJoLPkPPnXPjOM }
        Administrators = { admin }
        HacliUserLevel = COMMANDROOT
        CounterInterval = 5
        UseFence = SCSI3
        )

system galaxy (
        )

system nebula (
        )

system saturn (
        )

group cvm (
        SystemList = { galaxy = 0, nebula = 1, saturn = 2 }
        AutoFailOver = 0
        Parallel = 1
        AutoStartList = { galaxy, nebula, saturn }
        )
       CFSMount oradata_mnt (
                Critical = 0
                MountPoint = "/oradata"
                BlockDevice = "/dev/vx/dsk/oradatadg/oradatavol"
                )

       CVMVolDg oradata_voldg (
                Critical = 0
                CVMDiskGroup = oradatadg
                CVMVolume = { oradatavol }
                CVMActivation = sw
                )

       CVMVolDg orabin_voldg (
                Critical = 0
                CVMDiskGroup = orabindg
                CVMVolume = { orabinvol }
                CVMActivation = sw
                )
```

```
        CVMVolDg ocrvote_voldg (
                Critical = 0
                CVMDiskGroup = ocrvotedg
                               CVMActivation = sw
                 )

        CFSfsckd vxfsckd (
                 )

        CVMCluster cvm_clus (
                 CVMClustName = ora_cluster
                 CVMNodeId = { galaxy = 1, nebula = 2, saturn = 3 }
                 CVMTransport = gab
                 CVMTimeout = 200
                 )

        CVMVxconfigd cvm_vxconfigd (
                 Critical = 0
                 CVMVxconfigdArgs = { syslog }
                 )

        PrivNIC ora_priv (
                Critical = 0
                               Device = { eth1 = 0, eth2 = 1}
                Address@galaxy = "192.11.12.58"
                Address@nebula = "192.11.12.59"
                Address@saturn = "192.11.12.60"
                NetMask = "255.255.255.0"
                )

cvm_clus requires cvm_vxconfigd

oradata_voldg requires cvm_clus
ocrvote_voldg requires cvm_clus

ocrvote_mnt requires vxfsckd
oradata_mnt requires vxfsckd

oradata_mnt requires oradata_voldg
```

Removing a node from an Oracle 10g cluster

The examples used in these procedures describe removing one node from a three-system cluster.

Removing a Node from an Oracle 10g Cluster

For the Oracle procedure for removing a node, see:

Metalink document ID#269320.1, Removing a Node from a 10g RAC Cluster

Follow the instructions provided by Oracle.

Running the uninstallsfrac utility

You can run the script from any node in the cluster, including a node from which you are uninstalling Storage Foundation for Oracle RAC.

Note: Prior to invoking the `uninstallsfrac` script, all service groups must be brought offline and VCS must be shut down.

For this example, Storage Foundation for Oracle RAC is removed from the node named `saturn`.

To run the uninstallsfrac utility

1. Before starting ./uninstallsfrac, execute:

   `#/opt/VRTSvcs/bin/hastop -local`

2. As root user, start the uninstallation from any node from which you are uninstalling Storage Foundation for Oracle RAC. Enter:

   ```
   # cd /opt/VRTS/install
   # ./uninstallsfrac
   ```

3. The welcoming screen appears, followed by a notice that the utility discovers configuration files on the system. The information lists all the systems in the cluster and prompts you to indicate whether you want to uninstall from *all* systems. You must answer " **n**." For example:

   ```
   VCS configuration files exist on this system with the
   following information:

   Cluster Name: rac_cluster101
   ```

```
        Cluster ID Number: 7
        Systems: galaxy nebula saturn
        Service Groups: cvm oradb1_grp

Do you want to uninstall SFRAC from these systems? [y,n,q] (y) n
```

Caution: Be sure to answer N. Otherwise the utility begins the procedure to uninstall Storage Foundation for Oracle RAC from *all* systems.

4 The installer prompts you to specify the name of the system from which you are uninstalling Storage Foundation for Oracle RAC:

```
        Enter the system names separated by spaces on which to
uninstall
        SFRAC:saturn
```

5 The uninstaller checks for Storage Foundation for Oracle RAC packages currently installed on your system. It also checks for dependencies between packages to determine the packages it can safely uninstall and in which order.

6 Enter **y** when the uninstaller has completed checking.

7 When you press Enter to proceed, the uninstaller stops processes and drivers running on each system, and reports its activities.

8 When the installer begins removing packages from the systems, it indicates its progress by listing each step of the total number of steps required.

9 When the uninstaller is done, it describes the location of a summary file and a log of uninstallation activities.

Editing VCS configuration files on existing nodes

After running `uninstallsfrac`, modify the configuration files on the existing remaining nodes to remove references to the deleted node(s).

Edit /etc/llthosts

On the each of the existing nodes, using `vi` or another editor, edit the file `/etc/llthosts`, removing lines corresponding to the removed nodes. For example, if `saturn` is the node being removed from the cluster, remove the line "3 saturn" from the file:

```
1 galaxy
2 nebula
3 saturn
```

The file should now resemble:

```
1 galaxy
2 nebula
```

Edit /etc/gabtab

In the file `/etc/gabtab`, change the command contained in the file to reflect the number of systems after the node is removed:

```
/sbin/gabconfig -c -nN
```

where *N* is the number of nodes remaining. For example, with two nodes remaining, the file resembles:

```
/sbin/gabconfig -c -n2
```

Modify the VCS configuration to remove a system

You can modify the VCS configuration using one of three possible methods. You can edit `/etc/VRTSvcs/conf/config/main.cf` (the VCS configuration file) directly, you can use the VCS GUI (Cluster Manager), or you can use the command line, as illustrated in the following example. Please refer to the *Veritas Cluster Server User's Guide* for details about how to configure VCS.

At this point in the process, all Oracle binaries have been removed from the system to be deleted. The instance has been removed from the database, that is, the thread disabled, and the `spfile<SID>.ora` edited by Oracle to remove any references to this instance. The next step is to remove all references in the `main.cf` to the deleted node(s).

As root user execute the following on the CVM master node only.

To modify the CVM group in the main.cf file

1 To determine the CVM master node execute:

```
# vxdctl -c mode
```

2 Make a backup copy of the `main.cf` file.

```
# cd /etc/VRTSvcs/conf/config
# cp main.cf main.cf.3node.bak
```

3 Use the following commands to reconfigure the CVM group. Execute:

```
# haconf -makerw
# hagrp -modify cvm SystemList -delete saturn
# hares -modify cvm_clus CVMNodeId -delete saturn
# hasys -delete saturn
# haconf -dump -makero
```

Example of main.cf file: see "Sample main.cf for Removing an Oracle 10g Node" on page 159.

4 Verify the syntax of main.cf file:

```
# hacf -verify .
```

The main.cf file now should not contain entries for system saturn.

5 Stop the VCS engine on all systems, leaving the resources available.

```
# hastop -all -force
```

6 Copy the new version of the `main.cf` to each system in the cluster.

```
# rcp (or scp) main.cf  galaxy:/etc/VRTSvcs/conf/config
# rcp (or scp) main.cf  nebula:/etc/VRTSvcs/conf/config
```

7 Start the VCS engine on the current system.

```
# hastart
```

8 Verify the CVM group has come online.

```
# hastatus -sum
```

9 Repeat commands step 7 through step 8 on each system in the existing cluster.

Sample main.cf for Removing an *Oracle 10g* Node

Changes to the sample `main.cf` for adding a node are highlighted in red.

```
include "types.cf"
include "CFSTypes.cf"
include "CVMTypes.cf"
include "OracleTypes.cf"
include "PrivNIC.cf"

cluster ora_cluster (
        UserNames = { admin = dOPhOJoLPkPPnXPjOM }
        Administrators = { admin }
        HacliUserLevel = COMMANDROOT
        CounterInterval = 5
        UseFence = SCSI3
        )

system galaxy (
        )

system nebula (
        )

system saturn (
        )

group cvm (
        SystemList = { galaxy = 0, nebula = 1, saturn = 2 }
        AutoFailOver = 0
        Parallel = 1
        AutoStartList = { galaxy, nebula, saturn }
        )
       CFSMount oradata_mnt (
```

```
                Critical = 0
                MountPoint = "/oradata"
                BlockDevice = "/dev/vx/dsk/oradatadg/oradatavol"
                )

        CVMVolDg oradata_voldg (
                Critical = 0
                CVMDiskGroup = oradatadg
                CVMVolume = { oradatavol }
                CVMActivation = sw
                )

        CVMVolDg orabin_voldg (
                Critical = 0
                CVMDiskGroup = orabindg
                CVMVolume = { orabinvol }
                CVMActivation = sw
                )

        CVMVolDg ocrvote_voldg (
               Critical = 0
               CVMDiskGroup = ocrvotedg
                              CVMActivation = sw
                )

        CFSfsckd vxfsckd (
                )

        CVMCluster cvm_clus (
                CVMClustName = ora_cluster
                CVMNodeId = { galaxy = 1, nebula = 2, saturn = 3 }
                CVMTransport = gab
                CVMTimeout = 200
                )

        CVMVxconfigd cvm_vxconfigd (
                Critical = 0
                CVMVxconfigdArgs = { syslog }
                )

        PrivNIC ora_priv (
               Critical = 0
                              Device = { eth1 = 0, eth2 = 1}
               Address@galaxy = "192.11.12.58"
               Address@nebula = "192.11.12.59"
               Address@saturn = "192.11.12.60"
               NetMask = "255.255.255.0"
               )

cvm_clus requires cvm_vxconfigd

oradata_voldg requires cvm_clus
```

```
ocrvote_voldg requires cvm_clus

ocrvote_mnt requires vxfsckd
oradata_mnt requires vxfsckd

oradata_mnt requires oradata_voldg
```

Chapter 8

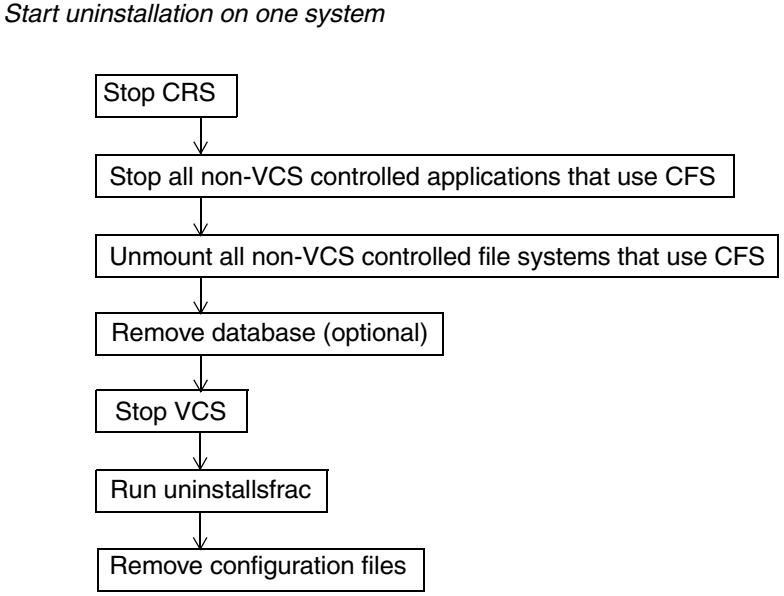
Uninstalling SF Oracle RAC from Oracle 10g systems

At the completion of the uninstallation procedure, you can continue to run Oracle using the single-instance binary generated when you unlink the Veritas binaries from Oracle.

Uninstalling SF Oracle RAC on Oracle 10*g*:

To uninstall SF Oracle RAC, you must remove all Veritas SF Oracle RAC software packages.

Figure 8-1 Uninstalling SF Oracle RAC



Offlining service groups

Offline all service groups and shutdown VCS prior to launching the `uninstallsfrac` script:

```
# /opt/VRTSvcs/bin/hastop -all
```

Do not use the `-force` option when executing `hastop`. This will leave all service groups online and shut down VCS, causing undesired results during the uninstallation of SF Oracle RAC.

Stopping Applications Using CFS (Outside of VCS Control)

All Oracle users must stop all applications using the CFS mounts *not* under VCS control.

To verify that no processes are using the CFS mount point

1 Enter:

```
# fuser mount_-point
```

2 Stop any processes using a CFS mount point.

Unmounting VxFS File Systems (Outside of VCS Control)

All Oracle users must unmount any CFS file systems *not* under VCS control on all nodes.

To unmount CFS file systems not under VCS control

1 Determine the file systems to unmount by checking the output of the mount file. For example, type:

```
# mount | grep vxfs | grep cluster
```

2 By specifying its mount point, unmount each file system listed in the output:

```
# umount mount_point
```

Removing the Oracle Database (Optional)

You can remove the Oracle database after safely relocating the data as necessary.

Unlinking Veritas libraries from Oracle 10g binaries

If you have uninstalled Oracle, skip this procedure. If you have not uninstalled Oracle, unlink the Veritas libraries, using the following procedure, which generates a single-instance Oracle binary.

To unlink Oracle 10*g* binaries from Veritas libraries

1 Log in as the `oracle` user.

```
# su -oracle
```

2 Change to the ORACLE_HOME directory.

```
$ cd $ORACLE_HOME/lib
```

3 Restore the original Oracle libraries from the backup copies. There could be multiple backup copies as `<library_name>_XX_XX_XX-XX_XX_XX`. Run the following command to verify that it is an oracle library.

```
$ strings <library_name>_XX_XX_XX-XX_XX_XX |grep -i veritas.
```

The output should not have "veritas" string. Out of the libraries which do not have the "veritas" string select the library with the latest time stamp use the following procedure to restore:

```
$ rm libskgxp10.so
$ cp libskgxp10.so_XX_XX_XX-XX_XX_XX libskgxp10.so
$ rm libskgxn2.so
$ cp libskgxn2.so_XX_XX_XX-XX_XX_XX libskgxn2.so
$ rm libodm10.so
$ cp libodm10.so_XX_XX_XX-XX_XX_XX libodm10.so
```

4 Change to the CRS_HOME directory.

```
$ cd CRS_HOME/lib
```

5 Restore the original CRS library. Use the method in step 3 above to identify the library to restore.

```
$ rm libskgxn2.so
$ cp libskgxn2.so_XX_XX_XX-XX_XX_XX libskgxn2.so
$ rm libskgxp10.so
$ cp libskgxp10.so_XX_XX_XX-XX_XX_XX libskgxp10.so
```

6 Change to the ORACLE _HOME directory and update the library. Use the method in step 3 above to identify the library to restore.

```
# cd ORACLE_HOME/lib32
# rm libskgxn2.so
# cp libskgxn2.so_XX_XX_XX-XX_XX_XX libskgxn2.so
```

7 Change to the CRS_HOME directory and update the library. Use the method in step 3 above to identify the library to restore.

```
# cd CRS_HOME/lib32
# rm libskgxn2.so
# cp libskgxn2.so_XX_XX_XX-XX_XX_XX libskgxn2.so
```

Removing repository database

To remove the Storage Foundation for Oracle repository database, use the following procedure.

To remove repository database

1 Run the following commands to remove the repository configuration from the VCS configuration and deport the repository diskgroup.

```
# /opt/VRTS/bin/sfua_db_config -o unconfig_cluster
```

2 Import the repository disk group using the command:

```
# vxdg import <name_of_disk_group>
```

3 Mount the repository volume using the command:

```
# /opt/VRTSdbcom/configu/sfua_rep_mount
```

4 Drop the repository database using the command:

```
# /opt/VRTS/bin/sfua_db_config -o dropdb
```

Removing SF Oracle RAC packages

The uninstallsfrac script removes packages installed by installsfrac on all systems in the cluster. The installer removes all SF Oracle RAC rpms, regardless of the version of Oracle used.

To run uninstallsfrac

1. As root user, navigate to the directory containing the uninstallsfrac program.
   ```
   # cd /opt/VRTS/install
   ```
2. Start uninstallsfrac:
   ```
   # ./uninstallsfrac [-rsh]
   ```
   The utility reports the cluster and systems for uninstalling.
3. Enter **y** if the cluster information is correct.
   After entering the systems where the uninstallation will take place, the script checks the operating system on each system, verifies system-to-system communication, and sets up a log file.
   The script checks for SF Oracle RAC packages currently installed on the nodes. This process involves identifying system uninstall requirements and dependencies between packages to determine the safety and order of uninstalling packages.
4. Confirm to uninstall SF Oracle RAC packages.
5. Review the output as the script stops processes and drivers running on each node, and reports its activities.
6. Review the output as the script indicates the progress of removing packages from the nodes by listing the steps that are completed. The total number of steps depends on the nature of the installation.
7. If necessary, review the summary and log files of uninstallation activities.

Removing other configuration files (optional)

You can remove the following configuration files:

```
/etc/vcsmmtab
/etc/vxfentab
/etc/vxfendg
/etc/llttab
/etc/gabtab
/etc/llthosts
```

Rebooting the Nodes

After uninstalling SF Oracle RAC, reboot each node:

```
# /usr/sbin/shutdown
```

Section IV

Backup and recovery

Use Checkpoints and FlashSnap procedures to back up your RAC database.

Chapter 9

Configuring the repository database for Oracle

After installing SF Oracle RAC, you can create and configure the repository database using the sfua_db_config script.This repository database configuration enables you to use SF Oracle RAC features such as Checkpoint, flashsnap and storage mapping. The script detects that the system is running in an HA configuration and automatically configures the repository database.

Creating and configuring the repository database for Oracle

Before running the sfua_db_config script, review the following requirements:

- Make sure a disk group exists with at least one volume, which should not be shared. A VxFS file system must be created on the disk group.
- The volume must be started and the file system must be mounted.
- Obtain an unique virtual IP address for public NIC interface.
- Obtain a device name for the public NIC interface (for example: eth0).
- Obtain a subnet mask for the public NIC interface.

Note: The volume is used to store the repository database.

Table 9-1 indicates the options available for the sfua_db_config script.

Table 9-1 sfua_db_config options

Options	Description
-ssh	Use this option in a high availability (HA) configuration. The option indicates that ssh and scp are to be used for communication between systems. Either ssh or rsh should be preconfigured so that you can execute the commands without being prompted for passwords or confirmations. The default is rsh.
-o dropdb	Drops the repository database.
-o unconfig_cluster	Use this option in a high availability (HA) configuration. This option unconfigures the repository database from the VCS cluster.
-o dbstatus	Verifies the status of the database and database server.
-o stopserver	Stops the database server.
-o startserver	Starts the database server.
-o serverstatus	Reports the database server status.
-o stopdb	Detaches the repository database from the database server.
-o startdb	Attaches the repository database to the database server.

To create and configure the repository database

1 Run the sfua_db_config script:

```
# /opt/VRTSdbcom/bin/sfua_db_config
```

2 The following is an example of configuring SF Oracle RAC:

```
Welcome to the SFORA configuration script.
This script creates repository for standalone and HA
configuration. Please create a Veritas File System on a Veritas
Volume and mount it, before starting configuration using this
script. This mount point will be used to store repository. The
following is required to configure $prod repository for HA
solution:

* A mount point of already mounted Veritas Volume on a shared
storage, with Veritas File system.
* A public NIC used by each system in the cluster.
* A Virtual IP address and netmask.
```

```
Press enter to continue.

Enter Veritas filesystem mount point for SFORA repository:
/sfua_rep
Enter the NIC for system galaxy for HA Repository
configuration:eth0

Enter the NIC for system nebula for HA Repository
configuration:eth0

Enter the Virtual IP address for repository
failover:10.182.186.249
Enter the netmask for public NIC interface:255.255.0.0

Following information will be used for SFORA HA configuration:
Public IP address: 10.182.186.249
Subnet mask: 255.255.0.0
Public interface: galaxy-eth0 nebula-eth0
Mount point: /sfua_rep
Volume Name for mount point: dbed_rep
Diskgroup for mount point: sfua_rep
Is this correct (y/n/q) [y]? y
Repository database configured sucessfully for HA.
```

3 If you are upgrading, migrate your old repository information into the new repository. If you are installing or upgrading Veritas Storage Foundation for Oracle RAC, run the `dbed_update` command.

Setting administrative permissions

To allow database administrators to administer a database using SF Oracle RAC, you must change permission settings. During SF Oracle RAC installation, you are asked if you want to allow database administrators access. If you did not change permissions installation, you can do so at a later time.

The default settings at installation time for the /opt/VRTSdbeddirectory allow only the root login to access the directory.

To enable access for users other than root

1 To enable the user “oracle” access to the /opt/VRTSdbed directory, use the `chown` and `chmod` commands, as follows:

```
# chown -R oracle /opt/VRTSdbed
# chmod -R 500 /opt/VRTSdbed
```

2 To allow users in the group “dba” access to the /opt/VRTSdbed directory, use the `chgrp` and `chmod` commands, as follows:

```
# chgrp -R dba /opt/VRTSdbed
# chmod -R 550 /opt/VRTSdbed
```

Chapter 10

Using Checkpoints and Storage Rollback with Storage Foundation for Oracle RAC

Note: Storage Foundation for Oracle RAC only supports the SFDB features described in this guide.

Veritas Storage Checkpoint enables efficient backup and recovery of Oracle databases. Storage Checkpoints can also be mounted, allowing regular file system operations to be performed or secondary databases to be started. This chapter describes Storage Checkpoints and Storage Rollback and how to use them through Storage Foundation for Oracle RAC.

Topics covered in this chapter include:

Storage Checkpoints and Storage Rollback concepts

The Veritas Storage Checkpoint feature is available with SF Oracle RAC as part of the Veritas File System package and is used for the efficient backup and recovery of Oracle databases. Storage Checkpoints can also be mounted, allowing regular file system operations to be performed. This chapter describes what Storage Checkpoints and storage rollback are and how to make use of these technologies through SF Oracle RAC.

SF Oracle RAC provides a Storage Checkpoint facility that is similar to the snapshot file system mechanism; however, a Storage Checkpoint persists after a system reboot. A Storage Checkpoint creates an exact image of a database instantly and provides a consistent image of the database from the point in time the Storage Checkpoint was created. The Storage Checkpoint image is managed and available through the Veritas Storage Foundation command line interface (CLI).

A direct application of the Storage Checkpoint facility is Storage Rollback. Because each Storage Checkpoint is a consistent, point-in-time image of a file system, Storage Rollback is the restore facility for these on-disk backups. Storage Rollback rolls back changed blocks contained in a Storage Checkpoint into the primary file system for restoring the database faster. For more information on Storage Checkpoints and Storage Rollback, see the *Veritas File System Administrator's Guide*.

How Storage Checkpoints and Storage Rollback work

A Storage Checkpoint is a disk and I/O efficient snapshot technology for creating a "clone" of a currently mounted file system (the *primary* file system). Like a snapshot file system, a Storage Checkpoint appears as an exact image of the snapped file system at the time the Storage Checkpoint was made. However, unlike a snapshot file system that uses separate disk space, all Storage Checkpoints share the same free space pool where the primary file system resides unless a Storage Checkpoint allocation policy is assigned. A Storage Checkpoint can be mounted as read-only or read-write, allowing access to the files as if it were a regular file system. A Storage Checkpoint is created using the `dbed_ckptcreate` command.

Initially, a Storage Checkpoint contains no data—it contains only the inode list and the block map of the primary fileset. This block map points to the actual data on the primary file system. Because only the inode list and block map are needed and no data is copied, creating a Storage Checkpoint takes only a few seconds and very little space.

A Storage Checkpoint initially satisfies read requests by finding the data on the primary file system, using its block map copy, and returning the data to the

requesting process. When a write operation changes a data block *n* in the primary file system, the old data is first copied to the Storage Checkpoint, and then the primary file system is updated with the new data. The Storage Checkpoint maintains the exact view of the primary file system at the time the Storage Checkpoint was taken. Subsequent writes to block *n* on the primary file system do not result in additional copies to the Storage Checkpoint because the old data only needs to be saved once. As data blocks are changed on the primary file system, the Storage Checkpoint gradually fills with the original data copied from the primary file system, and less and less of the block map in the Storage Checkpoint points back to blocks on the primary file system.

You can set a quota to limit how much space a file system will give to all storage checkpoints, to prevent the checkpoints from consuming all free space. See the command `dbed_ckptquota` for more information.

Storage Rollback restores a database, a tablespace, or datafiles on the primary file systems to the point-in-time image created during a Storage Checkpoint. Storage Rollback is accomplished by copying the "before" images from the appropriate Storage Checkpoint back to the primary file system. As with Storage Checkpoints, Storage Rollback restores at the block level, rather than at the file level. Storage Rollback is executed using the `dbed_ckptrollback` command.

Note: Whenever you change the structure of the database (for example, by adding or deleting datafiles, converting `PFILE` to `SPFILE`, or converting `SPFILE` to `PFILE`), you must run `dbed_update`.

Mountable Storage Checkpoints can be used for a wide range of application solutions, including backup, investigations into data integrity, staging upgrades or database modifications, and data replication solutions.

If you mount a Storage Checkpoint as read-write, roll back to this Storage Checkpoint will not be permitted. This ensures that any Storage Checkpoint data that has been modified incorrectly cannot be a source of any database corruption. When a Storage Checkpoint is mounted as read-write, the `dbed_ckptmount` command creates a "shadow" Storage Checkpoint of and mounts this "shadow" Storage Checkpoint as read-write. This enables the database to still be rolled back to the original Storage Checkpoint.

Determining space requirements for Storage Checkpoints

To support Block-level Incremental (BLI) Backup and storage rollback, the file systems need extra disk space to store the Storage Checkpoints. The extra space needed depends on how the Storage Checkpoints are used. Storage Checkpoints

that are used to keep track of the block changes contain only file system block maps, and therefore require very little additional space (less than 1 percent of the file system size).

When you use VERITAS NetBackup to back up your database, VERITAS NetBackup creates one set of Storage Checkpoints to provide a consistent view of the file systems for the database backups. The space required to hold this additional set of Storage Checkpoints depends on how busy the database load is when the backup is running. If the database is offline during the entire backup window, there is no additional space required.

If the database is online while the backup is running, the additional space required by each file system for Storage Checkpoints depends on the duration of the backup and the database workload. If workload is light during the backup or the backup window is relatively short (for example, for incremental backups), for most database configurations, an additional 10 percent of the file system size will be sufficient. If the database has a busy workload while a full backup is running, the file systems may require more space.

To support Storage Checkpoints and storage rollback, VxFS needs to keep track of the original block contents when the Storage Checkpoints were created. The additional space needed is proportional to the number of blocks that have been changed since a Storage Checkpoint was taken. The number of blocks changed may not be identical to the number of changes. For example, if a data block has been changed many times, only the first change requires a new block to be allocated to store the original block content. Subsequent changes to the same block require no overhead or block allocation.

If a file system that has Storage Checkpoints runs out of space, by default VxFS removes the oldest Storage Checkpoint automatically instead of returning an `ENOSPC` error code (UNIX `errno 28- No space left on device`), which can cause the Oracle instance to fail. Removing Storage Checkpoints automatically ensures the expected I/O semantics, but at the same time, eliminates a key recovery mechanism.

When restoring a file system that has data-full Storage Checkpoints from tape or other offline media, you need extra free space on the file system. The extra space is needed to accommodate the copy-on-write algorithm needed for preserving the consistent image of the Storage Checkpoints. The amount of free space required depends on the size of the restore and the number of Storage Checkpoints on the file system.

If you are restoring the entire file system, in most cases, you no longer need the existing Storage Checkpoint. You can simply re-make the file system using the `mkfs` command, and then restore the file system from tape or other offline media.

If you are restoring some of the files in the file system, you should first remove the data-full Storage Checkpoints that are no longer needed. If you have very

limited free space on the file system, you may have to remove all data-full Storage Checkpoints in order for the restore to succeed.

To avoid unnecessary Storage Checkpoint removal, instead of using a low quota limit use the SFDB utility to set up a Monitoring Agent to monitor file system space usage. When file system space usage exceeds a preset threshold value (say, 95 percent full), the Monitoring Agent alerts the system administrator and optionally grows the volume and the file system. Automatic notifications to the system administrator on the status of space usage and file system resizing are available through electronic mail, the `syslogd`(1M) program, or by logging messages to a simple log file.

Always reserve free disk space for growing volumes and file systems. You can also preallocate sufficient space for each file system when the file system is first created or manually grow the file system and logical volume where the file system resides.

See the `vxassist`(1) and `vxassist`(1) and `fsadm_vxfs`(1) and `chfs`(1) manual pages for more information.

Performance of Storage Checkpoints

Veritas File System attempts to optimize the read and write access performance on both the Storage Checkpoint and the primary file system. Reads from a Storage Checkpoint typically perform at nearly the throughput of reads from a normal VxFS file system, allowing backups to proceed at the full speed of the VxFS file system.

Writes to the primary file system are typically affected by the Storage Checkpoints because the initial write to a data block requires a read of the old data, a write of the data to the Storage Checkpoint, and finally, the write of the new data to the primary file system. Having multiple Storage Checkpoints on the same file system, however, will not make writes slower. Only the initial write to a block suffers this penalty, allowing operations like writes to the intent log or inode updates to proceed at normal speed after the initial write.

The performance impact of Storage Checkpoints on a database is less when the database files are Direct I/O files. A performance degradation of less than 5 percent in throughput has been observed in a typical OLTP workload when the Storage Checkpoints only keep track of changed information. For Storage Checkpoints that are used for storage rollback, higher performance degradation (approximately 10 to 20 percent) has been observed in an OLTP workload. The degradation should be lower in most decision-support or data-warehousing environments.

Reads from the Storage Checkpoint are impacted if the primary file system is busy, because the reads on the Storage Checkpoint are slowed by all of the disk

I/O associated with the primary file system. Therefore, performing database backup when the database is less active is recommended.

Backing up and recovering the database using Storage Checkpoints

Storage Checkpoints can be created by specifying one of the following options: online, offline, or instant. To create a Storage Checkpoint with the online option, the database should be online and you must enable ARCHIVELOG mode for the database. For the offline option, the database should be offline.

During the creation of the Storage Checkpoint, the tablespaces are placed in backup mode. Because it only takes a few seconds to take a Storage Checkpoint, the extra redo logs generated while the tablespaces are in online-backup mode are very small. You can roll back the entire database or individual tablespaces or datafiles to an online or offline Storage Checkpoint. After the rollback is complete, you may roll the database forward to restore the database if you have used an online Storage Checkpoint.

For the instant option, the database should be online and it can be running in either ARCHIVELOG or NOARCHIVELOG mode. You can only roll back the entire database to an instant Storage Checkpoint. Rolling back individual tablespaces or datafiles to an instant Storage Checkpoint is not possible. After the rollback is complete, you need to perform database recovery. Rolling the database forward is not supported; that is, you cannot apply archived redo logs.

To allow the easiest recovery, always keep ARCHIVELOG mode enabled, regardless of whether the database is online or offline when you create Storage Checkpoints.

Verifying a Storage Checkpoint using the command line

After creating a Storage Checkpoint and before using it to back up or restore a database, you can verify that the Storage Checkpoint is free of errors using the procedure below.

Usage Notes

- See the `dbed_ckptcreate`(1M) and `dbed_ckptmount`(1M) manual pages for more information.

To verify that a Storage Checkpoint is error-free using the command line

1 Create and mount a Storage Checkpoint:

```
$ /opt/VRTS/bin/dbed_ckptcreate -S PROD -H \
/oracle/product -o online
Storage Checkpoint Checkpoint_903937870 created.

