Veritas Storage Foundation™ for Oracle® RAC Administrator's Guide

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Section 1

SF Oracle RAC concepts and administration

Chapter 1

Overview of Veritas Storage Foundation for Oracle RAC

This chapter includes the following topics:

About Veritas Storage Foundation for Oracle RAC

Veritas Storage Foundation™ for Oracle® RAC (SF Oracle RAC) leverages proprietary storage management and high availability technologies to enable robust, manageable, and scalable deployment of Oracle RAC on UNIX platforms. The solution uses cluster file system technology that provides the dual advantage of easy file system management as well as the use of familiar operating system tools and utilities in managing databases.

The solution stack comprises the Veritas Cluster Server (VCS), Veritas Cluster Volume Manager (CVM), Veritas Cluster File System (CFS), and Veritas Storage Foundation, which includes the base Veritas Volume Manager (VxVM) and Veritas File System (VxFS).

Benefits of SF Oracle RAC

SF Oracle RAC provides the following benefits:

- Support for file system-based management. SF Oracle RAC provides a generic clustered file system technology for storing and managing Oracle data files as well as other application data.
- Support for high-availability of cluster interconnects. The combination of LMX/LLT protocols and the PrivNIC/MultiPrivNIC agents provides maximum bandwidth as well as high availability of the cluster interconnects, including switch redundancy.
- Use of clustered file system for placement of Oracle Cluster Registry and voting disks. Clustered file system and volume management technologies provide robust shared block and raw interfaces for placement of Oracle Cluster Registry and voting disks. In the absence of SF Oracle RAC, separate LUNs need to be configured for OCR and voting disks.
- Support for a standardized approach toward application and database management. A single-vendor solution for the complete SF Oracle RAC software stack lets you devise a standardized approach toward application and database management. Further, administrators can apply existing expertise of Veritas technologies toward SF Oracle RAC.
- Increased availability and performance using dynamic multi-pathing (DMP). DMP provides wide storage array support for protection from failures and performance bottlenecks in the HBAs and SAN switches.
- Easy administration and monitoring of SF Oracle RAC clusters from a single web console.
- Support for many types of applications and databases.
- Improved file system access times using Oracle Disk Manager (ODM).
- Ability to configure ASM disk groups over CVM volumes to take advantage of dynamic multi-pathing (DMP).
- Enhanced scalability and availability with access to multiple Oracle RAC instances per database in a cluster.
- Support for backup and recovery solutions using volume-level and file system-level snapshot technologies. SF Oracle RAC enables full volume-level snapshots for off-host processing and file system-level snapshots for efficient backup and rollback.
- Ability to failover applications without downtime using clustered file system technology.

- Prevention of data corruption in split-brain scenarios with robust SCSI-3 Persistent Reservation (PGR) based I/O fencing.
- Support for sharing all types of files, in addition to Oracle database files, across nodes.
- Fast disaster recovery with minimal downtime and interruption to users. Users can transition from a local high availability site to a wide-area disaster recovery environment with primary and secondary sites. If a node fails, clients that are attached to the failed node can reconnect to a surviving node and resume access to the shared database. Recovery after failure in the SF Oracle RAC environment is far quicker than recovery for a failover database.
- Verification of disaster recovery configuration using fire drill technology without affecting production systems.
- Support for a wide range of hardware replication technologies as well as block-level replication using VVR.
- Support for campus clusters with the following capabilities:
  - Consistent reattach with Site Awareness
  - Site aware reads with VxVM mirroring
  - Monitoring of Oracle resources
  - Protection against split brain
- Optimized 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.

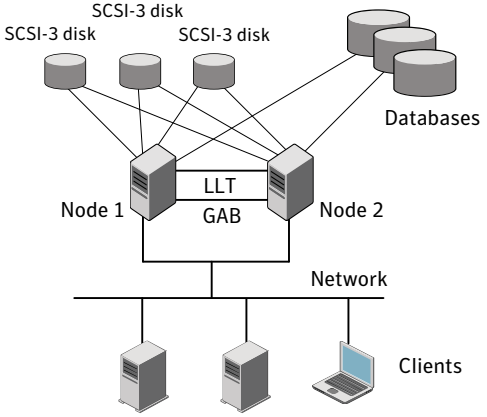
At a conceptual level, SF Oracle RAC is a cluster that manages applications (instances), networking, and storage components using resources contained in service groups. SF Oracle RAC clusters have the following properties:

- 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.

Figure 1-1 below displays the basic layout and individual components required for a SF Oracle RAC installation. This basic layout includes the following components:

- SCSI-3 Coordinator disks used for I/O fencing
- Nodes that form an application cluster and are connected to both the coordinator disks and databases
- Database(s) for storage and backup

Figure 1-1 SF Oracle RAC basic layout and components



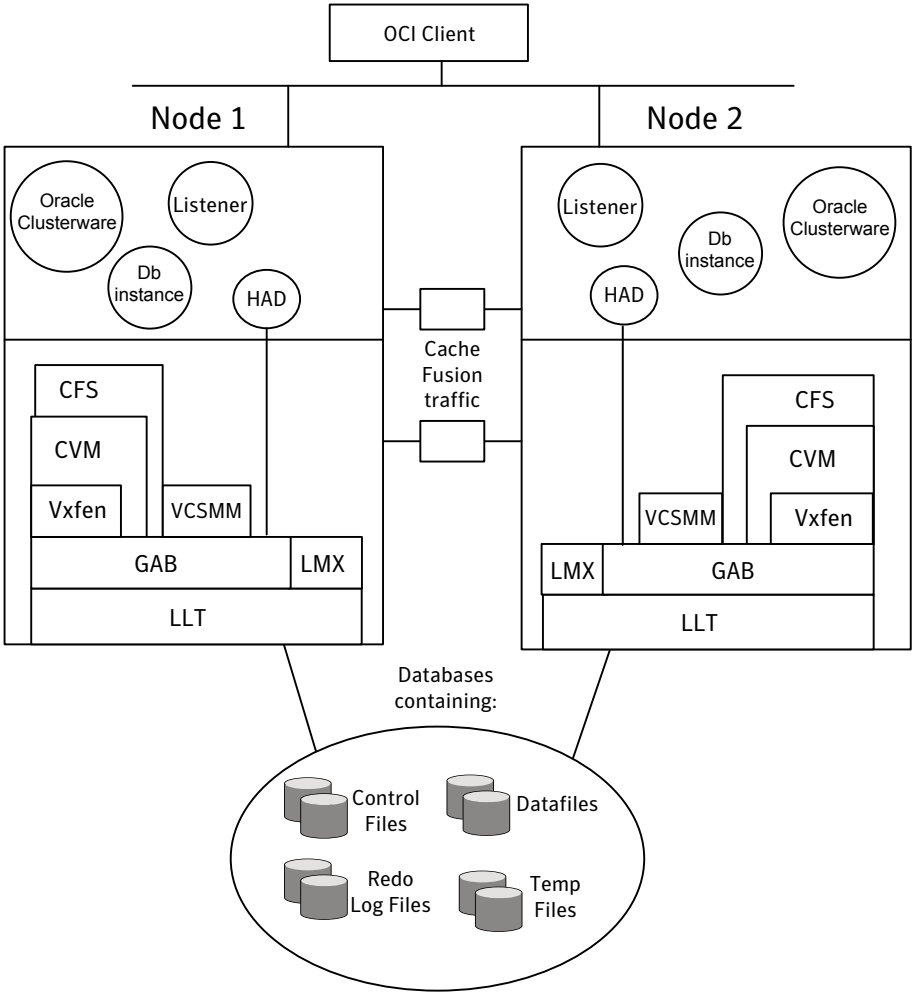
SF Oracle RAC adds the following technologies to a failover cluster environment, which are engineered specifically to improve performance, availability, and manageability of Oracle RAC environments:

- 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 and RAC for managing cluster membership and communication.

Figure 1-2 displays the technologies that make up the SF Oracle RAC internal architecture.

Figure 1-2 SF Oracle RAC architecture



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.

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.

Table 1-1 SF Oracle RAC component products

Component product	Description
Cluster Volume Manager (CVM)	Enables simultaneous access to shared volumes based on technology from Veritas Volume Manager (VxVM). See "Cluster Volume Manager (CVM)" on page 29.
Cluster File System (CFS)	Enables simultaneous access to shared file systems based on technology from Veritas File System (VxFS). See "Cluster File System (CFS)" on page 31.
Cluster Server (VCS)	Uses technology from Veritas Cluster Server to manage Oracle RAC databases and infrastructure components. See "Veritas Cluster Server" on page 35.
Database Accelerator	Provides the interface with the Oracle Disk Manager (ODM) API. See "Oracle Disk Manager" on page 34.
RAC Extensions	Manages cluster membership and communications between cluster nodes. See "RAC extensions" on page 38.

Communication infrastructure

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

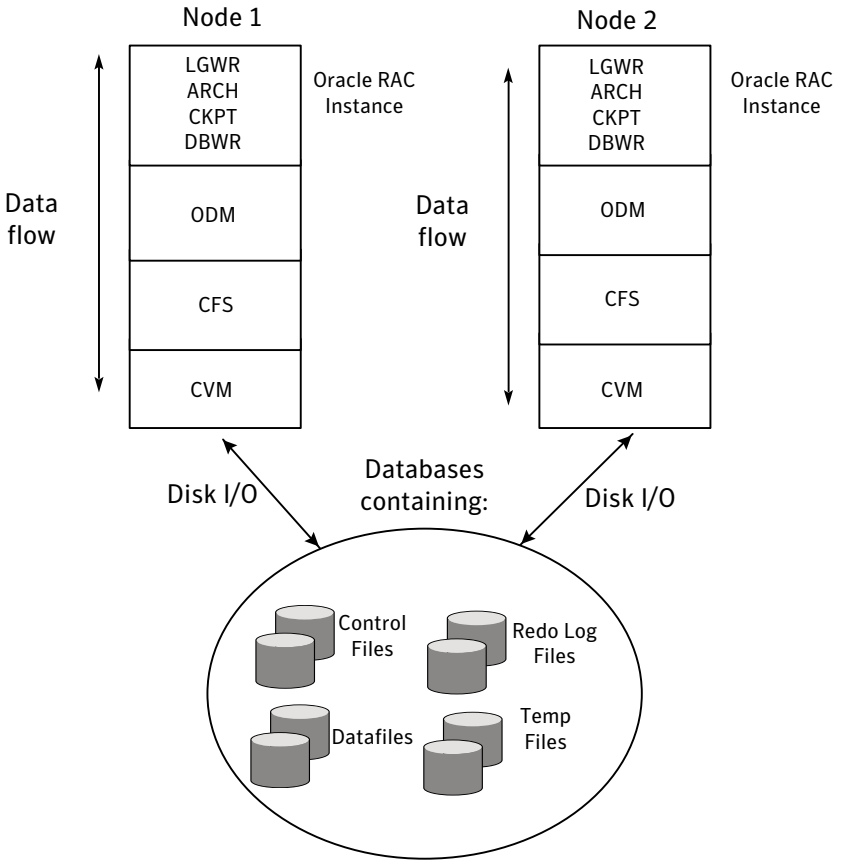
Data flow

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, and Archiver -- read and write data to the storage through the I/O stack. Oracle communicates through the ODM interface to CFS, which in turn accesses the storage through the CVM.

Figure 1-3 represents the overall data flow.

Figure 1-3 Data stack



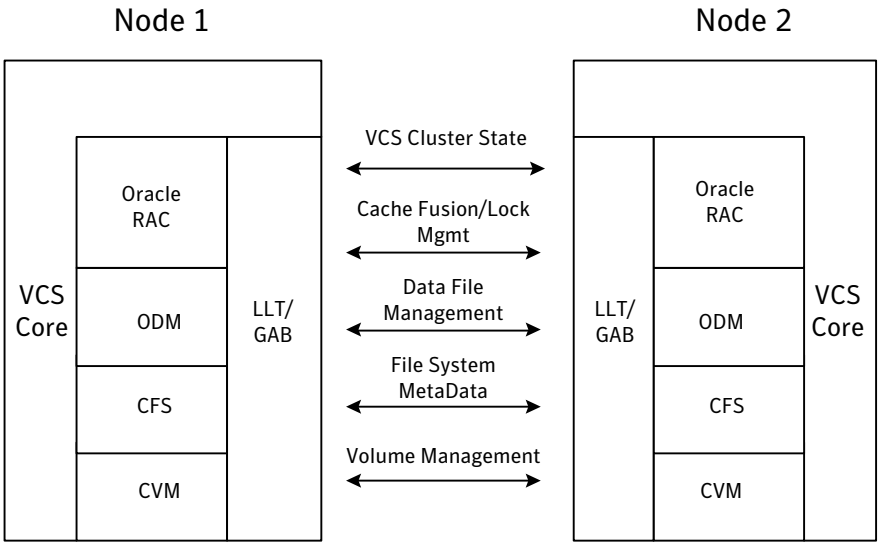
Communication requirements

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 communicate 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 1-4 represents the communication stack.

Figure 1-4 Communication stack



Cluster interconnect communication channel

The cluster interconnect provides an additional communication channel for all system-to-system communication, separate from the one-node 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, 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):

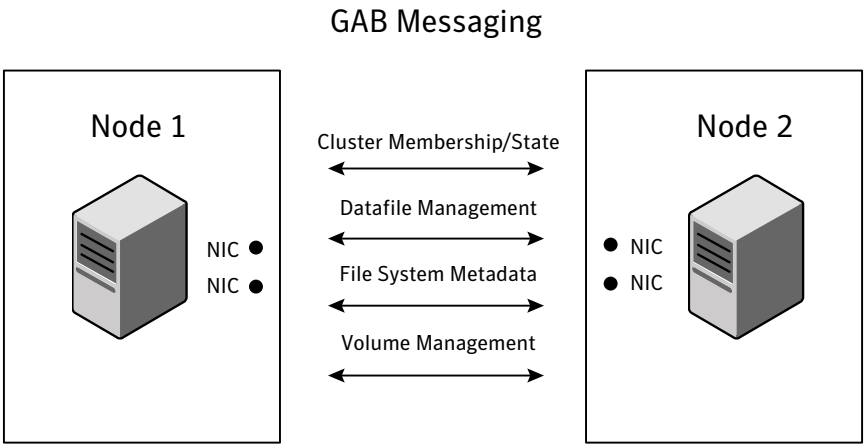
- Traffic distribution
  LLT distributes (load-balances) internode communication across all available cluster interconnect links. All cluster communications are evenly distributed across as many as eight network links for performance and fault resilience. If a link fails, LLT redirects traffic to the 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 1-5 shows the cluster communication using GAB messaging.

Figure 1-5 Cluster communication



Review the following information on cluster membership and cluster communication:

- 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:

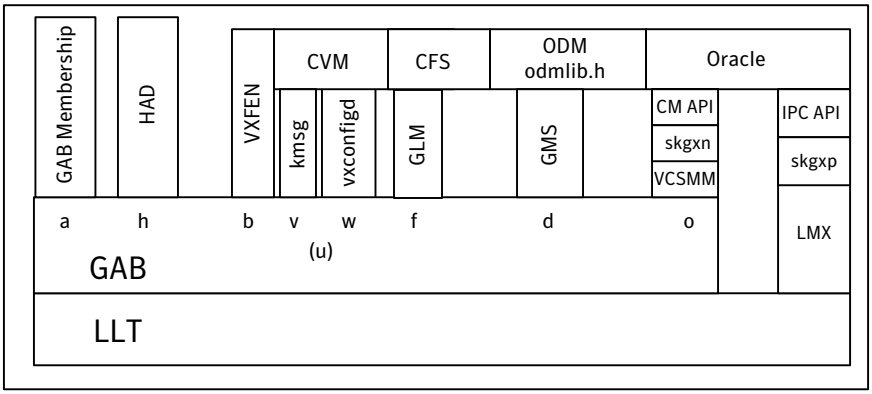
  - When systems no longer receive heartbeat messages from a peer for a predetermined interval, a protocol excludes the peer from the current membership.
  - GAB informs processes on the remaining nodes that the cluster membership has changed; this action initiates recovery actions specific to each module. 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 components 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 (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 modules 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.

Figure 1-6 Low-level communication



For additional information about the different GAB ports:

See "GAB port membership" on page 247.

Cluster Volume Manager (CVM)

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`.

Note: 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. The kernel module for CVM is ksmg.

See Figure 1-6 on page 29.

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. For an illustration of these ports:

See Figure 1-6 on page 29.

CVM communication involves the following GAB ports:

- 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 as 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.

CVM recovery

When a node leaves a cluster, the new membership is delivered by GAB, to CVM on existing cluster nodes. Fencing driver (VXFEN) ensures that split-brain scenarios are taken care of before CVM is notified. CVM then initiates recovery of mirrors of shared volumes that might have been in an inconsistent state following the exit of the node.

For database files, when ODM is enabled with SmartSync option, Oracle Resilvering handles recovery of mirrored volumes. For non-database files, this recovery is optimized using Dirty Region Logging (DRL). The DRL is a map stored in a special purpose VxVM sub-disk and attached as an additional plex to the mirrored volume. When a DRL subdisk is created for a shared volume, the length of the sub-disk is automatically evaluated so as to cater to the number of cluster nodes. If the shared volume has Fast Mirror Resync (FlashSnap) enabled, the DCO (Data Change Object) log volume created automatically has DRL embedded in it. In the absence of DRL or DCO, CVM does a full mirror resynchronization.

Configuration differences with VxVM

CVM configuration differs from VxVM configuration in the following 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.

Cluster File System (CFS)

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 other file systems which 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.

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.

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. One of the nodes in the cluster is the primary node for a file system. 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 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. SF Oracle RAC configurations minimize the use of GLM locking except when metadata for a file changes.

CFS communication involves various GAB ports for different types of communication. For an illustration of these ports:

See Figure 1-6 on page 29.

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 the following 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. Use the `vxresize` command from CVM master and CFS primary to dynamically change the size of a CFS filesystem. For more information on vxresize, refer to the vxresize(1), fsadm_vxfs(1) and chfs(1) manual pages.
- 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. The 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.

Comparing raw volumes and 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=Oracle owner=Oracle mode=660 \
  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 user.

Oracle Disk Manager

SF Oracle RAC requires Oracle Disk Manager (ODM), a standard API published by Oracle for support of database I/O. Veritas 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 the following 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

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 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.

For an illustration of the ODM and port d, see Figure 1-6.

Veritas Cluster Server

Veritas Cluster Server (VCS) directs SF Oracle RAC operations by controlling the startup and shutdown of components layers and providing monitoring and notification for failures.

In a typical SF Oracle RAC configuration, the Oracle 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 over 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 GAB 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. 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.

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, PrivNIC.cf, and MultiPrivNIC.cf.

Oracle RAC

Review the following information on Cluster Ready Services, the Oracle Cluster Registry, application resources, and the voting disk.

Note: Refer to the Oracle RAC documentation for additional information.

Oracle Clusterware

Oracle Clusterware manages Oracle cluster-related functions including membership, group services, global resource management, and databases. Oracle Clusterware is required for every Oracle RAC instance.

Oracle Clusterware requires the following major components:

- A cluster interconnect that allows for cluster communications
- A private virtual IP address for cluster communications over the interconnect.
- A public virtual IP address for client connections.
- Shared storage accessible by each node.

Oracle Cluster Registry

The Oracle Cluster Registry (OCR) contains cluster and database configuration and state information for Oracle RAC and Oracle Clusterware.

The information maintained in the OCR includes:

- The list of nodes
- The mapping of database instances to nodes
- Oracle Clusterware application resource profiles
- Resource profiles that define the properties of resources under Oracle Clusterware control
- Rules that define dependencies between the Oracle Clusterware resources
- The current state of the cluster

The OCR data exists on a shared raw volume or a cluster file system that is accessible to each node. For Oracle RAC 10g, this requires a minimum of 100 MB of disk space. For Oracle RAC 11g, this requires a minimum of 256 MB of disk space.

You can specify redundant storage for the OCR to protect against failures. Oracle Clusterware faults nodes if the OCR is not accessible because of corruption or disk failure. Oracle automatically backs up OCR data. You can also export the OCR contents before making configuration changes in Oracle Clusterware. This way, if you encounter configuration problems and are unable to restart Oracle Clusterware, you can restore the original contents.

Consult the Oracle documentation for instructions on exporting and restoring OCR contents.

Application Resources

Oracle Clusterware application resources are similar to VCS resources. Each component controlled by Oracle Clusterware is defined by an application resource, including databases, instances, services, and node applications.

Unlike VCS, Oracle Clusterware uses separate resources for components that run in parallel on multiple nodes.

Resource Profiles

Resources are defined by profiles, which are similar to the attributes that define VCS resources. The OCR contains application resource profiles, dependencies, and status information.

Oracle Clusterware Node Applications

Oracle Clusterware uses these node application resources to manage Oracle components, such as databases, listeners, and virtual IP addresses. Node application resources are created during Oracle Clusterware installation.

Voting Disk

The voting disk is a heartbeat mechanism used by Oracle Clusterware to maintain cluster node membership. Voting disk data exists on a shared raw volume or a cluster file system that is accessible to each node.

The ocssd processes of Oracle Clusterware provides cluster node membership and group membership information to RAC instances. On each node, ocssd processes write a heartbeat to the voting disk every second. If a node is unable to access the voting disk, Oracle Clusterware determines the cluster is in a split brain condition and panics the node.

RAC extensions

Oracle RAC relies on several support services provided by VCS. Key features include Veritas Cluster Server Membership Manager (VCSMM) and Veritas Cluster Server 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 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.

For an illustration of the connection between VCSMM, the skgxn library, and port o, see Figure 1-6.

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 dynamically linked to Oracle at installation time to implement the `skgxp` functionality. This module communicates with the LLT Multiplexer (LMX) using `ioctl` calls.

The LMX module 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.

Note: The LLT multiplexer is no longer supported with Oracle 11g.

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.

Oracle and cache fusion traffic

Private IP address types are required by Oracle for cache fusion traffic.

- For Oracle 10g, Veritas Cluster Inter-Process Communication (VCSIPC) supports Oracle cache fusion and provides an API for Oracle cache fusion. The API is provided through the libskgxp library. The libskgxp library makes calls into the LLT Multiplexer (LMX). LMX uses Low Latency Transport LLT to send data

across the private interconnects. LMX also provides link aggregation and redundancy of private links.

- For Oracle 11g, Symantec provides a MultiPrivNIC agent and UDP/IP support for Oracle's cache fusion.

About preventing data corruption with I/O fencing

I/O fencing is a feature that prevents data corruption in the event of a communication breakdown in a cluster.

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.

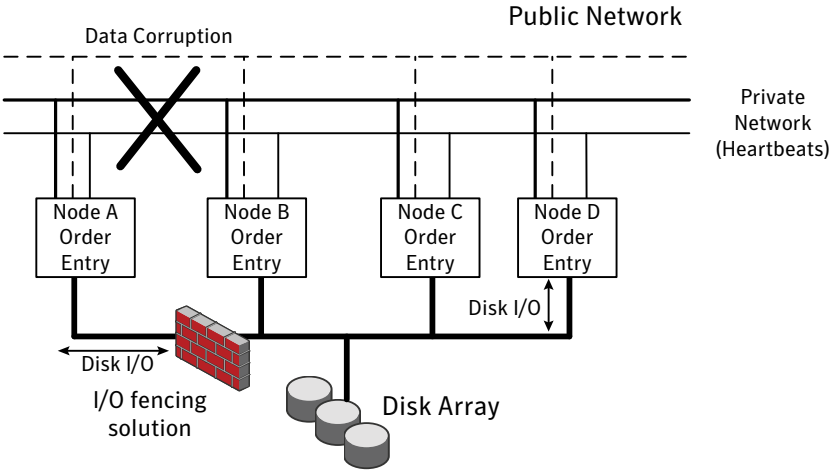
Problems arise when the mechanism that detects the failure breaks down because symptoms appear identical to those of a failed node. For example, if a system in a two-node cluster fails, the system stops sending heartbeats over the private interconnects. The remaining node then takes corrective action. The failure of the private interconnects, instead of the actual nodes, presents identical symptoms and causes each node to determine its peer has departed. This situation typically results in data corruption because both nodes try 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 the nodes that use the 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. They can declare it dead even if the system later returns and begins write operations.

SF Oracle RAC uses I/O fencing to remove the risk that is associated with split brain. I/O fencing allows write access for members of the active cluster. It blocks access to storage from non-members. It even blocks a node that is alive is unable to cause damage.

Figure 1-7 displays a schematic of a four node cluster, each node writing order entries to the connected disk array. When the private network connection between the four nodes is disrupted (between Node A and the other 3 nodes in the figure below), a split brain situation occurs with the possibility of data corruption to the disk array The I/O fencing process prevents split-brain and any data corruption by fencing off Node A from the cluster.

Figure 1-7 Private network disruption and I/O fencing solution



About 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." 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 easy 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.

About 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 tries 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 restarts the system.

About 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.