$ mkdir /tmp/ckpt_ro

$ /opt/VRTS/bin/dbed_ckptmount -S PROD \
-c Checkpoint_903937870 -m /tmp/ckpt_ro
```

Note: If the specified mount point directory does not exist, then `dbed_ckptmount` creates it before mounting the Storage Checkpoint, as long as the Oracle DBA user has permission to create it.

2 Examine the content of the Storage Checkpoint:

```
$ ls -l /tmp/ckpt_ro/dbvol_82/dbinst1
drwxr-xr-x                3       oracle             dba
1024                    Nov 11 2000 .
drwxr-xr-x                3       oracle  dba        512
Nov 16 11:00 ..
-rw-r--r--                1       oracle             dba
209747968               Nov 16 10:58 .tstmp
-rw-r--r--                1       oracle  dba
209747968               Nov 16 10:58 .tstab
lrwxrwxrwx                1       oracle  dba        18
Nov 11 2000 tstmp -> \

.tstmp::cdev:vxfs:
lrwxrwxrwx                1       oracle     dba
18                      Nov 11 2000 tstab -> \

.tstab::cdev:vxfs:
```

3 Run `dbv` tool against Quick I/O file `tstmp`:

Storage Checkpoints can only be used to restore from logical errors (for example, a human error). Because all the data blocks are on the same physical device, Storage Checkpoints cannot be used to restore files due to a media failure. A media failure requires a database restore from a tape backup or a copy of the database files kept on a separate medium. The combination of data redundancy (disk mirroring) and Storage Checkpoints is recommended for highly critical data to protect them from both physical media failure and logical errors.

Backing up using a Storage Checkpoint

You can back up a database by creating a Storage Checkpoint using the dbed_ckptcreate command, mount the Storage Checkpoint as read-only using the dbed_ckptmount command, and then back it up using tools such as tar or cpio.

Usage Notes

- See the dbed_ckptcreate(1M), dbed_ckptmount(1M), tar(1), and cpio(1) manual pages for more information.

To back up a frozen database image using the command line

Note: In this example, all the database datafiles reside on one VxFS file system named /db01.

1 Create a Storage Checkpoint using the dbed_ckptcreate command:

```
$ /opt/VRTS/bin/dbed_ckptcreate -S PROD1 -H /oracle/product -o
online
Storage Checkpoint Checkpoint_903937870 created.
```

2 Mount the Storage Checkpoint using the dbed_ckptmount command:

```
$ /opt/VRTS/bin/dbed_ckptmount -S PROD -c Checkpoint_903937870
-m /tmp/ckpt_ro
```

If the specified mount point directory does not exist, then the dbed_ckptmount command creates it before mounting the Storage Checkpoint, as long as the Oracle DBA user has permission to create it.

3 Use tar to back up the Storage Checkpoint:

```
$ cd /tmp/ckpt_ro
$ ls
db01
$ tar cvf /tmp/PROD_db01_903937870.tar ./db01
```

Recovering a database using a Storage Checkpoint

Since Storage Checkpoints record the before images of blocks that have changed, you can use them to do a file-system-based storage rollback to the exact time when the Storage Checkpoint was taken. You can consider Storage Checkpoints as backups that are online, and you can use them to roll back an entire database, a tablespace, or a single database file. Rolling back to or restoring from any Storage Checkpoint is generally very fast because only the changed data blocks need to be restored.

Some database changes made after a Storage Checkpoint was taken may make it impossible to perform an incomplete recovery of the databases after Storage Rollback of an online or offline Storage Checkpoint using the current control files. For example, you cannot perform incomplete recovery of the database to the point right before the control files have recorded the addition or removal of datafiles. To provide recovery options, a backup copy of the control file for the database is saved under the `/etc/vx/SFDB/$ORACLE_SID/checkpoint_dir/CKPT_NAME` directory immediately after a Storage Checkpoint is created. You can use this file to assist with database recovery, if necessary. If possible, both ASCII and binary versions of the control file will be left under the `/etc/vx/SFDB/$ORACLE_SID/checkpoint_dir/CKPT_NAME` directory. The binary version will be compressed to conserve space. Use extreme caution when recovering your database using alternate control files.

Suppose a user deletes a table by mistake right after 4:00 p.m., and you want to recover the database to a state just before the mistake. You created a Storage Checkpoint (`Checkpoint_903937870`) while the database was running at 11:00 a.m., and you have `ARCHIVELOG` mode enabled.

To recover the database using a Storage Checkpoint

1. As root, freeze the VCS service group for the database
   ```
   # hagrp -freeze Service_Group
   ```
2. Ensure that the affected datafiles, tablespaces, or database are offline.
3. Use the `dbed_ckptrollback` command (storage rollback command) to roll back any datafiles in the database that contained the table data from the Storage Checkpoint you created at 11:00 a.m. The `dbed_ckptrollback` command syntax is as follows:
   ```
   dbed_ckptrollback -S ORACLE_SID -H ORACLE_HOME -c CKPT_NAME
   [ -T TABLESPACE | -F DATAFILES | -f DATAFILE_LIST ]
   [ -b BUFF_SIZE ] [ -t THREADS ] [ -i ] [ -h ]
   ```
   For example, to roll back data files of an offline Oracle Database to a Storage Checkpoint :
   ```
   $ /opt/VRTS/bin/dbed_ckptrollback -S PROD -H $ORACLE_HOME \
   -F /oradata1/data01.dbf,/oradata2/index01.dbf -c \
   Checkpoint_903937870
   ```
4. Start up the database instance if it is down.
5. Unfreeze the service group
   ```
   # hagrp -unfreeze Service_Group
   ```
6. Use **recover database until cancel**, **recover database until change**, or **recover database until time** to re-apply archive logs to the point before the table was deleted to recover the database to 4:00 p.m.

7 Open the database with **`alter database open resetlogs`**.

8 Delete the Storage Checkpoint you created at 11:00 a.m. and any other Storage Checkpoints created before that time.

9 Create a new Storage Checkpoint.

Cloning the Oracle instance using dbed_clonedb

You can use the `dbed_clonedb` command to clone an Oracle instance using mountable and writable Storage Checkpoints to the same or different instance so the instance can coexist. You can also create a clone instance using a Storage Checkpoint that is not mounted.

You have the option to manually or automatically recover the Oracle database when using the `dbed_clonedb` command:

- Manual (interactive) recovery, which requires using the `-i` option, of the clone instance allows the user to control the degree of recovery by specifying which archive log files are to be replayed.
- Automatic (non-interactive) recovery, which is the default usage of the `dbed_clonedb` command, recovers the entire database and replays all of the archive logs. You will not be prompted for any archive log names.

Prerequisites

- You should be logged in as the database administrator.
- Make sure you have enough space to create a clone database on your system. A clone database takes up as much memory and machine resources as the primary database.
- You must first create a writable Storage Checkpoint. See the *Veritas Storage Foundation for Oracle Administration Guide*.
- If you choose to use an existing Storage Checkpoint to create the clone database, the Storage Checkpoint needs to be online or offline.

Usage notes

- The `dbed_clonedb` command is used to create a copy of an Oracle database, cloning all existing database files to new locations. This is required when using mountable, writable Storage Checkpoints, where a new Oracle database needs to be started on the same host as an existing database.
- The utility requires that the current environment be configured correctly for the existing Oracle database which has had a Storage Checkpoint created

underneath it. This means that the ORACLE_SID and ORACLE_HOME environment variables must be set correctly.

- the dbed_clonedb command cannot use instant checkpoint to clone a RAC database.
- When cloning an Oracle instance using the dbed_clonedb or dbed_vmclonedb command, the clone database's ORACLE_SID can only be eight characters or less. You will receive an error (ERROR V-81-5713) if the ORACLE_SID is more than eight characters.
- It is assumed that the user has a basic understanding of the Oracle recovery process.
- See the dbed_clonedb(1M) manual page for more information.

Options

-S Specifies the name of the new Oracle SID, which will be the name of the new database instance.

-m Indicates the new mount point of the Storage Checkpoint.

-c Indicates the name of the Storage Checkpoint.

-i Runs the command in interactive mode where you must respond to prompts by the system. The default mode is non-interactive. (Optional)

-d This option is only for use with the -o umount option. If the -d option is specified, the Storage Checkpoint used to create the clone database will be removed along with the clone.

-o The -o umount option shuts down the clone database and unmounts the Storage Checkpoint file system. The -o restartdb option mounts the Storage Checkpoint file system and starts the clone database.

-p The pfile_modification_file option

To clone an Oracle instance with manual Oracle recovery

1 Use the dbed_clonedb command as follows:

```
$ /opt/VRTS/bin/dbed_clonedb -S NEW10 -m /local/oracle10/1 \
    -c Checkpoint_988813047 -i
```

Output resembles the following:

```
Primary Oracle SID is TEST10g
New Oracle SID is NEW10
Checkpoint_988813047 not mounted at /local/oracle10/1
Mounting Checkpoint_988813047 at /local/oracle10/1
 Using environment-specified parameter file
       /local/oracle10/links/dbs/initTEST10g.ora
 Default Oracle parameter file found:
```

```
        /local/oracle10/links/dbs/initTEST10g.ora
    Copying /local/oracle10/links/dbs/initTEST10g.ora
        to /local/oracle10/1/testvol
    Control file 'ora_control2'
        path not explicitly specified in init file; assuming
        ORACLE_HOME/dbs

    All redo-log files found
    Copying initTEST10g.ora to initNEW10.ora
        in /local/oracle10/1/testvol
    Altering db_name in initNEW10.ora
    Altering control file locations in initNEW10.ora
    Creating new link for clone database init file
    Creating archive log directory

    About to start up new database and begin reconfiguration

    Database NEW10 is being reconfigured
    Altering clone database archive log directory
    Updating log_archive_dest in clone database init file
    Found archive log destination at /testvol

    The latest archive log(s) must now be applied. To apply
    the logs, open a new window and perform the following steps:

1. copy required archive log(s) from primary to clone:
       primary archive logs in /testvol
       clone archive logs expected in /local/oracle10/1/testvol
2. ORACLE_SID=NEW10; export ORACLE_SID # sh and ksh, OR
       setenv ORACLE_SID NEW10 #csh
3. /local/oracle10/links/bin/sqlplus /nolog
4. CONNECT / AS SYSDBA
5. RECOVER DATABASE UNTIL CANCEL USING BACKUP CONTROLFILE
6. enter the archive log(s) you wish to apply
7. EXIT

Press <Return> after you have completed the above steps.
<Return>

    Resetting logs on new database NEW10
    Database instance NEW10 is up and running
```

To clone an Oracle instance with automatic Oracle recovery

1 Use the dbed_clonedb command as follows:

```
$ /opt/VRTS/bin/dbed_clonedb -S NEW10 -m /local/oracle10/1 \
    -c Checkpoint_988813047
```

Output resembles the following:

```
Primary Oracle SID is TEST10g
New Oracle SID is NEW10
Checkpoint_988813047 not mounted at /local/oracle10/1
Mounting Checkpoint_988813047 at /local/oracle10/1
```

```
Using environment-specified parameter file
       /local/oracle10/links/dbs/initTEST10g.ora
Default Oracle parameter file found:
       /local/oracle10/links/dbs/initTEST10g.ora
Copying /local/oracle10/links/dbs/initTEST10g.ora
       to /local/oracle10/1/testvol
Control file 'ora_control2'
       path not explicitly specified in init file; assuming
       ORACLE_HOME/dbs

All redo-log files found
Copying initTEST10g.ora to initNEW10.ora
       in /local/oracle10/1/testvol
Altering db_name in initNEW10.ora
Altering control file locations in initNEW10.ora
Creating new link for clone database init file
Creating archive log directory

About to start up new database and begin reconfiguration
Database NEW10 is being reconfigured
Starting automatic (full) database recovery
Shutting down clone database
Altering clone database archive log directory
Updating log_archive_dest in clone database init file
Found archive log destination at /testvol
Mounting clone database
Resetting logs on new database NEW10
Database instance NEW10 is up and running
```

Guidelines for Oracle recovery

For optimal Oracle recovery, follow these guidelines:

- Back up all control files before Storage Rollback in case the subsequent Oracle recovery is not successful. Oracle recommends that you keep at least two copies of the control files for each Oracle database and that you store the copies on different disks. It is also a good idea to back up the control files before and after making structural changes to databases.

Note: The SFDB utility automatically saves control file and log information when you create a Storage Checkpoint.

- Make sure that the control files are *not* rolled back.
  A control file is a small binary file that describes the structure of the database and must be available to mount, open, and maintain the database. The control file stores all necessary database file information, log file information, the name of the database, the timestamp of database creation,

and synchronization information, such as the Storage Checkpoint and log-sequence information needed for recovery. Rolling back the control file will result in an inconsistency between the physical database structure and the control file.

Note: If you intend to roll back the database to recover from structural changes that you do not want to maintain, you may want to roll back control files. The SFDB utility saves control file and log information and provides the capability to roll back control files.

- Make sure that all archived redo logs are available.
  A database backup with online and archived logs is required for a complete database recovery. Query `V$ARCHIVED_LOG` to list all the archived log information and `V$ARCHIVE_DEST` to list the location of archive destinations.
  For Oracle RAC the archive log destination must be on a Veritas cluster file system.
  To restore the necessary archived redo log files, you can query `V$LOG_HISTORY` to list all the archived redo log history or query `V$RECOVERY_LOG` to list only the archived redo logs needed for recovery. The required archived redo log files can be restored to the destination specified in the `LOG_ARCHIVE_DEST` parameter or to an alternate location. If the archived redo logs were restored to an alternate location, use the `ALTER DATABASE RECOVER ... FROM` statement during media recovery.
- After Storage Rollback, perform Oracle recovery, applying some or all of the archived redo logs.

Note: After rolling back the database (including control files and redo logs) to a Storage Checkpoint, you need to recover the Oracle database instance. Rolling the database forward is not supported; that is, you cannot apply archived redo logs.

- To perform a complete media recovery:

```
SET AUTORECOVERY ON;
RECOVER DATABASE;
```

- To perform an incomplete media recovery, use one of the following:
  - **`RECOVER DATABASE UNTIL CANCEL;`**
  - **`RECOVER DATABASE UNTIL TIME 'yyyy-mm-dd:hh:mm:ss';`**
    (You can confirm the time of error by checking the `$ORACLE_HOME/rdbms/log/alert*.log` file.)

- **RECOVER DATABASE UNTIL TIME 'yyyy-mm-dd:hh:mm:ss' using **
  backup controlfile;
- **RECOVER DATABASE UNTIL CHANGE scn;**

- To open the database after an incomplete media recovery, use the following:
  - **ALTER DATABASE OPEN RESETLOGS;**
    RESETLOGS resets the log sequence. The RESETLOGS option is required after an incomplete media recovery. After opening the database with the RESETLOGS option, remove the Storage Checkpoint you just rolled back to as well as any Storage Checkpoints that were taken before that one. These earlier Storage Checkpoints can no longer be used for Storage Rollback. After removing these Storage Checkpoints, be sure to create a new Storage Checkpoint.

Caution: Attempting to roll back to the same Storage Checkpoint more than once can result in data corruption. After rolling back, be sure to delete the Storage Checkpoint that you rolled back to and then create a new one.

See your Oracle documentation for complete information on recovery.

Chapter 11

Using database FlashSnap for backup and off-host processing

This chapter describes how to use Database FlashSnap to create a point-in-time copy of a database for backup and off-host processing. Database FlashSnap enables you to make backup copies of your volumes online with minimal interruption to users.

Topics covered in this chapter include:

About Database FlashSnap

Database FlashSnap lets you capture an online image of an actively changing database at a given instant. You can perform backups and off-host processing tasks on snapshots while providing continuous availability of your critical data.

Execute Database FlashSnap commands from the command line.

Database FlashSnap offers you a flexible way to efficiently manage multiple point-in-time copies of your data, and reduce resource contention on your business-critical servers.

Database FlashSnap enables database administrators to create a consistent copy of a database without root privileges by creating a snapshot. A snapshot copy of the database is referred to as a *database snapshot*.

With Veritas Storage Foundation for Oracle RAC, Database FlashSnap is used on the same cluster that the database resides on.

Database FlashSnap can significantly reduce the time it takes to backup your database, increase the availability of your production database, and still maintain your production database's performance.

Note: You must have Veritas Storage Foundation Enterprise Edition on all systems on which you intend to use Database FlashSnap.

To use Database FlashSnap, you must first configure the volumes used by the database.

See "Preparing hosts and storage for Database FlashSnap" on page 196

Solving typical database problems with Database FlashSnap

Database FlashSnap is designed to enable you to use database snapshots to overcome the following types of problems encountered in enterprise database environments:

- In many companies, there is a clear separation between the roles of system administrators and database administrators. Creating database snapshots typically requires superuser (root) privileges, privileges that database administrators do not usually have.
- In some companies, database administrators are granted root privileges, but managing storage is typically not central to their job function or their core competency.
- Creating database snapshots is a complex process, especially in large configurations where thousands of volumes are used for the database. One mistake can render the snapshots useless.

Because it does not require root privileges, Database FlashSnap overcomes these obstacles by enabling database administrators to create consistent snapshots of the database more easily. The snapshots can be utilized for repetitive use.

About Database FlashSnap applications

The following are typical applications of Database FlashSnap:

- *Database Backup and Restore*: Enterprises require 24/7 online data availability. They cannot afford the downtime involved in backing up critical data offline. By creating a clone database or a duplicate volume snapshot of data, and then using it to back up your data, your business-critical applications can continue to run without extended down time or impacted performance. After a clone database or snapshot volume is created, it can be used as a source to back up the original database.
- *Decision-Support Analysis and Reporting*: Operations such as decision-support analysis and business reporting may not require access to real-time information. You can direct such operations to use a clone database that you have created from snapshots using Database FlashSnap, rather than allowing them to compete for access to the primary volume or database. When required, you can quickly resynchronize the clone database with the primary database to get up-to-date information.
- *Application Development and Testing*: Development or service groups can use a clone database created with Database FlashSnap as a test database for new applications. A clone database provides developers, system testers, and quality assurance groups with a realistic basis for testing the robustness, integrity, and performance of new applications.
- *Logical Error Recovery*: Logical errors caused by an administrator or an application program can compromise the integrity of a database. You can recover a database by restoring the database files from a volume snapshot or by recovering logical objects (such as tables, for example) from a clone database created from volume snapshots using Database FlashSnap. These solutions are faster than fully restoring database files from tape or other backup media.

Using Database FlashSnap

The system administrator needs to configure storage according to the requirements specified in the snapplan.

See "Preparing hosts and storage for Database FlashSnap" on page 196

Database FlashSnap allows you to check the storage setup against requirements set forth in the snapplan. Depending on the results, the database administrator

may need to modify the snapplan or the system administrator may need to adjust the storage configuration. Properly configuring storage is the only aspect of using Database FlashSnap that requires the system administrator's participation.

To use Database FlashSnap, a database administrator must first define their snapshot requirements. For example, they need to determine whether off-host processing is required and, if it is, which host should be used for it. In addition, it is also important to consider how much database downtime can be tolerated. Database snapshot requirements are defined in a file called a *snapplan*. The snapplan specifies snapshot options that will be used when creating a snapshot image (such as whether the snapshot mode will be `online`, `offline`, or `instant`).

See "Creating a snapplan (dbed_vmchecksnap)" on page 208

After creating the snapplan, the database administrator must validate it to ensure that it is correct. During validation the snapplan is copied to the repository before using it to create a snapshot. Depending on the validation results, the database administrator may need to modify the snapplan or the system administrator may need to adjust the storage configuration.

After storage is configured as specified in the snapplan and the snapplan has been validated, the database administrator can create snapshots of the database and create database clones based on the snapshots on either the same host or a secondary one.

A database clone can be used on a secondary host for off-host processing, including decision-support analysis and reporting, application development and testing, database backup, and logical error recovery. After a user has finished using the clone on a secondary host, the database administrator can shut down the clone and move the snapshot database back to the primary host. Regardless of whether a snapshot is used on the primary or secondary host, it can be resynchronized with the primary database using Database FlashSnap. Database FlashSnap uses Veritas Volume Manager FastResync to quickly resynchronize the changed section between the primary and snapshot.

See the *Veritas Volume Manager User's Guide* for details about the Volume Manager FastResync.

Database FlashSnap can also be used to recover the primary copy of the database if it becomes corrupted by overwriting it with the snapshot. You can recover the primary database with a snapshot using the reverse resynchronization functionality of Database FlashSnap.

Using Database FlashSnap commands

The Database FlashSnap feature consists of three commands:

- `dbed_vmchecksnap` (used on the master node)
  Creates and validates the snapshot plan used to create a snapshot image of an Oracle database. You can also use `dbed_vmchecksnap` to copy, list, or remove a snapplan or make sure the storage is configured properly for the task. `dbed_vmchecksnap` is also used on the other cluster nodes to list the snapplan.
- `dbed_vmsnap` (used on the master node)
  Creates a snapshot image of an Oracle database by splitting the mirror volumes used by the database. You can also use `dbed_vmsnap` to resynchronize snapshot volumes with their original volumes.
- `dbed_vmclonedb` (used on the master or slave nodes)
  Mounts and starts a clone database using snapshot volumes. It can also shut down a clone database and deport its volumes, as well as restart a clone database that has been shut down. The snapshot image can be brought up on any of the cluster nodes.

All of these commands can be executed by the Oracle database administrator and do not require superuser (`root`) privileges.

Using Database FlashSnap options

Database FlashSnap offers three options for creating database snapshots. The option you choose is specified in the snapplan.

- *online*
  With this option, the tablespaces are put into online backup mode before the snapshot is created. This type of snapshot is also a valid database backup. Select this option if you are performing a point-in-time recovery from logical errors.
- *instant*
  With this option, the database can be up and running, and the tablespaces do not need to be put into online backup mode before the snapshot is created. However, all the file systems used by the database (including those containing the online redo logs and control files) are temporarily frozen and the cache is flushed before the snapshot is created. By freezing the file systems, the snapshot will be a consistent point-in-time image of the database from which a database clone can be created.
  An instant snapshot can be used to guard against data corruption or for off-host decision-support queries. However, it *is not* a valid database backup and cannot be used to perform a point-in-time recovery or off-host backup

since tablespaces are not put into online backup mode before the snapshot is created. The instant option is much faster than the online option.

- *offline*
  The `offline` option can be used to clone or back up a database. With this option, the database must be shut down when the snapshot is created. and online redo logs are required. This type of snapshot is a valid database backup.

Note: In this release of SF Oracle RAC, Database FlashSnap supports third mirror break-off snapshots only. Third mirror break-off snapshots are fully synchronized, full-sized snapshots.

See the *Veritas Volume Manager Administrator's Guide* for more information.

Planning to use Database FlashSnap

Before using Database FlashSnap, you must first determine your intended application. You will then need to make the following decisions:

- Which snapshot mode is appropriate: online, offline, or instant?
- Will you need one or two hosts?

Selecting the snapshot mode

If your purpose is to use the snapshot for backup or to recover the database after logical errors have occurred, choose the online option. In the event that your production database is offline, choose offline. If you intend to use the snapshot for decision-support analysis, reporting, development, or testing, choose instant. An instant snapshot is not suitable for recovery because it is not necessarily an exact copy of the primary database.

Preparing hosts and storage for Database FlashSnap

Setting up hosts

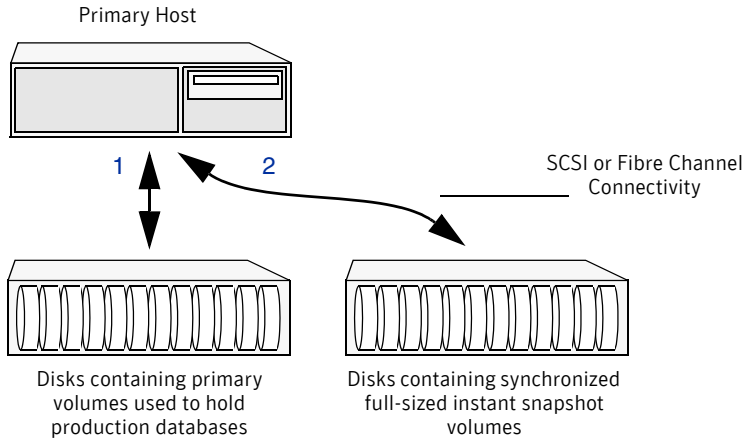
Database FlashSnap requires sufficient Veritas Volume Manager disk space, and can be used on the same host that the database resides on (the primary host) or

on a secondary host. Setting up a storage configuration for Database FlashSnap operations is a system administrator's responsibility and requires superuser (root) privileges. Database FlashSnap utilities *do not address* setting up an appropriate storage configuration.

Same-node configuration

Figure 11-1 on page 197 shows the suggested arrangement for implementing Database FlashSnap solutions on the primary host to avoid disk contention.

Figure 11-1 Example of a Database FlashSnap solution on a primary host

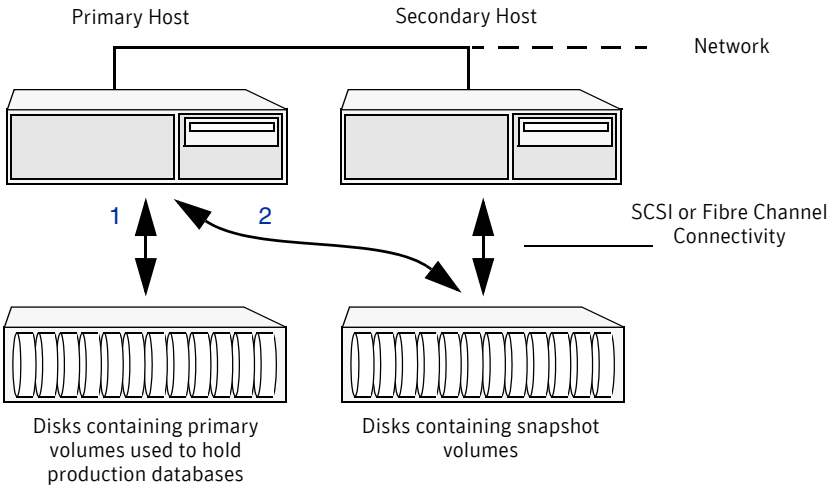


Node in the cluster configuration

As shown in Figure 11-2 on page 198, a Database FlashSnap configuration with two hosts allows CPU- and I/O-intensive operations to be performed for online backup and decision support without degrading the performance of the primary host running the production database. A node in the cluster configuration also allows the snapshot database to avoid contending for I/O resources on the primary host.

For off-host processing applications, both the primary and secondary hosts need to share the storage in which the snapshot database is created. Both the primary and secondary hosts must be able to access the disks containing the snapshot volumes.

Figure 11-2 Example of an off-host Database Flashsnap solution



Host and storage requirements

Before using Database FlashSnap, ensure that:

- All files are on VxFS file systems over VxVM volumes. Raw devices are not supported.
- Symbolic links to datafiles are not supported.
- *ORACLE_HOME* is on a separate file system.
- Archive logs are on a separate VxFS file system and are separate from the VxFS file system containing Oracle data files or *ORACLE_HOME*.
- The database does not contain `BFILES` and external tables.
- Oracle datafiles, archive logs, redo logs, and control files are in a single disk group.

Creating a snapshot mirror of a volume or volume set used by the database

With Database FlashSnap, you can mirror the volumes used by the database to a separate set of disks, and those mirrors can be used to create a snapshot of the database. These snapshot volumes can be split and placed in a separate disk group. This snapshot disk group can be imported on a separate host, which

shares the same storage with the primary host. The snapshot volumes can be resynchronized periodically with the primary volumes to get recent changes of the datafiles. If the primary datafiles become corrupted, you can quickly restore them from the snapshot volumes. Snapshot volumes can be used for a variety of purposes, including backup and recovery, and creating a clone database.

You must create snapshot mirrors for all of the volumes used by the database datafiles before you can create a snapshot of the database. This section describes the procedure used to create snapshot mirrors of volumes.

Use the `vxsnap` CLI command to create a snapshot mirror or synchronize a snapshot mirror.

Prerequisites

- You must be logged in as superuser (root).
- The disk group must be version 110 or later. For more information on disk group versions, see the `vxdg`(1M) online manual page.
- Be sure that a data change object (DCO) and a DCO log volume are associated with the volume for which you are creating the snapshot.
- Persistent FastResync must be enabled on the existing database volumes and disks must be assigned for the snapshot volumes. FastResync optimizes mirror resynchronization by tracking updates to stored data that have been missed by a mirror. When a snapshot mirror is reattached to its primary volumes, only the updates that were missed need to be re-applied to resynchronize it. FastResync increases the efficiency of the volume snapshot mechanism to better support operations such as backup and decision support. For detailed information about FastResync, see the *Veritas Volume Manager Administrator's Guide*.
- Snapshot mirrors and their associated DCO logs should be on different disks than the original mirror plexes, and should be configured correctly for creating snapshots by the system administrator.
- When creating a snapshot mirror, create the snapshot on a separate controller and separate disks from the primary volume.
- Allocate separate volumes for archive logs.
- Do not place any datafiles, including control files, in the `$ORACLE_HOME/dbs` directory.

Usage Notes

- Create a separate disk group for Oracle database-related files.
- Do not share volumes between Oracle database files and other software.
- ORACLE_HOME cannot be included in the snapshot mirror.
- Resynchronization speed varies based on the amount of data changed in both the primary and snapshot volumes during the break-off time.
- Do not share any disks between the original mirror and the snapshot mirror.
- Snapshot mirrors for datafiles and archive logs should be created so that they do not share any disks with the data of the original volumes. If they are not created in this way, the VxVM disk group cannot be split and, as a result, Database FlashSnap will not work.

Note: Database FlashSnap commands support third-mirror break-off snapshots only. The snapshot mirror must be in the SNAPDONE state.

Caution: The procedure given in this section is for existing volumes without existing snapshot plexes or associated snapshot volumes.

To create a snapshot mirror of a volume or volume set

Note: In the following procedure, *volume_name* is the name of either a volume or a volume set.

---

1 To prepare the volume for being snapshot, use the vxsnap prepare command:

```
# vxsnap -g diskgroup prepare volume \
alloc="storage_attribute ..."
```

Note: The vxsnap prepare command automatically creates a DCO and DCO volumes and associates them with the volume, and enables Persistent FastResync on the volume. Persistent FastResync is also set automatically on any snapshots that are generated from a volume on which this feature is enabled.
For enabling persistent FastResync on a volume in VxVM 5.0, either from the command line or from within a script, use the vxsnap prepare command as described above.

---

2 To verify that FastResync is enabled on the volume, use the vxprint command:

```
# vxprint -g diskgroup -F%fastresync volume_name
```

This returns `on` if FastResync is on. Otherwise, it returns `off`.

3 To verify that a DCO and DCO log volume are attached to the volume, use the `vxprint` command:

```
# vxprint -g diskgroup -F%hasdcolog volume_name
```

This returns `on` if a DCO and DCO log volume are attached to the volume. Otherwise, it returns `off`.

4 Create a mirror of a volume:

```
# vxsnap -g diskgroup addmir volume_name alloc= diskname
```

There is no option for creating multiple mirrors at the same time. Only one mirror can be created at a time.

5 List the available mirrors:

```
# vxprint -g diskgroup -F%name -e"pl_v_name in \"volume_name\""
```

Note: The following two steps enable database FlashSnap to locate the correct mirror plexes when creating snapshots.

---

6 Set the dbed_flashsnap for the data plex you want to use for breaking off the mirror. You can choose any tag name you like, but it needs to match the tag name specified in the snapplan.

```
# vxedit -g diskgroup set putil2=dbed_flashsnap plex_name
```

7 Verify that the *dbed_flashsnap* tag has been set to the desired data plex:

```
# vxprint -g diskgroup -F%name -e"pl_v_name in \"volume_name\"
    \ && p2 in \"dbed_flashsnap\""
```

If you require a backup of the data in the snapshot, use an appropriate utility or operating system command to copy the contents of the snapshot to tape or to some other backup medium.

This example shows the steps involved in creating a snapshot mirror for the volume `data_vol` belonging to the disk group `PRODdg`.

1 Prepare the volume `data_vol` for mirroring:

```
# vxsnap -g PRODdg prepare data_vol alloc=PRODdg01
```

2 Verify that FastResync is enabled:

```
# vxprint -g PRODdg -F%fastresync data_vol
on
```

3 Verify that a DCO and a DCO log are attached to the volume:

```
# vxprint -g PRODdg -F%hasdcolog data_vol
on
```

4 Create a snapshot mirror of `data_vol`:

```
# vxsnap -g PRODdg addmir data_vol alloc=PRODdg02
```

5 List the data plexes:

```
# vxprint -g PRODdg -F%name -e"pl_v_name in \"data_vol\""
data_vol-01
data_vol-02
```

Note: Choose the plex that is in the SNAPDONE state. Use the `vxprint -g diskgroup` command to identify the plex that is in the SNAPDONE state.

6 Decide which data plex you want to use and set the *dbed_flashsnap* tag for it:

```
# vxedit -g PRODdg set putil2=dbed_flashsnap data_vol-02
```

7 Verify that the *dbed_flashsnap* tag has been set to the desired data plex, data_vol-02:

```
# vxprint -g PRODdg -F%name -e"pl_v_name in \"data_vol\" \
&& p2 in \"dbed_flashsnap\""
data_vol-02
```

8 To verify that the snapshot volume was created successfully, use the `vxprint -g <dg>` command as follows:

```
# vxprint -g PRODdg
```

```
v  data_vol     fsgen
ENABLED4194304         -        ACTIVE   -       -
pl data_vol-01  data_vol
ENABLED4194304         -        ACTIVE   -       -
sd PRODdg03-01  data_vol-01
ENABLED4194304         0        -        -       -
pl data_vol-02  data_vol
ENABLED4194304         -        SNAPDONE -       -
sd PRODdg02-01  data_vol-02
ENABLED4194304         0        -        -       -
dc data_vol_dco data_vol                                          ---
-        -       -
v  data_vol_dcl gen
ENABLED560             -        ACTIVE   -       -
pl data_vol_dcl-01 data_vol_dcl ENABLED                           560
-        ACTIVE   -       -
sd PRODdg01-01  data_vol_dcl-01 ENABLED                           560
0        -        -       -
pl data_vol_dcl-02 data_vol_dcl DISABLED                          560
-        DCOSNP   -       -
sd PRODdg02-02  data_vol_dcl-02 ENABLED                           560
0        -        -       -
```

Identify that the specified plex is in the SNAPDONE state. In this example, it is data_vol-02.

The snapshot mirror is now ready to be used.

Summary of database snapshot steps

You can use Database FlashSnap commands to create a snapshot of your entire database on the same host or on a different one. Three types of snapshots can be created: `online`, `offline`, or `instant`.

If the `SNAPSHOT_MODE` specified in the snapplan is set to `online`, `dbed_vmsnap` first puts the tablespaces to be snapshot into backup mode. After the snapshot is created, the tablespaces are taken out of backup mode, the log files are switched to ensure that the extra redo logs are archived, and a snapshot of the archive logs is created.

If the `SNAPSHOT_MODE` is set to `offline`, the database must be shut down before the snapshot is created. Online redo logs and control files are required and will be used to ensure a full database recovery.

If the `SNAPSHOT_MODE` is set to `instant`, tablespaces are not put into and out of backup mode. Online redo logs and control files are required and will be used to ensure a full database recovery.

Both online and offline snapshots provide a valid backup copy of the database. You can use the snapshot as a source for backing up the database or creating a clone database for decision-support purposes. Instant snapshots *do not represent* a valid backup copy for point-in-time recovery.

The sections that follow explain how to create snapshots of all volumes on a database using the snapplan. Optionally, you can use the VxVM command (`vxsnap`) to create volume snapshots. However, unlike the Database FlashSnap commands, the `vxsnap` command does not automate disk group content reorganization functions. For more information about the `vxsnap` command, see *Veritas Volume Manager Administrator's Guide*.

Note: Make sure the volumes used by the database are configured properly before attempting to take a snapshot. This requires superuser (`root`) privileges.

Database FlashSnap commands must be run by the Oracle database administrator.

Note: Anytime you change the structure of the database (for example, by adding or deleting datafiles, converting `PFILE` to `SPFILE`, or converting `SPFILE` to `PFILE`), you must run `dbed_update`.

To create a snapshot image of a database

1. Perform the steps in "Creating a snapshot mirror of a volume or volume set used by the database" on page 198.
2. Use the `dbed_vmchecksnap` command to create a snapplan template and check the volume configuration to ensure that it is valid for creating volume snapshots of the database.
   The snapplan contains detailed database and volume configuration information that is needed for snapshot creation and resynchronization. You can modify the snapplan template with a text editor.
   The `dbed_vmchecksnap` command can also be used to:
   - List all snapplans associated with a specific *`ORACLE_SID`* (`dbed_vmchecksnap -o list`).
   - Remove the snapplan from the SFDB repository (`dbed_vmchecksnap -o remove -f` *`SNAPPLAN`*).
   - Copy a snapplan from the SFDB repository to your local directory (`dbed_vmchecksnap -o copy -f` *`SNAPPLAN`*).

   See "Creating a snapplan (dbed_vmchecksnap)" on page 208
3. Use the `dbed_vmsnap` command to create snapshot volumes for the database.
   See "Creating a snapplan (dbed_vmchecksnap)" on page 208
4. On the secondary host, use the `dbed_vmclonedb` command to create a clone database using the disk group deported from the primary host.
   See "Cloning a database (dbed_vmclonedb)" on page 225 for more information.
   If the primary and secondary hosts specified in the snapplan are different, the `dbed_vmclonedb` command imports the disk group that was deported from the primary host, recovers the snapshot volumes, mounts the file systems, recovers the database, and brings the database online with a different Oracle SID name than the primary host. If the secondary host is different, the database name can be same. You can use the `-o recoverdb` option to let `dbed_vmclonedb` perform an automatic database recovery, or you can use the `-o mountdb` option to perform your own point-in-time recovery and bring up the database manually. For a point-in-time recovery, the snapshot mode must be `online`.
   You can also create a clone on the primary host. Your snapplan settings specify whether a clone should be created on the primary or secondary host.
5. You can now use the clone database to perform database backup and other off-host processing work.
6. The clone database can be used to reverse resynchronize the original volume from the data in the snapshot, or can be discarded by rejoining the snapshot

volumes with the original volumes (that is, by resynchronizing the snapshot volumes) for future use.

Figure 11-3, "Prerequisites for creating a snapshot of your database." depicts the sequence of steps leading up to taking a snapshot using Database FlashSnap.

There are many actions you can take after creating a snapshot of your database using Database FlashSnap. You can create a clone of the database for backup and off-host processing purposes. You can resynchronize the snapshot volumes with the primary database. In the event of primary database failure, you can recover it by reverse resynchronizing the snapshot volumes.

Figure 11-4, "Actions you can perform after creating a snapshot of your database" depicts the actions you can perform after creating a snapshot of your database using Database FlashSnap.

Figure 11-3 Prerequisites for creating a snapshot of your database.

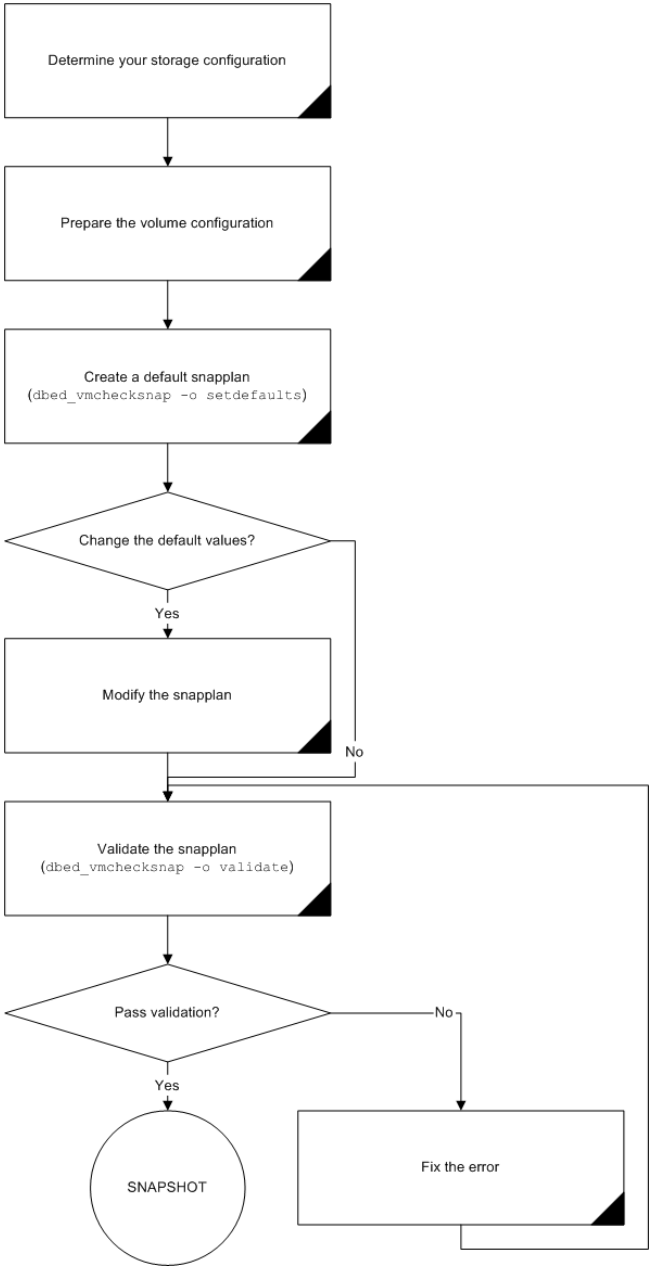
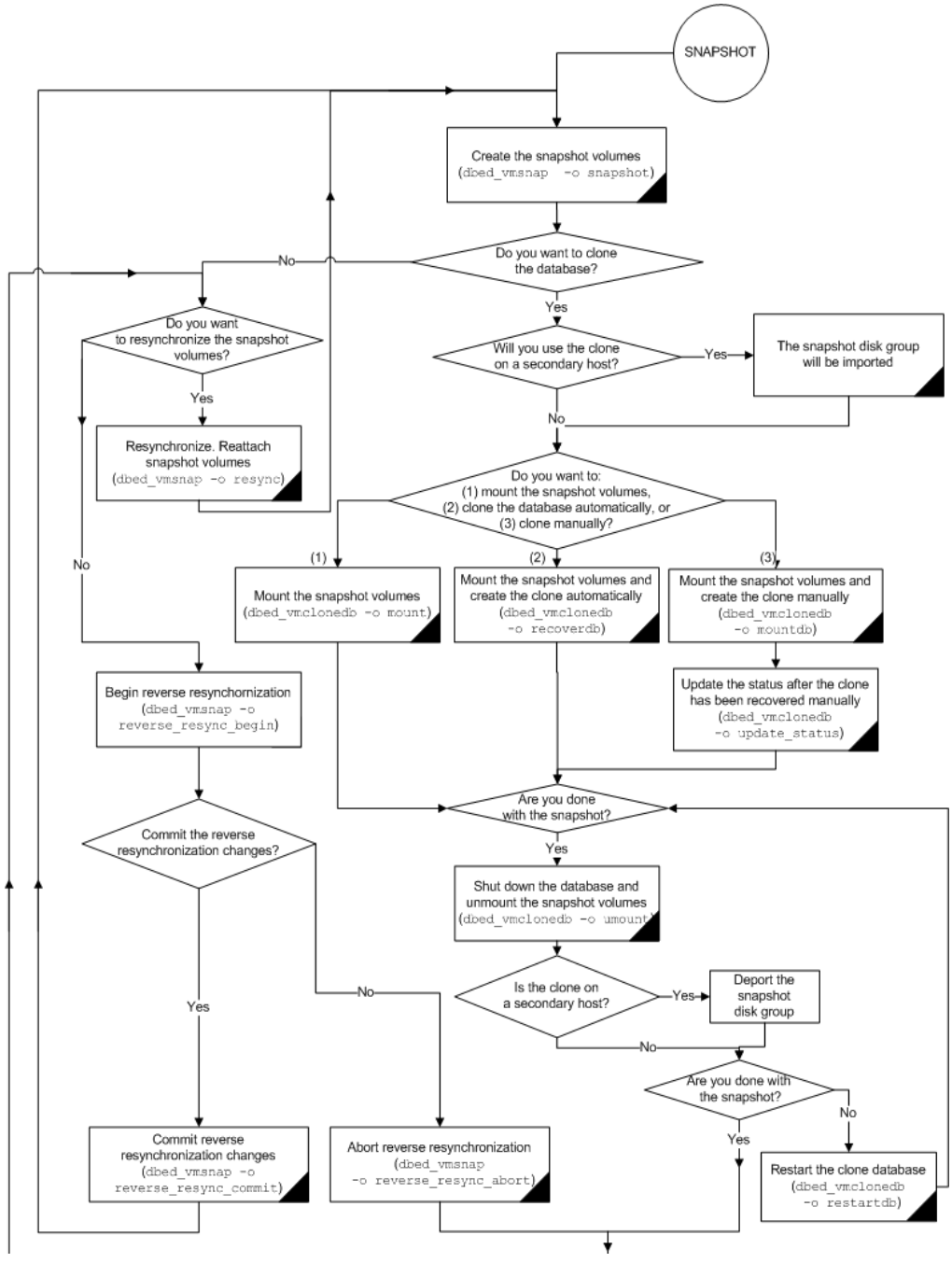


Figure 11-4 Actions you can perform after creating a snapshot of your database



Creating a snapplan (dbed_vmchecksnap)

The `dbed_vmchecksnap` command creates a snapplan that `dbed_vmsnap` uses to create a snapshot of an Oracle database. The snapplan specifies snapshot scenarios (such as `online`, `offline`, or `instant`).

You can name a snapplan file whatever you choose. Each entry in the snapplan file is a line in *`parameter=argument`* format.

When using `dbed_vmchecksnap` to create or validate a snapplan, the following parameters described in Table 11-1 are set.

Table 11-1 Parameter values for dbed_vmchecksnap

Parameter	Value
`SNAPSHOT_VERSION`	Specifies the snapshot version for this major release of Storage Foundation for Oracle RAC.
`PRIMARY_HOST`	The name of the host where the primary database resides.
`SECONDARY_HOST`	The name of the host where the database will be imported.
`PRIMARY_DG`	The name of the VxVM disk group used by the primary database.
`SNAPSHOT_DG`	The name of the disk group containing the snapshot volumes. The snapshot volumes will be put into this disk group on the primary host and deported. The secondary host will import this disk group to start a clone database.
`ORACLE_SID`	The name of the Oracle database. By default, the name of the Oracle database is included in the snapplan.
`ARCHIVELOG_DEST`	The full path of the archive logs. There are several archive log destinations that can be used for database recovery if you are muliplexing the archive logs. You must specify which archive log destination to use. It is recommended that you have the archive log destination on a separate volume if `SNAPSHOT_ARCHIVE_LOG` is **`yes`**.
`SNAPSHOT_ARCHIVE_LOG`	**`yes`** or **`no`** Specifies whether to create a snapshot of the archive log volumes. Specify **`yes`** to split the archive log volume mirrors and deport them to the secondary host. When using the Oracle remote archive log destination feature to send the archive logs to the secondary host, you can specify **`no`** to save some space. Because the archive logs may not always be delivered to the secondary host reliably, it is recommended that you specify **`yes`**.

Table 11-1 Parameter values for dbed_vmchecksnap

Parameter	Value
SNAPSHOT_MODE	**online** or **offline** or **instant** Specifies whether the database snapshot should be online, offline, or instant. If the snapshot is created while the database is online, the dbed_vmsnap command will put the tablespaces into backup mode. After dbed_vmsnap finishes creating the snapshot, it will take the tablespaces out of backup mode, switch the log files to ensure that the extra redo logs are archived, and create a snapshot of the archived logs. If the database if offline, it is not necessary to put the tablespaces into backup mode. The database must be shut down before creating an offline snapshot. If the database snapshot is instant, dbed_vmsnap will skip putting the tablespace into backup mode. **Note:** If SNAPSHOT_MODE is set to offline or instant, a node in the cluster configuration is required and the *-r relocate_path* option is not allowed.
SNAPSHOT_PLAN_FOR	The default value is **database** and cannot be changed. Specifies the database object for which you want to create a snapshot.
SNAPSHOT_PLEX_TAG	Specifies the snapshot plex tag. Use this variable to specify a tag for the plexes to be snapshot. The maximum length of the plex_tag is 15 characters. The default plex tag is dbed_flashsnap.
SNAPSHOT_VOL_PREFIX	Specifies the snapshot volume prefix. Use this variable to specify a prefix for the snapshot volumes split from the primary disk group. A volume name cannot be more than 32 characters. You should consider the length of the volume name when assigning the prefix.
ALLOW_REVERSE_RESYNC	**yes** or **no** By default, reverse resynchronization is off (set equal to no). Reverse resynchronization is not supported in a RAC environment. So the value should be always set to no.
SNAPSHOT_MIRROR	Specifies the number of plexes to be snapshot. The default value is 1.

When you first run dbed_vmchecksnap, use the -o setdefaults option to create a snapplan using default values for variables. You may then edit the file manually to set the variables for different snapshot scenarios.

Note: You cannot access Database FlashSnap commands (dbed_vmchecksnap, dbed_vmsnap, and dbed_vmclonedb) with the SFDB menu utility.

Before creating a snapplan, make sure the following conditions have been met:

Prerequisites

- Storage must be configured as specified in"Preparing hosts and storage for Database FlashSnap" on page 196.
- You must be the Oracle database administrator.
- The disk group must be version 110 or later. For more information on disk group versions, see the `vxdg`(1M) manual page.
- Be sure that a DCO and DCO volume are associated with the volume for which you are creating the snapshot.
- Snapshot plexes and their associated DCO logs should be on different disks than the original plexes, and should be configured correctly for creating snapshots by the system administrator.
- Persistent FastResync must be enabled on the existing database volumes and disks must be assigned for the snapshot volumes.
- The database must be running in archive log mode. Archive log mode is set in the Oracle initialization parameter file (`init.ora`).
- The Oracle database must have at least one mandatory archive destination.
  See "Establishing a mandatory archive destination" on page 213.
- *`ORACLE_HOME`* cannot reside on disk which will be used for snapshot.

Usage Notes

- The snapplan must be created on the primary host.
- After creating the snapplan using the `dbed_vmchecksnap` command, you can use a text editor to review and update the file, if necessary.
- It is recommended that you create a local working directory to store your snapplans in.
- See the `dbed_vmchecksnap` (1M) online manual page for more information.
- If the `SNAPSHOT_MODE` for the database is set to `online`, the primary and secondary hosts can be the same. If the `SNAPSHOT_MODE` is set to `offline` or `instant`, the primary and secondary hosts must be different.

To create a snapplan

1 Change directories to the working directory you want to store your snapplan in.

```
$ cd /working_directory
```

2 Create a snapplan with default values using the `dbed_vmchecksnap` command:

```
$ /opt/VRTS/bin/dbed_vmchecksnap -S ORACLE_SID \
-H ORACLE_HOME -f SNAPPLAN -o setdefaults -t host_name \
[-p PLEX_TAG]
```

3 Open the snapplan file in a text editor and modify it as needed.

In this example, a snapplan, `snap1`, is created for a snapshot image in a same-node configuration and default values are set. The host is named `host1` and the working directory is `/export/snap_dir`.

```
$ cd /export/snap_dir
$ /opt/VRTS/bin/dbed_vmchecksnap -S PROD \
-H /oracle/product/10g -f snap1 -o setdefaults -t host1
Snapplan snap1 for PROD.
=====================================================
SNAPSHOT_VERSION=5.0
PRIMARY_HOST=host1
SECONDARY_HOST=host1
PRIMARY_DG=PRODdg
SNAPSHOT_DG=SNAP_PRODdg
ORACLE_SID=PROD
ARCHIVELOG_DEST=/prod_ar
SNAPSHOT_ARCHIVE_LOG=yes
SNAPSHOT_MODE=online
SNAPSHOT_PLAN_FOR=database
SNAPSHOT_PLEX_TAG=dbed_flashsnap
SNAPSHOT_VOL_PREFIX=SNAP_
ALLOW_REVERSE_RESYNC=no
SNAPSHOT_MIRROR=1
```

In this other example, a snapplan, `snap2`, is created for a snapshot image in a node in the cluster configuration, and default values are set. The primary host is `host1`, the secondary host is `host2`, and the working directory is `/export/snap_dir`.

```
$ cd /export/snap_dir
$ /opt/VRTS/bin/dbed_vmchecksnap -S PROD \
-H /oracle/product/10g -f snap2 -o setdefaults -t host2
Snapplan snap2 for PROD.
=====================================================
SNAPSHOT_VERSION=5.0
PRIMARY_HOST=host1
SECONDARY_HOST=host2
PRIMARY_DG=PRODdg
SNAPSHOT_DG=SNAP_PRODdg
ORACLE_SID=PROD
ARCHIVELOG_DEST=/mytest/arch
SNAPSHOT_ARCHIVE_LOG=yes
SNAPSHOT_MODE=online
SNAPSHOT_PLAN_FOR=database
SNAPSHOT_PLEX_TAG=dbed_flashsnap
SNAPSHOT_VOL_PREFIX=SNAP_
```

```
    ALLOW_REVERSE_RESYNC=no
    SNAPSHOT_MIRROR=1
```

By default, a snapplan's SNAPSHOT_PLEX_TAG value is set as dbed_flashsnap. You can use the -p option to assign a different tag name. Make use of the -p option when creating the snapplan with the setdefaults option.

In the following example, the -p option is used with setdefaults to assign my_tag as the SNAPSHOT_PLEX_TAG value.

```
# dbed_vmchecksnap -S $ORACLE_SID -H $ORACLE_HOME -O setdefaults \
    -p my_tag -f snap1 -t PROD
Snapplan snap1 for PROD
=====================================================
SNAPSHOT_VERSION=5.0
PRIMARY_HOST=host1
SECONDARY_HOST=host2
PRIMARY_DG=PRODdg
SNAPSHOT_DG=SNAP_PRODdg
ORACLE_SID=PROD
ARCHIVELOG_DEST=/arch_data
SNAPSHOT_ARCHIVE_LOG=yes
SNAPSHOT_MODE=online
SNAPSHOT_PLAN_FOR=database
SNAPSHOT_PLEX_TAG=my_tag
SNAPSHOT_VOL_PREFIX=SNAP_
ALLOW_REVERSE_RESYNC=no
SNAPSHOT_MIRROR=1
```

Creating multi-mirror snapshots

To make Database Snapshots highly available, the snapped snapshot volume should contain more than one mirror. This makes the snapshot volumes available even if one of the mirrors gets disabled. Snapshot volumes can be mounted and the entire database snapshot is usable even if one of the mirror gets disabled. The multi-mirror snapshots are enabled via SNAPSHOT_MIRROR=<n> in the snapplan.

Note: There are no changes to the Command Line usage or arguments for the Flashsnap tools.

Note: Before taking the snapshot, make sure all tagged snapshot mirrors are in SNAPDONE state.

The following sample explains the setup and the procedure for taking multi-mirror snapshots:

1 Add the second mirror and DCO log. When allocating storage for the second mirror and DCO logs, make sure the snap volumes are splittable. If snap volumes are not splittable, `dbed_vmchecksnap` fails with appropriate errors. Tag the newly added mirror with the same tag as that of the first mirror. Assume that the volume has `fastresync = on`, has `dcolog = on`, and already has one `SNAPDONE` mirror and is tagged with `dbed_flashsnap`.

```
# vxsnap -g dg_a  addmir dg_a_vol1 alloc=dg_a03
# vxedit -g dg_a set putil2=dbed_flashsnap
dg_a_vol1-03
```

2 Add keyword to the snapplan.Here is a sample snapplan.

```
SNAPSHOT_VERSION=5.0
PRIMARY_HOST=host1
SECONDARY_HOST=host1
PRIMARY_DG=PRODdg
SNAPSHOT_DG=SNAP_PRODdg
ORACLE_SID=PROD
ARCHIVELOG_DEST=/prod_ar
SNAPSHOT_ARCHIVE_LOG=yes
SNAPSHOT_MODE=online
SNAPSHOT_PLAN_FOR=database
SNAPSHOT_PLEX_TAG=dbed_flashsnap
SNAPSHOT_VOL_PREFIX=SNAP_
ALLOW_REVERSE_RESYNC=no
SNAPSHOT_MIRROR=2
```

Establishing a mandatory archive destination

When cloning a database using Database FlashSnap, the Oracle database must have at least one mandatory archive destination.

See "Cloning a database (dbed_vmclonedb)" on page 225

If no mandatory archive destination is set, `dbed_vmchecksnap` results in this error message:

```
SFORA dbed_vmchecksnap ERROR V-81-5677 Could not find a mandatory,
primary and valid archive destination for database PROD.

Please review the LOG_ARCHIVE_DEST_n parameters and check
v$archive_dest.
```

This example shows how to establish a mandatory archive destination using SQL*Plus:

```
alter system set log_archive_dest_1 =
'LOCATION=/ora_mnt/oracle/oradata/PROD/archivelogs MANDATORY
[REOPEN]' [scope=both];
```

For more information about Oracle parameters for archiving redo logs, see your Oracle documentation.

Validating a snapplan (dbed_vmchecksnap)

After creating a snapplan, the next steps are to validate the snapplan parameters and check whether the snapshot volumes have been configured correctly for creating snapshots. If validation is successful, the snapplan is copied to the repository. The snapplan is validated using the `dbed_vmchecksnap` command with the `-o validate` option.

Consider the following prerequisites and notes before validating a snapplan:

Prerequisites

- The database must be up and running while executing the `dbed_vmchecksnap` command.

Usage Notes

- The `dbed_vmchecksnap` command must be run as the Oracle database administrator.
- After validating the snapplan, you have the option of modifying the snapplan file to meet your storage configuration requirements.
- When using `dbed_vmchecksnap` to validate the snapplan and storage, you can save the validation output. The system administrator can use this information to adjust the storage setup if the validation fails.
- If a snapplan is updated or modified, you must re-validate it. It is recommended that snapplans are revalidated when changes are made in the database disk group.
- The `dbed_vmchecksnap` command can be used on the primary or secondary host.
- See the `dbed_vmchecksnap`(1M) manual page for more information.

To validate a snapplan

1 Change directories to the working directory your snapplan is stored in:

```
$ cd /working_directory
```

2 Validate the snapplan using the `dbed_vmchecksnap` command:

```
$ /opt/VRTS/bin/dbed_vmchecksnap -S ORACLE_SID \
-H ORACLE_HOME -f SNAPPLAN -o validate
```

Note: In HA environment, you must modify the default snapplan, use the virtual host name defined for the resource group for the PRIMARY_HOST and/or SECONDARY_HOST, and run validation.

In the following example, a snapplan, snap1, is validated for a snapshot image in a same-node configuration. The primary host is host1 and the working directory is /export/snap_dir.