See "Low-level communication: port relationship between GAB and processes" on page 28.

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.

About database management using SF Oracle RAC

SF Oracle RAC database management options include:

- The ability to back up and recover data at the volume and file system levels using Veritas Storage Checkpoints and Veritas Database FlashSnap.
- The ability to manage tiered storage using Database Dynamic Tiered Storage. You can set policies and move files to maximize the economic efficiency of your storage.

- 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.

Database snapshot and backup options

You can configure the following database components with SF Oracle RAC for cloning and recovery of databases:

- Storage Checkpoints
- Database FlashSnap

The following sections provide a brief overview of these features.

Database FlashSnap for cloning

Veritas Database FlashSnap helps to create a point-in-time copy of a database for backup and off-host processing. Database FlashSnap lets you make backup copies of your volumes online and with minimal interruption to users.

Database FlashSnap lets you capture an online image of an actively changing database at a given instant that is known as a snapshot. A snapshot copy of the database is referred to as a database snapshot. You can use a database snapshot on the same host as the production database or on a secondary host sharing the same storage. A database snapshot can be used for off-host processing applications, such as backup, data warehousing, and decision-support queries. When the snapshot is no longer needed, the database administrator can import the original snapshot back to the primary host and resynchronize the snapshot to the original database volumes. Database FlashSnap commands are executed from the command line interface.

Database FlashSnap advantages

Database FlashSnap provides the following advantages:

- The database snapshot can be used on the same host as the production database or on a secondary host sharing the same storage.
- 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, the privileges that database administrators do not usually have. Because superuser privileges are not required, Database FlashSnap overcomes these obstacles by enabling database administrators to easily create consistent snapshots of the database.

Storage Checkpoints for recovery

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 command line interface (CLI).

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 the changed blocks that are contained in a Storage Checkpoint into the primary file system for faster database restoration.

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.

Advantages and limitations of Storage Checkpoints

Storage Checkpoints and rollback provides the following advantages:

- Initially, a Storage Checkpoint contains no data—it contains only the inode list and the block map of the primary fileset. The 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 keeps track of block change information and thereby enables incremental database backup at the block level.
- A Storage Checkpoint helps recover data from incorrectly modified files.
- A Storage Checkpoint can be mounted, allowing regular file system operations to be performed. Mountable Storage Checkpoints can be used for a wide range of application solutions that include backup, investigations into data integrity, staging upgrades or database modifications, and data replication solutions.

The limitations of Storage Checkpoints are as follows:

- 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 that are kept on a separate medium.

Database storage optimization options

Database Dynamic Storage Tiering (DST) matches data storage with data usage requirements. Data can then be relocated based upon data usage and other requirements that are determined by the database administrator (DBA).

As more and more data is retained over a period of time, eventually, some of that data is needed less frequently. The data that is needed less frequently still requires a large amount of disk space. DST enables the database administrator to manage data so that less frequently used data can be moved to slower, less expensive disks. This practice also permits the frequently accessed data to be stored on faster disks for quicker retrieval.

Chapter 2

Administering SF Oracle RAC and its components

This chapter includes the following topics:

Administering SF Oracle RAC

This section provides instructions for the following SF Oracle RAC administration tasks:

If you encounter issues while administering SF Oracle RAC, refer to the troubleshooting section for assistance.

Setting the PATH variable

To set the PATH variable for the root user:

For sh, ksh, bash:

```
PATH=/usr/ccs/bin:/usr/local/bin:/usr/bin/X11:/sbin:/usr/bin:
/usr/sbin:/usr/lib/vxvm/bin:/opt/VRTSvxfs/cfs/bin:
/opt/VRTSvcs/bin:/opt/VRTS/bin:/etc/vx/bin:/usr/ucb:/opt/VRTSvcs/vxfen/bin/:
/opt/VRTSdbcom/bin/:/opt/VRTSgab
export PATH
```

For csh:

```
setenv PATH
/opt/VRTSob/bin:/usr/ccs/bin:/usr/local/bin:/usr/bin/X11:/sbin:/usr/bin:/usr/sbin:
/usr/lib/vxvm/bin:/opt/VRTSvxfs/cfs/bin:/opt/VRTSvcs/bin:
/opt/VRTS/bin:/etc/vx/bin:/usr/ucb:/opt/VRTSvcs/vxfen/bin/:/opt/VRTSdbcom/bin/:
/opt/VRTSgab
```

To set the PATH variable for the Oracle user:

For sh, ksh, bash:

```
PATH=/usr/bin:/etc:/usr/sbin:/usr/ucb:/usr/oracle/bin:/usr/bin/X11:
/sbin:.:/oracle/orahome/bin:/crshome/crs/bin:/opt/VRTS/bin:
/opt/VRTSdbed/bin
export PATH
```

For csh:

```
setenv PATH
/usr/bin:/etc:/usr/sbin:/usr/ucb:/usr/oracle/bin:
/usr/bin/X11:/sbin:.:/oracle/orahome/bin:
/crshome/crs/bin:/opt/VRTS/bin:/opt/VRTSdbed/bin
```

In this example:

- `/oracle/orahome/bin` is the location of the Oracle Home bin directory.
- `/crshome/crs/bin` is the location of the Oracle Clusterware bin directory.

Setting the MANPATH variable

To set the MANPATH variable for the root user:

For sh, ksh, bash:

```
MANPATH=/usr/man:/usr/share/man:/opt/VRTS/man
export MANPATH
```

For csh:

```
setenv MANPATH /usr/man:/usr/share/man:/opt/VRTS/man
```

Stopping SF Oracle RAC manually on a single node

This section describes the procedure for gracefully stopping SF Oracle RAC on a single node within a cluster. This procedure may be required for cluster or node maintenance, cluster or node testing, or for any other user-specific requirement .

In this procedure, the node is galaxy.

Stopping SF Oracle RAC on a single node within a cluster

1. Log in as superuser to the node.
2. For Oracle database instances that are under VCS control:
   - Stop all applications that use CFS or VxVM, but are not under VCS control.
   - Make sure that no processes are running, which make use of mounted shared file system or shared volumes.

     ```
     # fuser -cu /mount_point
     ```

   - Unmount all the VxFS file systems, which are not under VCS control.

     ```
     # umount /mount_point
     ```

   - With SF Oracle RAC installed and configured, run the following command on the single node (galaxy) in the SF Oracle RAC cluster:

     ```
     # hastop -local
     ```

   For Oracle database instances that are not under VCS control:
   - Stop all applications that use CFS or VxVM, but are not under VCS control.
   - Take offline all VCS service groups that are dependent on the Oracle database.

     ```
     # hagrp -offline group_name -sys galaxy
     ```

   - If the database instances are under Oracle Clusterware control, run the following command on the node (galaxy) as the oracle user:

```
$ srvctl stop instance -d database_name -i instance_name
```

- With SF Oracle RAC installed and configured, run the following command on the single node (galaxy) in the SF Oracle RAC cluster:

```
# hastop -local
```

3 For an optional port verification step, make sure only ports a, b, d, and o are open on galaxy by running the `gabconfig -a` command:

```
# gabconfig -a

GAB Port Memberships
===============================================================
Port a gen 6b5901 membership 01
Port b gen 6b5904 membership 01
Port d gen 6b5907 membership 01
Port o gen 6b5905 membership 01
```

Run the `gabconfig -a` command on the other node(s) in the system . The following command output should be displayed:

```
# gabconfig -a

GAB Port Memberships
===============================================================
Port a gen 6b5901 membership 01
Port b gen 6b5904 membership 01
Port d gen 6b5907 membership 01
Port f gen 6b5905 membership ;1
Port h gen 6b5908 membership ;1
Port o gen 6b5903 membership 01
Port v gen 6b5907 membership ;1
Port w gen 6b5909 membership ;1
```

Stopping and starting LLT and GAB

You can use the following procedures to stop and restart LLT and GAB modules.

See the *Veritas Storage Foundation Cluster File System Administrator's Guide* for procedures to start and stop the CFS drivers.

To stop LLT and GAB

- Run the following in the order below:

```
# /sbin/init.d/odm stop
# /sbin/init.d/gab stop
# /sbin/init.d/llt stop
```

To start LLT and GAB

- Run the following in the order below:

```
# /sbin/init.d/llt start
# /sbin/init.d/gab start
# /sbin/init.d/odm start
```

Adding LLT links to increase capacity

In an SF Oracle RAC cluster, Oracle Clusterware heartbeat link MUST be configured as an LLT link. If Oracle Clusterware and LLT use different links for their communication, then the membership change between VCS and Oracle Clusterware is not coordinated correctly. For example, if only the Oracle Clusterware links are down, Oracle Clusterware kills one set of nodes after the expiry of the css-misscount interval and initiates the Oracle Clusterware and database recovery, even before CVM and CFS detect the node failures. This uncoordinated recovery may cause data corruption.

If you need additional capacity for Oracle communication on your private interconnects, you can add LLT links. The network IDs of the interfaces connected to the same physical network must match. The interfaces specified in the PrivNIC or MultiPrivNIC configuration must be exactly the same in name and total number as those which have been used for LLT configuration.

LLT links can be added or removed while clients are connected.

Refer to the `lltconfig` manual page for more information.

Note: When you add or remove LLT links, you need not shut down GAB or the high availability daemon, `had`. Your changes take effect immediately, but are lost on the next restart. For changes to persist, you must also update /etc/llttab.

To add a new LLT link

- Enter the following command:

```
# lltconfig -d device -t device_tag
```

To remove an LLT link

- Enter the following command:

```
# lltconfig -u device_tag
```

Administering VCS

This section provides instructions for the following VCS administration tasks:

- Viewing available Veritas devices and drivers
- Loading Veritas drivers into memory
- Configuring VCS to start Oracle with a specified Pfile
- Verifying VCS configuration
- Starting and stopping VCS

If you encounter issues while administering VCS, refer to the troubleshooting section for assistance.

See "Troubleshooting VCSIPC" on page 258.

Viewing available Veritas devices and drivers

To view the devices that are loaded in memory, run the `kcmodule` command as shown in the following examples.

For example:

If you want to view whether or not the driver 'gab' is loaded in memory:

```
# kcmodule |grep gab
gab             loaded  explicit  auto-loadable, unloadable
```

If you want to view whether or not the 'vx' drivers are loaded in memory:

```
# kcmodule |grep vx

vxdmp           static  best
vxfen           loaded  explicit  auto-loadable, unloadable
vxfs            unused
vxfs50          static  best      loadable, unloadable
vxglm           loaded  explicit  auto-loadable, unloadable
vxgms           loaded  explicit  auto-loadable, unloadable
vxportal        unused            auto-loadable, unloadable
vxportal50      static  best      loadable, unloadable
```

Loading Veritas drivers into memory

Under normal operational conditions, you do not need to load Veritas drivers into memory. You might need to load a Veritas driver only if there is a malfunction.

To load the ODM driver into memory:

```
# kcmodule odm=loaded
```

Configuring VCS to start Oracle with a specified Pfile

If you want to configure VCS such that Oracle starts with a specified Pfile, modify the main.cf file for the Oracle group as follows:

```
Oracle Ora_1 (
                Sid @galaxy = PROD11
                Sid @nebula = PROD12
                Owner = oracle
                Home = "/oracle/orahome"
                StartUpOpt = SRVCTLSTART
                ShutDownOpt = SRVCTLSTOP
                OnlineTimeout = 900
                )
```

Verifying VCS configuration

To verify the VCS configuration:

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

Starting and stopping VCS

To start VCS on each node:

```
# hastart
```

To stop VCS on each node:

```
# hastop -local
```

You can also use the command "hastop -all"; however, make sure that you wait for port 'h' to close before restarting VCS.

Administering I/O fencing

This section describes I/O fencing and provides instructions for common I/O fencing administration tasks.

If you encounter issues while administering I/O fencing, refer to the troubleshooting section for assistance.

See "Troubleshooting I/O fencing" on page 248.

About I/O fencing

I/O fencing protects the data on shared disks when nodes in a cluster detect a change in the cluster membership that indicates a split brain condition.

The fencing operation determines the following:

- The nodes that must retain access to the shared storage
- The nodes that must be ejected from the cluster

This decision prevents possible data corruption. The installxxxxx program installs the SF Oracle RAC I/O fencing driver, VRTSvxfen. To protect data on shared disks, you must configure I/O fencing after you install and configure SF Oracle RAC.

I/O fencing technology uses coordination points for arbitration in the event of a network partition.

See "About preventing data corruption with I/O fencing" on page 40.

About I/O fencing components

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

- Data disks—Store shared data
  See "About data disks" on page 55.
- Coordination points—Act as a global lock during membership changes

See "About coordination points" on page 55.

About 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 that are added to a disk group and new paths that are discovered for a device are automatically fenced.

About coordination points

Coordination points 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 coordination points before it can fence the peer from the data drives. Racing for control of the coordination points to fence data disks is the key to understand how fencing prevents split brain.

Disks that act as coordination points are called 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.

Dynamic Multipathing (DMP) allows coordinator disks to take advantage of the path failover and the dynamic adding and removal capabilities of DMP. On cluster nodes with HP-UX 11i v3, you must use DMP devices or iSCSI devices for I/O fencing. The following changes in HP-UX 11i v3 require you to not use raw devices for I/O fencing:

- Provides native multipathing support
- Does not provide access to individual paths through the device file entries

The metanode interface that HP-UX provides does not meet the SCSI-3 PR requirements for the I/O fencing feature. You can configure coordinator disks to use Veritas Volume Manager Dynamic Multipathing (DMP) feature.

See the *Veritas Volume Manager Administrator's Guide*.

How I/O fencing works in different event scenarios

Table 2-1 describes how I/O fencing works to prevent data corruption in different failure event scenarios. For each event, review the corrective operator actions.

Table 2-1 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 panics and 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.
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 panics and 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 2-1 I/O fencing scenarios *(continued)*

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. See "System panics to prevent potential data corruption" on page 249.

Table 2-1 I/O fencing scenarios *(continued)*

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. See "System panics to prevent potential data corruption" on page 249.
The disk array containing two of the three coordinator disks is powered off. Node B leaves the cluster and the disk array is still powered off.	Node A continues to operate as long as no nodes leave the cluster. Node A races for a majority of coordinator disks. Node A fails because only one of three coordinator disks is available. Node A panics and removes itself from the cluster.	Node B continues to operate as long as no nodes leave 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 I/O fencing utilities

The I/O fencing feature provides the following utilities that are available through the VRTSvxfen package:

vxfentsthdw	Tests hardware for I/O fencing Path: /opt/VRTSvcs/vxfen/bin/vxfentsthdw See "About vxfentsthdw utility" on page 59.
vxfenconfig	Configures and unconfigures I/O fencing Checks the list of coordinator disks used by the vxfen driver. Path: /sbin/vxfenconfig
vxfenadm	Displays information on I/O fencing operations and manages SCSI-3 disk registrations and reservations for I/O fencing Path: /sbin/vxfenadm See "About vxfenadm utility" on page 68.
vxfenclearpre	Removes SCSI-3 registrations and reservations from disks Path: /opt/VRTSvcs/vxfen/bin/vxfenclearpre See "About vxfenclearpre utility" on page 70.
vxfenswap	Replaces coordinator disks without stopping I/O fencing Path: /opt/VRTSvcs/vxfen/bin/vxfenswap See "About vxfenswap utility" on page 72.
vxfendisk	Generates the list of paths of disks in the diskgroup. This utility requires that Veritas Volume Manager is installed and configured. Path: /opt/VRTSvcs/vxfen/bin/vxfendisk

Refer to the corresponding manual page for more information on the commands.

About vxfentsthdw utility

You can use the vxfentsthdw utility to verify that shared storage arrays 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 disk groups.

See to set up I/O fencing.

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.

About general guidelines for using vxfentsthdw utility

Review the following guidelines to use the vxfentsthdw utility:

- 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, you can 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.

  See "Verifying that the nodes see the same disk" on page 70.

- 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 the `-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/vx/rdmp/c1t1d0 is ready to be configured for
  I/O Fencing on node galaxy
  ```

  If the utility does not show a message stating a disk is ready, verification has failed.

- If the disk you intend to test has existing SCSI-3 registration keys, the test issues a warning before proceeding.

About the vxfentsthdw command options

Table 2-2 describes the methods that the utility provides to test storage devices.

Table 2-2 vxfentsthdw options

vxfentsthdw option	Description	When to use
-n	Utility uses rsh for communication.	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. See "Performing non-destructive testing on the disks using the -r option" on page 64.
-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.
-d	Use DMP devices. May be used with -c or -g options.	By default, the script picks the DMP paths for disks in the diskgroup. If you want the script to use the raw paths for disks in the diskgroup, use the -w option.
-w	Use raw devices. May be used with -c or -g options.	With the -w option, the script picks the raw paths for disks in the diskgroup. By default, the script uses the -d option to pick up the DMP paths for disks in the disk group.
-c	Utility tests the coordinator disk group prompting for systems and devices, and reporting success or failure.	For testing disks in coordinator disk group. See "Testing the coordinator disk group using vxfentsthdw -c option" on page 62.
-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. See "Testing the shared disks using the vxfentsthdw -m option" on page 64.

Table 2-2 vxfentsthdw options *(continued)*

vxfentsthdw option	Description	When to use
-f *filename*	Utility tests system/device combinations listed in a text file. May be used with -r and -t options.	For testing several disks. See "Testing the shared disks listed in a file using the vxfentsthdw -f option" on page 66.
-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. See "Testing all the disks in a disk group using the vxfentsthdw -g option" on page 67.

Testing the coordinator disk group using vxfentsthdw -c option

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.

The procedure in this section uses the following disks for example:

- From the node galaxy, the disks are /dev/vx/rdmp/c1t1d0, /dev/vx/rdmp/c2t1d0, and /dev/vx/rdmp/c3t1d0.
- From the node nebula, the same disks are seen as /dev/vx/rdmp/c4t1d0, /dev/vx/rdmp/c5t1d0, and /dev/vx/rdmp/c6t1d0.

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: galaxy
Enter the second node of the cluster: nebula
```

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/vx/rdmp/c1t1d0 have PASSED.
The disk is now ready to be configured for I/O Fencing on node
galaxy as a COORDINATOR DISK.

ALL tests on the disk /dev/vx/rdmp/c4t1d0 have PASSED.
The disk is now ready to be configured for I/O Fencing on node
nebula 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.

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.

See the for instructions to initialize disks for I/O fencing and to set up coordinator disk groups.

If necessary, start the disk group.

See the *Veritas Volume Manager Administrator's Guide* for instructions to start the disk group.

3 Retest the disk group.

See "Testing the coordinator disk group using vxfentsthdw -c option" on page 62.

Performing non-destructive testing on the disks using the -r option

You can perform non-destructive testing on the disk devices when you want to preserve the data.

To perform non-destructive testing on disks

- To test disk devices containing data you want to preserve, you can use the -r option with the -m, -f, or -g options.

  For example, to use the -m option and the -r option, you can run the utility as follows:

  ```
  # /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.

Testing the shared disks using the vxfentsthdw -m option

Review the procedure to test the shared disks. By default, the utility uses the -m option.

This procedure uses the /dev/vx/rdmp/c1t1d0 disk in the steps.

If the utility does not show a message stating a disk is ready, verification has failed. Failure of verification can be the result of an improperly configured disk array. It can also be caused by a bad disk.

If the failure is due to a bad disk, remove and replace it. The vxfentsthdw utility indicates a disk can be used for I/O fencing with a message resembling:

```
The disk /dev/vx/rdmp/c1t1d0 is ready to be configured for
I/O Fencing on node galaxy
```

Note: For A/P arrays, run the `vxfentsthdw` command only on secondary paths.

To test disks using vxfentsthdw script

1. Make sure system-to-system communication is functioning properly.
2. From one node, start the utility.

   ```
   # /opt/VRTSvcs/vxfen/bin/vxfentsthdw [-n]
   ```

3. After reviewing the overview and warning that the tests overwrite 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
   ```

4. Enter the names of the disks 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/vx/rdmp/cxtxdx
   /dev/vx/rdmp/c2t13d0
   Enter the disk name to be checked for SCSI-3 PGR on node
   nebula in the format: /dev/vx/rdmp/cxtxdx
   Make sure it's the same disk as seen by nodes galaxy and nebula
   /dev/vx/rdmp/c2t13d0
   ```

   If the serial numbers of the disks are not identical, then the test terminates.

5. Review the output as the utility performs the checks and report its activities.

6 If a disk is ready for I/O fencing on each node, the utility reports success:

```
ALL tests on the disk /dev/vx/rdmp/c1t1d0 have PASSED
The disk is now ready to be configured for I/O Fencing on node
galaxy
...
Removing test keys and temporary files, if any ...
.
.
```

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

Testing the shared disks listed in a file using the vxfentsthdw -f option

Use the -f option to test disks that are listed in a text file. Review the following example procedure.

To test the shared disks listed in a file

1 Create a text file disks_test to test two disks shared by systems galaxy and nebula that might resemble:

```
galaxy /dev/vx/rdmp/c2t2d1 nebula /dev/vx/rdmp/c3t2d1
galaxy /dev/vx/rdmp/c2t2d1 nebula /dev/vx/rdmp/c3t2d1
```

where the first disk is listed in the first line and is seen by galaxy as /dev/vx/rdmp/c2t2d1 and by nebula as /dev/vx/rdmp/c3t2d1. The other disk, in the second line, is seen as /dev/vx/rdmp/c2t2d2 from galaxy and /dev/vx/rdmp/c3t2d2 from nebula. Typically, the list of disks could be extensive.

2 To test the disks, enter the following command:

```
# /opt/VRTSvcs/vxfen/bin/vxfentsthdw -f disks_test
```

The utility reports the test results one disk at a time, just as for the -m option.

3 To redirect the test results to a text file, enter the following command:

```
# /opt/VRTSvcs/vxfen/bin/vxfentsthdw -f\
disks_test > test_disks.txt
```

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.

Precede the command with "yes" to acknowledge that the testing destroys any data on the disks to be tested.

For example:

```
# yes | /opt/VRTSvcs/vxfen/bin/vxfentsthdw -f\
disks_blue > blue_test.txt
```

Testing all the disks in a disk group using the vxfentsthdw -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.

After testing, destroy the disk group and put the disks into disk groups as you need.

To test all the disks in a diskgroup

1. Create a diskgroup for the disks that you want to test.
2. Enter the following command to test the diskgroup test_disks_dg:

   ```
   # /opt/VRTSvcs/vxfen/bin/vxfentsthdw -g test_disks_dg
   ```

   The utility reports the test results one disk at a time.
3. To redirect the test results to a text file for review, enter the following command:

   ```
   # /opt/VRTSvcs/vxfen/bin/vxfentsthdw -g \
   test_disks_dg > dgtestdisks.txt
   ```

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.

About vxfenadm utility

Administrators can use the vxfenadm command to troubleshoot and test fencing configurations.

The command's options for use by administrators are as follows:

-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

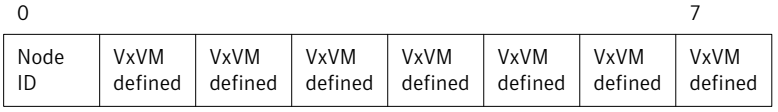
Refer to the `vxfenadm`(1m) manual page for a complete list of the command options.

About the registration key format

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.

Figure 2-1 depicts the format of the key.

Figure 2-1 I/O fencing key format



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/vx/rdmp/c1t12d0 by entering:

```
# /sbin/vxfenadm -g /dev/vx/rdmp/c2t1d0s2
Reading SCSI Registration Keys...
Device Name: /dev/vx/rdmp/c1t12d0
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 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."

Verifying that the nodes see the same disk

To confirm whether a disk (or LUN) supports SCSI-3 persistent reservations, two nodes must simultaneously have 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 that the same serial number for the LUN is returned on all paths to the LUN.

For example, an EMC array is accessible by the /dev/vx/rdmp/c2t13d0 path on node A and by the /dev/vx/rdmp/c2t11d0 path on node B.

To verify that the nodes see the same disks

1. Verify the connection of the shared storage for data to two of the nodes on which you installed SF Oracle RAC.
2. From node A, enter the following command:

```
# /sbin/vxfenadm -i /dev/vx/rdmp/c2t13d0

Vendor id       : EMC
Product id      : SYMMETRIX
Revision        : 5567
Serial Number   : 42031000a
```

The same serial number information should appear when you enter the equivalent command on node B using the /dev/vx/rdmp/c2t11d0 path.

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

```
# /sbin/vxfenadm -i /dev/vx/rdmp/c2t1d0

Vendor id       : HITACHI
Product id      : OPEN-3      -HP
Revision        : 0117
Serial Number   : 0401EB6F0002
```

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

About vxfenclearpre utility

You can use the vxfenclearpre utility to remove SCSI-3 registrations and reservations on the disks.

See "Removing preexisting keys" on page 71.

Removing preexisting keys

If you encountered a split brain condition, use the vxfenclearpre utility to remove SCSI-3 registrations and reservations on the coordinator disks as well as on the data disks in all shared disk groups.