```
$ cd /export/snap_dir
$ /opt/VRTS/bin/dbed_vmchecksnap -S PROD -H /oracle/product/10g\
-f snap1 -o validate

PRIMARY_HOST is host1

SECONDARY_HOST is host1

The version of PRIMARY_DG-PRODdg is 110.

SNAPSHOT_DG is SNAP_PRODdg

SNAPSHOT_MODE is online

The database is running in archivelog mode.

ARCHIVELOG_DEST is /prod_ar

SNAPSHOT_PLAN_FOR is database

SNAPSHOT_ARCHIVE_LOG is yes

ARCHIVELOG_DEST=/prod_ar is mount on /dev/vx/dsk/PRODdg/prod_ar.

Examining Oracle volume and disk layout for snapshot

Volume prod_db on PRODdg is ready for snapshot.
Original plex and DCO log for prod_db is on PRODdg01.
Snapshot plex and DCO log for prod_db is on PRODdg02.

SNAP_PRODdg for snapshot will include: PRODdg02

ALLOW_REVERSE_RESYNC is no

The snapplan snap1 has been created.
```

Displaying, copying, and removing a snapplan (dbed_vmchecksnap)

Consider these notes before listing all snapplans for a specific Oracle database, displaying a snapplan file, or copying and removing snapplans.

Usage Notes

- If the local snapplan is updated or modified, you must revalidate it.
- If the database schema or disk group is modified, you must revalidate.

To list all available snapplans for a specific Oracle database

- Use the dbed_vmchecksnap command as follows:

```
$ /opt/VRTS/bin/dbed_vmchecksnap -S ORACLE_SID -o list
```

In the following example, all available snapplans are listed for the database PROD.

```
    $ /opt/VRTS/bin/dbed_vmchecksnap -S PROD -o list
    The following snapplan(s) are available for PROD:

    SNAP_PLAN                       SNAP_STATUS
DB_STATUS                       SNAP_READY
    snap1                           init_full
init                            yes
    snap2                           init_full
init                            yes
```

Note: The command output displays all available snapplans, their snapshot status (SNAP_STATUS), database status (DB_STATUS), and whether a snapshot may be taken (SNAP_READY).
For Database FlashSnap status information, see the *Veritas Storage Foundation for Oracle Administrator's Guide*. The documentation disc contains the sf_ora_admin.pdf.

To display detailed information for a snapplan

- Use the dbed_vmchecksnap command as follows:

```
$ /opt/VRTS/bin/dbed_vmchecksnap -S\
ORACLE_SID -f SNAPPLAN -o list
```

In the following example, the snapplan snap1 is displayed.

```
$ /opt/VRTS/bin/dbed_vmchecksnap -S PROD -f snap1 -o list
SNAPSHOT_VERSION=5.0
PRIMARY_HOST=host1
SECONDARY_HOST=host1
PRIMARY_DG=PRODdg
SNAPSHOT_DG=SNAP_PRODdg
ORACLE_SID=PROD
ARCHIVELOG_DEST=/prod_ar
SNAPSHOT_ARCHIVE_LOG=yes
SNAPSHOT_MODE=online
SNAPSHOT_PLAN_FOR=database
SNAPSHOT_PLEX_TAG=dbed_flashsnap
SNAPSHOT_VOL_PREFIX=SNAP_
ALLOW_REVERSE_RESYNC=yes
SNAPSHOT_MIRROR=1
STORAGE_INFO
PRODdg02
SNAP_PLEX=prod_ar-02

STATUS_INFO
SNAP_STATUS=init_full
DB_STATUS=init
```

To copy a snapplan from the SFDB repository to your current directory

If you want to create a snapplan similar to an existing snapplan, you can simply create a copy of the existing snapplan and modify it. To copy a snapplan from the SFDB repository to your current directory, the snapplan must not already be present in the current directory.

Use the dbed_vmchecksnap command as follows:

```
$ /opt/VRTS/bin/dbed_vmchecksnap -S ORACLE_SID \
-f SNAPPLAN -o copy
```

Example

In the following example, the snapplan, snap1, is copied from the SFDB repository to the current directory.

```
$ /opt/VRTS/bin/dbed_vmchecksnap -S PROD \
-f snap1 -o copy
Copying 'snap1' to '/export/snap_dir'
```

To remove a snapplan from the SFDB repository

A snapplan can be removed from a local directory or repository if the snapplan is no longer needed.

Use the dbed_vmchecksnap command as follows:

```
$ /opt/VRTS/bin/dbed_vmchecksnap -S ORACLE_SID -f\
SNAPPLAN -o remove
```

Example

In the following example, the snapplan, snap1, is removed from the SFDB repository.

```
$ /opt/VRTS/bin/dbed_vmchecksnap -S PROD -f snap1 -o remove
The snapplan snap1 has been removed.
```

Creating a snapshot (dbed_vmsnap)

The dbed_vmsnap command creates a snapshot of an Oracle database by splitting the mirror volumes used by the database into a snapshot database. You can use the snapshot image on either the same host as the database or on a secondary host provided storage is shared by the two hosts.

The snapshot image created by dbed_vmsnap is a frozen image of an Oracle database's datafiles. dbed_vmsnap ensures that a backup control file is created when the snapshot database is created, which allows for complete data recovery, if needed.

For Database FlashSnap status information, see *Veritas Storage Foundation for Oracle Administrator's Guide*. The documentation disc contains the sf_ora_admin.pdf.

Note: You cannot access Database FlashSnap commands (`dbed_vmchecksnap`, `dbed_vmsnap`, and `dbed_vmclonedb`) with the SFDB menu utility.

Prerequisites

- You must be logged in as the Oracle database administrator.
- You must create and validate a snapplan using `dbed_vmchecksnap` before you can create a snapshot image with `dbed_vmsnap`.

Usage Notes

- The `dbed_vmsnap` command can only be used on the primary host.
- Do not share volumes between Oracle database files and other software.
- When creating a snapshot volume, create the snapshot on a separate controller and on separate disks from the primary volume.
- Make sure your archive log destination is separate from your Oracle database volumes.
- Do not place any datafiles, including control files, in the `$ORACLE_HOME/dbs` directory.
- Resynchronization speed varies based on the amount of data changed in both the primary and secondary volumes when the mirror is broken off.
- See the `dbed_vmsnap`(1M) manual page for more information.

To create a snapshot

1 Change directories to the working directory in which your snapplan is stored:

```
$ cd /working_directory
```

2 If `SNAPSHOT_MODE` is set to `offline` in the snapplan, shut down the database.

3 Create the snapshot image using the command:

```
$ /opt/VRTS/bin/dbed_vmsnap -S ORACLE_SID -f SNAPPLAN \
    -o snapshot
```

Note: To force snapshot creation, use the `-F` option. The `-F` option can be used after a snapshot operation has failed and the problem was fixed without using Veritas Storage Foundation commands. (That is, the volumes were synchronized without using Veritas Storage Foundation commands.) In this situation, the status of the snapplan will appear as unavailable for creating a snapshot. The `-F` option ignores the unavailable status, checks for the availability of volumes, and creates the snapshot after the volumes pass the availability check.

Note: After the snapshot is created, `dbed_vmsnap` returns values you will need to run `dbed_vmclonedb`. These values include the snapshot disk group, the snapplan name, and the SFDB repository volume for a node in the cluster configuration. Make a note of these values so you have them when running `dbed_vmclonedb`.
You can also use the command `dbed_vmchecksnap -f snapplan -o list` to access the information regarding the snapshot disk group, the snapplan name, and the SFDB repository.

The snapshot volumes now represent a consistent backup copy of the database. You can backup the database by copying the snapshot volumes to tape or other backup media.

See "Backing up the database from snapshot volumes (dbed_vmclonedb)" on page 220

You can also create another Oracle database for decision-support purposes.

See "Cloning a database (dbed_vmclonedb)" on page 225

In this example, a snapshot image of the database, `PROD`, is created for a same-node configuration. In this case, the `SECONDARY_HOST` parameter is set the same as the `PRIMARY_HOST` parameter in the snapplan.

```
$ /opt/VRTS/bin/dbed_vmsnap -S PROD -f snap1 -o snapshot

dbed_vmsnap started at 2004-04-02 14:15:27
SFDB repository is up to date.
The database is running in archivelog mode.
A snapshot of ORACLE_SID PROD is in DG SNAP_PRODdg.
Snapplan snap1 is used for the snapshot.

If -r <relocate_path> is used in dbed_vmclonedb,
                make sure <relocate_path> is created and owned
by
                Oracle DBA. Otherwise, the following mount
points
                need to be created and owned by Oracle DBA:

                /prod_db.
```

```
                    /prod_ar.

    dbed_vmsnap ended at 2004-04-02 14:16:11
```

In this example, a snapshot image of the primary database, PROD, is created for a node in the cluster configuration. In this case, the SECONDARY_HOST parameter specifies a different host name than the PRIMARY_HOST parameter in the snapplan.

```
$ /opt/VRTS/bin/dbed_vmsnap -S PROD -f snap2 -o snapshot

dbed_vmsnap started at 2004-04-09 23:01:10
SFDB repository is up to date.
The database is running in archivelog mode.
A snapshot of ORACLE_SID PROD is in DG SNAP_PRODdg.
Snapplan snap2 is used for the snapshot.
SFDB repository volume is SNAP_arch.

If -r <relocate_path> is used in dbed_vmclonedb,
make sure <relocate_path> is created and owned by
Oracle DBA. Otherwise, the following mount points
need to be created and owned by Oracle DBA:

dbed_vmsnap ended at 2004-04-09 23:02:58
```

Backing up the database from snapshot volumes (dbed_vmclonedb)

Snapshots are most commonly used as a source for backing up a database. The advantage of using snapshot volumes is that the backup will not contest the I/O bandwidth of the physical devices. Making the snapshot volumes available on a secondary host will eliminate the extra loads put on processors and I/O adapters by the backup process on the primary host.

A clone database can also serve as a valid backup of the primary database. You can back up the primary database to tape using snapshot volumes.

Figure 11-5, "Example system configuration for database backup on primary host" shows a typical configuration when snapshot volumes are located on the primary host.

Figure 11-5 Example system configuration for database backup on primary host

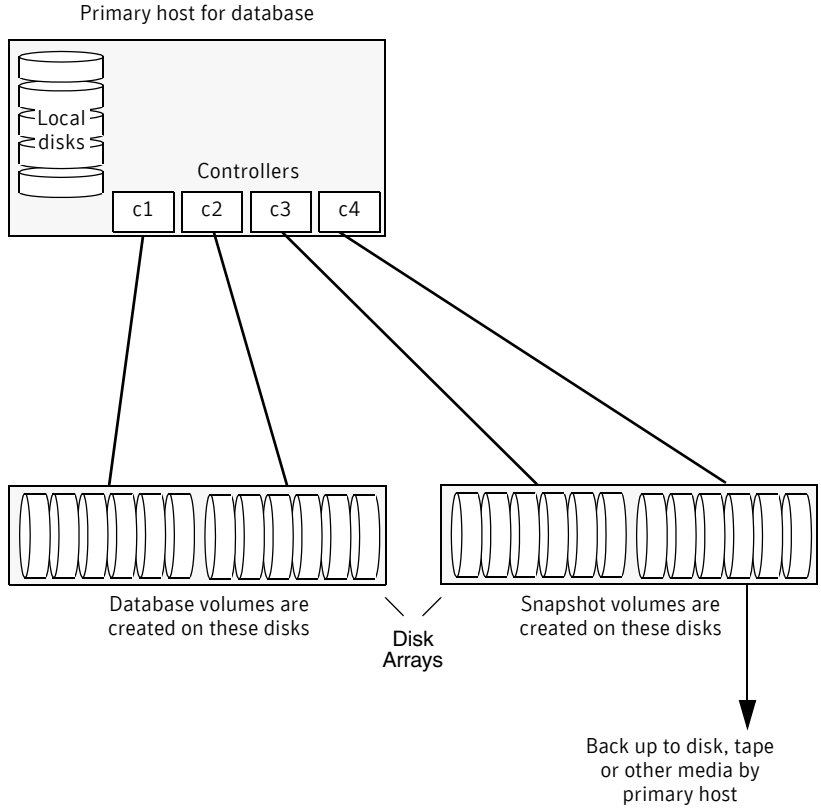
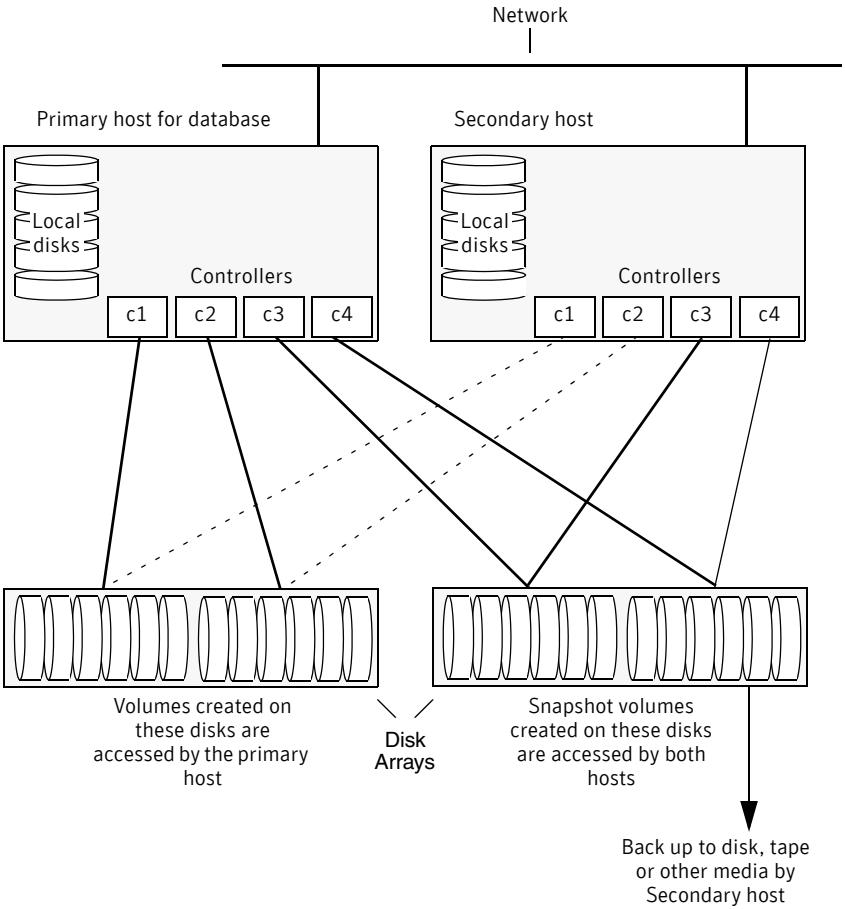


Figure 11-6, "Example system configuration for database backup on a secondary host,"shows a typical configuration when snapshot volumes are used on a secondary host.

Figure 11-6 Example system configuration for database backup on a secondary host



Prerequisites

- You must be logged in as the Oracle database administrator to use `dbed_vmclonedb` command.
- Before you can use the `dbed_vmclonedb` command, you must complete the steps in "Summary of database snapshot steps" on page 203, "Validating a snapplan (dbed_vmchecksnap)" on page 214, and "Creating a snapshot (dbed_vmsnap)" on page 217.
- The volume snapshot must contain the entire database.
- Before you can use the `dbed_vmclonedb` command with the `-r relocate_path` option (which specifies the initial mount point for the snapshot image), the system administrator must create the mount point and then change the owner to the Oracle database administrator.

Usage Notes

- The `dbed_vmclonedb` command can be used on the secondary host.
- In a same-node configuration, the primary and secondary hosts are the same.
- In a same-node configuration, `-r relocate_path` is required.
- In a node in the cluster configuration, the `SFDBvol=vol_name` option is required.
- If `SNAPSHOT_MODE` is set to `offline` or `instant`, a node in the cluster configuration is required and `-r relocate_path` is not allowed.
- See the `dbed_vmclonedb`(1M) manual page for more information.

Note: You cannot access Database FlashSnap commands (`dbed_vmchecksnap`, `dbed_vmsnap`, and `dbed_vmclonedb`) with the SFDB menu utility.

Mounting the snapshot volumes and backing up

Before using the snapshot volumes to do a backup, you must first mount them.

To mount the snapshot volumes

- Use the `dbed_vmclonedb` command as follows:

```
$ /opt/VRTS/bin/dbed_vmclonedb -S ORACLE_SID -g snap_dg \
-o mount,new_sid=new_sid,server_name=<server name> -f SNAPPLAN \
[-H ORACLE_HOME] \
[-r relocate_path]
```

You can now back up an individual file or a group of files under a directory onto the backup media.

In this example, snapshot volumes are mounted.

```
$ /opt/VRTS/bin/dbed_vmclonedb -S PROD -g SNAP_PRODdg \
-o mount,new_SID=NEWPROD,server_name=host1 -f snap1 -r \
/clone/single

dbed_vmclonedb started at 2004-04-02 15:35:41
Mounting /clone/single/prod_db on
/dev/vx/dsk/SNAP_PRODdg/SNAP_prod_db.
Mounting /clone/single/prod_ar on
/dev/vx/dsk/SNAP_PRODdg/SNAP_prod_ar.
dbed_vmclonedb ended at 2004-04-02 15:35:50
```

To mount a Storage Checkpoint carried over from the snapshot volumes to a secondary host

1 On the secondary host, list the Storage Checkpoints carried over from the primary database using:

```
$ /opt/VRTS/bin/dbed_ckptdisplay -S ORACLE_SID -n
```

2 You can mount one of the listed Storage Checkpoints using:

```
$ /opt/VRTS/bin/dbed_ckptmount -S ORACLE_SID -c CKPT_NAME \
    -m MOUNT_POINT
```

Limitations

- Any mounted Storage Checkpoints must be unmounted before running the following commands:

```
$ /opt/VRTS/bin/dbed_vmclonedb -o umount,\
new_sid=new_sid,server_name=svr_name \
    -f SNAPPLAN
```

- It is only possible to mount a Storage Checkpoint carried over with the snapshot volumes in a node in the cluster configuration if the snapshot volumes were mounted with the `dbed_vmclonedb` command with the `-o mount` option without the use of `-r relocate_path`.
- Storage Checkpoints carried over with the snapshot volumes can be mounted before a clone database is created using `dbed_vmclonedb` with the `-o mount` option. After a clone database is created using `dbed_vmclonedb` with the `-o recoverdb` option, however, Storage Checkpoints are no longer present.

To back up the database using the snapshot

- Copy the snapshot volumes to tape or other appropriate backup media.

Note: If you use the Oracle online backup method, you must also back up all the archived log files in order to do a complete restore and recovery of the database.

Cloning a database (dbed_vmclonedb)

Veritas Storage Foundation lets you create a clone database using snapshot volumes. You can use snapshots of a primary database to create a clone of the database at a given point in time. You can then implement decision-support analysis and report generation operations that take their data from the database clone rather than from the primary database to avoid introducing additional burdens on the production database.

A clone database can also serve as a valid backup of the primary database.

See "Backing up the database from snapshot volumes (dbed_vmclonedb)" on page 220

You can also back up the primary database to tape using snapshot volumes.

The resynchronization functionality of Database FlashSnap allows you to quickly refresh the clone database with up-to-date information from the primary database. Reducing the time taken to update decision-support data also lets you generate analysis reports more frequently.

Using Database FlashSnap to Clone a Database

In a same-node configuration, the `dbed_vmclonedb` command creates a clone database on the same host. The command can also be used to shut down the clone database and unmount its file systems. When creating or unmounting the clone database in a same-node configuration, `-r relocate_path` is required so that the clone database's file systems use different mount points than those used by the primary database.

When used in a node in the cluster configuration, the `dbed_vmclonedb` command imports the snapshot disk group `SNAP_dg`, mounts the file systems on the snapshot volumes, and starts a clone database. It can also reverse the process by shutting down the clone database, unmounting the file systems, and deporting the snapshot disk group. When creating the clone off host, `-o SFDBvol=vol_name` is required.

Caution: When creating a clone database, all Storage Checkpoints in the original database are discarded.

Prerequisites

- You must be logged in as the Oracle database administrator.
- Before you can use the `dbed_vmclonedb` command, you must complete the steps in "Summary of database snapshot steps" on page 203, "Validating a snapplan (dbed_vmchecksnap)" on page 214, and "Creating a snapshot (dbed_vmsnap)" on page 217.
- The volume snapshot must contain the entire database.
- The system administrator must provide the database administrator with access to the necessary volumes and mount points.
- Before you can use the `dbed_vmclonedb` command with the `-r relocate_path` option (which specifies the initial mount point for the snapshot image), the system administrator must create the mount point and then change the owner to the Oracle database administrator.
- If `SNAPSHOT_MODE` is set to `offline` or `instant`, a node in the cluster configuration is required and `-r relocate_path` is not allowed.
- The Oracle database must have at least one mandatory archive destination. See "Establishing a mandatory archive destination" on page 213

Usage Notes

- The `dbed_vmclonedb` command can be used on the secondary host.
- In a same-node configuration, `-r relocate_path` is required. This command is also needed if the name of the clone database is different than the primary database.
- The initialization parameters for the clone database are copied from the primary database. This means that the clone database takes up the same memory and machine resources as the primary database. If you want to reduce the memory requirements for the clone database, shut down the clone database and then start it up again using a different `init.ora` file that has reduced memory requirements. If the host where `dbed_vmclonedb` is run has little available memory, you may not be able to start up the clone database and the cloning operation may fail.
- See the `dbed_vmclonedb`(1M) manual page for more information.

To mount a database and recover it manually

1 Start and mount the clone database to allow manual database recovery:

```
$ /opt/VRTS/bin/dbed_vmclonedb -S ORACLE_SID -g snap_dg \
-o mountdb,new_sid=new_sid,server_name=server_name -f SNAPPLAN \
[-H ORACLE_HOME] [-r relocate_path]
```

2 Recover the database manually.

3 Update the snapshot status information for the clone database in the SFDB repository:

```
$ /opt/VRTS/bin/dbed_vmclonedb -o \
update_status,new_sid=new_sid,server_name=server_name \
-f SNAPPLAN [-r relocate_path]
```

Example

In this example, file systems are mounted *without bringing up the clone database*. The clone database must be manually created and recovered before it can be used. This example is for a clone created on the same host as the primary database.

```
$ /opt/VRTS/bin/dbed_vmclonedb -S PROD -g SNAP_PRODdg \
-o mountdb,new_sid=NEWPROD,server_name=host1 -f snap1 -r \
/clone
dbed_vmclonedb started at 2004-04-02 15:34:41
Mounting /clone/prod_db on /dev/vx/dsk/SNAP_PRODdg/SNAP_prod_db.
Mounting /clone/prod_ar on /dev/vx/dsk/SNAP_PRODdg/SNAP_prod_ar.
All redo-log files found.
Database NEWPROD (SID=NEWPROD) is in recovery mode.

If the database NEWPROD is recovered manually, you must run
dbed_vmclonedb -o update_status to change the snapshot status.
dbed_vmclonedb ended at 2004-04-02 15:34:59
```

The database is recovered manually using `dbinitdb`.

The database status (`database_recovered`) needs to be updated for a clone database on the primary host after manual recovery has been completed.

```
$ /opt/VRTS/bin/dbed_vmclonedb -o \
update_status,new_sid=NEWPROD,server_name=host1 \
-f snap1 -r /clone
dbed_vmclonedb started at 2004-04-02 15:19:16
The snapshot status has been updated.
dbed_vmclonedb ended at 2004-04-02 15:19:42
```

To clone the database automatically

Use the dbed_vmclonedb command as follows:

```
$ /opt/VRTS/bin/dbed_vmclonedb -S ORACLE_SID -g snap_dg \
-o recoverdb,new_sid=new_sid,server_name=svr_name -f SNAPPLAN \
[-H ORACLE_HOME] [-r relocate_path]
```

Where:

- *ORACLE_SID* is the name of the Oracle database used to create the snapshot.
- *snap_dg* is the name of the diskgroup that contains all the snapshot volumes.
- new_sid specifies the *ORACLE_SID* for the clone database.
- svr_name specifies the server name
- *SNAPPLAN* is the name of the snapplan file.
- *ORACLE_HOME* is the *ORACLE_HOME* setting for the *ORACLE_SID* database.
- *relocate_path* is the name of the initial mount point for the snapshot image.

Note: When cloning a database on a secondary host, ensure that PRIMARY_HOST and SECONDARY_HOST parameters in the snapplan file are different.

When the -o recoverdb option is used with dbed_vmclonedb, the clone database is recovered automatically using all available archive logs. If the -o recoverdb option is not used, you can perform point-in-time recovery manually.

In the following example, a clone of the primary database is automatically created on the same host as the primary database.

```
$ /opt/VRTS/bin/dbed_vmclonedb -S PROD -g SNAP_PRODdg \
-o recoverdb,new_sid=NEWPROD,server_name=host1 -f snap1 -r \
/clone
dbed_vmclonedb started at 2004-04-02 14:42:10
Mounting /clone/prod_db on /dev/vx/dsk/SNAP_PRODdg/SNAP_prod_db.
Mounting /clone/prod_ar on /dev/vx/dsk/SNAP_PRODdg/SNAP_prod_ar.
All redo-log files found.
Database NEWPROD (SID=NEWPROD) is running.
dbed_vmclonedb ended at 2004-04-02 14:43:05
```

Shutting Down the Clone Database and Unmounting File Systems

When you are done using the clone database, you can shut it down and unmount all snapshot file systems with the `dbed_vmclonedb -o umount` command. If the clone database is used on a secondary host that has shared disks with the primary host, the `-o umount` option also deports the snapshot disk group.

Note: Any mounted Storage Checkpoints mounted need to be unmounted before running `dbed_vmclonedb -o umount`.

To shut down the clone database and unmount all snapshot file systems

Use the `dbed_vmclonedb` command as follows:

```
$ /opt/VRTS/bin/dbed_vmclonedb -o umount,new_sid=new_sid,\
server_name=svr_name -f SNAPPLAN [-r relocate_path]
```

Example

In this example, the clone database is shut down and file systems are unmounted for a clone on the same host as the primary database (a same-node configuration).

```
$ /opt/VRTS/bin/dbed_vmclonedb -o umount,new_sid=NEWPROD,\
server_name=SERVER1 -f snap1 -r /clone
dbed_vmclonedb started at 2004-04-02 15:11:22
NOTICE: Umounting /clone/prod_db.
NOTICE: Umounting /clone/prod_ar.
dbed_vmclonedb ended at 2004-04-02 15:11:47
```

Example

In this example, the clone database is shut down, file systems are unmounted, and the snapshot disk group is deported for a clone on a secondary host (a node in the cluster configuration).

```
$ /opt/VRTS/bin/dbed_vmclonedb -o umount,new_sid=NEWPROD,\
server_name=SERVER1 -f snap2
dbed_vmclonedb started at 2004-04-09 23:09:21
NOTICE: Umounting /clone/arch.
NOTICE: Umounting /clone/prod_db.
dbed_vmclonedb ended at 2004-04-09 23:09:50
```

Restarting a Clone Database

If the clone database is down as a result of using `dbed_vmclonedb -o umount` or rebooting the system, you can restart it with the `-o restartdb` option.

Note: This option can only be used when a clone database is created successfully. If the clone database is recovered manually, `-o update_status` must be run to update the status before `-o restartdb` will work.

To start the clone database

- Use the `dbed_vmclonedb` command as follows:

```
$ /opt/VRTS/bin/dbed_vmclonedb -S ORACLE_SID -g snap_dg \
-o restartdb,new_sid=new_sid,server_name=host1 -f SNAPPLAN \
[-H ORACLE_HOME] \
[-r relocate_path]
```

In this example, the clone database is re-started.

```
$ /opt/VRTS/bin/dbed_vmclonedb -S PROD -g SNAP_PRODdg \
-o restartdb,new_sid=NEWPROD,server_name=host1 -f snap1 -r \
/clone
dbed_vmclonedb started at 2004-04-02 15:14:49
Mounting /clone/prod_db on
/dev/vx/dsk/SNAP_PRODdg/SNAP_prod_db.
Mounting /clone/prod_ar on
/dev/vx/dsk/SNAP_PRODdg/SNAP_prod_ar.
Oracle instance NEWPROD successfully started.
dbed_vmclonedb ended at 2004-04-02 15:15:19
```

Recreating Oracle tempfiles

After a clone database is created and opened, the tempfiles are added *if they were residing on the snapshot volumes*. If the tempfiles were not residing on the same file systems as the datafiles, `dbed_vmsnap` does not include the underlying volumes in the snapshot. In this situation, `dbed_vmclonedb` issues a warning message and you can then recreate any needed tempfiles on the clone database as described in the following procedure.

To recreate the Oracle tempfiles

1. If the tempfiles were not residing on the same file systems as the datafiles, `dbed_vmclonedb` will display the `WARNING` and `INFO` messages similar to the following:

```
WARNING: Not all tempfiles were included in snapshot for $ORACLE_SID,
there is no snapshot volume for /clone_path/temp02.dbf.
WARNING: Could not recreate tempfiles for $ORACLE_SID due to lack of
free space.
INFO: The sql script for adding tempfiles to $ORACLE_SID is at
/tmp/add_tf.$ORACLE_SID.sql.
```

Note: *$ORACLE_SID* is the name of the clone database.

2. A script named `add_tf.$ORACLE_SID.sql` is provided in the `/tmp` directory for the purpose of recreating Oracle tempfiles. This script contains the SQL*Plus commands to recreate the missing tempfiles.
3. Make a copy of the `/tmp/add_tf.$ORACLE_SID.sql` script and open it to view the list of missing tempfiles.

   An example of the `add_tf.$ORACLE_SID.sql` script is shown below:

```
$ cat /tmp/add_tf.$ORACLE_SID.sql
-- Commands to add tempfiles to temporary tablespaces.
-- Online tempfiles have complete space information.
-- Other tempfiles may require adjustment.
ALTER TABLESPACE TEMP ADD TEMPFILE
'/clone_path/temp01.dbf'
SIZE 4194304 REUSE AUTOEXTEND ON NEXT 1048576 MAXSIZE
33554432 ;
ALTER TABLESPACE TEMP ADD TEMPFILE
'/clone_path/temp02.dbf' REUSE;
ALTER DATABASE TEMPFILE '/clone_path2/temp02.dbf'
OFFLINE;
```

4. Evaluate whether you need to recreate any temp files. If you want to recreate tempfiles, proceed to the next step.

5 In the `add_tf.$ORACLE_SID.sql` file, edit the sizes and default path names of the tempfiles as needed to reside on cloned volumes configured for database storage.

Note: Do not run the script without first editing it because path names may not exist and the specified mount points may not contain sufficient space.

6 After you have modified the `add_tf.$ORACLE_SID.sql` script, execute it against your clone database.

7 After you have successfully run the script, you may delete it.

Resynchronizing the snapshot to your database

When you have finished using a clone database or want to refresh it, you can resynchronize it with the original database. This is also known as refreshing the snapshot volume or merging the split snapshot image back to the current database image. After resynchronizing, the snapshot can be retaken for backup or decision-support purposes.

There are two choices when resynchronizing the data in a volume:

- Resynchronizing the snapshot from the original volume. This option is explained in this section.
- Resynchronizing the original volume from the snapshot. This choice is known as *reverse resynchronization*. Reverse resynchronization may be necessary to restore a corrupted database and is usually much quicker than using alternative approaches such as full restoration from backup media.

Prerequisites

- You must be logged in as the Oracle database administrator.
- Before you can resynchronize the snapshot image, you must complete the steps in "Summary of database snapshot steps" on page 203, "Validating a snapplan (dbed_vmchecksnap)" on page 214, and "Creating a snapshot (dbed_vmsnap)" on page 217.
- If a clone database has been created, shut it down and unmount the file systems using the `dbed_vmclonedb -o umount` command. This command also deports the disk group if the primary and secondary hosts are different.
  See "Shutting Down the Clone Database and Unmounting File Systems" on page 229.

Usage Notes

- The dbed_vmsnap command can only be executed on the primary host.
- In a node in the cluster configuration, the dbed_vmsnap command imports the disk group that was deported from the secondary host and joins the disk group back to the original disk group. The snapshot volumes again become plexes of the original volumes. The snapshot is then resynchronized.
- See the dbed_vmsnap(1M) manual page for more information.
- You cannot access the Database FlashSnap commands dbed_vmsnap, (dbed_vmchecksnap, and dbed_vmclonedb) with the SFDB menu utility.

To resynchronize the snapshot image

- Use the dbed_vmsnap command as follows:

```
$ /opt/VRTS/bin/dbed_vmsnap -S ORACLE_SID -f SNAPPLAN -o
resync
```

In this example, the snapshot image is resynchronized with the primary database.

```
$ /opt/VRTS/bin/dbed_vmsnap -S PROD -f snap1 -o resync
dbed_vmsnap started at 2004-04-02 16:19:05
The option resync has been completed.
dbed_vmsnap ended at 2004-04-02 16:19:26
```

Now, you can again start creating snapshots.

Removing a snapshot volume

If a snapshot volume is no longer needed, you can remove it and free up the disk space for other uses by using the vxedit rm command.

Prerequisites

- You must be logged in as root.
- If the volume is on a mounted file system, you must unmount it before removing the volume.

To remove a snapplan and snapshot volume

1 To remove the snapshot and free up the storage used by it:
If the snapshot has been taken:

a Remove the snapshot as follows:

```
# vxsnap -g diskgroup dis snapshot_volume
# vxvol -g diskgroup stop snapshot_volume
```

```
# vxedit -g diskgroup -rf rm snapshot_volume
```

If the snapshot has not been taken and the snapshot plex (mirror) exists:

b Remove the snapshot as follows:

```
# vxsnap -g diskgroup rmmir volume
```

2 Remove the DCO and DCO volume:

```
# vxsnap -g diskgroup unprepare volume
```

3 Remove the snapplan.

```
# /opt/VRTS/bin/dbed_vmchecksnap -D db -f snapplan -o remove
```

For example, the following commands will remove a snapshot volume from disk group PRODdg:

```
# vxsnap -g PRODdg dis snap_v1
# vxvol -g PRODdg stop snap_v1
# vxedit -g PRODdg -rf rm snap_v1
```

Section V

Performance and troubleshooting

Enhancing performance:

Chapter 12

Investigating I/O performance using storage mapping

Veritas Storage Foundation for Oracle RAC provides storage mapping which enables you to map datafiles to physical devices. To obtain and view detailed storage topology information, use the `vxstorage_stats` command. You can also use the Oracle Enterprise Manager to access storage mapping information.

This chapter contains the following topics:

Understanding storage mapping

Storage mapping enables you to map datafiles to physical devices. You may obtain and view detailed storage topology information using the `vxstorage_stats` and `dbed_analyzer` commands. You may also use the Oracle Enterprise Manager to access storage mapping information.

Access to mapping information is important since it allows for a detailed understanding of the storage hierarchy in which files reside, information that is critical for effectively evaluating I/O performance.

Mapping files to their underlying device is straightforward when datafiles are created directly on a raw device. With the introduction of host-based volume managers and sophisticated storage subsystems that provide RAID features, however, mapping files to physical devices has become more difficult.

With the Veritas Storage Foundation for Oracle storage mapping option, you can map datafiles to physical devices. Storage mapping relies on Veritas Mapping Service (VxMS), a library that assists in the development of distributed SAN applications that must share information about the physical location of files and volumes on a disk.

The storage mapping option supports Oracle's set of storage APIs called Oracle Mapping ("ORAMAP" for short) that lets Oracle determine the mapping information for files and devices.

Oracle provides a set of dynamic performance views (`v$` views) that shows the complete mapping of a file to intermediate layers of logical volumes and physical devices. These views enable you to locate the exact disk on which any specific block of a file resides. You can use these mappings, along with device statistics, to evaluate I/O performance.

The Veritas Storage Foundation for Oracle storage mapping option supports a wide range of storage devices and allows for "deep mapping" into EMC, Hitachi, and IBM Enterprise Storage Server ("Shark") arrays. Deep mapping information identifies the physical disks that comprise each LUN and the hardware RAID information for the LUNs.

You can view storage mapping topology information and I/O statistics using:

- The `vxstorage_stats` command. This command displays the complete I/O topology mapping of specific datafiles through intermediate layers like logical volumes down to actual physical devices.
- The `dbed_analyzer` command. This command retrieves tablespace-to-physical disk mapping information for all the datafiles in a specified database. It also provides information about the amount of disk space being used by a tablespace.

In addition, you can also use the Oracle Enterprise Manager GUI to display storage mapping information after file mapping has occurred. Oracle Enterprise Manager does not display I/O statistics information. Unlike the information displayed using the Veritas command line, the information displayed in Oracle Enterprise Manager may be "stale," that is, it may not be the latest information.

For information on the command line options or the Oracle Enterprise Manager, see the chapter on using storage mapping in the *Veritas Storage Foundation for Oracle Administrator's Guide*.

Verifying the storage mapping setup

Before using the Veritas storage mapping option, verify that the features are set up correctly.

To verify that your system is using the Veritas storage mapping option

1. Verify that you have a license key for the storage mapping option.

   ```
   # /opt/VRTS/bin/vxlictest -n "VERITAS Mapping Services" -f \
   "Found_Edi_map"
   Found_Edi_map feature is licensed
   ```

2. Verify that the `VRTSvxmsa` package is installed.

   ```
   # rpm -qa | grep VRTSvxmsa
   ```

   Output similar to the following is displayed:

   ```
   VRTSvxmsa-4.3-009
   ```

Using vxstorage_stats

The `vxstorage_stats` command displays detailed storage mapping information and I/O statistics about an individual VxFS file. The mapping information and I/O statistics are recorded only for VxFS files and VxVM volumes.

In `vxstorage_stats` command output, I/O topology information appears first followed by summary statistics for each object.

The command syntax is as follows:

```
/opt/VRTSdbed/bin/vxstorage_stats -m [-s] [-i interval -c count]
-f filename
```

Prerequisites

- You must log in as the database administrator (typically, the user ID `oracle`) or root.

Usage Notes

- The `-s` option displays the file statistics for the specified file.
- The `-c` *`count`* option specifies the number of times to display statistics within the interval specified by `-i` *`interval`*.
- The `-i` *`interval`* option specifies the interval frequency for displaying updated I/O statistics.
- The `-f` *`filename`* option specifies the file to display I/O mapping and statistics for.
- For more information, see the `vxstorage_stats`(1m) online manual page.
- The `-m` option displays the I/O topology for the specified file.

Displaying storage mapping information

To display storage mapping information

- Use the `vxstorage_stats` command with the `-m` option to display storage mapping information:

  `$` **`/opt/VRTSdbed/bin/vxstorage_stats -m -f file_name`**

For example:

```
$ /opt/VRTSdbed/bin/vxstorage_stats -m -f\
/oradata/BAN57/system01.dbf
```

Output similar to the following is displayed:

```
TY NAME                          NSUB  DESCRIPTION     SIZE(sectors)   OFFSET(sectors)
PROPERTIES
fi /oradata/BAN57/system01.dbf    1     FILE           398467072(B)    65216    Extents:
17     Sparse Extents:0
v  /dev/vx/dsk/flashdg/datavol    2      MIRROR          10240000        0
pl vxvm:flashdg/datavol-01        1      CONCAT_VOLUME   10240000        0
rd /dev/vx/dmp/sde3               1      PARTITION       10240000        0
da /dev/sde                       0      DISK            20971520        0
pl vxvm:flashdg/datavol-02        1      CONCAT_VOLUME   10240000        0
rd /dev/vx/dmp/sdi3               1      PARTITION       10240000        0
da /dev/sdi                       0      DISK            20971520        0
```

Note: For file type (`fi`), the `SIZE` column is number of bytes, and for volume (`v`), plex (`pl`), sub-disk (`sd`), and physical disk (`da`), the `SIZE` column is in 512-byte blocks. Stripe sizes are given in sectors.

Displaying I/O statistics information

To display I/O statistics information

- Use the `vxstorage_stats` command with the `-s` option to display I/O statistics information:

  ```
  $ /opt/VRTSdbed/bin/vxstorage_stats -s -f file_name
  ```

For example:

```
$ /opt/VRTSdbed/bin/vxstorage_stats -s -f\
/oradata/BAN57/system01.dbf
```

Output similar to the following is displayed:

```
I/O OPERATIONS              I/O BLOCKS(512 byte)                    AVG TIME(ms)

OBJECT                          READ            WRITE           B_READ          B_WRITE         AVG_RD
AVG_WR
/oradata/BAN57/system01.dbf     29202           6409            601426          165200          15.12
120.43
/dev/vx/dsk/flashdg/datavol     118971          587800          3184966         15409598        68.38
54.14
vxvm:flashdg/datavol-01         118971          587800          3184966         15409598        68.35
49.99
/dev/sde                        119628          587434          3307042         15465467        6810.47
4992.62
vxvm:flashdg/datavol-02         0               587800          0               15409598        0.00
51.00
/dev/sdi                        208             587494          69772           15414109        6326.92
5082.38
```

To display storage mapping and I/O statistics information at repeated intervals

- Use the `vxstorage_stats` command with the `-i` *`interval`* and `-c` *`count`* options to display storage mapping and I/O statistics information at repeated intervals. The `-i` *`interval`* option specifies the interval frequency for displaying updated I/O statistics and the `-c` *`count`* option specifies the number of times to display statistics.

  ```
  $ /opt/VRTSdbed/bin/vxstorage_stats [-m] [-s] \
  [-i interval -c count ] -f file_name
  ```

For example, to display statistics twice with a time interval of two seconds:

```
$ /opt/VRTSdbed/bin/vxstorage_stats -s -i2 -c2 \
-f /oradata/BAN57/system01.dbf
```

Output similar to the following is displayed:

```
I/O OPERATIONS              I/O BLOCKS(512 byte)                      AVG TIME(ms)

OBJECT                        READ           WRITE          B_READ          B_WRITE          AVG_RD
AVG_WR
/oradata/BAN57/system01.dbf    0              0              0               0               0.00
0.00
/dev/vx/dsk/flashdg/datavol    118984         588009         3185006         15415578        68.37
54.13
vxvm:flashdg/datavol-01        118984         588009         3185006         15415578        68.34
49.97
/dev/sde                       119641         587643         3307082         15471447        6809.75
4991.18
vxvm:flashdg/datavol-02        0              588009         0               15415578        0.00
50.98
/dev/sdi                       208            587703         69772           15420089        6326.92
5080.93
                            I/O OPERATIONS             I/O BLOCKS(512 byte)                      AVG
TIME(ms)

OBJECT                        READ           WRITE          B_READ          B_WRITE          AVG_RD
AVG_WR
/oradata/BAN57/system01.dbf    0              0              0               0               0.00
0.00
/dev/vx/dsk/flashdg/datavol    0              0              0               0               0.00
0.00
vxvm:flashdg/datavol-01        0              0              0               0               0.00
0.00
/dev/sde                      0              0              0               0               0.00
0.00
vxvm:flashdg/datavol-02        0              0              0               0               0.00
0.00
/dev/sdi                      0              0              0               0               0.00
0.00
```

Using dbed_analyzer

Effectively performing a parallel backup requires an understanding of which tablespaces reside on which disks. If two tablespaces reside on the same disk, for example, backing them up in parallel will not reduce their downtime.

The `dbed_analyzer` command provides tablespace-to-physical disk mapping information for *all the datafiles in a specified tablespace, list of tablespaces, or an entire database*. (In contrast, the `vxstorage_stats` command provides this information on a per-file basis only.) In addition, `dbed_analyzer` provides information about the amount of disk space they are using.

Prerequisites

- You must log in as the database administrator (typically, the user ID `oracle`).

Usage Notes

- The `-o sort=tbs` option provides the layout of the specified tablespaces on the physical disk as well as the amount of disk space they are using.
- The `-o sort=disk` option provides the name of the disks containing the specified tablespaces as well as the amount of disk space the tablespaces are using.
- The `-f` *`filename`* option specifies the name of a file containing a list of the tablespaces for which to obtain mapping information.
- The `-t` *`tablespace`* option specifies the name of a tablespace for which to obtain mapping information.
- If `-f` *`filename`* or `-t` *`tablespace`* is not specified then all the tablespaces in the database will be analyzed.
- For more information, see the `dbed_analyzer`(1M) online manual page.

Obtaining storage mapping information for a list of tablespaces

To obtain storage mapping information sorted by tablespace

Use the `dbed_analyzer` command with the `-f` *`filename`* and `-o sort=tbs` options:

```
$ /opt/VRTSdbed/bin/dbed_analyzer -S $ORACLE_SID -H $ORACLE_HOME
\
-o sort=tbs -f filename
```

For example,

```
$ /opt/VRTSdbed/bin/dbed_analyzer -S $ORACLE_SID -H\
$ORACLE_HOME -o sort=tbs -f /tmp/tbsfile
```

Output similar to the following is displayed in the file `tbsfile`:

```
TABLESPACE      DATAFILE                        DEVICE          SIZE(sectors)
SYSTEM          /oradata/BAN63/system01.dbf     /dev/sdd        757776
UNDOTBS1        /oradata/BAN63/undotbs01.dbf    /dev/sde        419856
SYSAUX          /oradata/BAN63/sysaux01.dbf     /dev/sdd        245776
USERS           /oradata/BAN63/users01.dbf      /dev/sdf        10256
```

To obtain storage mapping information sorted by disk

Use the `dbed_analyzer` command with the `-f` *`filename`* and `-o sort=disk` options:

```
$ /opt/VRTSdbed/bin/dbed_analyzer -S $ORACLE_SID -H \
$ORACLE_HOME -o sort=disk -f filename
```

For example,

```
$ /opt/VRTSdbed/bin/dbed_analyzer -S $ORACLE_SID -H\
$ORACLE_HOME -o sort=disk -f /tmp/tbsfile
```

Output similar to the following is displayed in the file `tbsfile`:

```
DEVICE          TABLESPACE      DATAFILE        SIZE(sectors)
/dev/sdd        SYSTEM          /oradata/BAN63/system01.dbf     757776
/dev/sdd        UNDOTBS1        /oradata/BAN63/undotbs01.dbf    419856
/dev/sde        SYSAUX          /oradata/BAN63/sysaux01.dbf     245776
/dev/sdf        USERS           /oradata/BAN63/users01.dbf      10256
```

Oracle file mapping (ORAMAP)

Veritas has defined and implemented two libraries: `libvxoramap_64.so` and `libvxoramap_64.sl`. These two libraries provide a mapping interface to Oracle. `libvxoramap_64.so` serves as a bridge between Oracle's set of storage APIs (known as "ORAMAP") and Veritas Federated Mapping Service (VxMS), a library that assists in the development of distributed SAN applications that must share information about the physical location of files and volumes on a disk.

With Veritas Storage Foundation for Oracle storage mapping option, you can view the complete I/O topology mapping of datafiles through intermediate layers like logical volumes down to actual physical devices. This information can

be used to determine the exact location of an Oracle data block on a physical device and to help identify hot spots.

Mapping components

The mapping components in the System Global Area (SGA) and Oracle's representation of these components are described in this section. You will need an understanding of these components to interpret the mapping information in Oracle's dynamic performance views.

The mapping information in Oracle's dynamic performance views consists of:

- File components
  A mapping file component is a mapping structure describing a file. It provides a set of attributes for a file, including the file's size, number of extents, and type. File components are exported to the user through `v$map_file`.
- File extent components
  A mapping file extent component describes a contiguous group of blocks residing on one element. The description specifies the device offset, the extent size, the file offset, the extent type (`Data` or `Parity`), and the name of the element where the extent resides.
- Element components
  A mapping element component is a mapping structure that describes a storage component within the I/O stack. Elements can be mirrors, stripes, partitions, RAID5, concatenated elements, and disks.
  This component contains information about the element's mapping structure, such as the element's size, type, number of subelements, and a brief description. Element components are exported to the user through `v$map_element`.
- Subelement components
  A mapping subelement component describes the link between an element and the next element in the I/O stack. The subelement component contains the subelement number, size, the element name for the subelement, and the element offset. Subelement components are exported to the user through `v$map_subelement`.

These four types of mapping components completely describe the mapping information for an Oracle instance.

Storage mapping views

The mapping information that is captured is presented in Oracle's dynamic performance views. Brief descriptions of these views are provided below. For more detailed information, refer to your Oracle documentation.

Table 12-1 Storage Mapping Views

View	Description
V$MAP_LIBRARY	Contains a list of all the mapping libraries that have been dynamically loaded by the external process.
V$MAP_FILE	Contains a list of all the file mapping structures in the shared memory of the instance.
V$MAP_FILE_EXTENT	Contains a list of all the file extent mapping structures in the shared memory of the instance.
V$MAP_ELEMENT	Contains a list of all the element mapping structures in the SGA of the instance.
V$MAP_EXT_ELEMENT	Contains supplementary information for all element mapping structures.
V$MAP_SUBELEMENT	Contains a list of all subelement mapping structures in the shared memory of the instance.
V$MAP_COMP_LIST	Describes the component list associated with the element name.
V$MAP_FILE_IO_STACK	Contains the hierarchical arrangement of storage containers for the file. This information is displayed as a series of rows. Each row represents a level in the hierarchy.

Verifying Oracle file mapping setup

To verify that $ORACLE_HOME is set up for Oracle file mapping (ORAMAP)

1 Enter:

```
# cd $ORACLE_HOME/rdbms/filemap/bin
# ls -l
-r-xr-x--- 1 root system 900616 Apr 08 19:16 fmputl
-r-sr-xr-x 1 root system 14614 Apr 08 19:16 fmputlhp
```

2 Verify that:

- `fmputlhp` is owned by `root` and that the `setud` bit is set.
- The permissions for `fmputlhp` are set to `-r-sr-xr-x`.
- The permissions for `fmputl` are set to `-r-xr-x---`.

3 If any of these items is not set as specified, make the appropriate corrections.

Enabling Oracle file mapping

To enable Oracle file mapping with the Veritas storage mapping option

1 Ensure that the file `filemap.ora` exists and contains a valid entry for the Veritas mapping library for Oracle storage mapping.

```
# cd $ORACLE_HOME/rdbms/filemap/etc
# cat filemap.ora
```

For 64-bit Oracle, the `filemap.ora` file should contain the following setting:

```
lib=Veritas:/opt/VRTSdbed/lib/libvxoramap_64.so
```

2 After verifying that the system is using the Veritas library for Oracle storage mapping, set the `file_mapping` initialization parameter to `true`.

```
SQL> alter system set file_mapping=true;
```

The `file_mapping` initialization parameter is set to `false` by default. You do not need to shut down the instance to set this parameter. Setting `file_mapping=true` starts the `FMON` background process.

Note: If you want storage mapping to be enabled whenever you start up an instance, set the `file_mapping` initialization parameter to `true` in the `init.ora` file.

Accessing dynamic performance views

To access dynamic performance views

1 Confirm that the Veritas mapping library for Oracle file mapping has been enabled.

```
SQL> select lib_idx idx, lib_name name, vendor_name vname, \
path_name path from v$map_library;
```

2 After storage mapping has been enabled, Oracle datafiles can be mapped using the `DBMS_STORAGE_MAP` package.

The following example shows how to map a datafile using SQL:
For more information about various features and capabilities of the `DBMS_STORAGE_MAP` package, see your Oracle documentation.

3 Use SQL commands to display the mapping information that is captured in Oracle's dynamic performance views.

To display the contents of `v$map_file` for a Quick I/O file:

```
SQL> select file_name name, file_map_idx idx, \
file_status status, file_type type, file_structure str, \
file_size fsize, file_nexts nexts from v$map_file;
```

To display the contents of `v$map_file_extent`.

```
SQL> select * from v$map_file_extent;
```

To display the contents of `v$map_element`:

```
SQL> select elem_idx idx, elem_name, elem_type type, elem_size,
\
elem_nsubelem nsub, elem_descr, stripe_size from \
v$map_element;
```

To display the contents of `v$map_subelement`:

```
SQL> select * from v$map_subelement;
```

To display all the elements within the I/O stack for a specific file.

```
SQL> with fv as
2   (select file_map_idx, file_name from v$map_file
4   select
5   fv.file_name, lpad(' ', 4 * (level - 1)) || \
    el.elem_name elem_name, el.elem_size, el.elem_type, \
    el.elem_descr
6   from
7   v$map_subelement sb, v$map_element el, fv,
8   (select unique elem_idx from v$map_file_io_stack io, fv
    where io.file_map_idx = fv.file_map_idx) fs
10  where el.elem_idx = sb.child_idx
11  and fs.elem_idx = el.elem_idx
12  start with sb.parent_idx in
13  (select distinct elem_idx
14  from v$map_file_extent fe, fv
15  where fv.file_map_idx = fe.file_map_idx)
16  connect by prior sb.child_idx = sb.parent_idx;
```

About arrays for storage mapping and statistics

Veritas Storage Foundation for Oracle provides “deep” mapping information and performance statistics for supported storage arrays. Deep mapping information consists of identifying the physical disks that comprise each LUN and the hardware RAID information for the LUNs.

Note: To use deep mapping, you must have Oracle 10g installed.

Veritas Array Integration Layer (VAIL) software interfaces third-party hardware storage arrays with Veritas storage software. VAIL providers are software modules that enable Veritas applications to discover, query, and manage third-party storage arrays.

On Linux, the following VAIL providers support these third-party storage arrays:

- The `vx_emc_symmetrix` provider manages EMC Symmetrix arrays.

For the most up-to-date array support information, see the appropriate hardware compatibility list (HCL) on the Technical Support website at:

http://entsupport.symantec.com

If you want to use storage array information accessible through the VAIL providers, install VAIL and perform any required configuration for the storage arrays and VAIL providers. To use deep mapping services and performance statistics for supported storage arrays, you must install both VAIL and Veritas Mapping Services (VxMS).

You will need to install required third-party array CLIs and APIs on the host where you are going to install VAIL before you install VAIL. If you install any required CLI or API after you install VAIL, rescan the arrays so that Veritas Storage Foundation for Oracle RAC can discover them.

For detailed information about supported array models, see the *Veritas Array Integration Layer Array Configuration Guide*

Chapter 13

Troubleshooting SF Oracle RAC

Troubleshooting options, known problems, and their solutions:

Running scripts for engineering support analysis

These troubleshooting scripts gather information about the configuration and status of your cluster and its modules. The scripts identify package information, debugging messages, console messages, and information about disk groups and volumes. Forwarding the output of these scripts to Veritas Tech Support can assist with analyzing and solving any problems.

getcomms

This script gathers information about the GAB and LLT modules. The file `/tmp/commslog.`*time_stamp*`.tar` contains the script's output.

To use getcomms

On *each* system, enter:

```
# /opt/VRTSgab/getcomms -local
```

hagetcf

This script gathers information about the VCS cluster and the status of resources. The output from this script is placed in a tar file, `/tmp/vcsconf.sys_name.tar.gz`, on each cluster system.

To use hagetcf

On *each* system, enter:

```
# /opt/VRTSvcs/bin/hagetcf
```

Troubleshooting tips

To check the Oracle installation error log

Access:

```
$ORACLE_BASE/oraInventory/logs/installActions<date_time>.log
```

This file contains errors that occurred during installation. It clarifies the nature of the error and at exactly which point it occurred during the installation. If there are any installation problems, sending this file to Tech Support is required for debugging the issue.

To check the Veritas log file

Access:

```
/var/VRTSvcs/log/engine_A.log
```

This file contains all actions performed by `HAD`. Verify if there are any `CVM` or `PrivNIC` errors logged in this file, since they may prove to be critical errors.

Troubleshooting Oracle

For help resolving issues with Oracle components, check the:

- Oracle log files
- Oracle Notes
- Oracle Troubleshooting Topics

Oracle log files

To check the Oracle log file

For Oracle 10g Release 2, access:

```
$CRS_HOME/log/hostname/crsd
```

where *hostname* is the string returned by the `hostname` command.

The log file in this directory contains the logs pertaining to the CRS resources such as the virtual IP, Listener, and database instances. The file indicates some configuration errors or Oracle problems, since CRS does not directly interact with any of the Veritas components.

To check for crs core dumps

Access:

```
$CRS_HOME/crs/init
```

Core dumps for the `crsd.bin` daemon are written here. Use this file for further debugging.

To check the Oracle css log file

For Oracle 10g Release 2, access:

```
$CRS_HOME/log/hostname/cssd
```

where *hostname* is the string returned by the `hostname` command.

The log files in this directory indicate actions such as reconfigurations, missed checkins, connects, and disconnects from the client CSS listener. If there are membership issues, they will show up here. If there are communication issues over the private networks, they are logged here. The `ocssd` process interacts with `vcsmm` for cluster membership.

To check for ocssd core dumps

Access:

```
$CRS_HOME/css/init
```

Core dumps from the `ocssd` and the `pid` for the `css` daemon whose death is treated as fatal are located here. If there are abnormal restarts for `css` the core files are found here.

Oracle Notes

259301.1: CRS and 10g Real Application Clusters

Note: Oracle Note 259301.1 is extremely important to read.

280589.1: CRS Installation Does Not Succeed if One or More Cluster Nodes Present are Not to be Configured for CRS.

265769.1: 10g RAC: Troubleshooting CRS Reboots

279793.1: How to Restore a Lost Vote Disk in 10g

146580.1: What is an ORA-600 Internal Error?

268937.1: Repairing or Restoring an Inconsistent OCR in RAC

239998.1: 10g RAC: How to Clean Up After a Failed CRS Install

Two items missing in the above guide are:

- Remove the `/etc/oracle/ocr.loc` file. This file contains the location for the Cluster registry. If this file is not removed then during the next installation the installer will not query for the OCR location and will pick it from this file.

272332.1: CRS 10g Diagnostic Collection Guide

Oracle troubleshooting topics

Topics indicate symptoms and likely procedures required for a solution.

Oracle user must be able to read /etc/llttab File

Check the permissions of the file `/etc/llttab`. Oracle must be allowed to read it.

Error when starting an Oracle instance

If the VCSMM driver (the membership module) is not configured, an error displays on starting the Oracle instance that resembles:

```
ORA-29702: error occurred in Cluster Group Operation
```

To start the VCSMM driver

Enter the following command:

```
# /etc/init.d/vcsmm start
```

The command included in the `/etc/vcsmmtab` file enables the VCSMM driver to be started at system boot.

Oracle log files show shutdown

The Oracle log files may show that a shutdown was called even when not shutdown manually.

The Oracle enterprise agent calls shutdown if monitoring of the Oracle/Netlsnr resources fails for some reason. On all cluster nodes, look at the following VCS and Oracle agent log files for any errors or status:

```
/var/VRTSvcs/log/engine_A.log
/var/VRTSvcs/log/Oracle_A.log
```

root.sh hangs after Oracle binaries installation

This may occur when using OCR on a raw volume if Oracle patch Number 4045013 is not applied.

To prevent root.sh from hanging

1. Install Oracle Database Binaries.
2. Apply Oracle patch Number 4045013, available on metalink.oracle.com. In patch search criteria, specify 4045013 as patch number and Linux Opteron in Platform/Architecture.
3. Execute `root.sh`.

DBCA fails while creating database

Verify that the `hostname -i` command returns the public IP address of the current node. This command is used by the installer and the output is stored in the OCR. If `hostname -i` returns 127.0.0.1, it causes the DBCA to fail.

CRS processes fail to startup

Verify that the correct private IP address is configured on the private link using the `PrivNIC` agent. Check the CSS log files to learn more.

CRS fails after restart

If the CRS fails to start up after boot up, check for the occurrence of the following strings in the `/var/log/ message` file:

"Oracle CSSD failure. Rebooting for cluster integrity"

- Communication failure occurred and CRS fenced out the node.
- OCR and Vote disk became unavailable.
- `ocssd` was killed manually and on restarting from `inittab` it rebooted the cluster.
- Killing the `init.cssd` script.

"Waiting for file system containing"

The CRS installation is on a shared disk and the `init` script is waiting for that file system to be made available.

"Oracle Cluster Ready Services disabled by corrupt install"

The following file is not available or has corrupt entries: `/etc/oracle/scls_scr/`*`hostname`*`/root/crsstart`.

"OCR initialization failed accessing OCR device"

The shared file system containing the OCR is not available and CRS is waiting for it to become available.

Removing Oracle CRS if installation fails

Use the following procedure to remove Oracle CRS.

To remove Oracle CRS

1 Run the `rootdelete.sh` script:

```
# cd /crshome/install
# ./rootdelete.sh
```

a Run the `rootdeinstall.sh` script:

```
# cd /crshome/install
# ./rootdeinstall.sh
```

2 Stop the applications on all nodes:

```
# srvctl stop nodeapps -n node_name
```

3 Copy the file `inittab.orig` back to the name and remove other `init` files:

```
# cd  /etc
# cp inittab.orig inittab
# rm init.c* init.evmd
# rm /etc/rc.d/rc2.d/K96init.crs
# rm /etc/rc.d/rc2.d/S96init.crs
```

4 Remove `ora*` files from the `/etc` directory:

```
# cd /etc
# rm -r ora*
```

5 Remove file from `$CRS_HOME` and Oracle Inventory:

```
# rm -r $CRS_HOME/*
```

6 Remove files from the OCR and Voting disk directories. For our example:

```
# rm /ocrvote/ocr
# rm /ocrvote/vote-disk
```

If OCR and Voting disk storage are on raw volumes, use command resembling:

```
# dd if=/dev/zero of=/dev/vx/rdsk/ocrvotedg/ocrvol bs=8192 \
count=18000
# dd if=/dev/zero of=/dev/vx/rdsk/ocrvotedg/votvol bs=8192 \
count=3000
```

7 Reboot the systems to make sure no CRS daemons are running.

Troubleshooting the VIP Configuration

When encountering issues with the VIP configuration, you can use the following commands and files:

- Use the `/etc/ifconfig -a` command on all nodes to check for network problems.
- Use the command: `/usr/bin/nslookup` *`virtual_host_name`* to make sure the virtual host name is registered with the DNS server.
- Verify the `/etc/hosts` file on each node.
- Check the output from the command `$CRS_HOME/bin/crs_stat`.
- On the problem node, use the command: srvctl `start nodeapps -n` *`node_name`*. This command works only if the virtual IP address is plumbed.

OCR and Vote disk related issues

Verify that the permissions are set appropriately as given in the Oracle installation guide. If these files are present from a previous configuration, remove them. See "CRS fails after restart" on page 255.

OCRDUMP

Executing the `$ORA_CRS_HOME/bin/ocrdump` creates a `OCRDUMPFILE` in the working directory. This text file contains a dump of all the parameters stored in the cluster registry, which is useful in case of errors.

Check if the following variable occurs in the `OCRDUMPFILE`: SYSTEM.css.misscount. This variable is the time-out value in seconds that will be used by CRS to fence off the nodes in case of communication failure. Verify that the time-out value in OCRDUMP is 150 seconds. During Oracle installation, SF Oracle RAC software updates this value to 150 seconds.

Troubleshooting fencing

Topics indicate symptoms and likely procedures required for a solution.

SCSI reservation errors during bootup

When restarting a node of an SF Oracle RAC cluster, SCSI reservation errors may be observed such as:

```
Mar 25 13:18:28 galaxy kernel: scsi3 (0,0,6) : RESERVATION CONFLICT
```

This message is printed for each disk that is a member of any shared disk group which is protected by SCSI-3 I/O fencing. The message may be safely ignored.

vxfentsthdw fails when SCSI TEST UNIT READY command fails

A message may occur resembling:

```
Issuing SCSI TEST UNIT READY to disk reserved by other node
FAILED.
Contact the storage provider to have the hardware configuration
fixed.
```

The disk array does not support returning success for a SCSI TEST UNIT READY command when another host has the disk reserved using SCSI-3 persistent reservations. This happens with Hitachi Data Systems 99XX arrays if bit 186 of the system mode option is not enabled.

vxfentsthdw fails when prior registration key exists on disk

If you attempt to use the `vxfentsthdw` utility to test a disk that has a registration key already set, it will fail. If you suspect a key exists on the disk you plan to test, use the `vxfenadm -g` command to display it.

To display a key on a disk

Enter:

```
# vxfenadm -g diskname
```

- If the disk is not SCSI-3 compliant, an error is returned indicating:

  ```
  Inappropriate ioctl for device.
  ```

- If you have a SCSI-3 compliant disk and no key exists, then the output resembles:

  ```
  Reading SCSI Registration Keys...
  Device Name: diskname
  Total Number Of Keys: 0
  No keys ...
  ```

  Proceed to test the disk using the `vxfentsthdw` utility. See “Testing the disks using the vxfentsthdw script” on page 99.

- If keys exist, you must remove them before you test the disk. Refer to "Removing Existing Keys From Disks" in the next section.

Removing existing keys from disks

Use this procedure to remove existing registration and keys created by another node from a disk.

To remove the registration and reservation keys from disk

1. Create a file to contain the access names of the disks:

   ```
   # vi /tmp/disklist
   ```

   For example:

   ```
   /dev/sdh
   ```

2. Read the existing keys:

   ```
   # vxfenadm -g all -f /tmp/disklist
   ```

   The output from this command displays the key:

   ```
   Device Name: /dev/sdh
   Total Number Of Keys: 1
   key[0]:
   Key Value [Numeric Format]:   65,49,45,45,45,45,45,45
   Key Value [Character Format]: A1------
   ```

3. If you know on which node the key was created, log in to that node and enter:

   ```
   # vxfenadm -x -kA1 -f /tmp/disklist
   ```

   The key is removed.

   If you do not know on which node the key was created, follow step 4 through step 6 to remove the key.

4. Register a second key "A2" temporarily with the disk:

   ```
   # vxfenadm -m -kA2 -f /tmp/disklist
   Registration completed for disk path /dev/sdh
   ```

5. Remove the first key from the disk by pre-empting it with the second key:

   ```
   # vxfenadm -p -kA2 -f /tmp/disklist -vA1
   key: A2------ prempted the key: A1------ on disk
   /dev/sdh
   ```

6. Remove the temporary key assigned in step 4.

   ```
   # vxfenadm -x -kA2 -f /tmp/disklist
   Deleted the key : [A2------] from device /dev/sdk
   ```

   No registration keys exist for the disk.

7. Verify that the keys were properly cleaned:

   ```
   # vxfenadm -g all -f /tmp/diskslist
   ```

System panic prevents potential data corruption

When a system experiences a split brain condition and is ejected from the cluster, it panics and displays the following console message:

```
VXFEN:vxfen_plat_panic: Local cluster node ejected from cluster
to prevent potential data corruption.
```

How vxfen driver checks for pre-existing split brain condition

The `vxfen` driver functions to prevent an ejected node from rejoining the cluster after the failure of the private network links and before the private network links are repaired.

For example, suppose the cluster of *galaxy* and *nebula* is functioning normally when the private network links are broken. Also suppose *galaxy* is the ejected system. When *galaxy* reboots before the private network links are restored, its membership configuration does not show *nebula*; however, when it attempts to register with the coordinator disks, it discovers *nebula* is registered with them. Given this conflicting information about *nebula, galaxy* does not join the cluster and returns an error from `vxfenconfig` that resembles:

```
vxfenconfig: ERROR: There exists the potential for a preexisting
    split-brain. The coordinator disks list no nodes which are
    in the
    current membership. However, they also list nodes which are
    not
    in the current membership.

I/O Fencing Disabled!
```

Also, the following information is displayed on the console:

```
<date> <system name> vxfen: WARNING: Potentially a preexisting
<date> <system name> split-brain.
<date> <system name> Dropping out of cluster.
<date> <system name> Refer to user documentation for steps
<date> <system name> required to clear preexisting split-brain.
<date> <system name>
<date> <system name> I/O Fencing DISABLED!
<date> <system name>
<date> <system name> gab: GAB:20032: Port b closed
```

However, the same error can occur when the private network links are working and both systems go down, *galaxy* reboots, and *nebula* fails to come back up. From the view of the cluster from *galaxy, nebula* may still have the registrations on the coordinator disks.

Case 1: nebula up, galaxy ejected (actual potential split brain)

To respond to Case 1

1. Determine if *galaxy* is up or not.
2. If it is up and running, shut it down and repair the private network links to remove the split brain condition.
3. Restart *galaxy.*

Case 2: nebula down, galaxy ejected (apparent potential split brain)

To respond to Case 2

1. Physically verify that *nebula* is down.
2. Verify the systems currently registered with the coordinator disks. Use the following command:

   ```
   # vxfenadm -g all -f /etc/vxfentab
   ```

   The output of this command identifies the keys registered with the coordinator disks.
3. Clear the keys on the coordinator disks as well as the data disks using the command `/opt/VRTSvcs/vxfen/bin/vxfenclearpre`. See "Clearing keys after split brain" on page 261.
4. Make any necessary repairs to *nebula* and reboot.

Clearing keys after split brain

When you have encountered a split brain condition, use the `vxfenclearpre` command to remove SCSI-3 registrations and reservations on the coordinator disks as well as on the data disks in all shared disk groups.

To use vxfenclearpre

1. To prevent data corruption, shut down all other systems in the cluster that have access to the shared storage.
2. Start the script:

   ```
   # cd /opt/VRTSvcs/vxfen/bin
   # ./vxfenclearpre
   ```
3. Read the script's introduction and warning. Then, you can choose to let the script run.

   ```
   Do you still want to continue: [y/n] (default : n)
   y
   ```

Informational messages resembling the following may appear on the console of one of the nodes in the cluster when a node is ejected from a disk/LUN:

```
scsi1 (0,6,0) : RESERVATION CONFLICT
SCSI disk error : host 1 channel 0 id 6 lun 0 return
code = 18
I/O error: dev 08:80, sector 2000
```

These informational messages may be ignored.

```
Cleaning up the coordinator disks...

Cleaning up the data disks for all shared disk groups...

Successfully removed SCSI-3 persistent registration and
reservations from the coordinator disks as well as the shared
data disks.

Reboot the server to proceed with normal cluster startup...
#
```

4 Restart all systems in the cluster.

Adding or removing coordinator disks

Use the following procedure to add disks to the coordinator disk group, or to remove disks from the coordinator disk group.

Note the following about the procedure:

- ✔ You must have an odd number (three minimum) of disks/LUNs in the coordinator disk group.
- ✔ The disk you add must support SCSI-3 persistent reservations; see "Viewing guidelines for checking SCSI-3 support" on page 84.
- ✔ You must reboot each system in the cluster before the changes made to the coordinator disk group take effect.

To remove and replace a disk in the coordinator disk group

1 Log in as root user on one of the cluster systems.

2 Import the coordinator disk group. The file `/etc/vxfendg` includes the name of the disk group (typically, `vxfencoorddg`) that contains the coordinator disks, so use the command:

```
# vxdg -tfC import `cat /etc/vxfendg`
```

where:

`-t` specifies that the disk group is imported only until the system restarts.

`-f` specifies that the import is to be done forcibly, which is necessary if one or more disks is not accessible.

`-C` specifies that any import blocks are removed.

3 To add disks to the disk group, or to remove disks from the disk group, use the VxVM disk administrator utility, `vxdiskadm`.

4 After disks are added or removed, deport the disk group:

```
# vxdg deport `cat /etc/vxfendg`
```

5 Execute on all nodes in the cluster:

```
# /etc/init.d/vxfen start
```

Troubleshooting ODM

Topics indicate symptoms and likely procedures required for a solution.

File System configured incorrectly for ODM shuts down Oracle

Linking Oracle with the Veritas ODM libraries provides the best file system performance. Shared file systems in RAC clusters without ODM Libraries linked to Oracle may exhibit slow performance and are *not* supported.

If ODM cannot find the resources it needs to provide support for cluster file systems, it does not allow Oracle to identify cluster files and causes Oracle to fail at startup.

To verify cluster status

Run the command:

```
# cat /dev/odm/cluster
cluster status: enabled
```

If the status is "enabled," ODM is supporting cluster files. Any other cluster status indicates that ODM is not supporting cluster files. Other possible values include:

`pending` ODM cannot yet communicate with its peers, but anticipates being able to eventually.

`failed` ODM cluster support has failed to initialize properly. Check console logs.

`disabled` ODM is not supporting cluster files. If you think it should, check:

- `/dev/odm` mount options in `/etc/vfstab`. If the `nocluster` option is being used, it can force the `disabled` cluster support state.
- Make sure the `VRTSgms` (group messaging service) package is installed.

If `/dev/odm` is not mounted, no status can be reported.

To start ODM

1 Execute:

```
# /etc/init.d/vxgms start
```

2 Execute:

```
# /etc/init.d/vxodm start
```

Troubleshooting VCSIPC

Topics indicate symptoms and likely procedures required for a solution.

VCSIPC errors in Oracle trace/log files

If you see any VCSIPC errors in the Oracle trace/log files, check `/var/log/messages` for any LMX error messages. If you see messages that contain any of the following:

```
. . . out of buffers
. . . out of ports
. . . no minors available
```

Refer to "Tunable kernel driver parameters" on page 321.

If you see any VCSIPC warning messages in Oracle trace/log files that resemble:

```
connection invalid
```

or,

```
Reporting communication error with node
```

check whether the Oracle Real Application Cluster instance on the other system is still running or has been restarted. The warning message indicates that the VCSIPC/LMX connection is no longer valid.

Troubleshooting CVM

Topics indicate symptoms and likely procedures required for a solution.

Shared disk group cannot be imported

If you see a message resembling:

```
VxVM:vxconfigd:ERROR:vold_pgr_register(/dev/vx/rdmp/disk_name):
local_node_id
Please make sure that CVM and vxfen are configured and operating
correctly
```

This message is displayed when CVM cannot retrieve the node ID of the local system from the `vxfen` driver. This usually happens when port b is not configured.

To verify vxfen driver is configured

Check the GAB ports with the command:

```
# /sbin/gabconfig -a
```

Port b must exist on the local system.

Importing shared disk groups

The following message may appear when importing shared disk group:

```
VxVM vxdg ERROR V-5-1-587 Disk group disk group name: import
failed: No valid disk found containing disk group
```

You may need to remove keys written to the disk. Refer to "Removing existing keys from disks" on page 259.

Starting CVM

If you cannot start CVM, check the consistency between the `/etc/llthosts` and `main.cf` files for node IDs. You may need to remove keys written to the disk. Refer to "Removing existing keys from disks" on page 259.

CVMVolDg not online even though CVMCluster is online

When the CVMCluster resource goes online, the shared disk groups are automatically imported. If the disk group import fails for some reason, the CVMVolDg resources fault. Clearing and offlining the CVMVolDg type resources does not fix the problem.

To resolve the resource issue

1. Fix the problem causing the import of the shared disk group to fail.
2. Offline the service group containing the resource of type CVMVolDg as well as the service group containing the CVMCluster resource type.
3. Bring the service group containing the CVMCluster resource online.
4. Bring the service group containing the CVMVolDg resource online.

Shared disks not visible

If the shared disks in `/proc/scsi/scsi` are not visible:

Make sure that all shared LUNs are discovered by the HBA and SCSI layer. This can be verified by looking at `/proc/scsi/`*`fibre channel driver`*`/*` files.

Example:

```
/proc/scsi/qla2xxx/2 contains...
 ...
 SCSI LUN Information:
 (Id:Lun)  * - indicates lun is not registered with the OS.
 ( 0: 0): Total reqs 74, Pending reqs 0, flags 0x0, 0:0:84 00
 ( 0: 1): Total reqs 0, Pending reqs 0, flags 0x0*, 0:0:84 00
 ( 0: 2): Total reqs 0, Pending reqs 0, flags 0x0*, 0:0:84 00
 ( 0: 3): Total reqs 0, Pending reqs 0, flags 0x0*, 0:0:84 00
 ( 0: 4): Total reqs 0, Pending reqs 0, flags 0x0*, 0:0:84 00
 ...
```

The example indicates that not all LUNs are discovered by SCSI. The problem might be fixed by specifying `dev_flags` or `default_dev_flags` and *`max_luns`* parameters for SCSI driver.

RHEL 4.0 Example:

`/etc/modprobe.conf` includes:

```
options scsi_mod dev_flags="HITACHI:OPEN-3:0x240" options
scsi_mod max_luns=512
```

SLES9 Example:

`/boot/efi/efi/SuSE/elilo.conf` includes:

```
append = "selinux=0 splash=silent elevator=cfq
scsi_mod.default_dev_flags=0x240"
```

If the LUNs are not visible in `/proc/scsi/`*`fibre channel driver`*`/*` files, it may indicate a problem with SAN configuration or zoning.

Troubleshooting interconnects

Topics indicate symptoms and likely procedures required for a solution.

Restoring communication between host and disks after cable disconnection

If a Fibre cable is inadvertently disconnected between the host and a disk, you can restore communication between the host and the disk without restarting.

To restore lost cable communication between host and disk

1. Reconnect the cable.
2. Use the `fdisk -l` command to verify that the host sees the disks. It may take a few minutes before the host is capable of seeing the disk.
3. Issue the following `vxdctl` command to force the VxVM configuration daemon `vxconfigd` to rescan the disks:

```
# vxdctl enable
```

Network interfaces change their names after reboot

On SUSE systems, network interfaces change their names after reboot even with `HOTPLUG_PCI_QUEUE_NIC_EVENTS=yes` and `MANDATORY_DEVICES="..."` set.

Workaround: Use `PERSISTENT_NAME= ethX` where X is the interface number for all interfaces.

Example entries for mandatory devices

If you are using eth2 and eth3 for interconnectivity, use the following example procedures to set mandatory devices.

To set mandatory devices entry in the /etc/sysconfig/network/config

Enter:

```
MANDATORY_DEVICES="eth2-00:04:23:AD:4A:4C
eth3-00:04:23:AD:4A:4D"
```

To set a persistent name entry in an interface file

In file: /etc/sysconfig/network/ifcfg-eth-id-00:09:3d:00:cd:22 (Name of the eth0 Interface file), enter:

```
BOOTPROTO='static'
BROADCAST='10.212.255.255'
IPADDR='10.212.88.22'
MTU=' '
NETMASK='255.255.254.0'
NETWORK='10.212.88.0'
REMOTE_IP=' '
STARTMODE='onboot'
UNIQUE='RFE1.bBSepP2NetB'
_nm_name='bus-pci-0000:06:07.0'
PERSISTENT_NAME=eth0
```

Troubleshooting LLT

LLT fails to come up if network service is not up

If the system network service is not properly configured and the system interfaces (which LLT uses) are not visible at the time of LLT startup, then LLT will not come up.

One such issue may occur if during network service startup time, the network drivers for the concerned network interfaces are not loaded, in which case the system network service will not be able to bring those interfaces up and this will lead LLT to fail to start.

To ensure that the network drivers are loaded before the system network service is started, you may need to modify /etc/sysconfig/hardware/hwcfg-static-0 on SUSE systems and put entry for the corresponding network driver.

For example, for e1000 network drivers, the following entries can be made in this file:

```
MODULE='e1000'
MODULE_OPTIONS=''
STARTMODE='auto'
```

After making the above modifications, reboot the system.

Section VI

Reference information

Reference information:

Appendix A

Sample VCS configuration files for SF Oracle RAC

- All configuration shown here assume that Oracle and CRS binaries are installed on local disks and that they are managed by the operating system. These file systems must be specified in the file /etc/vfstab.
- The “cluster” definition in all of the configurations should specify UseFence=SCSI3.
- Sample main.cf file examples are provided for:
  - Oracle 10g without the Oracle agent
  - Oracle 10g with the Oracle agent

Oracle 10g configurations

Oracle 10g configuration without Oracle agent

Configuration details:

- Named: `10g_simple_main.cf`
- Use for single 10g and Oracle database only
- Has only one service group: cvm
- cvm group includes PrivNIC and Application resource for CSSD

```
include "types.cf"
include "CFSTypes.cf"
include "CVMTypes.cf"
include "OracleTypes.cf"
include "PrivNIC.cf"

cluster rac_cluster101 (
    UserNames = { admin = bopHo}
    Administrators = { admin }
    UseFence = SCSI3
    )

system galaxy (
    )

system nebula (
    )

group cvm (
    SystemList = { galaxy = 0, nebula = 1 }
    AutoFailOver = 0
    Parallel = 1
    AutoStartList = { galaxy, nebula }
    )

    Application cssd (
        Critical = 0
        StartProgram = "/opt/VRTSvcs/rac/bin/cssd-online"
        StopProgram = "/opt/VRTSvcs/rac/bin/cssd-offline"
        CleanProgram = "/opt/VRTSvcs/rac/bin/cssd-clean"
        MonitorProgram = "/opt/VRTSvcs/rac/bin/cssd-monitor"
        OnlineRetryLimit = 20
        )


    CVMVolDg ocrvote_voldg (
        Critical = 0
```

```
    CVMDiskGroup = ocrvotedg
    CVMVolume = { ocrvol, votevol }
    CVMActivation = sw
    )

CFSMount oradata_mnt (
    Critical = 0
    MountPoint = "/oradata"
    BlockDevice = "/dev/vx/dsk/oradatadg/oradatavol"
    )

CVMVolDg oradata_voldg (
    Critical = 0
    CVMDiskGroup = oradatadg
    CVMVolume = { oradatavol }
    CVMActivation = sw
    )

CFSfsckd vxfsckd (
    )

CVMCluster cvm_clus (
    CVMClustName = rac_cluster101
    CVMNodeId = { galaxy = 1, nebula = 2 }
    CVMTransport = gab
    CVMTimeout = 200
    )

CVMVxconfigd cvm_vxconfigd (
    Critical = 0
    CVMVxconfigdArgs = { syslog }
    )

PrivNIC ora_priv (
    Critical = 0
    Device = { eth0 = 0, eth1 = 1}
    Address@galaxy = "192.168.12.1"
    Address@nebula = "192.168.12.2"
    NetMask = "255.255.240.0"
        )

cssd requires oradata_mnt
cssd requires ora_priv
cssd requires ocrvote_voldg
oradata_mnt requires oradata_voldg
oradata_voldg requires cvm_clus
ocrvote_voldg requires cvm_clus
oradata_mnt requires vxfsckd
vxfsckd requires cvm_clus
cvm_clus requires cvm_vxconfigd
```

Oracle 10g configuration with Oracle agent

Configuration details:

- Named: 10g_main.cf
- More general purpose, can have multiple Oracle databases
- Has three service groups: cvm, oradb1_grp and oradb2_grp
- oradb1_grp depends on cvm
- oradb1_grp has Oracle and oradata mount resource
- oradb2_grp depends on cvm
- oradb2_grp has Oracle and oradata mount resource

```
include "types.cf"
include "CFSTypes.cf"
include "CVMTypes.cf"
include "OracleTypes.cf"
include "PrivNIC.cf"

cluster rac_cluster101 (
    UserNames = { admin = bopHo }
    Administrators = { admin }
    UseFence = SCSI3
    )

system galaxy (
    )

system nebula (
    )

group oradb1_grp (
    SystemList = { galaxy = 0, nebula = 1 }
    AutoFailOver = 0
    Parallel = 1
    AutoStartList = { galaxy, nebula }
    )

    Oracle ora1 (
        Critical = 0
        Sid @galaxy = vrts1
        Sid @nebula = vrts2
        Owner = oracle
        Home = "/app/oracle/orahome"
        StartUpOpt = "SRVCTLSTART"
        ShutDownOpt = "SRVCTLSTOP"
        )
```

```
    CFSMount oradata_mnt (
        Critical = 0
        MountPoint = "/oradata"
        BlockDevice = "/dev/vx/dsk/oradatadg/oradatavol"
        )

    CVMVolDg oradata_voldg (
        Critical = 0
        CVMDiskGroup = oradatadg
        CVMVolume = { oradatavol }
        CVMActivation = sw
        )

    requires group cvm online local firm
    ora1 requires oradata_mnt
    oradata_mnt requires oradata_voldg


group oradb2_grp (
    SystemList = { galaxy = 0, nebula = 1 }
    AutoFailOver = 0
    Parallel = 1
    AutoStartList = { galaxy, nebula }
    )

    Oracle ora2 (
        Critical = 0
        Sid @galaxy = hr1
        Sid @nebula = hr2
        Owner = oracle
        Home = "/app/oracle/orahome"
        StartUpOpt = "SRVCTLSTART"
        ShutDownOpt = "SRVCTLSTOP"
        )


    CFSMount oradata2_mnt (
        Critical = 0
        MountPoint = "/oradata2"
        BlockDevice = "/dev/vx/dsk/oradata2_dg/oradatavol"
        )

    CVMVolDg oradata2_voldg (
        Critical = 0
        CVMDiskGroup = oradata2_dg
        CVMVolume = { oradatavol }
        CVMActivation = sw
        )

    requires group cvm online local firm
    ora1 requires oradata2_mnt
    oradata_mnt requires oradata2_voldg
```

```
group cvm (
    SystemList = { galaxy = 0, nebula = 1 }
    AutoFailOver = 0
    Parallel = 1
    AutoStartList = { galaxy, nebula }
    )

    Application cssd (
        Critical = 0
        StartProgram = "/opt/VRTSvcs/rac/bin/cssd-online"
        StopProgram = "/opt/VRTSvcs/rac/bin/cssd-offline"
        CleanProgram = "/opt/VRTSvcs/rac/bin/cssd-clean"
        MonitorProgram = "/opt/VRTSvcs/rac/bin/cssd-monitor"
        OnlineRetryLimit = 20
        )

    CVMVolDg ocrvote_voldg (
        Critical = 0
        CVMDiskGroup = ocrvotedg
        CVMVolume = { ocrvol, votevol }
        CVMActivation = sw
        )

    CFSfsckd vxfsckd (
        )

    CVMCluster cvm_clus (
        CVMClustName = rac_cluster101
        CVMNodeId = { galaxy = 1, nebula = 2 }
        CVMTransport = gab
        CVMTimeout = 200
        )

    CVMVxconfigd cvm_vxconfigd (
        Critical = 0
        CVMVxconfigdArgs = { syslog }
        )

    PrivNIC ora_priv (
        Critical = 0
        Device = { eth0 = 0, eth1 = 1}

        Address@galaxy = "192.168.12.1"
        Address@nebula = "192.168.12.2"
        NetMask = "255.255.240.0"
                 )

    cssd requires ora_priv
    cssd requires ocrvote_voldg
    ocrvote_voldg requires cvm_clus
    vxfsckd requires cvm_clus
    cvm_clus requires cvm_vxconfigd
```

Appendix B

Creating a starter database

Creating a database for Oracle 10g

Create database tablespaces for Oracle10g using one of two options:

- Option 1: on shared raw volumes
- Option 2: on cluster file system, CFS

Before you begin, take note of the these prerequisites:

- CRS daemons must be running. To verify the status of CRS, type:
  ```
  # $CRS_HOME/bin/crs_stat
  ```
- Use the `ping` command to verify that all private IP addresses on each node are up.

Creating database tablespaces shared on raw volumes (option 1)

1. Log in as `root` user.
2. On the master node, create a shared disk group:
   ```
   # vxdg -s init oradatadg HDS0_20
   ```
3. Create a volume in the shared group for *each* of the required tablespaces. Refer to the Oracle documentation to determine the tablespace requirements. For example, type:
   ```
   # vxassist -g oradatadg make VRT_galaxy 1000M
   # vxassist -g oradatadg make VRT_spfile1 10M
   .
   .
   ```
4. Define the access mode and permissions for the volumes storing the Oracle data. For *each* volume listed in `$ORACLE_HOME/raw_config`, use the `vxedit`(1M) command:

```
vxedit -g disk_group set group=group user=user mode=660 volume
```

For example:

```
# vxedit -g oradatadg set group=dba user=oracle mode=660 \
VRT_galaxy
```

In this example, `VRT_galaxy` is the name of one of the volumes. Repeat the command to define access mode and permissions for each volume in the `oradatadg`.

5 Create the database using Oracle documentation.

Creating database tablespaces shared on CFS (option 2)

If you plan to use a cluster file system to store the Oracle database, use the following procedure to create the file system.

1 Create a disk group (for example, `oradatadg`):

```
# vxdg -s init oradatadg HDS0_20
```

2 Create a single shared volume (for example, `oradatavol`) that is large enough to contain a file system for all tablespaces. Refer to the Oracle documentation for tablespace sizes). Assuming 6.8 GB are required for the tablespaces, type:

```
# vxassist -g oradatadg make oradatavol 6800M
```

3 Start the volume in the disk group:

```
# vxvol -g oradatadg startall
```

4 Create a VxFS file system in this volume. From one node, type:

```
# mkfs -t vxfs /dev/vx/rdsk/oradatadg/oradatavol
```

5 Create a mount point for the shared file system:

```
# mkdir /oradata
```

6 From the same node, mount the file system:

```
# mount -t vxfs -o cluster /dev/vx/dsk/oradatadg/oradatavol \
/oradata
```

7 Set “oracle” as the owner of the file system, and set “755” as the permissions:

```
# chown oracle:oinstall /oradata
# chmod 755 /oradata
```

8 On the other node(s), complete step 5 through step 7.

9 Refer to Oracle documentation to create the database.

Appendix C

Agent reference

This Appendix describes the entry points and the attributes:

Use this information to make necessary changes to the configuration.Refer to the *Veritas Cluster Server User's Guide* for information on how to modify the VCS configuration.

Note: Refer to Chapter 6, "Configuring Oracle 10g service groups" on page 133 for details on the PrivNIC agent and Application agent for the CSSD resource.

CVMCluster agent

The CVMCluster resource is configured automatically during installation. The CVMCluster agent controls system membership on the cluster port associated with VxVM in a cluster.

CVMCluster agent, entry points

The following table describes the entry points used by the CVMCluster agent.

Table C-1 CVMCluster agent, entry points

Entry Point	Description
Online	Joins a node to the CVM cluster port. Enables the Volume Manager cluster functionality by autoimporting shared disk groups.
Offline	Removes a node from the CVM cluster port.
Monitor	Monitors the node's CVM cluster membership state.

CVMCluster agent type

The following table describes the user-modifiable attributes of the CVMCluster resource type.

Table C-2 CVMCluster resource type, user-modifiable attributes

Attribute	Dimension	Description
CVMClustName	string-scalar	Name of the cluster.
CVMNodeAddr	string-association	List of host names and IP addresses.
CVMNodeId	string-association	An associative list consisting of the name of the system and the system's LLT ID number.
CVMTransport	string-scalar	Specifies cluster messaging mechanism. Default = gab **Note:** Do not change this value.
PortConfigd	integer-scalar	Port number used by CVM for vxconfigd-level communication.
PortKmsgd	integer-scalar	Port number used by CVM for kernel-level communication.

Table C-2 CVMCluster resource type, user-modifiable attributes

Attribute	Dimension	Description
CVMTimeout	integer-scalar	Time-out in seconds used for CVM cluster reconfiguration. Default = 200

CVMCluster agent type definition

The following type definition is included in the file, `CVMTypes.cf`. Note that the `CVMNodeAddr`, `PortConfigd`, and `PortKmsgd` attributes are not used in an SF Oracle RAC environment because GAB, the required cluster communication messaging mechanism, does not use them.