You can also use this procedure to remove the registration and reservation keys created by another node from a disk.

To clear keys after split brain

1 Stop VCS on all nodes.

```
# hastop -all
```

2 Make sure that the port h is closed on all the nodes. Run the following command on each node to verify that the port h is closed:

```
# gabconfig -a
```

Port h must not appear in the output.

3 Stop I/O fencing on all nodes. Enter the following command on each node:

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

4 If you have any applications that run outside of VCS control that have access to the shared storage, then shut down all other nodes in the cluster that have access to the shared storage. This prevents data corruption.

5 Start the vxfenclearpre script:

```
# cd /opt/VRTSvcs/vxfen/bin
# ./vxfenclearpre
```

6 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
```

In some cases, 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. You can ignore these informational messages.

```
<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
```

The script cleans up the disks and displays the following status messages.

```
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...
#
```

7 Restart all nodes in the cluster.

About vxfenswap utility

The vxfenswap utility allows you to replace coordinator disks in a cluster that is online. The utility verifies that the serial number of the new disks are identical on all the nodes and the new disks can support I/O fencing.

Refer to the `vxfenswap`(1M) manual page.

You can replace the coordinator disks without stopping I/O fencing in the following cases:

- The disk becomes defective or inoperable and you want to switch to a new diskgroup.
  See "Replacing I/O fencing coordinator disks when the cluster is online" on page 73.
  See "Replacing the coordinator diskgroup in a cluster that is online" on page 76.
  If you want to replace the coordinator disks when the cluster is offline, you cannot use the vxfenswap utility. You must manually perform the steps that the utility does to replace the coordinator disks.
  See "Replacing defective disks when the cluster is offline" on page 252.
- You want to switch the disk interface between raw devices and DMP devices.
- The keys that are registered on the coordinator disks are lost.
  In such a case, the cluster might panic when a split-brain occurs. You can replace the coordinator disks with the same disks using the vxfenswap command. During the disk replacement, the missing keys register again without any risk of data corruption.
  See "Refreshing lost keys on coordinator disks" on page 80.

If the vxfenswap operation is unsuccessful, then you can use the `vxfenswap -a cancel` command to manually roll back the changes that the vxfenswap utility does. You must run this command if a node fails during the process of disk replacement, or if you aborted the disk replacement.

Replacing I/O fencing coordinator disks when the cluster is online

Review the procedures to add, remove, or replace one or more coordinator disks in a cluster that is operational.

Warning: The cluster might panic if any node leaves the cluster membership before the vxfenswap script replaces the set of coordinator disks.

To replace a disk in a coordinator diskgroup when the cluster is online

1. Make sure system-to-system communication is functioning properly.
2. Make sure that the cluster is online.

```
# /sbin/vxfenadm -d
I/O Fencing Cluster Information:
================================
Fencing Protocol Version: 201
Fencing Mode: SCSI3
Fencing SCSI3 Disk Policy: dmp
Cluster Members:
  * 0 (galaxy)
  1 (nebula)
RFSM State Information:
  node 0 in state 8 (running)
  node 1 in state 8 (running)
```

3. 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 node 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 locks are removed.

4. Turn off the coordinator attribute value for the coordinator disk group.

```
# vxdg -g vxfencoorddg set coordinator=off
```

5. To remove disks from the coordinator disk group, use the VxVM disk administrator utility vxdiskadm.
6. Perform the following steps to add new disks to the coordinator disk group:
   - Add new disks to the node.
   - Initialize the new disks as VxVM disks.
   - Check the disks for I/O fencing compliance.

- Add the new disks to the coordinator disk group and set the coordinator attribute value as "on" for the coordinator disk group.

See the for detailed instructions.

Note that though the disk group content changes, the I/O fencing remains in the same state.

7 Make sure that the /etc/vxfenmode file is updated to specify the correct disk policy.

See the for more information.

8 From one node, start the vxfenswap utility. You must specify the diskgroup to the utility.

Do one of the following:

- If you use ssh for communication:

```
# /opt/VRTSvcs/vxfen/bin/vxfenswap -g diskgroup
```

- If you use rsh for communication:

```
# /opt/VRTSvcs/vxfen/bin/vxfenswap -g diskgroup -n
```

The utility performs the following tasks:

- Backs up the existing /etc/vxfentab file.
- Creates a test file /etc/vxfentab.test for the diskgroup that is modified on each node.
- Reads the diskgroup you specified in the vxfenswap command and adds the diskgroup to the /etc/vxfentab.test file on each node.
- Verifies that the serial number of the new disks are identical on all the nodes. The script terminates if the check fails.
- Verifies that the new disks can support I/O fencing on each node.

9 If the disk verification passes, the utility reports success and asks if you want to commit the new set of coordinator disks.

10 Review the message that the utility displays and confirm that you want to commit the new set of coordinator disks. Else skip to step 11.

```
Do you wish to commit this change? [y/n] (default: n) y
```

If the utility successfully commits, the utility moves the /etc/vxfentab.test file to the /etc/vxfentab file.

11 If you do not want to commit the new set of coordinator disks, answer n.

The vxfenswap utility rolls back the disk replacement operation.

Replacing the coordinator diskgroup in a cluster that is online

You can also replace the coordinator diskgroup using the vxfenswap utility. The following example replaces the coordinator disk group vxfencoorddg with a new disk group vxfendg.

To replace the coordinator diskgroup

1 Make sure system-to-system communication is functioning properly.

2 Make sure that the cluster is online.

```
# /sbin/vxfenadm -d
I/O Fencing Cluster Information:
================================
Fencing Protocol Version: 201
Fencing Mode: SCSI3
Fencing SCSI3 Disk Policy: dmp
Cluster Members:
  * 0 (galaxy)
  1 (nebula)
RFSM State Information:
  node 0 in state 8 (running)
  node 1 in state 8 (running)
```

3 Find the name of the current coordinator diskgroup (typically vxfencoorddg) that is in the /etc/vxfendg file.

```
# cat /etc/vxfendg
vxfencoorddg
```

4 Find the alternative disk groups available to replace the current coordinator diskgroup.

```
# vxdisk -o alldgs list

DEVICE    TYPE    DISK  GROUP    STATUS
c4t0d1    auto:cdsdisk    -  (vxfendg)       online
c4t0d2    auto:cdsdisk    -  (vxfendg)       online
c4t0d3    auto:cdsdisk    -  (vxfendg)       online
c4t0d4    auto:cdsdisk    -  (vxfencoorddg)  online
c4t0d5    auto:cdsdisk    -  (vxfencoorddg)  online
c4t0d6    auto:cdsdisk    -  (vxfencoorddg)  online
```

5 Validate the new disk group for I/O fencing compliance. Run the following command:

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

See "Testing the coordinator disk group using vxfentsthdw -c option" on page 62.

6 If the new disk group is not already deported, run the following command to deport the disk group:

```
# vxdg deport vxfendg
```

7 Make sure that the /etc/vxfenmode file is updated to specify the correct disk policy.

See the for more information.

8 From any node, start the vxfenswap utility. For example, if vxfendg is the new diskgroup that you want to use as the coordinator diskgroup:

```
# /opt/VRTSvcs/vxfen/bin/vxfenswap -g vxfendg [-n]
```

The utility performs the following tasks:

- Backs up the existing /etc/vxfentab file.
- Creates a test file /etc/vxfentab.test for the diskgroup that is modified on each node.
- Reads the diskgroup you specified in the vxfenswap command and adds the diskgroup to the /etc/vxfentab.test file on each node.
- Verifies that the serial number of the new disks are identical on all the nodes. The script terminates if the check fails.
- Verifies that the new disk group can support I/O fencing on each node.

9 If the disk verification passes, the utility reports success and asks if you want to replace the coordinator disk group.

10 Review the message that the utility displays and confirm that you want to replace the coordinator disk group. Else skip to step 13.

```
Do you wish to commit this change? [y/n] (default: n) y
```

If the utility successfully commits, the utility moves the /etc/vxfentab.test file to the /etc/vxfentab file.

The utility also updates the /etc/vxfendg file with this new diskgroup.

11 Set the coordinator attribute value as "on" for the new coordinator disk group.

```
# vxdg -g vxfendg set coordinator=on
```

Set the coordinator attribute value as "off" for the old disk group.

```
# vxdg -g vxfencoorddg set coordinator=off
```

12 Verify that the coordinator disk group has changed.

```
# cat /etc/vxfendg
vxfendg
```

13 If you do not want to replace the coordinator disk group, answer n.

The vxfenswap utility rolls back any changes to the coordinator diskgroup.

Adding disks from a recovered site to the coordinator diskgroup

In a campus cluster environment, consider a case where the primary site goes down and the secondary site comes online with a limited set of disks. When the primary site restores, the primary site's disks are also available to act as coordinator disks. You can use the vxfenswap utility to add these disks to the coordinator diskgroup.

To add new disks from a recovered site to the coordinator diskgroup

1 Make sure system-to-system communication is functioning properly.

2 Make sure that the cluster is online.

```
# /sbin/vxfenadm -d
I/O Fencing Cluster Information:
================================
Fencing Protocol Version: 201
Fencing Mode: SCSI3
Fencing SCSI3 Disk Policy: dmp
Cluster Members:
  * 0 (galaxy)
  1 (nebula)
RFSM State Information:
  node 0 in state 8 (running)
  node 1 in state 8 (running)
```

3 Verify the name of the coordinator diskgroup.

```
# cat /etc/vxfendg
vxfencoorddg
```

4 Run the following command:

```
# vxdisk -o alldgs list

DEVICE    TYPE    DISK  GROUP    STATUS
c1t1d0    auto:cdsdisk    -  (vxfencoorddg)    online
c2t1d0    auto    -  -    offline
c3t1d0    auto    -  -    offline
```

5 Verify the number of disks used in the coordinator diskgroup.

```
# vxfenconfig -l
I/O Fencing Configuration Information:
======================================
Count               : 1
Disk List
Disk Name        Major  Minor  Serial Number     Policy

/dev/vx/rdmp/c1t1d0       32  48  R450 00013154 0312     dmp
```

6 When the primary site comes online, start the vxfenswap utility on any node in the cluster:

```
# /opt/VRTSvcs/vxfen/bin/vxfenswap -g vxfencoorddg [-n]
```

7 Verify the count of the coordinator disks.

```
# vxfenconfig -l
I/O Fencing Configuration Information:
======================================
Single Disk Flag      : 0
Count                 : 3
Disk List
Disk Name         Major  Minor  Serial Number     Policy

/dev/vx/rdmp/c1t1d0       32  48  R450 00013154 0312     dmp
/dev/vx/rdmp/c2t1d0       32  32  R450 00013154 0313     dmp
/dev/vx/rdmp/c3t1d0       32  16  R450 00013154 0314     dmp
```

Refreshing lost keys on coordinator disks

If the coordinator disks lose the keys that are registered, the cluster might panic when a split-brain occurs.

You can use the vxfenswap utility to replace the coordinator disks with the same disks. The vxfenswap utility registers the missing keys during the disk replacement.

To refresh lost keys on coordinator disks

1 Make sure system-to-system communication is functioning properly.

2 Make sure that the cluster is online.

```
# /sbin/vxfenadm -d
I/O Fencing Cluster Information:
================================
Fencing Protocol Version: 201
Fencing Mode: SCSI3
Fencing SCSI3 Disk Policy: dmp
Cluster Members:
  * 0 (galaxy)
  1 (nebula)
RFSM State Information:
  node 0 in state 8 (running)
  node 1 in state 8 (running)
```

3 Run the following command to view the coordinator disks that do not have keys:

```
# /sbin/vxfenadm -g all -f /etc/vxfentab
Device Name: /dev/vx/rdmp/c1t1d0
Total Number of Keys: 0
No keys...
...
```

4 On any node, run the following command to start the vxfenswap utility:

```
# /opt/VRTSvcs/vxfen/bin/vxfenswap -g vxfencoorddg [-n]
```

5 Verify that the keys are atomically placed on the coordinator disks.

```
# /sbin/vxfenadm -g all -f /etc/vxfentab
Device Name: /dev/vx/rdmp/c1t1d0
Total Number of Keys: 4
...
```

Administering CFS

This section describes some of the major aspects of cluster file system administration.

This section provides instructions for the following CFS administration tasks:

- Using cfsmount to mount CFS file systems
- Resizing CFS file systems
- Verifying the status of CFS file systems
- Verifying CFS port

If you encounter issues while administering CFS, refer to the troubleshooting section for assistance.

Using cfsmount to mount CFS file systems

To mount a CFS file system using cfsmount:

```
# cfsmount /ocrvote
Mounting...
[/dev/vx/dsk/galaxy_ocr/ocrvotevol]
mounted successfully at /ocrvote on galaxy
```

```
[/dev/vx/dsk/galaxy_ocr/ocrvotevol]
mounted successfully at /ocrvote on nebula
```

See the *Veritas Storage Foundation Cluster File System Administrator's Guide* for more information on the command.

Resizing CFS file systems

If you see a message on the console indicating that a CFS file system is full, you may want to resize the file system. The `vxresize` command lets you resize a CFS file system.

The following command resizes an Oracle binary CFS file system (the Oracle binary volume is CFS mounted):

```
# vxresize -g galaxy_ora ora_vol +2G
```

where galaxy_ora is the CVM disk group, ora_vol is the volume, and +2G indicates the increase in volume by 2 Gigabytes.

Verifying the status of CFS file systems

Run the "cfscluster status" command to see the status of the nodes and their mount points:

```
# cfscluster status

  Node             :  nebula
  Cluster Manager  :  not-running
  CVM state        :  not-running
  MOUNT POINT    SHARED VOLUME  DISK GROUP        STATUS

  /ocrvote       ocrvotevol     galaxy_ocr        NOT MOUNTED
  /oracle        ora_vol        galaxy_ora        NOT MOUNTED
  /crshome       ora_crs_vol    galaxy_crs        NOT MOUNTED
  /oradata1      ora_data1_vol  galaxy_data1      NOT MOUNTED
  /arch          archivol       galaxy_data1      NOT MOUNTED

  Node             :  galaxy
  Cluster Manager  :  running
  CVM state        :  running
  MOUNT POINT    SHARED VOLUME  DISK GROUP        STATUS

ta1      ora_data1_vol  galaxy_data1      MOUNTED
  /arch          archivol       galaxy_data1      MOUNTED
```

Verifying CFS port

CFS uses port 'f' for communication between nodes. The CFS port state can be verified as follows:

```
# gabconfig -a | grep "Port f"
```

Administering CVM

This section provides instructions for the following CVM administration tasks:

- Establishing CVM cluster membership manually
- Manually importing a shared disk group
- Manually deporting a shared disk group
- Evaluating the state of CVM ports
- Verifying if CVM is running in an SF Oracle RAC cluster
- Verifying CVM membership state
- Verifying the state of CVM shared disk groups
- Verifying the activation mode

If you encounter issues while administering CVM, refer to the troubleshooting section for assistance.

See "Troubleshooting CVM" on page 254.

Establishing CVM cluster membership manually

In most cases you do not have to start CVM manually; it normally starts when VCS is started.

Run the following command to start CVM manually:

```
# vxclustadm -m vcs -t gab startnode

vxclustadm: initialization completed
```

Note that `vxclustadm` reads main.cf for cluster configuration information and is therefore not dependent upon VCS to be running. You do not need to run the `vxclustadm startnode` command as normally the `hastart` (VCS start) command starts CVM automatically.

To verify whether CVM is started properly:

```
# vxclustadm nidmap
Name          CVM Nid     CM Nid      State
galaxy        0                0      Joined: Master
nebula        1                1      Joined: Slave
```

Manually importing a shared disk group

You can use the following command to manually import a shared disk group:

```
# vxdg -s import diskgroupname
```

Manually deporting a shared disk group

You can use the following command to manually deport a shared disk group:

```
# vxdg deport diskgroupname
```

Note that the deport of a shared disk group removes the SCSI-3 PGR keys on the disks. It also removes the 'shared' flag on the disks.

Evaluating the state of CVM ports

CVM kernel (vxio driver) uses port 'v' for kernel messaging and port 'w' for vxconfigd communication between the cluster nodes. The following command displays the state of CVM ports:

```
# gabconfig -a | egrep "Port [vw]"
```

Verifying if CVM is running in an SF Oracle RAC cluster

You can use the following options to verify whether CVM is up or not in an SF Oracle RAC cluster.

The following output is displayed on a node that is not a member of the cluster:

```
# vxdctl -c mode
mode: enabled: cluster inactive
# vxclustadm -v nodestate
state: out of cluster
```

On the master node, the following output is displayed:

```
# vxdctl -c mode

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

On the slave nodes, the following output is displayed:

```
# vxdctl -c mode

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

The following command lets you view all the CVM nodes at the same time:

```
# vxclustadm nidmap

Name      CVM Nid    CM Nid     State
galaxy          0          0     Joined: Master
nebula          1          1     Joined: Slave
```

Verifying CVM membership state

The state of CVM can be verified as follows:

```
# vxclustadm -v nodestate

state: joining
        nodeId=0
        masterId=0
        neighborId=0
        members=0x1
        joiners=0x0
        leavers=0x0
        reconfig_seqnum=0x0
        reconfig: vxconfigd in join
```

The state indicates that CVM has completed its kernel level join and is in the middle of vxconfigd level join.

The `vxdctl -c mode` command indicates whether a node is a CVM master or CVM slave.

Verifying the state of CVM shared disk groups

You can use the following command to list the shared disk groups currently imported in the SF Oracle RAC cluster:

```
# vxdg list |grep shared

orabinvol_dg enabled,shared 1052685125.1485.csha3
```

Verifying the activation mode

In an SF Oracle RAC cluster, the activation of shared disk group should be set to “shared-write” on each of the cluster nodes.

To verify whether the “shared-write”activation is set:

```
# vxdg list diskgroupname |grep activation

local-activation: shared-write
```

If "shared-write" activation is not set, run the following command:

```
# vxdg -g diskgroupname set activation=sw
```

Administering Oracle

This section provides instructions for the following Oracle administration tasks:

- Creating a database
- Increasing swap space for Oracle
- Stopping Oracle Clusterware
- Determining Oracle Clusterware object status
- Configuring virtual IP addresses for Oracle Clusterware
- Configuring Oracle group to start and stop Oracle Clusterware objects
- Configuring listeners
- Starting or stopping Oracle listener
- Starting and stopping Oracle service groups
- Starting or stopping Voting disks

If you encounter issues while administering Oracle, refer to the troubleshooting section for assistance.

See “Troubleshooting Oracle” on page 259.

Creating a database

To create a database, run the dbca command as follows:

```
$ export DISPLAY=display.ip

$ dbca
```

For more information, consult the Oracle documentation.

Increasing swap space for Oracle

The minimum swap space requirement for Oracle RAC 10g is 4 GB. The minimum swap space requirement for Oracle RAC 11g is 8 GB. The operating system requirement for minimum swap space is two times the size of RAM.

Between the minimum requirements of Oracle RAC and the operating system, make sure that you meet the minimum requirement that is higher. For example, if the operating system requirement for minimum swap space computes to 5 GB on your Oracle RAC 11g systems, make sure that you meet the minimum swap space requirement of Oracle RAC, that is 8 GB.

If you need more swap space, you must add a new swap volume. You cannot increase the existing swap space. Symantec recommends that the size of the secondary swap volume be the same as the primary swap volume. The volume must be created on a hard disk that does not have a primary swap volume.

To add a swap volume

1 Identify the volume group that has sufficient free space:

```
# vgdisplay /dev/volgrp_name
```

where *volgrp_name* is the name of the volume group that has free space.

Note the values of the 'Free PE' and 'PE size (Mbytes)' attributes of the volume group. Multiply the values of 'Free PE' and 'PE size (Mbytes)' to find out the free space available on the volume group.

2 Create a logical volume for secondary swap on the volume group.

Note: Make sure that you prevent the occurence of bad block relocation (-r n) and set the contiguous allocation policy (-C y) for the logical volume.

```
# lvcreate -L req_swap_space -n new_log_vol \
-C y -r n /dev/volgrp_name
```

where:

req_swap_space is the amount of space you require for the new volume

new_log_vol is the name of the new logical volume

volgrp_name is the name of the volume group on which you create the new logical volume

For example, to create a logical volume 'newvol' with '4' GB space on the volume group 'vg01':

```
# lvcreate -L 4000 -n newvol -C y -r n /dev/vg01
```

3 Open the `/etc/fstab` file and append the following line to the contents of the file:

```
/dev/volgrp_name/new_log_vol ... swap pri=0 0 0
```

For example, if you created a new volume 'newvol' on the volume group 'vg01':

```
/dev/vg01/newvol ... swap pri=0 0 0
```

4 Enable the swap volume for use without rebooting:

```
# swapon -a
```

5 Verify that the swap volume is created:

```
# swapinfo -t
```

Stopping Oracle Clusterware

If you need to manually stop Oracle Clusterware outside of VCS control, run the following command:

```
# $CRS_HOME/bin/crsctl stop crs
Stopping resources.
Successfully stopped CRS resources
Stopping CSSD.
Shutting down CSS daemon.
Shutdown request successfully issued.
```

Determining Oracle Clusterware object status

To determine the status of Oracle Clusterware objects:

```
# $CRS_HOME/bin/crs_stat -t

Name            Type        Target      State      Host
------------------------------------------------------------
ora....11.inst application    ONLINE    OFFLINE
ora....12.inst application    ONLINE    OFFLINE
ora.sample3.db application    ONLINE    OFFLINE
ora....EY.lsnr application    ONLINE    ONLINE    galaxy
ora.galaxy.gsd application    ONLINE    ONLINE    galaxy
ora.galaxy.ons application    ONLINE    ONLINE    galaxy
ora.galaxy.vip application    ONLINE    ONLINE    galaxy
ora....ER.lsnr application    ONLINE    ONLINE    nebula
ora....ver.gsd application    ONLINE    ONLINE    nebula
ora....ver.ons application    ONLINE    ONLINE    nebula
ora....ver.vip application    ONLINE    ONLINE    nebula
```

The Oracle Clusterware objects 'gsd', 'ons', 'vip', and 'lsnr' are the nodes applications for the nodes galaxy and nebula.

Configuring virtual IP addresses for Oracle Clusterware

To configure virtual IP addresses for Oracle Clusterware:

```
# export DISPLAY=display.ip

# $CRS_HOME/bin/vipca
```

where display.ip is the display IP address.

For more information, consult the Oracle documentation.

Configuring Oracle group to start and stop Oracle Clusterware objects

Symantec recommends that your Oracle group within VCS be configured to start and stop Oracle Clusterware objects.

The following sample main.cf extract shows how to configure VCS to start your Oracle Clusterware instance objects:

```
Oracle Ora_1 (
                Critical = 0
                Sid @galaxy = PROD11
                Sid @nebula = PROD12
                Owner = oracle
                Home = "/oracle/orahome"
                StartUpOpt = SRVCTLSTART
                ShutDownOpt = SRVCTLSTOP
                OnlineTimeout = 900
                )
```

Configuring listeners

To configure listeners:

```
$ export DISPLAY=display.ip

$ netca
```

For more information, consult Oracle documentation.

Starting or stopping Oracle listener

If you have issues with Oracle listener, you can stop and restart the listener as oracle user.

To start Oracle listener:

```
$ lsnrctl start
```

To stop Oracle listener:

```
$ lsnrctl stop
```

To check the status of Oracle listener:

```
$ lsnrctl status
```

For more information, consult the Oracle documentation.

Starting and stopping Oracle service groups

To start the Oracle service group "grp10g" on nodes "galaxy" and "nebula":

```
# hagrp -online grp10g -sys galaxy

# hagrp -online grp10g -sys nebula
```

To stop the Oracle service group "grp10g" on nodes "galaxy" and "nebula":

```
# hagrp -offline grp10g -sys galaxy

# hagrp -offline grp10g -sys nebula
```

Starting or stopping Voting disks

Because the voting disk is a critical component and single point of failure in a Oracle Clusterware cluster, the storage for the voting disk uses either the Oracle redundancy feature or third-party mirroring and multipathing features to prevent interruptions to the cluster. Placing the storage objects for the voting disk under VCS control ensures that the voting disk is in place before the ocssd process is started (through resource dependencies) and provides notification in the event the voting disk fails.

To start or stop VOTE disk, add the CFSMount and CVMVoIDG resource to the main.cf file. The following sample extract from the main.cf file assumes two nodes "galaxy" and "nebula".