```
type CVMCluster (
        static int InfoTimeout = 0
        static int NumThreads = 1
        static int OnlineRetryLimit = 2
        static int OnlineTimeout = 400
        static str ArgList[] = { CVMTransport, CVMClustName,
           CVMNodeAddr, CVMNodeId, PortConfigd, PortKmsgd,
           CVMTimeout }
        NameRule = ""
        str CVMClustName
        str CVMNodeAddr{}
        str CVMNodeId{}
        str CVMTransport
        int PortConfigd
        int PortKmsgd
        int CVMTimeout
)
```

CVMCluster agent sample configuration

The following is an example definition for the CVMCluster service group. See "Sample VCS configuration files for SF Oracle RAC" on page 271 for a more extensive `main.cf` example that includes the CVMCluster resource.

```
CVMCluster cvm_clus (
        Critical = 0
        CVMClustName = RACCluster1
        CVMNodeId = { galaxy = 0, nebula = 1 }
        CVMTransport = gab
        CVMTimeout = 200
)
```

CVMVxconfigd Agent

The CVMVxconfigd agent is responsible for starting and monitoring the `vxconfigd` daemon. The `vxconfigd` daemon maintains disk and disk group configurations, communicates configuration changes to the kernel, and modifies configuration information stored on disks. CVMVxconfigd is always required in the CVM service group.

The CVMVxconfigd is an OnOnly agent; that is, the agent starts it when the cluster starts up and it is always restarted by VCS whenever necessary. This is specified by default in the `Operations` attribute.

It is highly recommended that the `vxconfigd` daemon be started with the `syslog` option, which enables logging of debug messages. The `syslog` option is configured for the CVMVxconfigd agent during installation.

CVMVxconfigd agent, entry points

The following table describes the entry points used by the CVMVxconfigd agent.

Table C-3 CVMVxconfigd agent, entry points

Entry Point	Description
Online	Starts the `vxconfigd` daemon
Offline	N/A
Monitor	Monitors whether `vxconfigd` daemon is running

CVMVxconfigd agent type

The following table describes the attribute of the CVMVxconfigd agent type.

Table C-4 CVMVxconfigd agent type, attribute

Attribute	Dimension	Description
CVMVxconfigdArgs	keylist	Includes the list of arguments to be sent to the `online` entry point. It is highly recommended that the `syslog` option always be specified.

CVMVxconfigd type definition

The following type definition is included in the file, `CVMTypes.cf`.

```
type CVMVxconfigd (
        static int FaultOnMonitorTimeouts = 2
        static int RestartLimit = 5
        static str ArgList[] { CVMVxconfigdArgs }
        static str Operations = OnOnly
        keylist CVMVxconfigdArgs
)
```

Sample CVMVxconfigd agent configuration

The following is an example definition for the CVMVxconfigd resource in the CVM service group. See also Appendix A, "Sample VCS configuration files for SF Oracle RAC".

```
CVMVxconfigd cvm_vxconfigd (
        Critical = 0
        CVMVxconfigdArgs = { syslog }
)
.
.
cvm_clus requires cvm_vxconfigd
// resource dependency tree
//
// group cvm
// {
// CVMCluster cvm_clus
//     {
//     CVMVxconfigd cvm_vxconfigd
//     }
// }
```

CVMVolDg and CFSMount resources

The CVMVolDg agent represents and controls CVM disk groups and the CVM volumes within the disk groups. Because of the global nature of the CVM disk groups and the CVM volumes, they are imported only once on the CVM master node.

Configure the CVMVolDg agent for each disk group used by an Oracle service group. A disk group must be configured to only one Oracle service group.If cluster file systems are used for the database, configure the CFSMount agent for each volume in the disk group.

CVMVolDg agent entry points

The following table describes the entry points used by the CVMVolDg agent.

Table C-5 CVMVolDg agent, entry points

Entry Point	Description
Online	If the system is the CVM master and the disk group is not imported, the online entry point imports the disk group and starts all the volumes in the shared disk group. It then sets the disk group activation mode to shared-write as long as the `CVMActivation` attribute is set to `sw`. The activation mode is set on both slave and master systems.
Offline	Clears internal state.
Monitor	Monitors the specified critical volumes in the disk group. The volumes to be monitored are specified by the `CVMVolume` attribute. In an SF Oracle RAC environment, at least one volume in a disk group must be specified.
Clean	Clears internal state.

CVMVolDg agent type attribute descriptions

The following table describes the user-modifiable attributes of the CVMVolDg resource type.

Table C-6 CVMVolDg resource type, user-modifiable attributes

Attribute	Dimension	Description
CVMDiskGroup	string-scalar	Names the disk group.
CVMVolume	string-keylist	Lists the critical volumes in the disk group. At least one volume in the disk group must be specified.
CVMActivation	string-scalar	Sets the activation mode for the disk group. Default = `sw`

CVMVolDg agent type definition

The CVMVolDg type definition is included in the `CVMTypes.cf` file, installed by the `installsfrac` utility.

```
type CVMVolDg (
        static keylist RegList = { CVMActivation }
        static str ArgList[] = { CVMDiskGroup, CVMVolume,
            CVMActivation }
        str CVMDiskGroup
        keylist CVMVolume[]
        str CVMActivation
        temp int voldg_stat
)
```

Sample CVMVolDg agent configuration

Each Oracle service group requires a CVMVolDg resource type to be defined. Refer to “Sample VCS configuration files for SF Oracle RAC” on page 271 to see CVMVolDg defined in a more extensive example.

```
CVMVolDg ora_voldg (
        CVMDiskGroup = oradatadg
        CVMVolume = { oradata1, oradata2 }
        CVMActivation = sw
)
```

CFSMount agent entry points

The CFSMount agent brings online, takes offline, and monitors a cluster file system mount point. The agent executable is `/opt/VRTSvcs/bin/CFSMount/CFSMountAgent`. The CFSMount type definition is in the file `/etc/VRTSvcs/conf/config/CFSTypes.cf`.

Table C-7 CFSMount agent, entry points

Entry Point	Description
Online	Mounts a block device in cluster mode.
Offline	Unmounts the file system, forcing unmount if necessary, and sets primary to secondary if necessary.
Monitor	Determines if the file system is mounted. Checks mount status using the fsclustadm command.
Clean	A null operation for a cluster file system mount.

CFSMount agent type, attribute descriptions

The following table lists user-modifiable attributes of the CFSMount Agent resource type.

Table C-8 CFSMount resource type, user modifiable attributes

Attribute	Dimension	Description
MountPoint	string-scalar	Directory for the mount point.
BlockDevice	string-scalar	Block device for the mount point.
NodeList	string-keylist	List of nodes on which to mount. If NodeList is NULL, the agent uses the service group system list.

Table C-8 CFSMount resource type, user modifiable attributes

Attribute	Dimension	Description

MountOpt (optional)	string-scalar	Options for the mount command. To create a valid MountOpt attribute string:
		■ Use the VxFS type-specific options only.
		■ Do not use the -o flag to specify the VxFS-specific options.
		■ Do not use the **-t** vxfs file system type option.
		■ The cluster option is not required.
		■ Specify options in comma-separated list as in these examples:
		`ro`
		`ro,cluster`
		`blkclear,mincache=closesync`

Policy (optional)	string-scalar	List of nodes to assume the primaryship of the cluster file system if the primary fails. If set to NULL or if none of the hosts specified in the list is active when the primary fails, a node is randomly selected from the set of active nodes to assume primaryship.

CFSMount agent type definition

The CFSMount agent type definition is included in the `CFSTypes.cf` file, installed by the `installsfrac` utility.

```
type CFSMount (
        static keylist RegList = { MountOpt, Policy, NodeList }
        static int FaultOnMonitorTimeouts = 1
        static int InfoTimeout = 0
        static int OnlineRetryLimit = 16
        static int OnlineWaitLimit = 0
        static str ArgList[] = { MountPoint, BlockDevice,
            MountOpt }
        NameRule = resource.MountPoint
        str MountPoint
        str MountType
        str BlockDevice
        str MountOpt
        keylist NodeList
        keylist Policy
        temp str Primary
        str SetPrimary
        str RemountRes
        str ForceOff
        )
```

Sample CFSMount agent configuration

Each Oracle service group requires a CFSMount resource type to be defined. Refer to "Sample VCS configuration files for SF Oracle RAC" on page 271 to see CFSMount defined in a more extensive example.

```
CFSMount ora_mount (
        MountPoint = "/oradata"
        BlockDevice = "/dev/vx/dsk/oradatadg/oradatavol1"
        Primary = nebula
)
```

PrivNIC agent

The PrivNIC resource is used to maintain a “private IP address” that is locally highly available on LLT Ethernet interfaces. Such private IP addresses are required by the CRS daemons in Oracle10g to provide communication.

The PrivNIC agent relies on LLT to monitor the interfaces. It queries LLT to count the number of visible nodes on each of the LLT interfaces.

PrivNIC agent: monitor entry point

The following table describes the `monitor` entry point used by the PrivNIC agent. Only the monitor entry point is required because the resource is persistent.

Table C-9 Monitor entry point

Entry Point	Description
Monitor	Queries LLT to make a list of nodes visible on every LLT network interface. It applies various filters to the list to arrive at a most desired failover decision and calculates a “winner” device on which to configure the IP address. The “winner” is compared to the currently active device where the IP is currently configured; if the active and winner device are different, the agent fails over the device.

PrivNIC agent: type attribute descriptions

The following table describes the user-modifiable attributes of the PrivNIC resource type

Required Attributes

Table C-10 PrivNic resource type, user-modifiable attributes (required)

Attribute	Dimension	Description

Device	string - association	Specifies the network interface device as shown by the "ifconfig" command and the "network-id" associated with the interface. Network-ids of the interfaces connected to the same physical network must match. The interface with the lower network-id has the higher preference for failover. Interfaces specified in the PrivNIC configuration should be exactly the same in name and total number as those which have been used for LLT configuration. Example:
		`Device@galaxy = {eth0=0, eth1=1, eth2=2}`
		`Device@nebula = {eth0=0, eth1=1, eth2=2}`

Address	string-scalar	The numerical private IP address. For example: `Address = "192.11.12.13"`
NetMask	string - association	The numerical netmask for the private IP address. For example: `Address = "255.255.255.0"`

Optional Attributes

Table C-11 PrivNic resource type, attributes (optional)

Attribute	Dimension	Description

DeviceTag	string - association	Associates an LLT device "tag" with device via the network-id. If an LLT device tag (as specified in the `/etc/lltab` file) differs from the name of the network interface as shown in "ifconfig," then DeviceTag must be specified for that interface.
		For example: in the common case, `/etc/lltab` contains:
		`link eth0 /dev/eth:0 - ether - -`
		`link eth1 /dev/eth:1 - ether - -`
		`link-lowpri eth0 /dev/eth:0 - ether - -`
		In the above case, DeviceTag does not need to be specified. However, if `/etc/lltab` contains:
		`link link1 /dev/eth:0 - ether - -`
		`link link2 /dev/eth:1 - ether - -`
		`link-lowpri spare /dev/eth:0 - ether - -`
		And,
		`Device@galaxy = { eth0=0, eth1=1, eth2=2 }`
		DeviceTag needs to be specified as:
		`DeviceTag@galaxy = { spare=2 }`

GabPort	string-scalar	A single lower-case letter specifying the name of the GAB port to be used for filtering. "o" is the default. NULL disables GAB port filtering. Example: `GabPort = "b"`
UseVirtualIP	integer-scalar	The default is 0, which specifies that the agent use the physical interface for configuring the private IP address when possible. The value 1 specifies that the agent always use the virtual interface for configuring the private IP address. The value 2 (which includes the functionality of the value 1) specifies the agent should complain if the private IP address already exists on a physical interface.
UseSystemList	integer-scalar	The value 1 specifies that the agent use the SystemList of the service group to filter the node list. Default = 0.

Table C-11 PrivNic resource type, attributes (optional)

Attribute	Dimension	Description
ExcludeNode	integer-vector	List of nodes to permanently excluded from calculation.

PrivNIC agent: type definition

The following shows the content of the `PrivNIC.cf` file:

```
type PrivNIC (
        static str ArgList[] = { Device, DeviceTag, Address,
           NetMask, UseVirtualIP, GabPort, UseSystemList,
           ExcludeNode }
        static int OfflineMonitorInterval = 60
        static int MonitorTimeout = 300
        static str Operations = None

        str Device{}
        str DeviceTag{}
        str Address = ""
        str NetMask = ""
        int UseVirtualIP = 0
        str GabPort = "o"
        int UseSystemList = 0
        int ExcludeNode[]
)
```

PrivNIC agent: sample configuration

The following is a sample configuration using the PrivNIC agent.

```
group cvm (
        SystemList = { galaxy = 0, nebula = 1 }
        AutoFailOver = 0
        Parallel = 1
        AutoStartList = { galaxy, nebula }
    )
        PrivNIC ora_priv (
        Device = { eth0 = 0, eth1 = 1, eth2 = 5 }

        Address@galaxy = "192.11.12.13"
        Address@nebula = "192.11.12.14"
        NetMask = "255.255.255.0"
    )
```

Configuring the Application agent to monitor CSSD

The `cssd` resource is optional. It monitors the Oracle 10*g* `cssd` process. The purpose of the `cssd` resource is to ensure that the dependency of `cssd` on the OCR and VOTE resources and the PrivNIC (optional) resource are satisfied. If the `cssd` resource is online and any of its dependencies are brought offline, the machine will reboot. This agent allows this behavior to be avoided since the dependencies will be enforced by VCS.

Note: VCS will not actually stop the CRS daemon. Instead, it will report an error message to the VCS engine log file if an offline is issued. Refer to the Oracle documentation to understand how to safely stop the CRS daemon.
VCS will not start the CRS daemon. It will wait for the daemon to start automatically upon system boot up. If CRS daemon is stopped, refer to the Oracle documentation to understand how to safely restart the daemon.

The `cssd` resource should use the Application agent. The name of the resource is up to the user. The following are required attributes of the `cssd` resource:

Table C-12 cssd resource, required attributes

Attribute Name	Required Value
Critical	0
OnlineRetryLimit	20
StartProgram	/opt/VRTSvcs/rac/bin/cssd-online
StopProgram	/opt/VRTSvcs/rac/bin/cssd-offline
CleanProgram	/opt/VRTSvcs/rac/bin/cssd-clean
MonitorProgram	/opt/VRTSvcs/rac/bin/cssd-monitor

An example `main.cf` entry is as follows:

```
Application cssd-resource (
    Critical = 0
    StartProgram = "/opt/VRTSvcs/rac/bin/cssd-online"
    StopProgram = "/opt/VRTSvcs/rac/bin/cssd-offline"
    CleanProgram = "/opt/VRTSvcs/rac/bin/cssd-clean"
    MonitorProgram = "/opt/VRTSvcs/rac/bin/cssd-monitor"
    OnlineRetryLimit = 20
    )
```

Oracle agent functions

The Oracle agent monitors the database processes. Table C-13 lists the Oracle agent operations. The functions an agent performs are called entry points.

For more on the Veritas high availability agent for Oracle, see the *Veritas High Availability for Oracle Agent Guide*.

Table C-13 Oracle agent operations

Agent operation	Description
Online	Starts the Oracle database by using the following `sqlplus` command: `startup force pfile=$PFile` The default Startup option is STARTUP_FORCE. You can also configure the agent to start the database using different Startup options for Oracle. See "Startup options" on page 295.
Offline	Stops the Oracle database with the specified options by using the following `sqlplus` command: `shutdown immediate` The default Shutdown option is IMMEDIATE. You can also configure the agent to stop the database using different Shutdown options for Oracle. See "Shutdown options" on page 296.
Monitor	Verifies the status of the Oracle processes. The Oracle agent provides two levels of monitoring: basic and detail. See "Monitor options for Oracle agent" on page 296.
Clean	Forcibly stops the Oracle database by using the following `sqlplus` command: `shutdown abort` If the process does not respond to the `shutdown` command, the agent scans the process table for processes associated with the configured instance and kills them.
Info	Provides static and dynamic information about the state of the database. See "Info entry point" on page 297.
Action	Performs predefined actions on a resource. See "Action entry point" on page 297.

Startup and shutdown options

You can specify Startup and Shutdown options for Oracle instances that are configured.

Startup options

Table C-14 lists the startup options that the agent supports.

Table C-14 Startup options

Option	Description
STARTUP_FORCE (Default)	Runs `startup force pfile='location_of_pfile'` if the pfile is configured. If the pfile is not configured, the agent runs `startup force`. It picks up the default parameter files from their default locations.
STARTUP	Runs `startup pfile='location_of_pfile'` if the pfile is configured. If the pfile is not configured, the agent picks up the default parameter files from their default locations and runs `startup`.
RESTRICTED	Starts the database in the RESTRICTED mode.
RECOVERDB	Performs a database recovery on instance startup.

CUSTOM	Uses a predefined SQL script (`start_custom_$SID.sql`) and runs custom startup options. The script must be in the /opt/VRTSagents/ha/bin/Oracle directory and must have access to the Oracle Owner OS user. If the file is not present, the agent logs an error message.
	With a custom script, the agent takes the following action:
	`sqlplus /nolog <<!`
	`connect / as sysdba;`
	`@start_custom_$SID.sql`
	`exit;`
	`!`

Shutdown options

Table C-15 lists the shutdown options that the agent supports.

Table C-15 Shutdown options

Option	Description
IMMEDIATE (Default)	Shuts down the Oracle instance by running `shutdown immediate`.
TRANSACTIONAL	Runs the `shutdown transactional` command. This option is valid only for database versions that support this option.
CUSTOM	Uses a predefined SQL script (`shut_custom_$SID.sql`) and runs custom shutdown options. The script must be in the /opt/VRTSagents/ha/bin/Oracle directory and must have access to the Oracle Owner OS user. If the file is not present, the agent shuts the agent down with the default option.

Monitor options for Oracle agent

The Oracle agent provides two levels of monitoring: basic and detail. By default, the agent does a basic monitoring.

Basic monitoring options

The basic monitoring mode has two options: Process check and Health check. Table C-16 describes the basic monitoring options.

Table C-16 Basic monitoring options

Option	Description
0 (Default)	Process check The agent scans the process table for the ora_dbw, ora_smon, ora_pmon, and ora_lgwr processes to verify that Oracle is running.
1	Health check (supported on Oracle 10*g* and later) The agent uses the Health Check APIs from Oracle to monitor the SGA and retrieve the information about the instance.

Detail monitoring

In the detail monitoring mode, the agent performs a transaction on a test table in the database to ensure that Oracle is functioning properly.

Info entry point

The Veritas high availability agent for Oracle supports the Info entry point, which provides static and dynamic information about the state of the database.

To invoke the Info entry point, type the following command:

```
# hares -refreshinfo resource [-sys system] \
[-clus cluster | -localclus]
```

The entry point retrieves the following static information:

- Version
- InstanceNo
- InstanceName
- DatabaseName
- HostName
- StartupTime
- Parallel
- Thread
- InstanceRole

The entry point retrieves the following dynamic information:

- InstanceStatus
- Logins
- OpenMode
- LogMode
- ShutdownPending
- DatabaseStatus
- Shared Pool Percent free
- Buffer Hits Percent

You can add additional attributes by adding sql statements to the file /opt/VRTSagents/ha/bin/Oracle/resinfo.sql. For example:

```
select 'static:HostName:'||host_name from v$instance;
select 'dynamic:ShutdownPending:'||shutdown_pending from
v$instance;
```

The format of the selected record must be as follows:

```
attribute_type:userkey_name:userkey_value
```

The variable *attribute_type* can take the value static and/or dynamic.

Action entry point

The Veritas high availability agent for Oracle supports the Action entry point, which enables you to perform predefined actions on a resource. Table C-17 describes the agent's predefined actions.

To perform an action on a resource, type the following command:

```
# hares -action res token [-actionargs arg1 ...] \
[-sys system] [-clus cluster]
```

You can also add custom actions for the agent. For further information, refer to the *Veritas Cluster Server Agent Developer's Guide*.

Table C-17 Predefined agent actions

Action	Description
VRTS_GetInstanceName	Retrieves the name of the configured instance. You can use this option for the Oracle and the Netlsnr resources.
VRTS_GetRunningServices	Retrieves the list of processes monitored by the agent. You can use this option for the Oracle and the Netlsnr resources.
DBRestrict	Changes the database session to enable the RESTRICTED mode.
DBUndoRestrict	Changes the database session to disable the RESTRICTED mode.
DBSuspend	Suspends a database.
DBResume	Resumes a suspended database.
DBTbspBackup	Backs up a tablespace; `actionargs` contains name of the tablespace to be backed up.

Netlsnr agent functions

The listener is a server process that listens to incoming client connection requests and manages traffic to the database. The Netlsnr agent brings the listener services online, monitors their status, and takes them offline. Table C-18 lists the Netlsnr agent operations.

Table C-18 Netlsnr agent operations

Agent operation	Description
Online	Starts the listener process by using the following command: `lsnrctl start $LISTENER`
Offline	Stops the listener process by using the following command: `lsnrctl stop $LISTENER` If the listener is configured with a password, the agent uses the password to stop the listener.

Table C-18 Netlsnr agent operations

Agent operation	Description
Monitor	Verifies the status of the listener process. The Netlsnr agent provides two levels of monitoring: basic and detail. ■ In the basic monitoring mode, the agent scans the process table for the `tnslsnr` process to verify the listener process is running. (Default) ■ In the detail monitoring mode, the agent uses the `lsnrctl status $LISTENER` command to verify the status of the Listener process.
Clean	Scans the process table for `tnslsnr $Listener` and kills it.
Action	Performs predefined actions on a resource. See "Action entry point" on page 297.

Appendix D

I/O fencing topics

This appendix includes additional topics related to I/O fencing, including descriptions of how to initialize disks, how to use options and methods of the vxfentsthdw command to test disks for SCSI-3 compliance, the vxfenadm command, and various I/O fencing behaviors to protect data in certain scenarios.

Initializing disks as VxVM disks

Install the driver and HBA card. Refer to the documentation from the vendor for instructions.

After you physically add shared disks to the nodes, you must initialize them as VxVM disks and verify that all the nodes see the same disk. Use the example procedure; see the *Veritas Volume Manager Administrator's Guide* for more information on adding and configuring disks.

To initialize disks

1. Make the new disks recognizable. On each node, enter:

   ```
   # fdisk -l
   ```

2. If the Array Support Library (ASL) for the array you are adding is not installed, obtain and install it on each node before proceeding. The ASL for the supported storage device you are adding is available from the disk array vendor or Symantec technical support.

3. Verify that the ASL for the disk array is installed on each of the nodes. Run the following command on each node and examine the output to verify the installation of ASL. The following output is a sample:

   ```
   # vxddladm listsupport all
   libvxCLARiiON.so      DGC
   libvxcscovrts.so      CSCOVRTS
   libvxemc.so           EMC
   ```

4 Scan all disk drives and their attributes, update the VxVM device list, and reconfigure DMP with the new devices. Type:

```
# vxdisk scandisks
```

See the Veritas Volume Manager documentation for details on adding and configuring disks.

5 To initialize the disks as VxVM disks, use one of the following methods:

- Use the interactive vxdiskadm utility to initialize the disks as VxVM disks.

  For more information see the *Veritas Volume Manager Administrator's Guide*.

- Use the `vxdisksetup` command to initialize a disk as a VxVM disk.

  ```
  vxdisksetup -i device_name format=cdsdisk
  ```

  The example specifies the CDS format:

  ```
  # vxdisksetup -i sdr format=cdsdisk
  ```

  Repeat this command for each disk you intend to use as a coordinator disk.

vxfentsthdw options and methods

The vxfentsthdw basic operation is described earlier in this guide.

See"Checking shared disks for SCSI-3 support" on page 84.

You can use the vxfentsthdw utility to verify that shared storage arrays are to be used for data support SCSI-3 persistent reservations and I/O fencing. During the I/O fencing configuration, the testing utility is used to test a single disk. The utility has other options that may be more suitable for testing storage devices in other configurations. You also need to test coordinator disks.

The utility, which you can run from one system in the cluster, tests the storage used for data by setting and verifying SCSI-3 registrations on the disk or disks you specify, setting and verifying persistent reservations on the disks, writing data to the disks and reading it, and removing the registrations from the disks. Refer also to the `vxfentsthdw`(1M) manual page.

General guidelines for using vxfentsthdw

- The utility requires two systems connected to the shared storage.

  Caution: The tests overwrite and destroy data on the disks, unless you use the -r option.

- The two nodes must have `ssh` (default) or `rsh` communication. If you use `rsh`, launch the vxfentsthdw utility with the `-n` option.

After completing the testing process, remove permissions for communication and restore public network connections.

- To ensure both systems are connected to the same disk during the testing, you can use the `vxfenadm -i diskpath` command to verify a disk's serial number.
  "Verifying the nodes see the same disk" on page 98
- For disk arrays with many disks, use the `-m` option to sample a few disks before creating a disk group and using the `-g` option to test them all.
- When testing many disks with the `-f` or `-g` option, you can review results by redirecting the command output to a file.
- The utility indicates a disk can be used for I/O fencing with a message resembling:

  ```
  The disk /dev/sdr is ready to be configured for I/O Fencing on
  node north
  ```
- If the disk you intend to test has existing SCSI-3 registration keys, the test issues a warning before proceeding.

Table D-1 describes various options the utility provides to test storage devices.

Table D-1 vxfentsthdw options

vxfentsthdw option	Description	When to use
-n	Use /bin/rsh.	Use when `rsh` is used for communication.
-r	Non-destructive testing. Testing of the disks for SCSI-3 persistent reservations occurs in a non-destructive way; that is, there is only testing for reads, not writes. May be used with -m, -f, or -g options.	Use during non-destructive testing.
-t	Testing of the return value of `SCSI TEST UNIT (TUR)` command under SCSI-3 reservations. A warning is printed on failure of TUR testing.	When you want to perform TUR testing.

Table D-1 vxfentsthdw options

vxfentsthdw option	Description	When to use
-d	Use DMP devices. May be used with -c or -g options.	By default, the script picks up the OS paths for disks in the disk group. If you want the script to use the DMP path, use the -d option.
-c	Utility tests the coordinator disk group prompting for systems and devices, and reporting success or failure.	For testing disks in coordinator disk group.
-m	Utility runs manually, in interactive mode, prompting for systems and devices, and reporting success or failure. May be used with -r and -t options. -m is the default option.	For testing a few disks or for sampling disks in larger arrays.
-f *filename*	Utility tests system/device combinations listed in a text file. May be used with -r and -t options.	For testing several disks.
-g *disk_group*	Utility tests all disk devices in a specified disk group. May be used with -r and -t options.	For testing many disks and arrays of disks. Disk groups may be temporarily created for testing purposes and destroyed (ungrouped) after testing.

Testing the coordinator disk group using vxfentsthdw -c

Use the vxfentsthdw utility to verify disks are configured to support I/O fencing. In this procedure, the vxfentsthdw utility tests the three disks one disk at a time from each node.

- From the node north, the disks are /dev/sdg, /dev/sdh, and /dev/sdi.
- From the node south, the disks are /dev/sdx, /dev/sdy, and /dev/sdz.

Note: To test the coordinator disk group using the vxfentsthdw utility, the utility requires that the coordinator disk group, vxfencoorddg, be accessible from two nodes.

To test the coordinator disk group using vxfentsthdw -c

1 Use the `vxfentsthdw` command with the `-c` option. For example:

```
# /opt/VRTSvcs/vxfen/bin/vxfentsthdw -c vxfencoorddg
```

2 Enter the nodes you are using to test the coordinator disks:

```
Enter the first node of the cluster:
north
Enter the second node of the cluster:
south
```

3 Review the output of the testing process for both nodes for all disks in the coordinator disk group. Each disk should display output that resembles:

```
ALL tests on the disk /dev/sdg have PASSED.
The disk is now ready to be configured for I/O Fencing on node
north as a COORDINATOR DISK.