```
CFSMount cfsmount1 (
                Critical = 0
                MountPoint = "/ocrvote"
                BlockDevice = "/dev/vx/dsk/galaxy_ocr/ocrvotevol"
                MountOpt @galaxy = "suid,rw"
                MountOpt @nebula = "suid,rw"
                NodeList = { nebula, galaxy }
```

```
                )
.....
        CVMVolDg cvmvoldg1 (
                Critical = 0
                CVMDiskGroup = galaxy_ocr
                CVMActivation @galaxy = sw
                CVMActivation @nebula = sw
                )
.....
        cfsmount1 requires cvmvoldg1
        cssd requires cfsmount1
```

Administering ODM

This section provides instructions for the following ODM administration tasks:

- Verifying the ODM port
- Starting ODM

If you encounter issues while administering ODM, refer to the troubleshooting section for assistance.

See "Troubleshooting ODM" on page 264.

Verifying the ODM port

It is recommended to enable ODM in SF Oracle RAC. Run the following command to verify that ODM is running:

```
# gabconfig -a | grep "Port d"
```

Starting ODM

The following procedure provides instructions for starting ODM.

To start ODM

1 Execute:

```
#/sbin/init.d/vxgms start
```

2 Execute:

```
#/sbin/init.d/odm start
```

Stopping ODM

The following procedure provides instructions for stopping ODM.

To stop ODM

1 On all nodes, issue the following command:

```
# hastop -local
```

2 Next, issue the following command:

```
#/sbin/init.d/odm stop
```

Note: The administrator does not usually need to stop or start ODM. Normally, ODM is stopped during `shutdown -r`. ODM is started while rebooting, going to multi-user mode.

Section 2

Managing a database using SF Oracle RAC

Chapter 3

Configuring and managing the repository database for Oracle

This chapter includes the following topics:

About the repository database

The Storage Foundation for Databases (SFDB) repository or repository database stores metadata information required by SF Oracle RAC. This information includes data about user databases, snapshot databases, storage configuration, scheduled tasks, and storage statistics.

Note: The repository database requires only occasional interaction outside of the initial installation and configuration of SF Oracle RAC.

In this release of SF Oracle RAC, the repository is stored in a relational database and is managed by a lightweight embedded relational DBMS, called VxDBMS. VxDBMS is a special OEM version of a Sybase ASA (Adaptive Server Anywhere) DBMS, which is delivered and supported by Symantec. The SFDB repository

database consists of a database file, dbed_db.db, and transaction log files, yymmddxx.log.

VxDBMS supports remote client access from any host in the network that has proper authorization and configuration.

Note: The information in this chapter is only applicable for a SF Oracle RAC configuration. For information about single instance configurations, single instance commands, or any other single instance information, please refer to the appropriate Storage Foundation documentation.

Setting up the repository database using the sfua_db_config script

After installing SF Oracle RAC and the configuration of VCS is complete, you can create and configure a repository database using the sfua_db_config script.

The sfua_db_config script detects that the system is running a SF Oracle RAC configuration and automatically configures the repository database.

The repository database configuration enables you to use the following SF Oracle RAC features:

- Storage checkpoint and storage rollback
- Database FlashSnap
- Database Dynamic Storage Tiering

Note: The SF Oracle RAC features listed above are discussed in the following chapters.

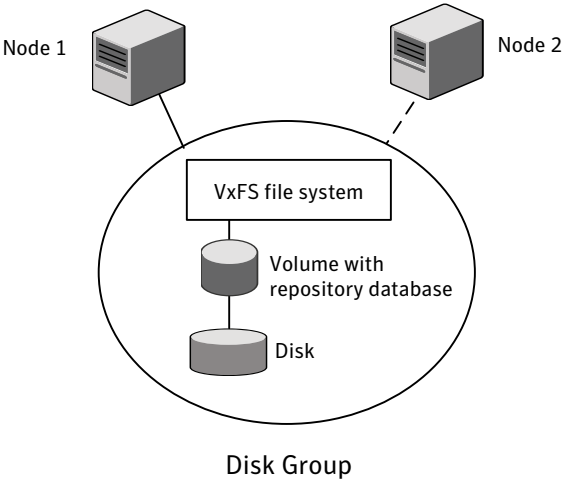
Creating and configuring the repository database

Before running the sfua_db_config script, review the following requirements:

- Make sure a disk group exists with at least one volume. The volume is to be used to store the repository database. A VxFS file system must be created on a VxVM volume in a disk group, on shared storage.
- Storage on the volume must be shared between nodes, although at any given time the disk group is only visible from a single node.
  See the Figure 3-1 below for a schematic of a repository database set up with two nodes accessing one disk group.

- The volume must be started and the file system must be mounted.
- Obtain a unique virtual IP address for public NIC interface.
- Obtain a device name for the public NIC interface (for example: lan0).
- Obtain a subnet mask for the public NIC interface.

Figure 3-1 Repository database schematic



To create and configure the repository database

1 As a root user, run the sfua_db_config script by entering the following command:

```
# /opt/VRTSdbcom/bin/sfua_db_config
```

Note: The above command must be run on one node. Make sure that the disk group is visible to that one node.

2 The following is an example of configuring a repository database for 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 following information when prompted:

```
Enter the NIC for system galaxy for HA Repository
configuration:lan0

Enter the NIC for system nebula for HA Repository
configuration:lan0

Enter the Virtual IP address for repository
failover:10.182.186.249

Enter the netmask for public NIC interface:255.255.0.0

The 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-lan0, nebula-lan0

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 successfully 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. The `dbed_update` command either creates or updates the Veritas Storage Foundation for Oracle SFDB repository. If the repository already exists, this command will refresh it.

Note: When upgrading the repository from SFRAC for Oracle version 4.1 to version 5.0, run the `dbed_update` command as described below. When upgrading SFRAC for Oracle version 5.0 to a later version, run `/sfua_db_config` which automatically upgrades the repository.

The `dbed_update` command has the following syntax:

```
dbed_update -S ORACLE_SID -H ORACLE_HOME\
 [-G <SERVICE_GROUP>] [-P <ORACLE_PFILE>]
```

To use the `dbed_update` command, the database must be up and running, and the ORACLE_SID and the ORACLE_HOME variables must be specified with and -S and -H options.

Checking the SFDB repository with sfua_db_config

If for any reason the VxDBMS process is not running or is having problems, use the `sfua_db_config` command to check the status of the repository database and its server.

To check the repository status, use the command with the `-o dbstatus` option.

For example:

```
# /opt/VRTSdbcom/bin/sfua_db_config -o dbstatus
```

For troubleshooting SFDB repository issues: See "Troubleshooting the repository database" on page 255.

Setting administrative permissions

To allow database administrators to administer a database using SF Oracle RAC, you must change the permission settings.

During the SF Oracle RAC installation, you are asked if you want to allow database administrator access. If you did not change permissions during the SF Oracle RAC 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

- To enable access for users other than root, use the following `chown` and `chmod` commands.

```
# chmod 750 /opt/VRTSdbed
# chown oracle:dba /opt/VRTSdbed
```

Runtime management tasks for the repository

Most interactions with the SFDB repository are handled automatically by the SFDB code. Administrators only need to handle SFDB backup and restore activities and to monitor the hard disk space usage of the repository. A configuration file /etc/vx/vxdbed/admin.properties is created during installation to record the file system and volume used for the SFDB repository. The VxDBMS server starts automatically after a system reboot using rc files.

Backing up and restoring the repository with sfua_rept_adm

Use the `sfua_rept_adm` command to manage the backing up and restoring of the SFDB repository.

With this command, you can perform the following tasks:

- Create and configure a schedule for automatically backing up the SFDB repository, including specifying the type of backup (full or incremental), its start time and frequency, and the destination directory for the backed up files.
- Restore the repository from backup files.
- Disable or enable an existing backup schedule.
- Create and configure a free space monitoring schedule that emails an alert when the free space on the file system containing the repository falls to a specified threshold.
- Disable or enable an existing free space monitoring schedule.

Note: You must be logged in as root to use the `sfua_rept_adm` command.

Table 3-1 sfua_rept_adm command options

Command option	Description
`-h`	Displays the help for the `sfua_rept_adm` command.

Table 3-1 sfua_rept_adm command options *(continued)*

Command option	Description
`-m backup_dest`	This command option specifies a directory where the backup data of the repository is stored.
`-o backup_sched`	This command option creates a full or incremental backup schedule. The backup type is specified by the accompanying -t option. Only one full and one incremental backup schedule can be created. Creating a second schedule overwrites any existing backup schedule of that same type. After a backup schedule is created it is automatically enabled.
`-o backup_enable`	This command option re-enables the existing full or incremental backup schedule, as specified by the -t option.
`-o backup_disable`	This command option disables the existing full or incremental backup schedule, as specified by the -t option.
`-o restore`	This command option restores the SFDB repository from the backup files in the directory specified by the -m option.
`-o space_monitor`	This command option creates and configures a free space monitoring schedule that emails a warning when the free space on the file system containing the SFDB repository reaches or goes below a threshold specified by the -w option.
`-o space_monitor_enable`	This command option enables the free space monitoring schedule, if one exists.
`-o space_monitor_disable`	This command option disables the free space monitoring schedule, if one exists.
`-t full | incr`	This command option specifies the type of backup schedule being created, enabled , or disabled by the accompanying -o option. Specify full for a full backup or incr for an incremental backup. An incremental backup copies the SFDB repository database transaction logs to the directory specified by the -m option. A full backup copies these transaction log files and the database file. Only two backup schedules can be enabled simultaneously, one incremental backup and one full backup. For example, you cannot have two different incremental backup schedules.

Table 3-1 sfua_rept_adm command options *(continued)*

Command option	Description
`-f backup_freq`	This command option specifies the frequency of the scheduled backups as h (hours), d (days), or w (weeks) from the start time specified by the -s option. By default, the backup frequency value is assumed to be hours (h).
`-s start_time`	This command option specifies the time to start the backup process in hh:mm:ss format.
`-w warn_threshold`	This command option specifies the warning threshold for the free space monitoring schedule, as a number representing the percentage of free space on the file system containing the backup files. If the percentage of free space falls to this value or lower, then a warning is emailed according to the other settings in this free space monitoring schedule.
`-e notify_email`	This command option specifies the email address to send the warning message when the repository file system free space falls below the threshold specified by the -w option.
`-u smtp_sender`	This command option specifies the SMTP sender in whose name the warning email is emailed when the repository file system free space falls below the threshold specified by the -w option.
`-s smtp_server`	This command option specifies the SMTP email server to use when sending the warning message when the repository file system free space falls below the threshold specified by the -w option.

To create a backup schedule for the SFDB repository

To create a backup schedule for the SFDB repository, use the `sfua_rept_adm -o backup_sched` command.

For example:

```
# /opt/VRTSdbcom/bin/sfua_rept_adm -o backup_sched -t full|incr -f \
 backup_freq -s start_time -m backup_dest
```

After a backup schedule is created, it is automatically enabled. You can create only one of each type of backup schedule, incremental (-t incr) and full (-t full). If you create a new backup schedule, it automatically replaces any currently-enabled

backup schedule. You can disable the current backup schedule with the `-o backup_disable` command, and re-enable it with `-o backup_enable` command.

In an HA environment, use NFS to mount the backup destination directory on all nodes.

Note: For an SFDB repository, the backup is within the same disk group, but on a separate disk and a separate volume.

To restore the SFDB repository from a backup

To restore the SFDB repository from a backup, use the `sfua_rept_adm -o restore` command.

For example:

```
# /opt/VRTSdbcom/bin/sfua_rept_adm -o restore -m backup_dest
```

This command restores the repository using the full backup and all incremental backup files from the backup directory specified by -m backup_dest.

To determine if a repository backup has failed

To determine if a repository backup has failed, use either of the following methods:

- Check the system console for error messages received at the time the backup was scheduled.
- Verify the existence of the proper backup files in the backup directory (specified by -m backup_dest). The type of repository backup you schedule determines which files should be found in this directory. If an incremental backup was scheduled and performed, then only repository transaction log files (yymmddxx.log) are created there. If a full backup was scheduled and performed, then both transaction log files and a repository database file (dbed_db.db) are created.

Monitoring free space for the SFDB repository

To guard against the SFDB repository failing by filling its file system, use the `sfua_rept_adm -o space_monitor` command to create a monitoring schedule.

Table 3-1 shows all the `sfua_rept_adm` command options, including those used for creating, disabling, and re-enabling a free space monitoring schedule.

This schedule monitors the available free space on the repository file system. If the free space falls below a specified threshold (a percentage value), a warning is emailed to a specified user.

Note: You must be logged in as root to use the `sfua_rept_adm` command.

To create a free space monitoring schedule for the repository file system

To create a free space monitoring schedule for the repository file system, use the following `sfua_rept_adm -o space_monitor` command.

For example:

```
# /opt/VRTSdbcom/bin/sfua_rept_adm -o space_monitor -w warn_threshold \
-e notify_email -u smtp_sender -s smtp_server
```

After a free space monitoring schedule is created, it is automatically enabled. When the free space on the file system containing the SFDB repository falls below the threshold specified by -w warn_threshold, a warning is sent to the email address specified by -e notify_email.

Adding a new system to a SF Oracle RAC configuration

When adding a new system to an existing SF Oracle RAC configuration, you must also add the system to the existing SFDB repository so that it can share the same repository data.

To add a new system to the SFDB repository

1. After installing Veritas SF Oracle RAC, add the new system to the cluster.

   See the Veritas Cluster Server User's Guide for additional information on this procedure.

2. Make sure the system is running using the following `hasys` command:

   ```
   # hasys -state
   ```

3 Add the system to the Sfua_Base group by running the following command sequence:

```
# haconf -makerw

# hagrp -modify Sfua_Base SystemList -add new_sys sys_id

# hares -modify sfua_ip Device new_sys_NIC -sys new_sys

# haconf -dump -makero
```

4 Copy the /etc/vx/vxdbed/.odbc.ini file from an existing node to the new system using a remote file copy utility such as rcp, tcp, or scp.

For example, to use rcp:

```
# rcp /etc/vx/vxdbed/.odbc.ini new_sys:/etc/vx/vxdbed
```

Chapter 4

Using Storage Checkpoints and Storage Rollback

This chapter includes the following topics:

About Storage Checkpoints and Storage Rollback in SF Oracle RAC

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 or secondary databases to be started. Review the following information on Storage Checkpoints and Storage Rollback and how to use these technologies through Storage Foundation for Oracle RAC.

Note: Veritas Storage Foundation for Oracle RAC only supports the SFDB features described in this guide. Additionally, the information in this chapter is only applicable for a Veritas Storage Foundation for Oracle RAC configuration. For information about single instance configurations and Storage Checkpoints and Storage Rollback, please refer to the appropriate Storage Foundation documentation.

Using Storage Checkpoints and Storage Rollback for backup and restore

Storage Checkpoints and Storage Rollback enable efficient backup and recovery of Oracle databases.

Storage Checkpoints

A Storage Checkpoint instantly creates an exact image of a database 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).

Note: A Storage Checkpoint persists after a system reboot.

Storage Rollbacks

A direct application of the Storage Checkpoint facility is Storage Rollback.

Each Storage Checkpoint is a consistent, point-in-time image of a file system, and 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 faster database restoration.

Storage Checkpoints and Storage Rollback process

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.

Note: 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. The Storage Checkpoint only contains 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 required 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 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.

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.

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 the `dbed_update` command.

For example:

```
$ /opt/VRTS/bin/dbed_update -S $ORACLE_SID -H $ORACLE_HOME
```

Mountable Storage Checkpoints can be used for a wide range of application solutions including the following:

- Backups
- Investigations into data integrity
- Staging upgrades

- Database modifications
- Data replication solutions

If you mount a Storage Checkpoint as read-write, the command will not allow you to roll back to this Storage Checkpoint. 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 allows the database to still be rolled back to the original Storage Checkpoint.

For more information on mountable Storage Checkpoints:

See "Mounting Storage Checkpoints using dbed_ckptmount" on page 132.

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).

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 (for example, 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.

For more information, refer to the `vxassist`(1) and `fsadm_vxfs`(1) manual pages.

Storage Checkpoint Performance

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 such as writes to the intent log or inode updates to proceed at normal speed after the initial write.

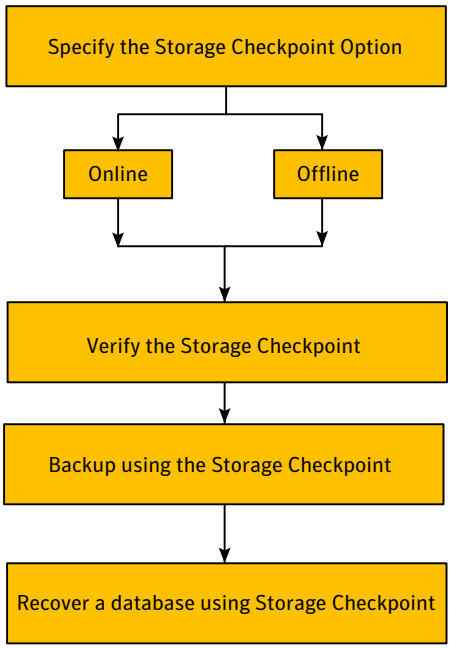
The performance impact of Storage Checkpoints on a database is less when the database files are Direct I/O files. A performance degradation of less than 5 percent in throughput has been observed in a typical OLTP workload when the Storage Checkpoints only keep track of changed information. For Storage 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

Figure 4-1 below describes the general process for backing up and recovering the database using Storage Checkpoints.

Figure 4-1 Backing up and recovering database using Storage Checkpoints



The following sections discuss this process:

- Specify the Storage Checkpoint option
- Verifying a Storage Checkpoint
- Backing up using a Storage Checkpoint
- Recovering a database using a Storage Checkpoint

Specify the Storage Checkpoint option

Storage Checkpoints can be created by specifying one of the following options:

- Online
- Offline

To create a Storage Checkpoint with the online option, the database should be online and you must enable ARCHIVELOG mode for the database.

Note: Refer to your Oracle documentation for information about enabling the archive log.

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.

Note: 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

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.

Usage notes	See the `dbed_ckptcreate`(1M) and `dbed_ckptmount`(1M) manual pages for more information.

See "Creating Storage Checkpoints using dbed_ckptcreate" on page 127.

See "Mounting Storage Checkpoints using dbed_ckptmount" on page 132.

Storage Checkpoints can only be used to restore from logical errors (for example, a human error). Storage Checkpoints cannot be used to restore files due to a media failure, because all the data blocks are on the same physical device.

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 protecting highly critical data from both physical media failure and logical errors.

To verify that a Storage Checkpoint is error-free

1 As oracle user, create and mount a Storage Checkpoint by issuing the following commands:

```
$ /opt/VRTS/bin/dbed_ckptcreate -S PROD1 -H $ORACLE_HOME\
 -o online

Storage Checkpoint Checkpoint_1244130973 created.

$ mkdir /tmp/testckpt

$  /opt/VRTS/bin/dbed_ckptmount -S PROD1\
 -c Checkpoint_1244130973 -m /tmp/testckpt -o rw

Creating Storage Checkpoint on /tmp/testckpt/oradata with name
Checkpoint_1244130973_wr001
```

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.

2 Examine the contents of the Storage Checkpoint:

```
$ ls -l /tmp/testckpt/oradata/PROD1
total 4438620
-rw-r-----   1 oracle     oinstall   18628608 Jun  4 22:07 control01.ct
-rw-r-----   1 oracle     oinstall   18628608 Jun  4 22:07 control02.ct
-rw-r-----   1 oracle     oinstall   18628608 Jun  4 22:07 control03.ct
-rw-r-----   1 oracle     oinstall      3072 May 26 17:19 orapwPROD1
-rw-r-----   1 oracle     oinstall   52429824 Jun  4 22:05 redo01.log
-rw-r-----   1 oracle     oinstall   52429824 Jun  4 21:10 redo02.log
-rw-r-----   1 oracle     oinstall   52429824 Jun  4 22:05 redo03.log
-rw-r-----   1 oracle     oinstall   52429824 Jun  4 21:50 redo04.log
-rw-r-----   1 oracle     oinstall   52429824 Jun  4 22:07 redo05.log
-rw-r-----   1 oracle     oinstall   52429824 Jun  4 21:52 redo06.log
-rw-r-----   1 oracle     oinstall   1027547136 Jun  4 22:07 sysaux01.db
-rw-r-----   1 oracle     oinstall   734011392 Jun  4 22:07 system01.dbf
-rw-r-----   1 oracle     oinstall   20979712 Jun  4 22:02 temp01.dbf
-rw-r-----   1 oracle     oinstall   57679872 Jun  4 22:07 undotbs01.dbf
-rw-r-----   1 oracle     oinstall   26222592 Jun  4 22:07 undotbs02.dbf
-rw-r-----   1 oracle     oinstall   30416896 Jun  4 22:07 undotbs03.dbf
-rw-r-----   1 oracle     oinstall   5251072 Jun  4 22:07 users01.dbf
```

3 Run the dbv tool against the datafile. For example:

```
$ $ORACLE_HOME/bin/dbv file=/tmp/testckpt/oradata/\
PROD1/undotbs01.dbf

DBVERIFY: Release 11.1.0.6.0 - Production on Thu Jun 4 21:35:03 2009

Copyright (c) 1982, 2007, Oracle.  All rights reserved.

DBVERIFY - Verification starting : FILE = /tmp/testckpt/oradata/PROD1\
/undotbs01.dbf


DBVERIFY - Verification complete

Total Pages Examined         : 7040
Total Pages Processed (Data) : 0
Total Pages Failing   (Data) : 0
Total Pages Processed (Index): 0
Total Pages Failing   (Index): 0
Total Pages Processed (Other): 6528
Total Pages Processed (Seg)  : 0
Total Pages Failing   (Seg)  : 0
Total Pages Empty            : 512
Total Pages Marked Corrupt   : 0
Total Pages Influx           : 0
Total Pages Encrypted        : 0
Highest block SCN            : 6532192 (0.6532192)
$
```

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.

See "Creating Storage Checkpoints using dbed_ckptcreate" on page 127.

See "Mounting Storage Checkpoints using dbed_ckptmount" on page 132.

In the example procedure, all the database datafiles reside on one VxFS file system named /db01.

To back up a frozen database image using the command line

1 As an Oracle user, create a Storage Checkpoint using the `dbed_ckptcreate` command:

```
$ /opt/VRTS/bin/dbed_ckptcreate -S PROD -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 an 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.

Warning: 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 storage rollback to roll back any datafiles in the database that contained the table data from the Storage Checkpoint you created at 11:00 a.m.

   For example:

   ```
   $ /opt/VRTS/bin/dbed_ckptrollback -S $ORACLE_SID -H\
   $ORACLE_HOME -c Checkpoint_903937870
   ```

   For other examples of this command (for a database, tablespace, or datafile):

   See "Performing Storage Rollback using dbed_ckptrollback" on page 136.
4. Start up the database instance if it is down.
5. Unfreeze the service group.

   ```
   # hagrp -unfreeze Service_Group
   ```

6 Re-apply archive logs to the point before the table was deleted to recover the database to 4:00 p.m. Use one of the following commands:

```
SQL> recover database until cancel

SQL> recover database until change

SQL> recover database until time
```

7 Open the database with the following command:

```
SQL> 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.

Guidelines for Oracle recovery

For an optimal Oracle recovery, the following steps should be taken:

- Back up all control files before Storage Rollback
- Ensure that the control files are not rolled back
- Ensure that all archived redo logs are available
- Media recovery procedures

Back up all control files before Storage Rollback

This guideline is recommended 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. Control files should also be backed up before and after making structural changes to databases.

Note: The `dbed_ckptcreate` command automatically saves control file and log information when you create a Storage Checkpoint.

See "Creating Storage Checkpoints using dbed_ckptcreate" on page 127.

Ensure 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.

If your intention is to roll back the database to recover from structural changes that you do not want to maintain, you may want to use the backup control file that was created by the `dbed_ckptcreate` command. The backup control file is located in the directory *$VXDBA_DBPATH/$ORACLE_SID*/checkpoint_dir/*CKPT_NAME*.

Ensure 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.

Note: Refer to your Oracle documentation for information about querying archived information.

For SF 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.

Media recovery procedures

The following are the procedures for performing either a complete or incomplete media recovery.

Media recovery procedures

- To perform a complete media recovery:

```
SQL> SET AUTORECOVERY ON;

SQL> RECOVER DATABASE;
```

- To perform an incomplete media recovery, use one of the following:

```
SQL> RECOVER DATABASE UNTIL CANCEL;
```

or

```
SQL> RECOVER DATABASE UNTIL TIME 'yyyy-mm-dd:hh:mm:ss';
```

(You can confirm the time of error by checking the ../bdump/alert*.log file.)
or

```
SQL> RECOVER DATABASE UNTIL TIME 'yyyy-mm-dd:hh:mm:ss'\
using backup controlfile;
```

or

```
SQL> RECOVER DATABASE UNTIL CHANGE scn;
```

- To open the database after an incomplete media recovery, use the following:

```
SQL> 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.

Warning: 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.

Using the Storage Checkpoint Command Line Interface (CLI)

Veritas Storage Foundation for Oracle RAC provides a command line interface to many key operations. The command line interface lets you incorporate command operations into scripts and other administrative processes.

Note: The SF Oracle RAC command line interface depends on certain tablespace and container information that is collected and stored in a repository. Some CLI commands update the repository by default. It is also important to regularly ensure that the repository is up-to-date by using the `dbed_update` command.

Note: For SF Oracle RAC database, when you issue the commands, replace `$ORACLE_SID` with `$ORACLE_SID=instance_name` and provide the instance name on which the instance is running.

Commands Overview

SF Oracle RAC commands supported in the command line interface are located in the /opt/VRTS/bin directory.

The online manual pages for these commands are located in the /opt/VRTS/man directory.

Table 4-1 summarizes the commands available to you from the command line.

Table 4-1 Veritas Storage Foundation for Oracle RAC Checkpoint Commands

Command	Description
`dbed_update`	Command that creates or updates the Veritas Storage Foundation for Oracle SFDB repository. See "Creating or updating the repository using dbed_update" on page 126.
`dbed_ckptcreate`	Command that creates a Storage Checkpoint for an Oracle database. See "Creating Storage Checkpoints using dbed_ckptcreate" on page 127.
`dbed_ckptdisplay`	Command that displays the Storage Checkpoints associated with an Oracle instance. See "Displaying Storage Checkpoints using dbed_ckptdisplay" on page 128.
`dbed_ckptmount`	Command that mounts a Storage Checkpoint for an Oracle instance. See "Mounting Storage Checkpoints using dbed_ckptmount" on page 132.
`dbed_ckptquota`	Command that administers quotas for Storage Checkpoints. **Note:** This command only administers quotas for Storage Checkpoints for the local instance for SF Oracle RAC.
`dbed_ckptumount`	Command that unmounts a Storage Checkpoint for an Oracle instance. See "Unmounting Storage Checkpoints using dbed_ckptumount" on page 133.
`dbed_ckptrollback`	Command that rolls back an Oracle instance to a Storage Checkpoint point-in-time image. See "Performing Storage Rollback using dbed_ckptrollback" on page 136.
`dbed_ckptremove`	Command that removes a Storage Checkpoint for an Oracle instance. See "Removing Storage Checkpoints using dbed_ckptremove" on page 138.

Table 4-1 Veritas Storage Foundation for Oracle RAC Checkpoint Commands *(continued)*

Command	Description
`dbed_clonedb`	Command that creates a copy of an Oracle database by cloning all existing database files and recreating the control file accordingly. This cloned database can only be started on the same host as the existing database as long as it uses a different SID. See "Cloning the Oracle instance using dbed_clonedb" on page 138.

Command Line Interface examples

This section displays examples of SF Oracle RAC commands that are used to perform administrative operations for Storage Checkpoints and Storage Rollbacks.

Note: For detailed information about these commands, their command syntax, and available options, see the individual manual pages.

Prerequisites

Review the prerequisites and usage notes listed below for each command before using that command.

Creating or updating the repository using dbed_update

You can use the `dbed_update` command to create or update the repository.

Note: Any time 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 the `dbed_update` command.

Before creating or updating the repository, the following conditions must be met:

Prerequisites

- You must be logged on as the database administrator (typically, the user ID oracle).

Usage notes

- The `dbed_update` command creates a repository in the /etc/vx/vxdbed/*$ORACLE_SID* directory where information used by SF Oracle RAC is kept. If the repository already exists, the command will refresh the information.
- The database must be up and running, and the *ORACLE_SID* and the *ORACLE_HOME* variable arguments must be specified with the `-S` and `-H` options, respectively.
- See the `dbed_update`(1M) manual page for more information.

To update the repository

- Use the dbed_update command as follows:

```
$ /opt/VRTS/bin/dbed_update -S PROD -H /oracle/product/ORA_HOME
```

To view the status of the repository

- Use the `dbed_update` command as follows:

```
$ /opt/VRTS/bin/dbed_update -S PROD -H /oracle/product/ORA_HOME
```

Creating Storage Checkpoints using dbed_ckptcreate

You can use the `dbed_ckptcreate` command to create a Storage Checkpoint for an Oracle database from the command line.

Storage Checkpoints can be either online or offline. By default, Storage Checkpoints are offline. If online is specified, the database is put into hot-backup mode when the Storage Checkpoint is created. If offline is specified, the database is expected to be down.

Before creating a Storage Checkpoint, the following conditions must be met:

Prerequisites

- You must be logged on as the database administrator (typically, the user ID oracle).
- For best recoverability, always keep ARCHIVELOG mode enabled when you create Storage Checkpoints.

Usage notes

- dbed_ckptcreate stores Storage Checkpoint information under the following directory:
  /etc/vx/vxdbed/$ORACLE_SID/checkpoint_dir
- See the `dbed_ckptcreate`(1M) manual page for more information.

To create Storage Checkpoints while the database is online

- Use the `dbed_ckptcreate` command as follows:

```
$/opt/VRTS/bin/dbed_ckptcreate -S PROD \
-H /oracle/product/ORA_HOME -o online

Storage Checkpoint Checkpoint_971672043 created.
```

To create Storage Checkpoints without updating the repository while the database is online

- Use the `dbed_ckptcreate` command as follows:

```
$/opt/VRTS/bin/dbed_ckptcreate -S PROD \
-H /oracle/product/ORA_HOME -o online -n

Storage Checkpoint Checkpoint_971672046 created.
```

To create Storage Checkpoints while the database is offline

- Use the `dbed_ckptcreate` command as follows:

```
$/opt/VRTS/bin/dbed_ckptcreate -S PROD \
-H /oracle/product/ORA_HOME -o offline

Storage Checkpoint Checkpoint_971672049 created.
```

Note: The default option is offline.

To assign a Storage Checkpoint allocation policy to a Storage Checkpoint

- Use the `dbed_ckptcreate` command as follows:

```
$/opt/VRTS/bin/dbed_ckptcreate -S PROD \
-H /oracle/product/ORA_HOME -o online -p ckpt_data,ckpt_metadata

Storage Checkpoint Checkpoint_971672055 created.
```

Displaying Storage Checkpoints using dbed_ckptdisplay

You can use the `dbed_ckptdisplay` command to display the Storage Checkpoints associated with an Oracle database from the command line.

You can also use it to display fileset quota values.

Before displaying Storage Checkpoints, the following conditions must be met:

Prerequisites

- You must be logged on as the database administrator.

Usage Notes

- In addition to displaying the Storage Checkpoints created by SF Oracle RAC, `dbed_ckptdisplay` also displays other Storage Checkpoints (for example, Storage Checkpoints created by the Capacity Planning Utility and NetBackup).
- The Status field identifies if the Storage Checkpoint is partial (P), complete (C), invalid (I), mounted (M), read only (R), writable (W), or of type online (ON), offline (OF), instant (IN), or unknown (UN). Note that instant (IN) Storage Checkpoints are not supported in an SF Oracle RAC environment.
- Database FlashSnap commands are integrated with Storage Checkpoint functionality. It is possible to display and mount Storage Checkpoints carried over with snapshot volumes to a secondary host. However limitations apply.
  See "Mounting the snapshot volumes and backing up" on page 185.
- See the `dbed_ckptdisplay`(1M) manual page for more information.

To display Storage Checkpoints created by Veritas Storage Foundation for Oracle RAC

- Use the `dbed_ckptdisplay` command as follows to display information for Storage Checkpoints created by SF Oracle RAC:

```
$ /opt/VRTS/bin/dbed_ckptdisplay -S PROD \
-H /oracle/product/ORA_HOME

Checkpoint_974428422_wr001Thu May 16 17:28:42 2005       C+R+ON
Checkpoint_974428423      Thu May 16 17:28:42 2004       P+R+ON
```

To display other Storage Checkpoints

- Use the `dbed_ckptdisplay` command as follows: :

```
$ /opt/VRTS/bin/dbed_ckptdisplay -S PROD \
-H /oracle/product/ORA_HOME -o other

NetBackup_incr_PROD_955187480          NBU       /db01
NetBackup_full_PROD_95518725   54       NBU       /db01
```

To display other Storage Checkpoints without updating the repository

- Use the `dbed_ckptdisplay` command as follows:

```
$ /opt/VRTS/bin/dbed_ckptdisplay -S PROD \
-H /oracle/product/ORA_HOME -o other -n

NetBackup_incr_PROD_955187480          NBU      /db01
NetBackup_full_PROD_95518725   54       NBU      /db01
```

To display all Storage Checkpoints

- Use the `dbed_ckptdisplay` command as follows:

```
$ /opt/VRTS/bin/dbed_ckptdisplay -S PROD \
-H /oracle/product/ORA_HOME -o all

Checkpoint_903937870   Fri May 13 22:51:10 2005        C+R+ON
Checkpoint_901426272   Wed May 11 16:17:52 2005        P+R+ON
NetBackup_incr_PROD_955133480          NBU          /db01
NetBackup_full_PROD_9551329   52       NBU          /db01
```

To display all Storage Checkpoints without updating the repository

- Use the `dbed_ckptdisplay` command as follows:

```
$ /opt/VRTS/bin/dbed_ckptdisplay -S PROD \
-H /oracle/product/ORA_HOME -o all -n

Checkpoint_903937870   Fri May 13 22:51:10 2005        C+R+ON
Checkpoint_901426272   Wed May 11 16:17:52 2005        P+R+ON
NetBackup_incr_PROD_955133480           NBU        /db01
NetBackup_full_PROD_9551329   52        NBU        /db01
```

To display fileset quota values

- Use the `dbed_ckptdisplay` command as follows:

```
$ /opt/VRTS/bin/dbed_ckptdisplay -S PROD -c \
Checkpoint_903937870 -Q
Checkpoint_903937870      Wed Mar 19 9:12:20 2005       C+R+ON
Filesystem                HardLim    SoftLim    CurrentUse
/oradata1/indx1_1         100000     50000      2028
/oradata1/user1_1         100000     50000      2028
/oradata1/temp            150000     80000      2142
/oradata1/system1         150000     70000      3092
```

Scheduling Storage Checkpoints using dbed_ckptcreate and cron

You can use the `dbed_ckptcreate` command to schedule Storage Checkpoint creation in a `cron` job or other administrative script.

Before scheduling Storage Checkpoints, the following conditions must be met:

Prerequisites

- You must be logged on as the database administrator (typically, the user ID oracle).

Usage notes

- Create a new crontab file or edit an existing crontab file to include a Storage Checkpoint creation entry with the following space-delimited fields:
  minute hour day_of_month month_of_year day_of_week \/opt/VRTS/bin/dbed_ckptcreate
  where:
  minute - numeric values from 0-59 or *
  hour - numeric values from 0-23 or *
  day_of_month - numeric values from 1-31 or *
  month_of_year - numeric values from 1-12 or *
  day_of_week - numeric values from 0-6, with 0=Sunday or *
  Each of these variables can either be an asterisk (meaning all legal values) or a list of elements separated by commas. An element is either a number or two numbers separated by a hyphen (meaning an inclusive range).
- See the `dbed_ckptcreate`(1M), `cron`(1M), and `crontab`(1) manual pages for more information.

Scheduling Storage Checkpoint creation in a cron job

Depending on when you want to schedule Storage Checkpoint creation, make entries to the crontab file.

- To create a Storage Checkpoint at 1:00 a.m. every Sunday while the database is offline, include the following entry in your crontab file:

```
0 1 * * 0 /opt/VRTS/bin/dbed_ckptcreate -S PROD \
-H /oracle/product/ORA_HOME -o offline
```

Note: This is a crontab example for user oracle.

Mounting Storage Checkpoints using dbed_ckptmount

You can use the `dbed_ckptmount` command to mount a Storage Checkpoint for the database from the command line.

Before mounting Storage Checkpoints, the following conditions must be met:

Prerequisites
- You must be logged on as the database administrator.

Usage notes
- The `dbed_ckptmount` command is used to mount a Storage Checkpoint into the file system namespace. Mounted Storage Checkpoints appear as any other file system on the machine and can be accessed using all normal file system based commands.
- Storage Checkpoints can be mounted as read only or read-write. By default, Storage Checkpoints are mounted as read only.
- If the rw (read-write) option is used, _wrxxx, where xxx is an integer, will be appended to the Storage Checkpoint name.
- If the specified mount point directory does not exist, then `dbed_ckptmount` creates it before mounting the Storage Checkpoint, as long as the Oracle database owner has permission to create it.
- Database FlashSnap commands are integrated with Storage Checkpoint functionality. It is possible to display and mount Storage Checkpoints carried over with snapshot volumes to a secondary host. However limitations apply.
  See "Mounting the snapshot volumes and backing up" on page 185.
- See the `dbed_ckptmount`(1M) manual page for more information.

To mount Storage Checkpoints with the read/write option

- Use the `dbed_ckptmount` command as follows:

```
$ /opt/VRTS/bin/dbed_ckptmount -S PROD -c Checkpoint_971672042 \
-m /tmp/ckpt_rw -o rw
Creating Storage Checkpoint on /tmp/ckpt_rw/share/oradata with
name Checkpoint_971672042_wr001
```

To mount Storage Checkpoints with the read only option

- Use the dbed_ckptmount command as follows:

```
$ /opt/VRTS/bin/dbed_ckptmount -S PROD -c Checkpoint_971672042 \
-m /tmp/ckpt_ro -o ro
```

Unmounting Storage Checkpoints using dbed_ckptumount

You can use the `dbed_ckptumount` command to unmount a Storage Checkpoint for an Oracle database from the command line.

Before unmounting Storage Checkpoints, the following conditions must be met:

Prerequisites
- You must be logged on as the database administrator.

Usage notes
- The `dbed_ckptumount` command is used to unmount a mounted Storage Checkpoint from the file system namespace. Mounted Storage Checkpoints appear as any other file system on the machine and can be accessed using all normal file system based commands. When mounted Storage Checkpoints are not required, they can be unmounted.
- See the `dbed_ckptumount`(1M) manual page for more information.

To unmount Storage Checkpoints

- Use the `dbed_ckptumount` command as follows:

```
$ /opt/VRTS/bin/dbed_ckptumount -S PROD \
-c Checkpoint_971672042
```

Creating and working with Storage Checkpoint allocation policies using dbed_ckptpolicy

You can use the `dbed_ckptpolicy` command to create and administer Storage Checkpoint allocation policies for Multi-Volume File Systems (MVS). Storage Checkpoint allocation policies specify a list of volumes and the order in which to allocate data to them.

Before creating or working with Storage Checkpoint allocation policies, the following conditions must be met:

Prerequisites
- You must be logged on as the database administrator (typically, the user ID oracle).

Usage notes

- The `dbed_ckptpolicy` command can be used only on file systems using disk layout Version 6.
- The VxVM volume set and VxFS Multi-Volume File System features must be enabled to use Storage Checkpoint allocation policies.
- If you want to set a Storage Checkpoint allocation policy for a particular file system in the database, the VxFS Multi-Volume File System feature must be enabled on that file system.
- The status of a Storage Checkpoint allocation policy is either partial or complete. A partial policy is one that does not exist on all file systems used by the database. A complete policy is one that exists on all file systems.
- After an allocation policy is assigned to a Storage Checkpoint, the allocation mechanism attempts to satisfy requests from each device in the order specified in the allocation policy. If the request cannot be satisfied from any of the devices in the allocation policy, the request will fail, even if other devices that have space exist in the file system. Only devices listed in the policy can be allocated.
- See the `dbed_ckptpolicy`(1M) manual page for more information.

To create a Storage Checkpoint allocation policy

- Use the `dbed_ckptpolicy` command as follows:

```
$ /opt/VRTS/bin/dbed_ckptpolicy -S ORACLE_SID \
-o create -p ckpt_policy
```

Output similar to the following is displayed:

```
File System: /mvsfs/v2 (MVS volumes: mvsv4,mvsv5)
Assigned Data Policy: NONE (MVS Volumes: N/A)
Assigned Meta Data Policy: NONE (MVS Volumes: N/A)
Please enter the volume name(s), sperated by space, for the
policy ckpt_policy [skip,quit]: mvsv4

File System: /mvsfs/v1 (MVS volumes: mvsv1,mvsv2,mvsv3)
Assigned Data Policy: NONE (MVS Volumes: N/A)
Assigned Meta Data Policy: NONE (MVS Volumes: N/A)
Please enter the volume name(s), separated by space, for the
policy ckpt_policy [skip,quit]: mvsv2

The following information will be used to create policy
ckpt_sample
ckpt_sample             /mvsfs/v2                       mvsv4
ckpt_sample             /mvsfs/v1                       mvsv2
```

This example assumes the following:

- Two MVS file systems /mvsfs/v1 and /mvsfs/v2 are used for datafiles.
- File system /mvsfs/v1 is created on volume set mvsvset1.
- File system /mvsfs/v2 is created on volume set mvsvset2.
- Volume set mvsvset1 contains volumes mvsv1, mvsv2, and mvsv3.
- Volume set mvsvset2 contains volumes mvsv4 and mvsv5.

To display Storage Checkpoint allocation policy within the database

- Use the `dbed_ckptpolicy` command as follows:

```
$ /opt/VRTS/bin/dbed_ckptpolicy -S ORACLE_SID \
-n -o display [-c storage_ckpt | -p ckpt_policy]
```

If `-p ckpt_policy` and `-c storage_ckpt` options are not specified, output similar to the following is displayed:

```
Policy Name          File System Coverage
-------------------- --------------------
 ckpt                Complete
 ckpt_data           Complete
 ckpt_metadata       Complete
 new_ckpt            Partial
 ckpt_sample         Complete
```

If `-p ckpt_policy` option is specified, output similar to the following is displayed:

```
Policy Name              File System    MVS volumes
---------------          -----------    -----------
ckpt_sample              /mvsfs/v2      mvsv4
ckpt_sample              /mvsfs/v1      mvsv2
```

If the `-c storage_ckpt` option is specified, output similar to the following is displayed:

```
Storage Checkpoint File System     Data PolicyMeta Data Policy
------------------ ------------    --------------------------
Checkpoint_1095125037/mvsfs/v2     ckpt_data   ckpt_metadata
Checkpoint_1095125037/mvsfs/v1     ckpt_data   ckpt_metadata
```

To update a Storage Checkpoint allocation policy

- Use the `dbed_ckptpolicy` command as follows:

```
$ /opt/VRTS/bin/dbed_ckptpolicy -S ORACLE_SID \
-n -o update -p ckpt_policy
```

Output similar to the following is displayed:

```
File System: /mvsfs/v2 (MVS volumes: mvsv4,mvsv5)
Policy: ckpt_sample (MVS volumes: mvsv4)
Please enter the volume name(s), separated by space, for the
policy ckpt_sample [skip,quit]: mvsv5

File System: /mvsfs/v1 (MVS volumes: mvsv1,mvsv2,mvsv3)
Policy: ckpt_sample (MVS volumes: mvsv2)
Please enter the volume name(s), separated by space, for the
policy ckpt_sample [skip,quit]: mvsv2,mvsv3

The following information will be used to create policy
ckpt_sample
ckpt_sample             /mvsfs/v2                       mvsv5
ckpt_sample             /mvsfs/v1
mvsv2,mvsv3
```

To assign a Storage Checkpoint allocation policy

- Use the `dbed_ckptpolicy` command as follows to assign an allocation policy to a specified Storage Checkpoint:

```
$ /opt/VRTS/bin/dbed_ckptpolicy -S ORACLE_SID \
-n -o assign -c ckpt_name -p ckpt_policy[,ckpt_metadata_policy]
```

To remove a Storage Checkpoint allocation policy

- Use the `dbed_ckptpolicy` command as follows to remove an allocation policy from a specified Storage Checkpoint:

```
$ /opt/VRTS/bin/dbed_ckptpolicy -S ORACLE_SID \
-n -o remove -p ckpt_policy
```

Performing Storage Rollback using dbed_ckptrollback

You can use the `dbed_ckptrollback` command to rollback an Oracle database to a Storage Checkpoint.

Before performing a Storage Rollback, the following conditions must be met:

Prerequisites
- You must be logged on as the database administrator.

Usage notes
- The `dbed_ckptrollback` command rolls an Oracle database back to a specified Storage Checkpoint. You can perform a Storage Rollback for the entire database, a specific tablespace, or list of datafiles.
  Database rollback for the entire database requires that the database be inactive before Storage Rollback commences. The `dbed_ckptrollback` command will not commence if the Oracle database is active. However, to perform a Storage Rollback of a tablespace or datafile, only the tablespace or datafile to be rolled back must be offline (not the entire database).
- You must run the `dbed_update` command after upgrading to Storage Foundation 5.0 for Oracle RAC from a previous release. This will allow you to roll back to a Storage Checkpoint that was created with an earlier version of this product.
- See the `dbed_ckptrollback`(1M) manual page for more information.

To roll back an Oracle database to a Storage Checkpoint

- Use the `dbed_ckptrollback` command as follows:

```
$ /opt/VRTS/bin/dbed_ckptrollback -S PROD \
-H /oracle/product/ORA_HOME -c Checkpoint_903937870
```

To rollback a tablespace to a Storage Checkpoint

- Use the `dbed_ckptrollback` command with the `-T` option as follows:

```
$ /opt/VRTS/bin/dbed_ckptrollback -S PROD \
-H /oracle/product/ORA_HOME -T DATA01 -c Checkpoint_903937870
```

If the Oracle database is running, you must take the tablespace offline before running this command. If the tablespace is online, the command will fail.

To rollback datafiles to a Storage Checkpoint

- Use the `dbed_ckptrollback` command with the `-F` option as follows:

```
$ /opt/VRTS/bin/dbed_ckptrollback -S PROD \
-H /oracle/product/ORA_HOME \
-F /share/oradata1/data01.dbf,/share/oradata2/index01.dbf \
-c Checkpoint_903937870
```

  If the Oracle database is running, you must take the datafile offline before running this command. If the datafile is online, the command will fail.

Removing Storage Checkpoints using dbed_ckptremove

You can use the `dbed_ckptremove` command to remove a Storage Checkpoint for an Oracle database at the command line.

Before removing Storage Checkpoints, the following conditions must be met:

Prerequisites
- You must be logged on as the database administrator.

Usage notes
- The `dbed_ckptremove` command is used to remove a Storage Checkpoint from the file system, or file systems, it is associated with. The Storage Checkpoint must have been created using the `dbed_ckptcreate`(1M) command.
- You must unmount the Storage Checkpoint before you can remove it.
- See the `dbed_ckptremove`(1M) manual page for more information.

To remove Storage Checkpoints

- Use the dbed_ckptremove command as follows:

```
$ /opt/VRTS/bin/dbed_ckptremove -S PROD \
-c Checkpoint_971672042_wr001
```

Cloning the Oracle instance using dbed_clonedb

You can use the `dbed_clonedb` command to clone an Oracle instance using a Storage Checkpoint.

Cloning an existing database using a Storage Checkpoint must be done on the same host.

You have the option to manually or automatically recover the database when using the `dbed_clonedb` command:

- Manual (interactive) recovery, which requires using the `-i` option, of the clone database 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 command, recovers the entire database and replays all of the archive logs. You will not be prompted for any archive log names.

Before cloning the Oracle instance, the following conditions must be met:

Prerequisites
- You must first create a Storage Checkpoint.
  See "Creating Storage Checkpoints using dbed_ckptcreate" on page 127.
- You must be logged in as the database administrator.
- Make sure you have enough space and system resources to create a clone database on your system.
- A clone database takes up as much memory and machine resources as the primary database.

Usage notes
- The `dbed_clonedb` command is used to create a copy of a database, cloning all existing database files to new locations.
- The *ORACLE_SID* and *ORACLE_HOME* environment variables must be set to the primary database.
- It is assumed that the user has a basic understanding of the database recovery process.
- See the `dbed_clonedb`(1M) manual page for more information.

Limitations for SF Oracle RAC
- Note that the database cloning using Instant Checkpoint is not supported for SF Oracle RAC.
- When you clone the database by using Checkpoint, the node can be any node in the same SF Oracle RAC cluster but the archive log destination is required to be on CFS file system. Otherwise, you must manually copy the archive log files.

Table 4-2 lists the options for the dbed_clonedb command.

Table 4-2 dbed_clonedb command options

Option	Description
`-S` *CLONE_SID*	Specifies the name of the new Oracle SID, which will be the name of the new database instance.
`-m` *MOUNT_POINT*	Indicates the new mount point of the Storage Checkpoint.
`-c` *CKPT_NAME*	Indicates the name of the Storage Checkpoint.

Table 4-2 dbed_clonedb command options *(continued)*

Option	Description
-i	Runs the command in interactive mode where you must respond to prompts by the system. The default mode is non-interactive. (Optional)
-o umount	Shuts down the clone database and unmounts the Storage Checkpoint file system.
-o restartdb	Mounts the Storage Checkpoint file system and starts the clone database. The -o restartdb option will not attempt to recover the clone database.
-d	Used 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 database.
-p	Specifies a file containing initialization parameters to be modified or added to the clone database's initialization parameter file prior to startup. The format of the pfile_modification_file is the same as that of the Oracle initialization parameter file.

To clone an Oracle instance with manual Oracle recovery

- Use the dbed_clonedb command as follows:

```
$ /opt/VRTS/bin/dbed_clonedb -S NEW10 -m /local/ORA_HOME/1 \
-c Checkpoint_988813047 -i
Primary Oracle SID is TEST10i
New Oracle SID is NEW10
Checkpoint_988813047 not mounted at /local/oracle10g/1
Mounting Checkpoint_988813047 at /local/oracle10g/1
Using environment-specified parameter file
  /local/oracle10g/links/dbs/initTEST10i.ora
Default Oracle parameter file found:
  /local/oracle10g/links/dbs/initTEST10i.ora
Copying /local/oracle10g/links/dbs/initTEST10i.ora to
   /local/oracle10g/1/testvol
Control file 'ora_control2' path not explicitly specified in
init file; assuming ORACLE_HOME/dbs

All redo-log files found
Copying initTEST10i.ora to initNEW10.ora
  in /local/oracle10g/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/oracle10g/1/testvol
2. ORACLE_SID=NEW10; export ORACLE_SID # sh and ksh, OR
    setenv ORACLE_SID NEW10 #csh
3. /local/oracle10g/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

- Use the `dbed_clonedb` command as follows:

```
$/opt/VRTS/bin/dbed_clonedb -S NEW10 -m /local/ORA_HOME/1 \
-c Checkpoint_988813047
Primary Oracle SID is TEST10i
New Oracle SID is NEW10
Checkpoint_988813047 not mounted at /local/oracle10g/1
Mounting Checkpoint_988813047 at /local/oracle10g/1
Using environment-specified parameter file
   /local/oracle10g/links/dbs/initTEST10i.ora
Default Oracle parameter file found:
```

```
  /local/oracle10g/links/dbs/initTEST10i.ora
Copying /local/oracle10g/links/dbs/initTEST10i.ora
  to /local/oracle10g/1/testvol
Control file 'ora_control2' path not explicitly specified in
init file; assuming ORACLE_HOME/dbs

All redo-log files found
Copying initTEST10i.ora to initNEW10.ora
  in /local/oracle10g/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
```

To shut down the clone database and unmount the Storage Checkpoint

- Use the `dbed_clonedb` command as follows:

```
$ opt/VRTS/bin/dbed_clonedb -S NEW -o umount
```

To mount a Storage Checkpoint file system and start the clone database

- Use the `dbed_clonedb` command as follows:

```
$/opt/VRTS/bin/dbed_clonedb -S NEW -o restartdb
Database instance NEW is up and running.
```

To delete a clone database and the Storage Checkpoint used to create it

- Use the dbed_clonedb command as follows:

```
$ /opt/VRTS/bin/dbed_clonedb -S NEW -o umount -d
```

Chapter 5

Using Database FlashSnap for backup and off-host processing

This chapter includes the following topics:

About Veritas Database FlashSnap

Database FlashSnap lets you capture an online image of an actively changing database at a given instant, known as a snapshot. You can then perform backups and off-host processing tasks on these snapshots while still maintaining continuous availability of your critical data. 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.