ALL tests on the disk /dev/sdx have PASSED.
The disk is now ready to be configured for I/O Fencing on node
south as a COORDINATOR DISK.
```

4 After you test all disks in the disk group, the vxfencoorddg disk group is ready for use.

Removing and replacing a failed disk

If a disk in the coordinator disk group fails verification, remove the failed disk or LUN from the vxfencoorddg disk group, replace it with another, and retest the disk group.

If you need to replace a disk in an active coordinator disk group, refer to the procedure in the troubleshooting chapter.

"Adding or removing coordinator disks" on page 262

To remove and replace a failed disk

1 Use the vxdiskadm utility to remove the failed disk from the disk group. Refer to the *Veritas Volume Manager Administrator's Guide*.

2 Add a new disk to the node, initialize it, and add it to the coordinator disk group.
"Initializing disks as VxVM disks" on page 301
"Configuring coordinator disks" on page 101

3 Retest the disk group.

Using the -r option for non-destructive testing

To test disk devices containing data you want to preserve, you can use the -r option with the -m, -f, or -g options, which are described in the following

sections. For example, to use the -m option and the -r option, you can run the utility by entering:

```
# /opt/VRTSvcs/vxfen/bin/vxfentsthdw -rm
```

When invoked with the -r option, the utility does not use tests that write to the disks. Therefore, it does not test the disks for all of the usual conditions of use.

Using the -m option

Review the procedure to manually test the shared disks.

"Testing the disks using the vxfentsthdw script" on page 99

The -m option which is the default option.

Using the -f option

Use the -f option to test disks that are listed in a text file. For example, you can create a file to test two disks shared by systems north and south that might resemble:

```
north /dev/sdz south /dev/sdy
north /dev/sdu south /dev/sdw
```

Where the first disk is listed in the first line and is seen by north as /dev/sdz and by south as /dev/sdy. The other disk, in the second line, is seen as /dev/sdu from north and /dev/sdw from south. Typically, the list of disks could be extensive.

Suppose you created the file named disks_blue. To test the disks, you would enter:

```
# /opt/VRTSvcs/vxfen/bin/vxfentsthdw -f disks_blue
```

The utility reports the test results one disk at a time, just as for the -m option.

You can redirect the test results to a text file. Precede the command with "yes" to acknowledge that the testing destroys any data on the disks to be tested.

Caution: Be advised that by redirecting the command's output to a file, a warning that the testing destroys data on the disks cannot be seen until the testing is done.

For example:

```
# yes | /opt/VRTSvcs/vxfen/bin/vxfentsthdw -f disks_blue >
blue_test.txt
```

Using the -g option

Use the -g option to test all disks within a disk group. For example, you create a temporary disk group consisting of all disks in a disk array and test the group.

Note: Do not import the test disk group as shared; that is, do not use the -s option of vxdg command when importing the disk group.

The utility reports the test results one disk at a time. You can redirect the test results to a text file for review.

```
# /opt/VRTSvcs/vxfen/bin/vxfentsthdw -g red_disks_dg >
redtest.txt
```

After testing, destroy the disk group and put the disks into disk groups as you need.

Testing a disk with existing keys

If the utility detects that a coordinator disk has existing keys, you see a message that resembles:

```
There are Veritas I/O Fencing keys on the disk. Please make sure
that I/O Fencing is shut down on all nodes of the cluster before
continuing.

          ******** WARNING!!!!!!!! ********

THIS SCRIPT CAN ONLY BE USED IF THERE ARE NO OTHER ACTIVE NODES
IN THE CLUSTER!  VERIFY ALL OTHER NODES ARE POWERED OFF OR
INCAPABLE OF ACCESSING SHARED STORAGE.

If this is not the case, data corruption will result.

Do you still want to continue : [y/n] (default: n) y
```

The utility prompts you with a warning before proceeding. You may continue as long as I/O fencing is not yet configured.

How I/O fencing works in different event scenarios

Table D-2 describes how I/O fencing works to prevent data corruption in different failure event scenarios. For each event, corrective operator actions are indicated.

Table D-2 I/O fencing scenarios

Event	Node A: What happens?	Node B: What happens?	Operator action
Both private networks fail.	Node A races for majority of coordinator disks. If Node A wins race for coordinator disks, Node A ejects Node B from the shared disks and continues.	Node B races for majority of coordinator disks. If Node B loses the race for the coordinator disks, Node B removes itself from the cluster.	When Node B is ejected from cluster, repair the private networks before attempting to bring Node B back.
Both private networks function again after event above.	Node A continues to work.	Node B has crashed. It cannot start the database since it is unable to write to the data disks.	Restart Node B after private networks are restored.
One private network fails.	Node A prints message about an IOFENCE on the console but continues.	Node B prints message about an IOFENCE on the console but continues.	Repair private network. After network is repaired, both nodes automatically use it.

Table D-2 I/O fencing scenarios

Event	Node A: What happens?	Node B: What happens?	Operator action
Node A hangs.	Node A is extremely busy for some reason or is in the kernel debugger. When Node A is no longer hung or in the kernel debugger, any queued writes to the data disks fail because Node A is ejected. When Node A receives message from GAB about being ejected, it removes itself from the cluster.	Node B loses heartbeats with Node A, and races for a majority of coordinator disks. Node B wins race for coordinator disks and ejects Node A from shared data disks.	Verify private networks function and restart Node A.

Table D-2 I/O fencing scenarios

Event	Node A: What happens?	Node B: What happens?	Operator action
Nodes A and B and private networks lose power. Coordinator and data disks retain power. Power returns to nodes and they restart, but private networks still have no power.	Node A restarts and I/O fencing driver (vxfen) detects Node B is registered with coordinator disks. The driver does not see Node B listed as member of cluster because private networks are down. This causes the I/O fencing device driver to prevent Node A from joining the cluster. Node A console displays: `Potentially a preexisting split brain. Dropping out of the cluster. Refer to the user documentation for steps required to clear preexisting split brain.`	Node B restarts and I/O fencing driver (vxfen) detects Node A is registered with coordinator disks. The driver does not see Node A listed as member of cluster because private networks are down. This causes the I/O fencing device driver to prevent Node B from joining the cluster. Node B console displays: `Potentially a preexisting split brain. Dropping out of the cluster. Refer to the user documentation for steps required to clear preexisting split brain.`	Resolve preexisting split brain condition. "System panic prevents potential data corruption" on page 260.

Table D-2 I/O fencing scenarios

Event	Node A: What happens?	Node B: What happens?	Operator action
Node A crashes while Node B is down. Node B comes up and Node A is still down.	Node A is crashed.	Node B restarts and detects Node A is registered with the coordinator disks. The driver does not see Node A listed as member of the cluster. The I/O fencing device driver prints message on console: `Potentially a preexisting split brain. Dropping out of the cluster. Refer to the user documentation for steps required to clear preexisting split brain.`	Resolve preexisting split brain condition. "System panic prevents potential data corruption" on page 260

Table D-2 I/O fencing scenarios

Event	Node A: What happens?	Node B: What happens?	Operator action
The disk array containing two of the three coordinator disks is powered off.	Node A continues to operate as long as no nodes leave the cluster.	Node B continues to operate as long as no nodes leave the cluster.	
Node B leaves the cluster and the disk array is still powered off.	Node A races for a majority of coordinator disks. Node A fails because only one of three coordinator disks is available. Node A removes itself from the cluster.	Node B leaves the cluster.	Power on failed disk array and restart I/O fencing driver to enable Node A to register with all coordinator disks.

About the vxfenadm utility

Administrators can use the `vxfenadm` command to troubleshoot and test fencing configurations. The command's options for use by administrators are:

-g read and display keys

-i read SCSI inquiry information from device

-m register with disks

-n make a reservation with disks

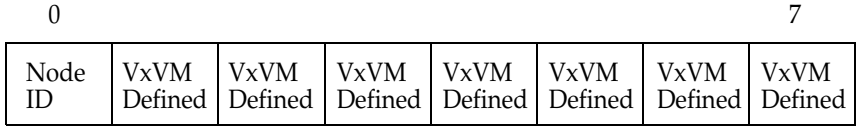
-p remove registrations made by other systems

-r read reservations

-x remove registrations

Registration key formatting

The key defined by VxVM associated with a disk group consists of seven bytes maximum. This key becomes unique among the systems when the VxVM prefixes it with the ID of the system. The key used for I/O fencing, therefore, consists of eight bytes.



The keys currently assigned to disks can be displayed by using the `vxfenadm` command.

For example, from the system with node ID 1, display the key for the disk /dev/sdy by entering:

```
# vxfenadm -g /dev/sdy
Reading SCSI Registration Keys...
Device Name: /dev/sdy
Total Number of Keys: 1
key[0]:
        Key Value [Numeric Format]: 65,45,45,45,45,45,45,45
        Key Value [Character Format]: A-------
```

The -g option of `vxfenadm` displays all eight bytes of a key value in two formats. In the numeric format, the first byte, representing the Node ID, contains the system ID plus 65. The remaining bytes contain the ASCII values of the letters of the key, in this case, "-------". In the next line, the node ID 0 is expressed as "A;" node ID 1 would be "B."

Appendix E

Configuring the Symantec License Inventory Agent

This appendix includes the following topics:

The Symantec License Inventory Manager installation disc is available separately. For information on how to order the full product, see "How to order the Symantec License Inventory Manager license and media kit" on page 319. The installation media provides online documentation with details on all topics discussed in this appendix.

Read the following Technical Support TechNote for the latest information on updates, patches, and software issues regarding the Symantec License Inventory Manager:

http://entsupport.symantec.com/docs/282183

You can also download the *Symantec License Inventory Agent 4.1 Release Notes*, from this website.

About the Symantec License Inventory Manager

The Symantec License Inventory Manager (license inventory manager) is an enterprise asset management tracking tool that inventories Symantec Information Availability products in your network and consolidates critical information on the deployment of these products to facilitate license management and compliance tracking. Using the information provided by the license inventory manager, you can:

- Determine all the Symantec software products and licenses being used in your enterprise
- Achieve easier license self-compliance management
- Know your Enterprise License Agreement deployment status
- Reduce administrative overhead for managing license compliance
- Renew support and maintenance based on the licenses you have deployed
- Gain more control over your Symantec software usage
- Manage department chargebacks based on actual software usage
- Use more flexible licensing and pricing models
- Exploit detailed deployment data to perform return on investment analyses for purchased software

The license inventory manager is a three-tiered system that consists of a server tier, access point tier, and an agent tier. The server tier is the Symantec License Inventory Server, which consolidates and stores information that it gathers from the agents and access points.

The optional access point tier includes Symantec License Inventory Access Points and serves as a consolidation layer between the agents and server.

The agent tier includes Symantec License Inventory Agents, which are deployed on individual hosts in a network. Each agent gathers product information on the supported Symantec products that are installed on the agent's host, then sends the information to an access point or the server.

When the Symantec License Inventory Agent is installed

The Symantec product installer installs or upgrades the agent on the host with the Symantec product. The agent is installed in the following directory:

`/opt/SYMClma`

The agent is installed with a default configuration that minimizes its impact on a running system. The minimum configuration prevents remote communication with the agent to keep its data and interfaces secure.

When the server and access points are installed

The server and access points are not installed automatically. If you want to use the Symantec License Inventory Manager, you must manually install the server and, optionally, the access points. After you install the server and access points, the agents can gather information and you can create inventory reports.

You can install the server and access points from the Symantec License Inventory Manager installation disc.

What you can do with the agent after it is installed

If you are already participating in a Symantec sales program that requires the use of the agent, or if you want to order and deploy the Symantec License Inventory Manager, you can use the agent to track Symantec products on the systems on which it was installed. To use the agent, however, you must manually configure it to enable remote communication between the agent and its server or access point.

Complete instructions for reconfiguring the agent are provided in the *Symantec License Inventory Manager 4.1 Release Notes*.

How to remove the agent

If you do not want to use the Symantec License Inventory Manager, you can remove the agent using the operating system package removal commands to remove the agent packages, which include SYMClma and VRTSsmf.

The server and access point also use the VRTSsmf package. If the server or access point is installed on this host with the agent, you can remove the SYMClma package, but not the VRTSsmf package. If neither the server nor the access point is installed on this host, you can remove both the SYMClma and VRTSsmf packages.

If you remove both packages, remove the SYMClma package first.

Table E-1 lists the commands required to remove these packages on the supported platforms.

Table E-1 Package removal commands required to remove the agent

Platform	Package removal command
AIX	`installp -u VRTSlma` `installp -u VRTSsmf`
HP-UX	`swremove SYMClma` `swremove VRTSsmf`
Linux	`rpm evv SYMClma` `rpm evv VRTSsmf`
Solaris	`pkgrm VRTSlma` `pkgrm VRTSsmf`

Later, you can reinstall the agent with the Symantec License Inventory Manager installation disc. This disc is available in the Symantec License Inventory Manager kit.

How to order the Symantec License Inventory Manager license and media kit

To order a Symantec License Inventory Manager license and media kit, contact your Symantec sales representative.

The installation media provides online documentation for the Symantec License Inventory Manager. You can contact your sales representative to order printed copies of the documentation. The documents you can order include:

- *Symantec License Inventory Manager Installation and Configuration Guide*
- *Symantec License Inventory Manager Administrator's Guide*
- *Symantec License Inventory Manager User's Guide*

Appendix F

Tunable kernel driver parameters

The tunable parameters described in this appendix are not intended to be used for performance enhancement. Several of the parameters pre-allocate memory for critical data structures, and a change in their values could increase memory use or degrade performance.

Note: Do not change the tunable kernel parameters described in this document without assistance from Symantec support personnel.

About LMX Tunable Parameters

Edit the file `/etc/sysconfig/lmx` to change the values of the LMX driver tunable global parameters. Table F-1 describes the LMX driver tunable parameters.

Table F-1 LMX Tunable Parameters

LMX Parameter	Description	Default Value	Maximum Value
LMX_MINOR_MAX	Specifies the maximum number of contexts system-wide. Each Oracle process typically has two LMX contexts. "Contexts" and "minors" are used interchangeably in the documentation; "context" is an Oracle-specific term and should be used to specify the value in the `lmx.conf` file.	2048	65535

Table F-1 LMX Tunable Parameters

LMX Parameter	Description	Default Value	Maximum Value
LMX_PORT_MAX	Specifies the number of communication endpoints for transferring messages from the sender to the receiver in a uni-directional manner.	2048	65535
LMX_BUFFER_MAX	Specifies the number of addressable regions in memory to which LMX data can be copied.	1024	65535

Example: Configuring LMX Parameters

If you see the message “no minors available” on one node, you can edit the file `/etc/sysconfig/lmx` and add a configuration parameter increasing the value for the maximum number of contexts. Be aware that increasing the number of contexts on a system has some impact on the resources of that system.

In the following example, configuring `contexts=16384` allows a maximum of 8192 Oracle processes (8192 * 2 = 16384). Note that double-quotes are not used to specify an integer value.

```
#
# LMX configuration file
#
# Maximum number of contexts allowed
LMX_MINORS_MAX=16384
```

For the changes to take effect, either reboot the system, or reconfigure the LMX module.

To reconfigure the LMX module

1. Shut down all Oracle service groups on the system:
   ```
   # hagrp -offline oragrp -sys galaxy
   ```
2. Stop all Oracle client processes on the system, such as `sqlplus`.
3. Unconfigure the LMX module:
   ```
   # /etc/init.d/lmx stop
   ```
4. Configure the LMX module:
   ```
   # /etc/init.d/lmx start
   ```
5. Bring the service groups back online:
   ```
   # hagrp -online oragrp -sys galaxy
   ```

About VXFEN Tunable Parameters

On each node, edit the file /etc/sysconfig/vxfen to change the value of the vxfen driver tunable global parameter, vxfen_max_delay and vxfen_min_delay. You must restart the system to put change into effect.

Table F-2 vxfen Parameters

vxfen Parameter	Description and Values: Default, Minimum, and Maximum
vxfen_debug_sz	Size of debug log in bytes ■ Values Default: 65536 Minimum: 65536 Maximum: 256K
vxfen_max_delay	Specifies the maximum number of seconds that the smaller sub-cluster waits before racing with larger clusters for control of the coordinator disks. This value must be greater than the vxfen_max_delay value. ■ Values Default: 60 Minimum: 0 Maximum: 600
vxfen_min_delay	Specifies the minimum number of seconds that the smaller sub-cluster waits before racing with larger clusters for control of the coordinator disks. This value must be smaller than the vxfen_max_delay value. ■ Values Default: 1 Minimum: 0 Maximum: 600

In the event of a network partition, the smaller cluster delays before racing for the coordinator disks. The time delayed allows a larger sub-cluster to win the race for the coordinator disks. The vxfen_max_delay and vxfen_min_delay parameters define the delay in seconds.

Example: Configuring the VXFEN Parameters

To reconfigure the VXFEN module

1 Shut down all Oracle service groups on the node.

```
# hagrp -offline oragrp -sys north
```

2 Stop all Oracle client processes, such as sqlplus and gsd, on the node.

3 Unconfigure the VXFEN module.

```
# /sbin/vxfenconfig -U
```

4 Unload the module.

```
# /etc/init.d/vxfen stop
```

5 Edit the /etc/sysconfig/vxfen file.
For example, change the entry from:

```
vxfen_min_delay=0
```

to:

```
vxfen_min_delay=30
```

6 Start the VXFEN module.

```
# /etc/init.d/vxfen start
```

7 Bring the service groups online.

```
# hagrp -online oragrp -sys north
```

Appendix G

Error messages

The error messages listed in this appendix are grouped by the software module in which the error occurs.

LMX Error Messages, Critical

Table G-1 lists LMX kernel module error messages. These messages report critical errors seen when the system runs out of memory, when LMX is unable to communicate with LLT, or when you are unable to load or unload LMX.

Refer to "Running scripts for engineering support analysis" on page 251 for information on how to gather information about your systems and configuration that Symantec support personnel can use to assist you.

Table G-1 Critical Error Messages

Message ID	LMX Message
00001	lmxload packet header size incorrect (*number*)
00002	lmxload invalid lmx_llt_port *number*
00003	lmxload context memory alloc failed
00004	lmxload port memory alloc failed
00005	lmxload buffer memory alloc failed
00006	lmxload node memory alloc failed
00007	lmxload msgbuf memory alloc failed
00008	lmxload tmp msgbuf memory alloc failed
00009	lmxunload node *number* conngrp not NULL
00010	lmxopen return, minor non-zero

Message ID	LMX Message
00011	lmxopen return, no minors available
00012	lmxconnect lmxlltopen(1) err= *number*
00013	lmxconnect new connection memory alloc failed
00014	lmxconnect kernel request memory alloc failed
00015	lmxconnect mblk memory alloc failed
00016	lmxconnect conn group memory alloc failed
00017	lmxlltfini: LLT unregister failed err = *number*
00018	lmxload contexts *number* > *number*, max contexts = system limit = *number*
00019	lmxload ports *number* > *number*, max ports = system limit = *number*
00020	lmxload buffers *number* > *number*, max buffers = system limit = *number*
00021	lmxload msgbuf *number* > *number*, max msgbuf size = system limit = *number*

LMX Error Messages, Non-Critical

Table G-2 on page 327 contains LMX error messages that may be displayed during runtime. Refer to “Running scripts for engineering support analysis” on page 251 for information on how to gather information about your systems and configuration that Symantec support personnel can use to assist you.

If you encounter errors while running your Oracle application due to the display of these messages, you may use the lmxconfig command to turn off their display. For example, use this command to disable the display of messages:

```
# sbin/lmxconfig -e 0
```

To re-enable the display of the messages, type:

```
# sbin/lmxconfig -e 1
```

Table G-2 Noncritical Error Messages

Message ID	LMX Message
06001	lmxreqlink duplicate kreq= 0x*address*, req= 0x*address*
06002	lmxreqlink duplicate ureq= 0x*address* kr1= 0x*address*, kr2= 0x*address* req type = number
06003	lmxrequnlink not found kreq= 0x*address* from= number
06004	lmxrequnlink_l not found kreq= 0x*address* from= number
06005	kreq was not found
06101	lmxpollreq not in doneq CONN kreq= 0x*address*
06201	lmxnewcontext lltinit fail err= number
06202	lmxnewcontext lltregister fail err= number
06301	lmxrecvport port not found unode= number node= number ctx= *number*
06302	lmxrecvport port not found (no port) ctx= *number*
06303	lmxrecvport port not found ugen= *number* gen= *number* ctx= *number*
06304	lmxrecvport dup request detected
06401	lmxinitport out of ports
06501	lmxsendport lltsend node= *number* err= *number*
06601	lmxinitbuf out of buffers
06602	lmxinitbuf fail ctx= *number* ret= *number*
06701	lmxsendbuf lltsend node= *number* err= *number*
06801	lmxconfig insufficient privilege, uid= *number*
06901	lmxlltnodestat: LLT getnodeinfo failed err= *number*

VxVM Errors Related to I/O Fencing

Table G-3 lists VxVm error messages related to I/O fencing.

Table G-3 VxVM errors related to I/O fencing

Message	Explanation
vold_pgr_register(*disk_path*): failed to open the vxfen device. Please make sure that the vxfen driver is installed and configured.	The vxfen driver has not been configured. Follow the instructions in the chapter on installing and configuring SF Oracle RAC to set up coordinator disks and start I/O fencing. Then clear the faulted resources and online the service groups.
vold_pgr_register(*disk_path*): Probably incompatible vxfen driver.	Incompatible versions of VxVM and the vxfen driver are installed on the system. Install the proper version of SF Oracle RAC.

VXFEN Driver Error Messages

Table G-4 lists VXFEN driver error messages.

Table G-4 VXFEN Driver Error Messages

Message	Explanation
Unable to register with coordinator disk with serial number: *xxxx*	This message appears when the vxfen driver is unable to register with one of the coordinator disks. The serial number of the coordinator disk that failed is printed.
Unable to register with a majority of the coordinator disks. Dropping out of cluster.	This message appears when the vxfen driver is unable to register with a majority of the coordinator disks. The problems with the coordinator disks must be cleared before fencing can be enabled. This message is preceded with the message "VXFEN: Unable to register with coordinator disk with serial number *xxxx*."
There exists the potential for a preexisting split-brain. The coordinator disks list no nodes which are in the current membership. However, they, also list nodes which are not in the current membership. I/O Fencing Disabled!	This message appears when there is a preexisting split-brain in the cluster. In this case configuration of vxfen driver fails. Clear the split-brain using the instructions given in Chapter 13, "Troubleshooting SF Oracle RAC" on page 251, before configuring vxfen driver.
Unable to join running cluster since cluster is currently fencing a node out of the cluster	This message appears while configuring vxfen driver, if there is a fencing race going on in the cluster. The vxfen driver can be configured by retrying after sometime (after the cluster completes the fencing).

VXFEN Driver Informational Message

The following messages are for information only. They show how long it takes the data disks to be fenced for nodes that have left the cluster.

```
date and time VXFEN:00021:Starting to eject leaving nodes(s)
from data disks.

date and time VXFEN:00022:Completed ejection of leaving node(s)
from data disks.
```

Informational Messages When Node is Ejected

The following informational messages may be ignored.

```
Informational messages resembling the following may appear on
the console of one of the nodes in the cluster when a node is
ejected from a disk/LUN:
<date> <system name> scsi: WARNING:
/sbus@3,0/lpfs@0,0/sd@0,1(sd91):
<date> <system name> Error for Command: <undecoded cmd 0x5f>
Error Level: Informational
<date> <system name> scsi: Requested Block: 0 Error Block 0
<date> <system name> scsi: Vendor: <vendor> Serial Number:
0400759B006E
<date> <system name> scsi: Sense Key: Unit Attention
<date> <system name> scsi: ASC: 0x2a (<vendor unique code
0x2a>), ASCQ: 0x4, FRU: 0x0
```

Glossary

Agent

A process that starts, stops, and monitors all configured resources of a type, and reports their status to VCS.

Active/Active Configuration

A failover configuration where each system runs a service group. If either fails, the other one takes over and runs both service groups. Also known as a symmetric configuration.

Active/Passive Configuration

A failover configuration consisting of one service group on a primary system, and one dedicated backup system. Also known as an asymmetric configuration.

Cluster

A cluster is one or more computers that are linked together for the purpose of multiprocessing and high availability. The term is used synonymously with VCS cluster, meaning one or more computers that are part of the same GAB membership.

Cluster Manager (Java Console)

A Java-based graphical user interface to manage VCS clusters. It provides complete administration capabilities for a cluster, and can run on any system inside or outside the cluster, on any operating system that supports Java.

Cluster Manager (Web Console)

A Web-based graphical user interface for monitoring and administering the cluster.

Disk Heartbeats (GABDISK)

A way to improve cluster resiliency, GABDISK enables a heartbeat to be placed on a physical disk shared by all systems in the cluster.

Failover

A failover occurs when a service group faults and is migrated to another system.

GAB

Group Atomic Broadcast (GAB) is a communication mechanism of the VCS engine that manages cluster membership, monitors heartbeat communication, and distributes information throughout the cluster.

Global Service Group

A VCS service group which spans across two or more clusters. The `ClusterList` attribute for this group contains the list of clusters over which the group spans.

hashadow Process

A process that monitors and, when required, restarts HAD.

High Availability Daemon (HAD)

The core VCS process that runs on each system. The HAD process maintains and communicates information about the resources running on the local system and receives information about resources running on other systems in the cluster.

Jeopardy

A node is in *jeopardy w*hen it is missing one of the two required heartbeat connections. When a node is running with one heartbeat only (in jeopardy), VCS does *not* restart the applications on a new node. This action of disabling failover is a safety mechanism that prevents data corruption.

LLT

Low Latency Transport (LLT) is a communication mechanism of the VCS engine that provides kernel-to-kernel communications and monitors network communications.

main.cf

The file in which the cluster configuration is stored.

Monitor Program

The Monitor Program informs the application agent whether the application process is online or offline, and properly returning service requests.

Network Partition

If all network connections between any two groups of systems fail simultaneously, a *network partition* occurs. When this happens, systems on both sides of the partition can restart applications from the other side resulting in duplicate services, or "split-brain." A split brain occurs when two independent systems configured in a cluster assume they have exclusive access to a given resource (usually a file system or volume). The most serious problem caused by a network partition is that it affects the data on shared disks. See "Jeopardy" on page 332 and "Seeding" on page 333.

Node

The physical host or system on which applications and service groups reside. When systems are linked by VCS, they become nodes in a cluster.

N-to-1

An N-to-1 configuration is based on the concept that multiple, simultaneous server failures are unlikely; therefore, a single backup server can protect multiple active servers. When a server fails, its applications move to the backup server. For example, in a 4-to-1 configuration, one server can protect four servers, which reduces redundancy cost at the server level from 100 percent to 25 percent.

N-to-N

N-to-N refers to multiple service groups running on multiple servers, with each service group capable of being failed over to different servers in the cluster. For example, consider a four-node cluster with each node supporting three critical database instances. If any node fails, each instance is started on a different node, ensuring no single node becomes overloaded.

N-to-M

N-to-M (or Any-to-Any) refers to multiple service groups running on multiple servers, with each service group capable of being failed over to different servers in the same cluster, and

also to different servers in a linked cluster. For example, consider a four-node cluster with each node supporting three critical database instances and a linked two-node back-up cluster. If all nodes in the four-node cluster fail, each instance is started on a node in the linked back-up cluster.

Resources

Individual components that work together to provide application services to the public network. A resource may be a physical component such as a disk or network interface card, a software component such as Oracle8*i* or a Web server, or a configuration component such as an IP address or mounted file system.

Resource Dependency

A dependency between resources is indicated by the keyword “requires” between two resource names. This indicates the second resource (the child) must be online before the first resource (the parent) can be brought online. Conversely, the parent must be offline before the child can be taken offline. Also, faults of the children are propagated to the parent.

Resource Types

Each resource in a cluster is identified by a unique name and classified according to its type. VCS includes a set of pre-defined resource types for storage, networking, and application services.

Seeding

Seeding is used to protect a cluster from a preexisting network partition. By default, when a system comes up, it is not seeded. Systems can be seeded automatically or manually. Only systems that have been seeded can run VCS. Systems are seeded automatically only when an unseeded system communicates with a seeded system or all systems in the cluster are unseeded and able to communicate with each other. See “Network Partition” on page 332.

Service Group

A service group is a collection of resources working together to provide application services to clients. It typically includes multiple resources, hardware- and software-based, working together to provide a single service.

Service Group Dependency

A service group dependency provides a mechanism by which two service groups can be linked by a dependency rule, similar to the way resources are linked.

Shared Storage

Storage devices that are connected to and used by two or more systems.

SNMP Notification

Simple Network Management Protocol (SNMP) developed to manage nodes on an IP network.

State

The current activity status of a resource, group or system. Resource states are given relative to both systems.

System

The physical system on which applications and service groups reside. When a system is linked by VCS, it becomes a node in a cluster. See “Node” on page 332

types.cf

The types.cf file describes standard resource types to the VCS engine; specifically, the data required to control a specific resource.

Virtual IP Address

A unique IP address associated with the cluster. It may be brought up on any system in the cluster, along with the other resources of the service group. This address, also known as the IP alias, should not be confused with the base IP address, which is the IP address that corresponds to the host name of a system.

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