A database snapshot can be used on the same host as the production database or on a secondary host sharing the same storage.

A database snapshot can be used for the following off-host processing applications:

- Data backup
- Data warehousing

- Decision-support queries

When the snapshot is no longer needed, the database administrator can import the original snapshot back to the primary host and resynchronize the snapshot to the original database volumes.

Database FlashSnap commands are executed from the command-line interface.

Database FlashSnap significantly reduces the time it takes to backup your database, increase the availability of your production database, and still maintain your production database's performance.

Note: The information in this chapter is only applicable for a SF Oracle RAC configuration. For information about any other configuration types and Database FlashSnap, please refer to the appropriate Storage Foundation documentation.

Solving typical database problems with Database FlashSnap

Database FlashSnap allows database administrators to create a snapshot without root privileges.

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 neither central to their job function nor 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 root privileges are not required, Database FlashSnap overcomes these obstacles by enabling database administrators to easily create consistent snapshots of the database. The snapshots can be utilized for repetitive use.

Database FlashSnap applications

Table 5-1 displays typical applications of Database FlashSnap.

Table 5-1 Typical Database FlashSnap applications

Application	Description
Database Backup and Restore	Enterprises require 24/7 online data availability. Enterprises 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

Database snapshot requirements are defined in a file called a snapplan.. 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 148.

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.

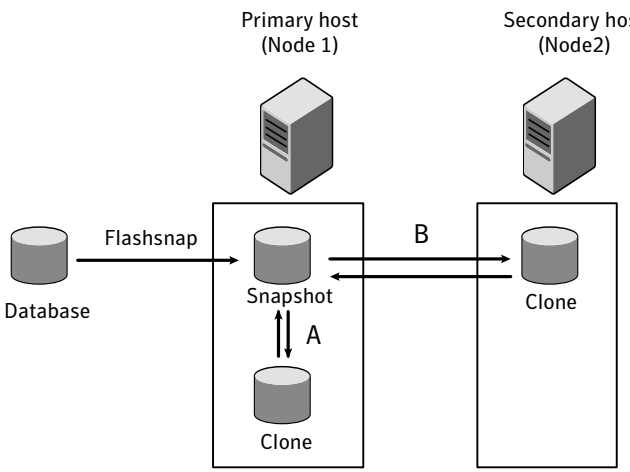
To use Database FlashSnap, a database administrator must first define the snapshot requirements. For example, the database administrator needs to determine whether off-host processing is required and, if it is, which host should be used for it. In addition, it is also important to consider how much database downtime can be tolerated. Database snapshot requirements are defined in the snapplan file.

See "Creating a snapplan (dbed_vmchecksnap)" on page 168.

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 (seeFigure 5-1 below).

Figure 5-1 Database FlashSnaps on either the primary or secondary host



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.

Using Database FlashSnap commands

Table 5-2 describes the three Database FlashSnap commands. All of these commands can be executed by the Oracle database administrator and do not require superuser (root) privileges.

Table 5-2 Database FlashSnap commands

Command	Description
`dbed_vmchecksnap`	This command creates and validates the snapshot plan that is used to create a snapshot image of an Oracle database. You can also use this command to copy, list, or remove a snapplan or make sure the storage is properly configured for the task.
`dbed_vmsnap`	This command is used to create a snapshot image of an Oracle database by splitting the mirror volumes used by the database. You can also use the `dbed_vmsnap` command to resynchronize snapshot volumes with their original volumes. **Note:** Snapplan creation and validation is only supported on CVM master host.
`dbed_vmclonedb`	This command 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. **Note:** The `dbed_vmclonedb` command does not support instant snapshot for database cloning.

Using the Database FlashSnap online option

The Database FlashSnap supports an online option for creating database snapshots.

With the online option, the tablespaces are put into online backup mode before the snapshot is created. This type of snapshot is a valid database backup.

Note: This option can be used if you are performing a point-in-time recovery from logical errors.

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

Selecting the snapshot mode

Select the online option for the snapshot mode:

See "Using the Database FlashSnap online option" on page 147.

Preparing hosts and storage for Database FlashSnap

Review the following details to prepare the hosts and storage for Database FlashSnap.

Setting up hosts

Database FlashSnap requires sufficient disk space in the disk group to add a mirror of equal size of the existing database.

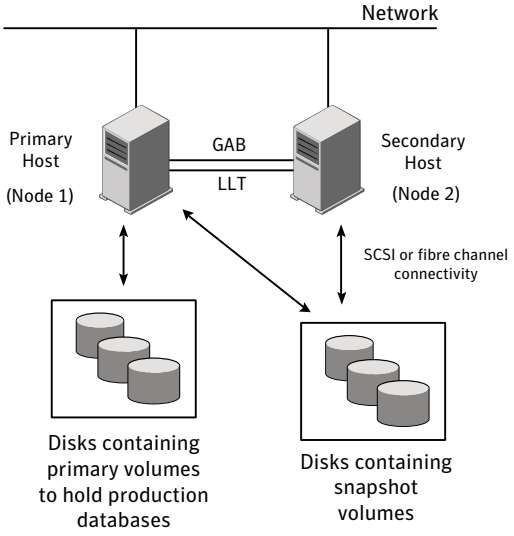
Setting up a storage configuration for Database FlashSnap operations is a system administrator's responsibility and requires superuser (root) privileges. Database FlashSnap utilities do not address setting up an appropriate storage configuration.

Database FlashSnap in a cluster configuration

A Database FlashSnap configuration with two hosts (nodes) in a cluster 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. Both the primary and secondary hosts share the storage in which the snapshot database is created. Both the primary and secondary hosts have access to the disks containing the snapshot volumes.

Figure 5-2 shows a Database FlashSnap configuration with two hosts (nodes) in a cluster.

Figure 5-2 Example of off-host Database FlashSnap solution



Host and storage requirements

Before using Database FlashSnap, ensure that the following requirements are met:

- 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` 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.

The following sample procedure is for existing volumes without existing snapshot plexes or associated snapshot volumes. In this procedure, volume_name is the name of either a volume or a volume set.

Note: You must be logged in as superuser (root) to issue the commands in the following procedure.

To create a snapshot mirror of a volume or volume set

1 Enter the following command on the hosts (nodes) in your cluster to locate the CVM master node:

```
# vxdctl -c mode
```

In an example with an application cluster consisting of two nodes (nebula and galaxy) , on the node which is the master the following output appears:

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

On the node which is the slave, the following output appears:

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

After determining the CVM master node in your application cluster, be sure to issue the following commands in this procedure on that CVM master node.

2 To prepare the volume for being snapshot, use the `vxsnap prepare` command:

```
# vxsnap -g diskgroup prepare volume \
alloc="storage_attribute ..."
```

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 4.1 or 5.0, either from the command line or from within a script, use the `vxsnap prepare` command as described above.

3 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.

4 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.

5 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.

6 List the available mirrors:

```
# vxprint -g diskgroup -F%name -e"pl_v_name in \"volume_name\""
```

7 Enable database FlashSnap to locate the correct mirror plexes when creating snapshots:

- Set the dbed_flashsnap tag 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
  ```

- 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.

Example procedure to create a snapshot mirror of a volume

This example shows the steps involved in creating a snapshot mirror for the volume data_vol belonging to the disk group PRODdg.

Note: You must be logged in as superuser (root) to issue the commands in the following procedure.

To create a snapshot mirror of the volume data_vol

1 Prepare the volume data_vol for mirroring:

```
# vxsnap -g PRODdg prepare data_vol alloc=PRODdg01,PRODdg02
```

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
```

6 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.

7 Identify the plex name in the above step and set the dbed_flashsnap tag for it:

```
# vxedit -g PRODdg set putil2=dbed_flashsnap data_vol-02
```

8 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
```

9 To verify that the snapshot volume was created successfully, use the `vxprint -g dg` command as follows:

```
# vxprint -g PRODdg
```

The following output appears on a system running the HPUX OS.

```
TY NAME         ASSOC        KSTATE   LENGTH   PLOFFS   STATE    TUTIL0 PUTIL0
dg PRODdg       PRODdg       -        -        -        -        -       -
dm PRODdg01     Disk_1       -        71117760 -        -        -       -
dm PRODdg02     Disk_2       -        71117760 -        -        -       -
dm PRODdg03     Disk_3       -        71117760 -        -        -       -

v  data_vol     fsgen
ENABLED        4194304             -        ACTIVE   -       -
pl data_vol-01  data_vol
ENABLED        4194304             -        ACTIVE   -       -
sd PRODdg03-01  data_vol-01
ENABLED        4194304             0        -        -       -
pl data_vol-02  data_vol
ENABLED        4194304             -        SNAPDONE -       -
sd PRODdg02-01  data_vol-02
ENABLED        4194304             0        -        -       -
dc data_vol_dco data_vol
-              -                   -        -        -       -
v  data_vol_dcl gen
ENABLED        560                 -        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.

Upgrading existing volumes to use Veritas Volume Manager 5.0

The procedure in this section describes how to upgrade a volume created using a version older than VxVM 5.0, so that it can take advantage of Database FlashSnap.

Note the following requirements and caveats for this procedure:

- The plexes of the DCO volume require persistent storage space on disk to be available. To make room for the DCO plexes, you may need to add extra disks to the disk group, or reconfigure existing volumes to free up space in the disk group. Another way to add disk space is to use the disk group move feature to bring in spare disks from a different disk group.
- Existing snapshot volumes created by the `vxassist` command are not supported. A combination of snapshot volumes created by `vxassist` and `vxsnap` are also not supported.
- You must be logged in as superuser (root) to issue the commands in the following procedure. Additionally, all operations involving the creation or modification using the commands `vxassist` or `vxdg` require that the user perform the task on the master CVM node.

To upgrade an existing volume created with an earlier version of VxVM

1. Upgrade the disk group that contains the volume, to a version 120 or higher, before performing the remainder of the procedure described in this section. Use the following command to check the version of a disk group:

   ```
   # vxdg list diskgroup
   ```

   To upgrade a disk group to the latest version, use the following command:

   ```
   # vxdg upgrade diskgroup
   ```

2. If the volume to be upgraded has a DRL plex or subdisk from an earlier version of VxVM, use the following command to remove this:

   ```
   # vxassist [-g diskgroup] remove log volume [nlog=n]
   ```

   Use the optional attribute nlog=*n* to specify the number, *n*, of logs to be removed. By default, the `vxassist` command removes one log.

3. For a volume that has one or more associated snapshot volumes, use the following command to reattach and resynchronize each snapshot:

   ```
   # vxsnap [-g diskgroup] snapback snapvol
   ```

   If persistent FastResync was enabled on the volume before the snapshot was taken, the data in the snapshot plexes is quickly resynchronized from the original volume. If persistent FastResync was not enabled, a full resynchronization is performed.

4 Use the following command to turn off persistent FastResync for the volume:

```
# vxvol [-g diskgroup] set fastresync=off volume
```

5 Use the following command to dissociate a DCO object from an earlier version of VxVM, DCO volume and snap objects from the volume:

```
# vxassist [-g diskgroup] remove log volume logtype=dco
```

6 Use the following command on the volume to upgrade it:

```
# vxsnap [-g diskgroup] prepare volume \
alloc="disk_name1,disk_name2"
```

Provide two disk names to avoid overlapping the storage of the snapshot DCO plex with any other non-moving data or DCO plexes.

The `vxsnap prepare` command automatically enables persistent FastResync on the volume and on any snapshots that are generated from it. It also associates a DCO and DCO log volume with the volume to be snapshot.

7 To view the existing DCO plexes and see whether there are enough for the existing data plexes, enter:

```
# vxprint -g diskgroup
```

There needs to be one DCO plex for each existing data plex.

8 If there are not enough DCO plexes for the existing data plexes, create more DCO plexes:

```
# vxsnap [-g diskgroup] addmir dco_volume_name \
[alloc=disk_name]
```

where *dco_volume_name* is the name of the DCO volume you are creating.

9 If the plex is in a SNAPDONE state, convert it to an ACTIVE state:

```
# vxplex [-g diskgroup] convert state=ACTIVE data_plex
```

10 Convert the data plexes to a SNAPDONE state and associate a DCO plex with the data plex that will be used for snapshot operations:

```
# vxplex [-g diskgroup] -o dcoplex=dco_plex_name convert \state=SNAPDONE data_plex
```

where *dco_plex_name* is the name of the DCO plex you are creating.

Example procedure to upgrade existing volumes to use Veritas Volume Manager 5.0

Note: You must be logged in as superuser (root) to issue the commands in the following procedure. Additionally, all operations involving the creation or modification using the commands `vxassist` or `vxdg` require that the user perform the task on the master CVM node.

In this example, the volume, `data_vol`, is upgraded to make use of VxVM 5.0 features.

To upgrade an existing volume created with an earlier version of VxVM

1 Upgrade the disk group, PRODdg.

```
# vxdg upgrade PRODdg
```

2 Remove the DRL plexes or subdisks, belonging to an earlier version of VxVM, from the volume to be upgraded.

```
# vxassist -g PRODdg remove log data_vol logtype=drl
```

3 Reattach any snapshot volume back to the primary volume to be upgraded.

```
# vxsnap -g PRODdg snapback SNAP-data_vol
```

4 Turn off FastResync on the volume to be upgraded.

```
# vxvol -g PRODdg set fastresync=off data_vol
```

5 Disassociate and remove any older DCO object and DCO volumes.

```
# vxassist -g PRODdg remove log data_vol logtype=dco
```

6 Upgrade the volume by associating a new DCO object and DCO volume.

```
# vxsnap -g PRODdg prepare data_vol alloc="PRODdg01,PRODdg02"
```

7 View the existing DCO plexes and plex state.

Scenario 1

In this scenario, there are enough DCO plexes for the data plexes. Also, no data plex is associated with a DCO plex.

```
# vxprint -g PRODdg
```

The following output appears on a system running the HPUX OS.

```
TY NAME         ASSOC        KSTATE   LENGTH   PLOFFS   STATE    TUTIL0 PUTIL0
dg PRODdg       PRODdg       -        -        -        -        -       -
dm PRODdg01     Disk_1       -        71117760 -        -        -       -
dm PRODdg02     Disk_2       -        71117760 -        -        -       -
dm PRODdg03     Disk_3       -        71117760 -        -        -       -

v  data_vol     fsgen
ENABLED        4194304          -        ACTIVE   -       -
pl data_vol-01  data_vol
ENABLED        4194304          -        ACTIVE   -       -
sd PRODdg01-01  data_vol-01
ENABLED        4194304          0        -        -       -
pl data_vol-04  data_vol
ENABLED        4194304          -        SNAPDONE -       -
sd PRODdg02-03  data_vol-04
ENABLED        4194304          0        -        -       -
dc data_vol_dco data_vol
-              -                -        -        -       -
v  data_vol_dcl gen
ENABLED       560               -        ACTIVE   -       -
pl data_vol_dcl-01 data_vol_dcl
ENABLED       560               -        ACTIVE   -       -
sd PRODdg01-02  data_vol_dcl-01
ENABLED       560               0        -        -       -
pl data_vol_dcl-02 data_vol_dcl
ENABLED       560               -        ACTIVE   -       -
sd PRODdg02-02  data_vol_dcl-02
ENABLED       560               0        -        -       -
```

- Convert the data plex state from SNAPDONE to ACTIVE.

  ```
  # vxplex -g PRODdg convert state=ACTIVE data_vol-04
  ```

- Associate the data plex with a new DCO plex and convert it back to a SNAPDONE state.

  ```
  # vxplex -g PRODdg -o dcoplex=data_vol_dcl-02 \
  convert state=SNAPDONE data_vol-04

  # vxprint -g PRODdg
  ```

  The following output appears on a system running the HPUX OS.

```
TY NAME         ASSOC        KSTATE   LENGTH   PLOFFS   STATE    TUTIL0 PUTIL0
dg PRODdg       PRODdg       -        -        -        -        -      -
dm PRODdg01     Disk_1       -        71117760 -        -        -      -
dm PRODdg02     Disk_2       -        71117760 -        -        -      -
dm PRODdg03     Disk_3       -        71117760 -        -        -      -

                        pl data_vol-03  -
                        DISABLED       4194304          -         -        -       -
                        sd PRODdg02-01  data_vol-03
                        ENABLED        4194304          0         -        -       -

                        v  data_vol     fsgen
                        ENABLED        4194304          -         ACTIVE   -       -
                        pl data_vol-01  data_vol
                        ENABLED        4194304          -         ACTIVE   -       -
                        sd PRODdg01-01  data_vol-01
                        ENABLED        4194304          0         -        -       -
                        pl data_vol-04  data_vol
                        ENABLED        4194304          -         SNAPDONE -       -
                        sd PRODdg02-03  data_vol-04
                        ENABLED        4194304          0         -        -       -
                        dc data_vol_dco data_vol
                        -              -                -         -        -       -
                        v  data_vol_dcl gen
                        ENABLED        560              -         ACTIVE   -       -
                        pl data_vol_dcl-01 data_vol_dcl
                        ENABLED        560              -         ACTIVE   -       -
                        sd PRODdg01-02  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         -        -       -
```

Scenario 2

In this scenario, there are fewer DCO plexes than data plexes.

```
# vxprint -g PRODdg
```

The following output appears on a system running the HPUX OS.

```
TY NAME         ASSOC        KSTATE   LENGTH   PLOFFS   STATE    TUTIL0 PUTIL0
dg PRODdg       PRODdg       -        -        -        -        -      -
dm PRODdg01     Disk_1       -        71117760 -        -        -      -
```

```
dm PRODdg02     Disk_2       -        71117760 -        -        -       -
dm PRODdg03     Disk_3       -        71117760 -        -        -       -

                        pl data_vol-03  -
                        DISABLED       4194304       -        -        -       -
                        sd PRODdg02-01  data_vol-03
                        ENABLED        4194304       0        -        -       -
                        v  data_vol     fsgen
                        ENABLED        4194304       -        ACTIVE   -       -
                        pl data_vol-01  data_vol
                        ENABLED        4194304       -        ACTIVE   -       -
                        sd PRODdg01-01  data_vol-01
                        ENABLED        4194304       0        -        -       -
                        pl data_vol-04  data_vol
                        ENABLED        4194304       -        ACTIVE   -       -
                        sd PRODdg02-03  data_vol-04
                        ENABLED        4194304       0        -        -       -
                        dc data_vol_dco data_vol
                        -              -             -        -        -       -
                        v  data_vol_dcl gen
                        ENABLED        560           -        ACTIVE   -       -
                        pl data_vol_dcl-01 data_vol_dcl
                        ENABLED        560           -        ACTIVE   -       -
                        sd PRODdg01-02  data_vol_dcl-01
                        ENABLED        560           0        -        -       -
```

- Add a DCO plex to the DCO volume using the vxassist mirror command.

  ```
  # vxsnap -g PRODdg addmir data_vol_dcl alloc=PRODdg02
  ```

- Associate the data plex with the new DCO plex and convert it to a SNAPDONE state.
  The following command is used for a system running the HPUX OS.

  ```
  # vxplex -g PRODdg -o dcoplex=data_vol_dcl-02 \
    convert state=SNAPDONE data_vol-04
  ```

  The following output appears on a system running the HPUX OS.

```
TY NAME         ASSOC        KSTATE   LENGTH   PLOFFS   STATE    TUTIL0 PUTIL0
dg PRODdg       PRODdg       -        -        -        -        -       -
dm PRODdg01     Disk_1       -        71117760 -        -        -       -
dm PRODdg02     Disk_2       -        71117760 -        -        -       -
dm PRODdg03     Disk_3       -        71117760 -        -        -       -
```

```
pl data_vol-03  -
DISABLED       4194304       -        -        -       -
v  data_vol     fsgen
ENABLED        4194304       -        ACTIVE   -       -
pl data_vol-01  data_vol
ENABLED        4194304       -        ACTIVE   -       -
sd PRODdg01-01  data_vol-01
ENABLED        4194304       0        -        -       -
pl data_vol-04  data_vol
ENABLED        4194304       -        SNAPDONE -       -
sd PRODdg02-03  data_vol-04
ENABLED        4194304       0        -        -       -
dc data_vol_dco data_vol
-              -             -        -        -       -
v  data_vol_dcl gen
ENABLED        560           -        ACTIVE   -       -
pl data_vol_dcl-01 data_vol_dcl
ENABLED        560           -        ACTIVE   -       -
sd PRODdg01-02  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        -        -       -
```

About creating database snapshots

A snapshot can be a source for backing up the database or creating a clone database for decision-support purposes. You can use Database FlashSnap commands to create a snapshot of your entire database on the same host (node) or on a different one.

Online database snapshots

Database FlashSnap supports online database snapshot types.

When the SNAPSHOT_MODE specified in the snapplan is set to online, the `dbed_vmsnap`command 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.

Online snapshots provide a valid backup copy of the database

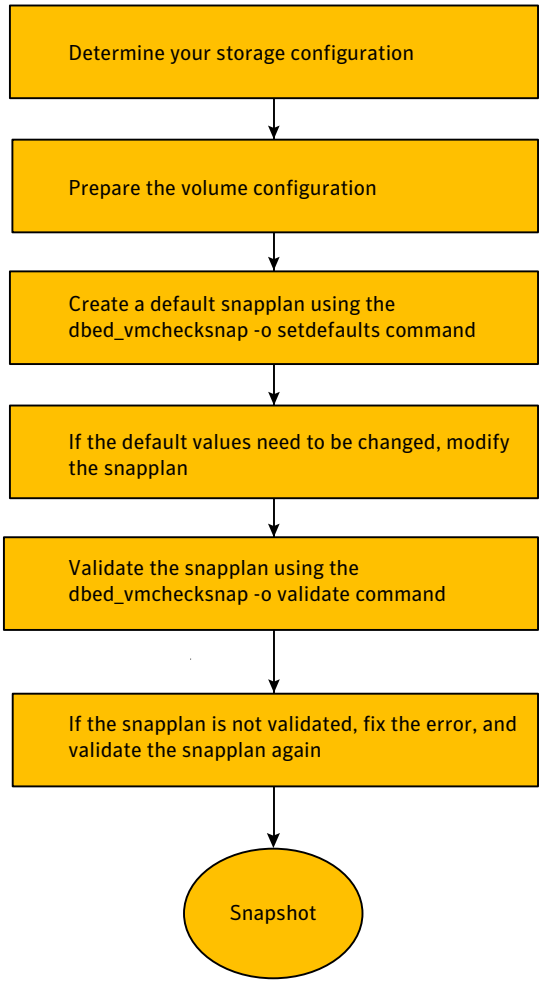
Tasks before creating a snapshot

Review the details on 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.

Figure 5-3 depicts the sequence of steps leading up to taking a snapshot using Database FlashSnap.

Figure 5-3 Prerequisites for creating a snapshot of your database



Creating a snapshot

Make sure the volumes used by the database are configured properly before attempting to take a snapshot. This database configuration requires superuser (root) privileges.

Note: Database FlashSnap commands must be run by the Oracle database administrator.

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`. For example:

```
$ /opt/VRTS/bin/dbed_update -S $ORACLE_SID -H $ORACLE_HOME
```

To create a snapshot image of a database

1. Create a snapshot mirror of a volume or volume set.

   See "To create a snapshot mirror of a volume or volume set" on page 152.

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 168.

3. Use the `dbed_vmsnap` command to create snapshot volumes for the database.

   See "Creating a snapshot (dbed_vmsnap)" on page 180.

4 On the secondary host, use the `dbed_vmclonedb` command to create a clone database using the disk group deported from the primary host. For more information:

See "Cloning a database (dbed_vmclonedb)" on page 187.

If the primary and secondary hosts specified in the snapplan are different, the `dbed_vmclonedb` command takes the following actions:

- Imports the disk group that was deported from the primary host
- Recovers the snapshot volumes
- Mounts the file systems
- Recovers the database
- 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.

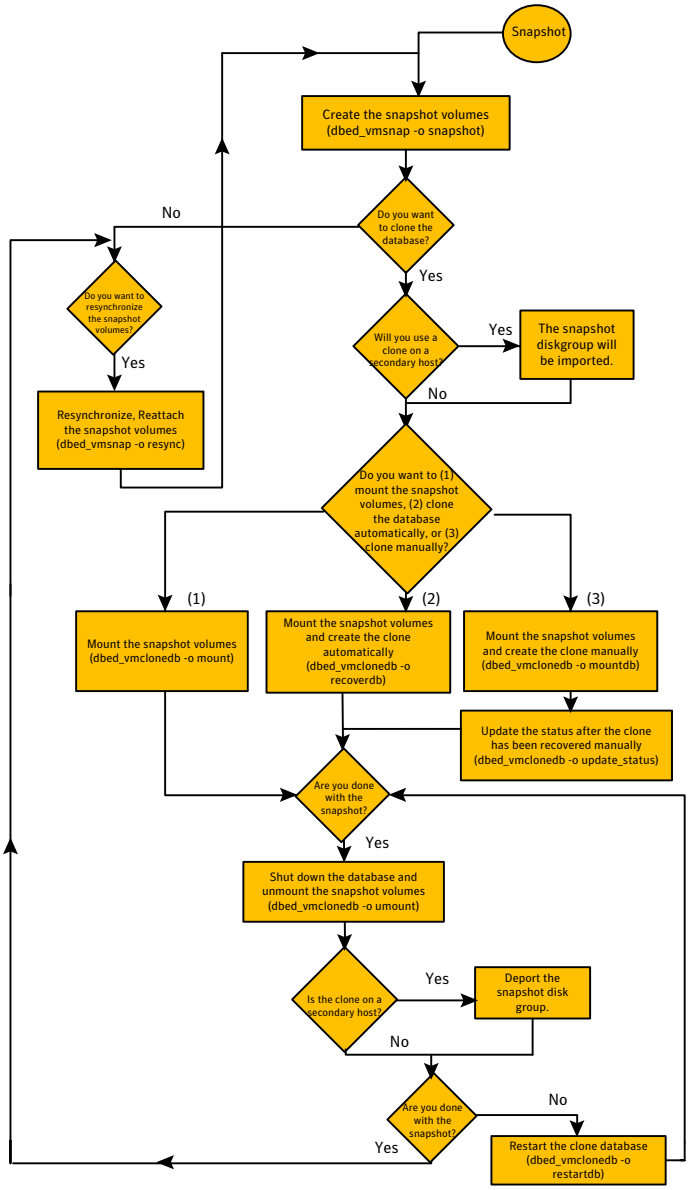
6 The clone database can be discarded by rejoining the snapshot volumes with the original volumes (that is, by resynchronizing the snapshot volumes) for future use.

Tasks after creating a snapshot

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.

Figure 5-4 is a flow chart that depicts the actions you can perform after creating a snapshot of your database using Database FlashSnap.

Figure 5-4 Actions you can perform after creating a snapshot of your database



FlashSnap commands

Database FlashSnap actions can be performed by using the following FlashSnap commands described in the following sections:

- Creating a snapplan (dbed_vmchecksnap)
- Validating a snapplan (dbed_vmchecksnap)
- Displaying, copying, and removing a snapplan (dbed_vmchecksnap)
- Creating a snapshot (dbed_vmsnap)
- Backing up the database from snapshot volumes (dbed_vmclonedb)
- Cloning a database (dbed_vmclonedb)
- Resynchronizing the snapshot to your database
- Removing a snapshot volume

Creating a snapplan (dbed_vmchecksnap)

The `dbed_vmchecksnap` command creates a snapplan that `dbed_vmsnap` uses to create a snapshot of an Oracle database.

You can name a snapplan file whatever you choose. Each entry in the snapplan file is a line in parameter=argument format.

Table 5-3 describes the parameters that can be set when using the `dbed_vmchecksnap` command to create or validate a snapplan.

Table 5-3 Parameter values for dbed_vmchecksnap

Parameter	Value
SNAPSHOT_VERSION	Specifies the snapshot version for this major release of SF 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.

Table 5-3 Parameter values for dbed_vmchecksnap *(continued)*

Parameter	Value
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 multiplexing 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.
SNAPSHOT_MODE	online Specifies what the database snapshot should be (online). ■ 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.

Table 5-3 Parameter values for dbed_vmchecksnap *(continued)*

Parameter	Value
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.
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: The `dbed_vmchecksnap -o validate` command must be run on the CVM master.

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:
  See "Preparing hosts and storage for Database FlashSnap" on page 148.
- 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.
- The Oracle database must have at least one mandatory archive destination.
- ORACLE_HOME cannot reside on disk which will be used for snapshot.
- The Oracle database files and archive log files should use different volumes with unique disks in same disk group.

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.

Note: You must issue commands as an Oracle database administrator in the following procedure.

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.

Example snapplans created for a snapshot image

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.

The following is an example of the dbed_vmchecksnap command and sample output:

```
$ cd /export/snap_dir

$ /opt/VRTS/bin/dbed_vmchecksnap -S PROD \
-H /oracle/product/orahome -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 second example, a snapplan, snap2, is created for a snapshot image in a two-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.

The following is an example of the `dbed_vmchecksnap` command and sample output:

```
$cd /export/snap_dir

$/opt/VRTS/bin/dbed_vmchecksnap -S PROD \
-H /oracle/product/orahome -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 PROD -H $ORACLE_HOME -O setdefaults \
-p my_tag -f snap1 -t host2
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 the 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 becomes disabled. Snapshot volumes can be mounted and the entire database snapshot is usable even if one of the mirrors becomes disabled. The multi-mirror snapshots are enabled by `SNAPSHOT_MIRROR=<n>` in the snapplan.

Note: There are no changes to the Command Line usage or arguments for the Flashsnap tools.

Before taking the snapshot, make sure all tagged snapshot mirrors are in SNAPDONE state.

For information about snapshot mirrors, refer to the *Veritas Volume Manager Administrator's Guide*.

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 -o validate` 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.

If you modify the default snapplan, use the virtual host (node) name defined for the resource group for the PRIMARY_HOST and/or SECONDARY_HOST, and run validation.

Note: You must issue commands as an Oracle database administrator in the following procedure.

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
```

Example to validate a snapplan snap1 for a snapshot image

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.

Note: You must issue commands as an Oracle database administrator in the following procedure.

The following is an example of the dbed_vmchecksnap command and sample output:

```
$ cd /export/snap_dir
$ /opt/VRTS/bin/dbed_vmchecksnap -S PROD -H /oracle/product/orahome \
-f snap1 -o validate

PRIMARY_HOST is host1
SECONDARY_HOST is host1
The version of PRIMARY_DG-PRODdg is 110.
The primary diskgroup PRODdg is a shared disk group
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.
```

In the following example, a snapplan, snap2, is validated for a snapshot image in a two node in a cluster configuration. The primary host is host1, the secondary host is host2, and the working directory is /export/snap_dir.

The following is an example of the dbed_vmchecksnap command and sample output:

```
$ cd /export/snap_dir
$ /opt/VRTS/bin/dbed_vmchecksnap -S PROD -H \
/oracle/product/orahome -f snap2 -o validate

PRIMARY_HOST is host1
```

```
SECONDARY_HOST is host2
The version of PRIMARY_DG-PRODdg is 110.
The primary diskgroup PRODdg is a shared disk group
SNAPSHOT_DG is SNAP_PRODdg
SNAPSHOT_MODE is online

The database is running in archivelog mode.

ARCHIVELOG_DEST is /mytest/arch
SNAPSHOT_PLAN_FOR is database
SNAPSHOT_ARCHIVE_LOG is yes
ARCHIVELOG_DEST=/mytest/arch is mount on
/dev/vx/dsk/PRODdg/arch.

Examining Oracle volume and disk layout for snapshot.
Volume arch on PRODdg is ready for snapshot.
Original plex and DCO log for arch is on PRODdg01.
Snapshot plex and DCO log for arch is on PRODdg02.

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 PRODdg04.

SNAP_PRODdg for snapshot will include: PRODdg02

ALLOW_REVERSE_RESYNC is no

The snapplan snap2 has been created.
```

Displaying, copying, and removing a snapplan (dbed_vmchecksnap)

Consider the following usage 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 it after running `dbed_update`.

Displaying a snapplan

You can use the `dbed_vmchecksnap` command to list all available snapplans, and then use the `dbed_vmchecksnap` command to display detailed information for a particular snapplan.

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
  ```

  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*.

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=no
SNAPSHOT_MIRROR=1
STORAGE_INFOPRODdg02
SNAP_PLEX=prod_ar-02

STATUS_INFO
SNAP_STATUS=init_full
DB_STATUS=init
```

Copying a snapplan

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.

To copy a snapplan from the SFDB repository to your current directory

- Use the `dbed_vmchecksnap` command as follows:

```
$ /opt/VRTS/bin/dbed_vmchecksnap -S  ORACLE_SID \
-f SNAPPLAN -o copy
```

In the following example, the snapplan, snap1, is copied from the VxDBA repository to the current directory.

```
$ /opt/VRTS/bin/dbed_vmchecksnap -S PROD -f snap1 -o  copy
Copying 'snap1' to '/export/snap_dir'
```

Removing a snapplan

A snapplan can be removed from a local directory or repository if the snapplan is no longer needed.

To remove a snapplan from the SFDB repository

- Use the `dbed_vmchecksnap` command as follows:

```
$ /opt/VRTS/bin/dbed_vmchecksnap -S ORACLE_SID -f\
SNAPPLAN -o remove
```

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. The `dbed_vmsnap` command 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 the *Veritas Storage Foundation for Oracle Administrator's Guide*.

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.

Note the following points:

- 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.
- 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 two node in a 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.

Note: You must issue commands as an Oracle database administrator in the following procedure.

To create a snapshot

1 Change directories to the working directory in which your snapplan is stored:

```
$ cd /working_directory
```

2 Create the snapshot image using the `dbed_vmsnap` command.

```
$ /opt/VRTS/bin/dbed_vmsnap -S ORACLE_SID -f SNAPPLAN \
-o snapshot [-F]
```

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 183.

3 You can also create another Oracle database for decision-support purposes.

See "Cloning a database (dbed_vmclonedb)" on page 187.

Example to create a snapshot image of the database PROD

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.

Note: You must issue commands as an Oracle database administrator in the following procedure.

```
$ /opt/VRTS/bin/dbed_vmsnap -S PROD -f snap1 -o snapshot

dbed_vmsnap started at 2006-03-02 14:15:27
VxDBA 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 2006-03-02 14:16:11
```

In this example, a snapshot image of the primary database, PROD, is created for a two node in a 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 2005-03-02 23:01:10
VxDBA 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.
VxDBA 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:

      /prod_db.
      /prod_ar.

dbed_vmsnap ended at 2005-03-02 23:02:58
```

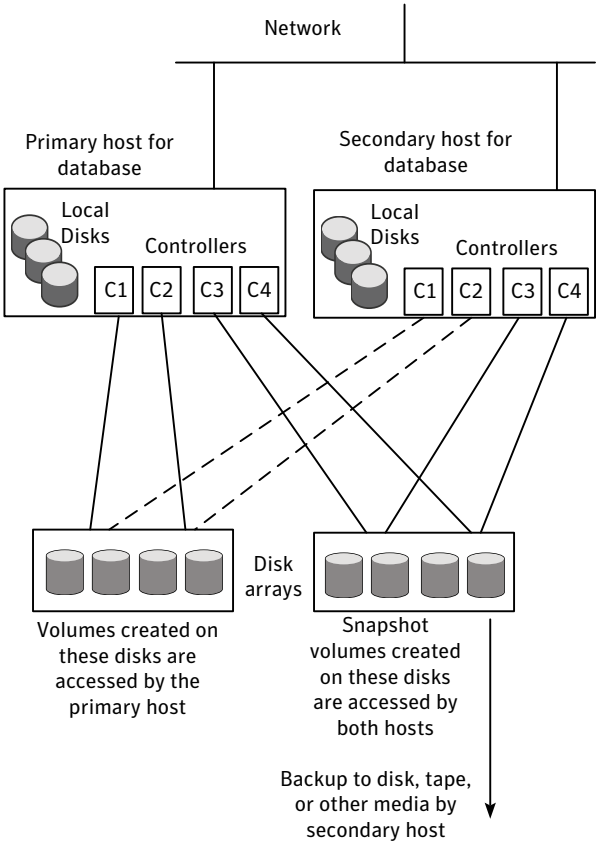
Backing up the database from snapshot volumes (dbed_vmclonedb)

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 5-5 shows a typical configuration when snapshot volumes are used on a secondary host.

Figure 5-5 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 validate a snapplan and create a snapshot.
  See "About creating database snapshots" on page 163.
  See "Validating a snapplan (dbed_vmchecksnap)" on page 174.
  See "Creating a snapshot (dbed_vmsnap)" on page 180.
- 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 two node in a cluster configuration, the `SFDBvol=`*`vol_name`* option is required.
- 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.

Note: You must issue commands as an Oracle database administrator in the following procedure.

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.

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=svr_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=svr_name -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
```

The following is an example of creating a snapshot on the same host (host nobody):

```
$  /opt/VRTS/bin/dbed_vmclonedb -S PROD -g SNAP_PRODdg \
 -o mount,new_sid=NEWPROD,server_name=nobody -f snap1 -r /clone/single


dbed_vmclonedb started at 2006-10-24 10:44:54
Mounting /clone/single/archivelogs on /dev/vx/dsk/SNAP_PRODdg/SNAP_archvol.
Mounting /clone/single/oradata on /dev/vx/dsk/SNAP_PRODdg/
SNAP_ora_data_vol.
dbed_vmclonedb ended at 2006-10-24 10:45:49
```

Note: A usage error is displayed if the server_name is not given in the above command.

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 the `dbed_ckptdisplay` command.

For example:

```
$ /opt/VRTS/bin/dbed_ckptdisplay -S ORACLE_SID -n
```

2 You can mount one of the listed Storage Checkpoints using the `dbed_ckptmount` command.

For example:

```
$ /opt/VRTS/bin/dbed_ckptmount -S ORACLE_SID -c CKPT_NAME \
-m MOUNT_POINT
```

Note the following 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 two node in a 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.

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 183.

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 two node in a 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.

Warning: 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 validate a snapplan and create a snapshot.
  See "About creating database snapshots" on page 163.
  See "Validating a snapplan (dbed_vmchecksnap)" on page 174.
  See "Creating a snapshot (dbed_vmsnap)" on page 180.
- 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.
- The Oracle database must have at least one mandatory archive destination.

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.
- In a two node in a cluster configuration, the `SFDBvol=`*`vol_name`* option is required.
- 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.

Note: You must issue commands as an Oracle database administrator in the following procedure.

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=svr_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=svr_name -f SNAPPLAN [-r relocate_path]
```

Example: Mounting the file systems without bringing up the clone database

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.

Note: You must issue commands as an Oracle database administrator in the following procedure.

```
$ /opt/VRTS/bin/dbed_vmclonedb -S PROD -g SNAP_PRODdg \
  -o mountdb,new_sid=NEWPROD,server_name=svr_name -f snap1 -r /clone

dbed_vmclonedb started at 2006-03-02 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.
Altering instance_name paramter in initabc.ora.
Altering instance_number paramter in initabc.ora.
Altering thread paramter in initabc.ora.Starting automatic database recovery.
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 2006-03-02 15:34:59
```

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=svr_name -f snap1 -r /clone
```

```
dbed_vmclonedb started at 2006-03-02 15:35:16
The snapshot status has been updated.
dbed_vmclonedb ended at 2006-03-02 15:35:42
```

Example: Mounting the file systems without recovering the clone database

Note: You must issue commands as an Oracle database administrator in the following procedure.

In this example, file systems are mounted without recovering the clone database. The clone database must be manually recovered before it can be used. This example is for a clone created on a secondary host.

```
$ /opt/VRTS/bin/dbed_vmclonedb -S HOST2_SID -g SNAP_PRODdg \
  -o mountdb,new_sid=NEWPROD,server_name=host2 -f snap2

dbed_vmclonedb started at 2006-03-09 23:26:50
Mounting /clone/arch on /dev/vx/dsk/SNAP_PRODdg/SNAP_arch.
Mounting /clone/prod_db on /dev/vx/dsk/SNAP_PRODdg/SNAP_prod_db.
All redo-log files found.
Altering instance_name paramter in initabc.ora.
Altering instance_number paramter in initabc.ora.
Altering thread paramter in initabc.ora.
Starting automatic database recovery.
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 2006-03-09 23:27:17
```

The database is recovered manually.

The snapshot status (database_recovered) is updated for a clone database on a secondary host after manual recovery has been completed.

```
$ /opt/VRTS/bin/dbed_vmclonedb -o update_status,\
  new_sid=NEWPROD,server_name=host2 -f snap2

dbed_vmclonedb started at 2006-03-09 23:34:01
The snapshot status has been updated.
dbed_vmclonedb ended at 2006-03-09 23:34:35
```

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	Represents the name of the Oracle database used to create the snapshot.
snap_dg	Represents the name of the diskgroup that contains all the snapshot volumes.
new_sid	Specifies the ORACLE_SID for the clone database.
server_name	Specifies the server name as svr_name.
SNAPPLAN	Represents the name of the snapplan file.
ORACLE_HOME	Represents the ORACLE_HOME setting for the ORACLE_SID database.
relocate_path	Represents the name of the initial mount point for the snapshot image.

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=svr_name -f snap1 -r /clone

dbed_vmclonedb started at 2006-03-02 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.
Altering instance_name paramter in initabc.ora.
Altering instance_number paramter in initabc.ora.
```

```
Altering thread paramter in initabc.ora.
Starting automatic database recovery.
Database NEWPROD (SID=NEWPROD) is running.
dbed_vmclonedb ended at 2006-03-02 14:43:05
```

In the following example, a clone of the primary database is automatically created on a secondary host.

```
$ /opt/VRTS/bin/dbed_vmclonedb -S PROD -g SNAP_PRODdg \
  -o recoverdb,new_sid=NEWPROD,server_name=svr_name -f snap2

dbed_vmclonedb started at 2006-03-09 23:03:40
Mounting /clone/arch on /dev/vx/dsk/SNAP_PRODdg/SNAP_arch.
Mounting /clone/prod_db on /dev/vx/dsk/SNAP_PRODdg/SNAP_prod_db.
All redo-log files found.
Altering instance_name paramter in initabc.ora.
Altering instance_number paramter in initabc.ora.
Altering thread paramter in initabc.ora.
Starting automatic database recovery.
Database NEWPROD (SID=NEWPROD) is running.
dbed_vmclonedb ended at 2006-03-09 23:04:50
```

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]
```

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=svr_name \
  -f snap1 -r /clone

                    dbed_vmclonedb started at 2006-03-02 15:11:22
                    umounting /clone/prod_db
                    umount /clone/arch
                    dbed_vmclonedb ended at 2006-03-02 15:11:47
```

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 (two node in a cluster configuration).

```
$ /opt/VRTS/bin/dbed_vmclonedb -o umount,new_sid=NEWPROD,server_name=svr_name \
  -f snap2
dbed_vmclonedb started at 2006-03-09 23:09:21

                    dbed_vmclonedb ended at 2006-03-09 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=svr_name -f SNAPPLAN [-H ORACLE_HOME] \
  [-r relocate_path]
```

In this example, the clone database is re-started on the same host as the primary database (same-node configuration).

```
$ /opt/VRTS/bin/dbed_vmclonedb -S PROD -g SNAP_PRODdg \
  -o restartdb,new_sid=NEWPROD,server_name=svr_name -f snap1 -r /clone

dbed_vmclonedb started at 2006-03-02 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 2006-03-02 15:15:19
```

In this example, the clone database is re-started on the secondary host (two node in a cluster configuration).

```
$ /opt/VRTS/bin/dbed_vmclonedb -S PROD -g SNAP_PRODdg \
  -o restartdb,new_sid=NEWPROD,server_name=svr_name -f snap2

dbed_vmclonedb started at 2006-03-09 23:03:40
Mounting /clone/arch on /dev/vx/dsk/SNAP_PRODdg/SNAP_arch.
Mounting /clone/prod_db on /dev/vx/dsk/SNAP_PRODdg/SNAP_prod_db.
Oracle instance NEWPROD successfully started.
dbed_vmclonedb ended at 2006-03-09 23:04:50
```

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, the `dbed_vmclonedb` command displays 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
```

where $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.

Warning: 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.

When resynchronizing the data in a volume:

- Resynchronize the snapshot from the original volume. This procedure is explained in this section.

You can resynchronize the snapshot from the original volume.

Prerequisites

- You must be logged in as the Oracle database administrator.
- Before you can resynchronize the snapshot image, you must validate a snapplan and create a snapshot.
  See "About creating database snapshots" on page 163.
  See "Validating a snapplan (dbed_vmchecksnap)" on page 174.
  See "Creating a snapshot (dbed_vmsnap)" on page 180.
- 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 193.
- The Oracle database must have at least one mandatory archive destination.

Usage Notes

- The `dbed_vmsnap` command can only be executed on the primary host.
- In a two node in a 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.

Note: You must issue commands as an Oracle database administrator in the following procedure.

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 2006-03-02 16:19:05
  The option resync has been completed.
  dbed_vmsnap ended at 2006-03-02 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 superuser.
- 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, 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, 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 -S PROD -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
```

Chapter 6

Using Database Dynamic Storage Tiering

This chapter includes the following topics:

About Database Dynamic Storage Tiering

Database Dynamic Storage Tiering (DST) matches data storage with data usage requirements. After data matching, the data can then be relocated based upon data usage and other requirements determined by the database administrator (DBA).

As more and more data is retained over a period of time, eventually, some of that data is needed less frequently. The data that is needed less frequently still requires a large amount of disk space. DST enables the database administrator to manage data so that less frequently used data can be moved to slower, less expensive disks. This also permits the frequently accessed data to be stored on faster disks for quicker retrieval.

Tiered storage is the assignment of different types of data to different storage types to improve performance and reduce costs. With DST, storage classes are

used to designate which disks make up a particular tier. There are two common ways of defining storage classes:

- Performance, or storage, cost class: The most-used class consists of fast, expensive disks. When data is no longer needed on a regular basis, the data can be moved to a different class that is made up of slower, less expensive disks.
- Resilience class: Each class consists of non-mirrored volumes, mirrored volumes, and n-way mirrored volumes.
  For example, a database is usually made up of data, an index, and logs. The data could be set up with a three-way mirror because data is critical. The index could be set up with a two-way mirror because the index is important, but can be recreated. The logs are not required on a daily basis and could be set up without mirroring.

Dynamic Storage Tiering policies control initial file location and the circumstances under which existing files are relocated. These policies cause the files to which they apply to be created and extended on specific subsets of a file systems's volume set, known as placement classes. The files are relocated to volumes in other placement classes when they meet specified naming, timing, access rate, and storage capacity-related conditions.

In addition to preset policies, you can manually move files to faster or slower storage with DST, when necessary. You can also run reports that list active policies, display file activity, display volume usage, or show file statistics.

Database Dynamic Storage Tiering building blocks

To use Database Dynamic Storage Tiering, your storage must be managed using the following features:

- VxFS multi-volume file system
- VxVM volume set
- Volume tags
- Dynamic Storage Tiering policies

About VxFS multi-volume file systems

Multi-volume file systems are file systems that occupy two or more virtual volumes. The collection of volumes is known as a volume set, and is made up of disks or disk array LUNs belonging to a single Veritas Volume Manager (VxVM) disk group. A multi-volume file system presents a single name space, making the existence of multiple volumes transparent to users and applications. Each volume retains a separate identity for administrative purposes, making it possible to control the

locations to which individual files are directed. This feature is available only on file systems meeting the following requirements:

- The minimum Diskgroup version is 140.
- The minimum filesystem version is 7.

To convert your existing VxFS file system to a VxFS multi-volume file system, you must convert a single volume to a volume set. See "Converting a VxFS file system to a VxFS multi-volume file system" on page 212.

The VxFS volume administration utility (fsvoladm utility) can be used to administer VxFS volumes. The fsvoladm utility performs administrative tasks, such as adding, removing, resizing, encapsulating volumes, and setting, clearing, or querying flags on volumes in a specified Veritas File System.

See the fsvoladm (1M) manual page for additional information about using this utility.

About VxVM volume sets

Volume sets allow several volumes to be represented by a single logical object. Volume sets cannot be empty. All I/O from and to the underlying volumes is directed via the I/O interfaces of the volume set. The volume set feature supports the multi-volume enhancement to Veritas File System (VxFS). This feature allows file systems to make best use of the different performance and availability characteristics of the underlying volumes. For example, file system metadata could be stored on volumes with higher redundancy, and user data on volumes with better performance.

About volume tags

You make a VxVM volume part of a placement class by associating a volume tag with it. For file placement purposes, VxFS treats all of the volumes in a placement class as equivalent, and balances space allocation across them. A volume may have more than one tag associated with it. If a volume has multiple tags, the volume belongs to multiple placement classes and is subject to allocation and relocation policies that relate to any of the placement classes.

Warning: Multiple tagging should be used carefully.

A placement class is a Dynamic Storage Tiering attribute of a given volume in a volume set of a multi-volume file system. This attribute is a character string, and is known as a volume tag.

About Dynamic Storage Tiering policies

Dynamic Storage Tiering allows administrators of multi-volume VxFS file systems to manage the placement of files on individual volumes in a volume set by defining placement policies that control both initial file location and the circumstances under which existing files are relocated. These placement policies cause the files to which they apply to be created and extended on specific subsets of a file system's volume set, known as placement classes. The files are relocated to volumes in other placement classes when they meet the specified naming, timing, access rate, and storage capacity-related conditions.

Database Dynamic Storage Tiering in a High Availability (HA) environment

Veritas Cluster Server does not provide a bundled agent for volume sets. If issues arise with volumes or volume sets, the issues can only be detected at the DiskGroup and Mount resource levels.

The DiskGroup agent brings online, takes offline, and monitors a Veritas Volume Manager (VxVM) disk group. This agent uses VxVM commands. When the value of the StartVolumes and StopVolumes attributes are both 1, the DiskGroup agent onlines and offlines the volumes during the import and deport operations of the disk group. When using volume sets, set StartVolumes and StopVolumes attributes of the DiskGroup resource that contains the volume set to 1. If a file system is created on the volume set, use a Mount resource to mount the volume set.

The Mount agent brings online, takes offline, and monitors a file system or NFS client mount point.

If you are using any of the Database Dynamic Storage Tiering commands in a high availability (HA) environment, the time on each system in the cluster must be synchronized. Otherwise, the scheduled task may not be executed at the expected time after a service group failover.

For additional information, see the *Veritas Cluster Server Bundled Agents Reference Guide*.

Dynamic Storage Tiering policy management

You can choose to manually relocate files or tablespaces, or you can use a preset Dynamic Storage Tiering (DST) policy.

Note: You must issue commands as an Oracle database administrator in the following procedures.

Relocating files

Table 6-1 shows the `dbdst_file_move` command options.

Table 6-1 dbdst_file_move command options

Command options	Description
`-o archive[n] | flashback`	Specifies which archive logs or Flashback logs to move. Do not use this option with the `-f` option.
`-o external | datafile`	Specifies whether to move external files or datafiles. Use this option with the -f option.
`-f listfile`	Specifies a listfile that contains a list of files or directories to be moved.
`-c class [:days]`	Specifies the storage class to which the files should be moved. If the days option is used, the files will be moved to the class specified if they have not been accessed in the number of days specified. Do not specify days if you are using the -o datafile option.
`-R`	Removes the policy for the specified object.

Before relocating a file, review the following information:

Usage notes

- Multiple partitions cannot reside on the same tablespace.

To relocate a file

- Use the `dbdst_file_move` command as follows:

```
$ /opt/VRTS/bin/dbdst_file_move -S $ORACLE_SID -o datafile \
-f listfile -c storage_class:days [-c storage_class:days]
```

Relocating tablespaces

Use the `dbdst_tbs_move` command to move tablespaces to the desired storage class. The command queries the SFDB repository for the tablespace file names, then performs a one-time move based on your immediate requirements.

To relocate a tablespace

- Use the `dbdst_tbs_move` command as follows:

  ```
  $ /opt/VRTS/bin/dbdst_tbs_move -S $ORACLE_SID -t tablespace \
  -c class
  ```

  where

  - *tablespace* indicates which tablespace to move.
  - *class* indicates to which class the tablespace should be moved.

Relocating table partitions

Use the `dbdst_partition_move` to move table partitions. The command queries the database to validate the names of the table and partition. From this information, a list of datafiles is derived and a one-time move of the files to the desired class is executed.

Before relocating table partitions, review the following information:

Prerequisites	The database must be up when you run the `dbdst_partition_move` command.

To relocate a table partition

- Use the `dbdst_partition_move` command as follows:

  ```
  $ /opt/VRTS/bin/dbdst_partition_move -S $ORACLE_SID -T table_name \
  -p partition_name -c class
  ```

  where

  - `-T` indicates the table name.
  - `-p` indicates the partition name.
  - `-c` indicates the class to which the table partition is to be moved.

For example, to move the SALES_Q1 partition of the SALES table to storage class SLOW, use the `dbdst_partition_move` as follows:

```
$ /opt/VRTS/bin/dbdst_partition_move -S $ORACLE_SID -T SALES \
-p SALES_Q1 -c SLOW
```

Using preset policies

Use the `dbdst_preset_policy` command to set a policy based on file name patterns before the files are created.

Table 6-2 shows the preset policies command options.

Table 6-2 dbdst_present_policy command options

Command option	Description
`-d` directory	Indicates the directory on which the placement policy will be applied.
`-e`	Enforces the file system of the specified directory. Use this option if there was an error in the previous enforcement that has been corrected and needs to be enforced again.
`-R`	Removes all pattern-based placement policies related to this directory.
`-l`	Lists the existing file placement that is set to the specified directory.
`-P` pattern_spec	Specifies file patterns and class assignment. This option will automatically place files in the desired class as soon as they are created. Existing files and newly created files will be moved immediately to the class specified.
`-f` pattern file	Specifies a file that contains a particular class and pattern. New files with this pattern will be placed in the class immediately. Existing files will be moved as well.
`-E`	Specifies that existing files should be moved to the designated class in a one-time move to be scheduled at a later time, such as the sweeptime specified in the `dbdst_admin` command.

To create a preset policy

- Use the `dbdst_preset_policy` command as follows:

```
$ /opt/VRTS/bin/dbdst_preset_policy -S $ORACLE_SID -d directory \
-P pattern_spec
```

Configuring Database Dynamic Storage Tiering

To use database Dynamic Storage Tiering, the following requirements must be met:

- An Oracle database must be up and running.
- Only the Oracle database administrator can run Database Dynamic Storage Tiering commands.

To use Database Dynamic Storage Tiering, the following tasks must be performed:

- Review the Database Dynamic Storage Tiering command requirements.
- Define the database parameters.
- Set up storage classes.
- Convert an existing VxFS database file system to a VxFS multi-volume file system for use with Database Dynamic Storage Tiering.
- Classify, or tag, volumes so that the tags indicate the quality of the underlying disk.
- Display the free space on each class.
- Add or remove volumes as necessary.

Database Dynamic Storage Tiering command requirements

Before defining your database parameters, review the following command requirements:

- Run the `dbed_update` command before running any of the Database Dynamic Storage Tiering commands. You should also run the `dbed_update` command if any of the database files change.
  The repository must be up to date, since the Database Dynamic Storage Tiering commands retrieve database information from the repository.
- Define the LD_LIBRARY_PATH environment variable as follows:

```
LD_LIBRARY_PATH=$LD_LIBRARY_PATH:/opt/VRTSdbms3/lib:\
/opt/VRTSdbms3/lib32; export LD_LIBRARY_PATH

SHLIB_PATH=$SHLIB_PATH:/opt/VRTSdbms3/lib:\
/opt/VRTSdbms3/lib32; export SHLIB_PATH
```

- If you are using any of the Database Dynamic Storage Tiering commands in a high availability (HA) environment, the time on each system in the cluster must be synchronized.

- Create the volumes that you want to add to the multi-volume file system in the same disk group as the file system volume. As root, use the following command to change the owner of each volume:

```
# /opt/VRTS/bin/vxedit -g disk_group \
set user=oracle volume
```

- Change the owner of the mount point on which you want to implement Database Dynamic Storage Tiering to oracle.

Defining database parameters

Running the `dbdst_admin` command defines parameters for the entire database. You must run this command at least once to define the database parameters for Database Dynamic Storage Tiering. Three pre-defined storage classes will be created (PRIMARY, SECONDARY, and BALANCE). Parameter values are stored in the SFDB repository.

Set at least one of the parameters in maxclass, minclass, statinterval, sweeptime, sweepinterval, purgetime, or purgeinterval, to enable default values. Add at least one class to enable the default classes.

Table 6-3 lists the options for the `dbdst_admin` command:

Table 6-3 dbdst_admin command options

Command option	Description
`-S $ORACLE_SID`	Specifies the `ORACLE_SID`, which is the name of the Oracle instance.
list	Lists all of the Database Dynamic Storage Tiering parameters of the database, including class name and description. This option should be used exclusively from the other options.
maxclass=	Maximum number of storage classes allowed in the database. The default value is 4.
minclass=	Minimum number of storage classes allowed in the database. The default value is 2.
sweepinterval=	Interval for file sweeping for file relocation. Default value is 1, which means one per day. If this value is set to 0, all scheduled sweep tasks will become unscheduled.

Table 6-3 dbdst_admin command options *(continued)*

Command option	Description
sweeptime=	Time per day for the file sweep to take place. Times are entered in 24-hour periods and should list hour: minute. For example, 8:30 AM is represented as 08:30 and 10:00 PM is represented as 22:00. Default value is 22:00.
statinterval=	Interval in minutes for gathering file statistics. Default value is 30, which represents every 30 minutes. If this value is set to 0, all scheduled tasks will become unscheduled.
purgeinterval=	Number of days after which the file statistics in the repository will be summarized and purged. Default value is 30. It is recommended that you set your purge insterval sooner because you will not be able to view any statistics until the first 30-day interval is over, if you use the default.
purgetime=	Time per day for the file purge to take place. Times are entered in 24-hour periods and should list hour: minute. For example, 8:30 AM is represented as 08:30 and 8:00 PM is represented as 20:00. Default value is 20:00.
addclass=	Parameter that allows you to add a class to a database. The information should be entered as class:"description", where the class represents the class name and description is a string of up to 64 characters enclosed by double quotes used to describe the class.
rmclass=	Parameter that allows you to remove a class from a database. Enter the class name as it appears in the database.
-o definechunk=<classname>{128k|256k|512k|1m}	Defines a chunksize in bytes for the given storage class. Valid chunksizes are 128k, 256k, 512k or 1m bytes. When a chunksize is specified for a storage class, the files in this storage class will be extent-balanced. Each chunk of the file will be in a separate volume of the storage class. A given file will have appraximately equal number of chunks on each component volumes of the stortage class. When a new volume is added or an existing volume is removed from the storage class (using dbdst_addvol or dbdst_rmvol), the files are automatically balanced again.

Note: If you do not want to change specific default values, you can omit those parameters when you run the dbdst_admin command. You only need to enter the parameters that need to be changed.

To define database parameters

- Use the `dbdst_admin` command as follows:

```
$ /opt/VRTS/bin/dbdst_admin -S $ORACLE_SID -o list,maxclass=number,\
minclass=number,sweepinterval=interval,sweeptime=hh:mm,\
statinterval=interval,purgeinterval=interval,purgetime=hh:mm,\
addclass=class:"description",rmclass=class
```

For example, to add a class called tier1 for database PROD, and to set up a purge interval of one, meaning that the file statistics will be gathered for one day and then summarized and purged, use the dbdst_admin command as follows:

```
$ /opt/VRTS/bin/dbdst_admin -S PROD -o addclass=tier1:"Fast Storage",\
purgeinterval=1
```

Setting up storage classes

When you define your database parameters, three pre-defined storage classes are created. You will need to add or remove storage classes to meet your needs.

Adding storage classes

In addition to the default storage classes, you can add storage classes to better manage your data.

Before adding a storage class, review the following information:

- Use the `dbdst_admin` command as follows:

```
$ /opt/VRTS/bin/dbdst_admin -S $ORACLE_SID -o addclass=class:\
"description"
```

For example, to create a storage class named "FAST" for an EMC array, use the `dbdst_admin` command as follows:

```
$ /opt/VRTS/bin/dbdst_admin -S $ORACLE_SID -o addclass=FAST:\
"fast EMC array"
```

Removing storage classes

If you no longer require a specific storage class, you can remove it.

Note: You cannot remove the pre-defined storage classes (PRIMARY, SECONDARY, and BALANCE).

Before removing a storage class, review the following information:

- Use the `dbdst_admin` command as follows:

```
$ /opt/VRTS/bin/dbdst_admin -S $ORACLE_SID rmclass=class
```

For example, to remove a storage class called "SLOW," use the dbdst_admin command as follows:

```
$ /opt/VRTS/bin/dbdst_admin -S $ORACLE_SID rmclass=SLOW
```

Displaying storage classes

You can display a list of Database Dynamic Storage Tiering properties and storage classes using the dbdst_admin command.

Before displaying your storage classes, review the following information:

- Use the `dbdst_admin` command as follows:

```
$ /opt/VRTS/bin/dbdst_admin -S $ORACLE_SID -o list
```

Converting a VxFS file system to a VxFS multi-volume file system

To convert your existing VxFS file system to a VxFS multi-volume file system, you must convert a single volume to a volume set.

Converting a single volume to a volume set

When you convert to a volume set using the `dbdst_convert` command, the original volume will be renamed to a new volume name. The mount device name will become the new volume set name. Creating the new volume set name with the mount device name nullifies the need to rename the mount device in various locations.

Before converting to a volume set, make sure the following conditions have been met:

Prerequisites

- The Db database must not be active, and must be down.
- Create at least one additional volume.

Usage Notes

- You must convert the single-volume file system on which you plan to implement Database Dynamic Storage Tiering.
- The file system has to be unmounted when you run the `dbdst_convert` command.
- If the file system has n volumes, volumes 1 through n–1 will be placed in the storage class "PRIMARY" and volume n will be placed in the storage class "SECONDARY."
- The volumes specified when running the conversion must be in the same disk group as the mount device.

To convert a mount device from a single volume device to a volume set

1 Use the `dbdst_convert` command as follows:

```
$ /opt/VRTS/bin/dbdst_convert -S $ORACLE_SID -M mount_device -v \
volume_name,volume_name
```

2 Bring the database objects online.

For example, to convert a volume-based oradata file system to a Database Dynamic Storage Tiering-ready volume set file system on mount device /dev/vx/dsk/oradg/oradata, use the `dbdst_convert` command as follows:

```
$ /opt/VRTS/bin/dbdst_convert -S PROD -M /dev/vx/dsk/oradg/oradata -v \
new_vol1,new_vol2
```

After conversion, you will have a volume set named oradata containing three volumes (oradata_b4vset, new_vol1, and new_vol2). The file system will have two storage classes defined as PRIMARY and SECONDARY. The volumes will be assigned as follows:

- PRIMARY storage class will contain volumes oradata_b4vset and new_vol1.
- SECONDARY storage class will contain volume new_vol2.

Classifying volumes into a storage class

Before creating a DST policy or manually moving data, assign classes to your volumes.

Before assigning classes to volumes, review the following information:

Usage notes

- You must convert your VxFS file system to a multi-volume file system first.
- Storage classes must be registered using the `dbdst_admin` command before assigning classes to volumes.
- The database can be online or offline.

To classify a volume

- Use the `dbdst_classify` command as follows:

```
$ /opt/VRTS/bin/dbdst_classify -S $ORACLE_SID -M mount_device \
-v volume_name:class[,volume_name:class]
```

For example, to assign the class "FAST" to volume new_vol1, use the `dbdst_classify` command as follows

```
$ /opt/VRTS/bin/dbdst_classify -S $ORACLE_SID -M /dev/vx/dsk/oradg/oradata \
-v new_vol1:FAST
```

Displaying free space on your storage class

To see the free space, class information, and volume information on your storage classes, use the `dbdst_show_fs` command.

Table 6-4 shows the `dbdst_show_fs` command options.

Table 6-4 dbdst_show_fs command options

Command options	Description
`-S $ORACLE_SID`	Specifies the `ORACLE_SID`, which is the name of the Oracle instance.
`-o volume`	Displays the free space on volumes in each class.
`-m`	Specifies the mount point.

Before displaying the free space on a storage class, review the following information:

Prerequisites

- Make sure the file system is mounted.
- See the `dbdst_show_sf` (1M) manual page.

To display the free space on a storage class

- Use the `dbdst_show_fs` command as follows:

```
$ /opt/VRTS/bin/dbdst_show_fs -S $ORACLE_SID -o volume \
-m mount_point
```

Adding new volumes to a storage class

Use the `dbdst_addvol` command to add volumes to a volume set.

Before adding a volume, review the following information:

Usage notes

- The database must be inactive when adding volumes to a storage class.
- The database file system has to be mounted.

To add a volume to a volume set

- Use the `dbdst_addvol` command as follows:

```
$ /opt/VRTS/bin/dbdst_addvol -S $ORACLE_SID -M mount_device \
-v volume_name:class[,volume_name:class]
```

Removing volumes from a storage class

You may need to remove a volume from a volume set. To remove a volume, use the `dbdst_rmvol` command.

Before removing a volume, review the following information:

Usage notes

- The database must be inactive when removing volumes from a storage class.
- Only a volume that does not contain any file system data can be removed.

To remove a volume from a volume set

Use the `dbdst_rmvol` command as follows:

```
$ /opt/VRTS/bin/dbdst_rmvol -S $ORACLE_SID -M mount_device \
-v volume_name[,volume_name]
```

Extent balancing in a database environment

To obtain better performance in a database environment, you would normally use a volume striped over several disks. As the amount of data stored in the file system increases over time, additional space in the form of new disks must be added.

To increase space, you could perform a volume relayout using the `vxrelayout` command. However, changing a large volume from a four-way striped volume to six-way striped volume involves moving old block information into temporary space and writing those blocks from the temporary space to a new volume, which would require an extended amount of time. To solve this problem, Veritas Storage Foundation for Db provides the Extent Balanced File System or EBFS .

An Extent Balanced File System is created on a multi-volume file system where individual volumes are not striped over individual disks. For data-availability, these individual volumes can be mirrored. The file system on the EBFS has a special placement policy called a balance policy. When the balance policy is applied, all the files are divided into small "chunks" and the chunks are laid out on volumes so that adjacent chunks are on different volumes. The default chunk size is 1MB and can be modified. Since every file contains chunks on all available volumes, it is important that individual volumes that make up the EBFS and volume set be of same size and same access properties.

Setting up the file system in this way provides the same benefit as striping your volumes.

Note: You cannot convert an existing file system to an EBFS file system.

Extent balancing file system

You can define allocation policies with a balance allocation order and "chunk" size to files or a file system, known as extent balancing. The chunk size is the maximum size of any extent that files or a file system with this assigned policy can have. The chunk size can only be specified for allocation policies with a balance allocation order.

An extent balancing policy specifies the balance allocation order and a non-zero chunk size. The balance allocation order distributes allocations randomly across the volumes specified in the policy and limits each allocation to a maximum size equal to the specified chunk size.

Extent balancing extends the behavior of policy enforcement by rebalancing extent allocations such that each volume in the policy is as equally used as possible. Policy enforcement handles the following cases:

- New volumes are added to the policy, and the extents associated with a file need rebalancing across all volumes, including the new ones.
- Volumes are removed from the volume set or from the policy, and the extents for a file residing on a removed volume need to be moved to other volumes in the policy.
- An extent balancing policy is assigned to a file and its extents have to be reorganized to meet the chunk size requirements defined in the policy.

The extent balancing policy is intended for balancing data extents belonging to files across volumes defined in the policy. However, there is no restriction imposed in assigning extent balancing policy for metadata.

Note: If the fixed extent size is less than the chunk size, then the extent size will be limited to the largest multiple of the fixed extent size that is less than the chunk size. If the fixed extent size is greater than the chunk size, then the extent size will be the fixed extent size.

Creating an extent balanced file system

Any MultiVolume File System (MVFS) can become an extent balanced file system, if the storage tier has a chunk size associated with the class. The `dbdst_admin` command permits the user to define a chunk size for the class.

For example, the following `dbdst_admin` commands define chunk sizes for the gold and silver storage classes:

```
$ /opt/VRTS/bin/dbdst_admin -S $ORACLE_SID -o definechunk gold:256K

$ /opt/VRTS/bin/dbdst_admin -S $ORACLE_SID -o definechunk silver:128K
```

The above commands make storage class gold as extent balanced.

Once the chunksize is defined for a storage tier, we can classify any MVFS into this storage tier.

For example, assume that /oradata is the filesystem created on volume-set /dev/vx/dsk/oradg/ora_vset, and contains database datafiles. Let us further assume that datafile names end with extension *.dbf. To define storage class in this MVFS, the following `dbdst_classify` command is used:

```
$ /opt/VRTS/bin/dbdst_classify  -S $ORACLE_SID -M /dev/vx/dsk/oradg/ora_vset -v \
vol1:GOLD,vol2:GOLD,vol3:GOLD
```

It is important to note that, an MVFS can have multiple storage tiers and that each tier may have a different chunk size. For example, for the same MVFS in the

above example, we can define another storage tier using the `dbdst_classify` command:

```
$ /opt/VRTS/bin/dbdst_classify  -S $ORACLE_SID -M /dev/vx/dsk/oradg/ora_vset -v \
vol4:silver,vol5:silver
```

At this point we have two storage tiers in MVFS /oradata each having different chunksizes. To create the real extent balance, we need to assign a DST policy and to enforce it.

To define and enforce the policy, you could use the following `dbdst_preset_policy` command:

```
$ /opt/VRTS/bin/dbdst_preset_policy -S $ORACLE_SID -d /oradata -P GOLD=*.dbf,SILVER=*.inx
```

The above example creates a DST policy, assigns the policy to /oradata and enforces the policy. All datafiles of the form *.dbf will be extent balanced in GOLD tier with chunksize 256K and all index files of the form *.inx will be extent balanced in SILVER tier with chunk size 128K.

To view the space usage in the /oradata MVFS use the `dbdst_show_fs` command. For example:

```
$ /opt/VRTS/bin/dbdst_show_fs -S $ORACLE_SID -m /oradata
```

When the GOLD or SILVER tier requires more space, we could add extra space by adding new volumes to the respective storage tier using the `dbdst_addvol` command. For example:

```
$ /opt/VRTS/bin/dbdst_addvol -S $ORACLE_SID -M /dev/vx/dsk/oradg/ora_vset  -v vol7:GOLD
```

As soon as you add a new volume, the DST policy is enforced and the extents are balanced over the new volume too. This can be viewed by using the `dbdst_show_fs` command again.

To view detailed extent information about a given file, you can use the `fsmap` command. For example:

Running Database Dynamic Storage Tiering reports

You can create a report that lists all updated allocation policies or you can view an audit report, which lists recent relocation changes for a specific date range resulting from your policies.

Viewing modified allocation policies

To create a list of modified allocation policies, use the `dbdst_report` command with the `policy` option.

To list allocation policies

- Use the `dbdst_report` command as follows:

```
$ /opt/VRTS/bin/dbdst_report -S $ORACLE_SID -o policy
```

For example to view a list of modified allocation policies, use the `dbdst_report` command as follows:

```
$ /opt/VRTS/bin/dbdst_report -S $ORACLE_SID -o policy
```

Viewing audit reports

To view an audit report, which lists recent file relocation changes within a specific date range, use the `dbdst_report` command with the `audit` option.

To view an audit report

- Use the `dbdst_report` command as follows:

```
$ /opt/VRTS/bin/dbdst_report -S $ORACLE_SID -o audit \
startdate=yyyy-mm-dd,enddate=yyyy-mm-dd
```

For example, to view an audit report of changes from January 1, 2007 through March 1, 2007, use the `dbdst_report` command as follows:

```
$ /opt/VRTS/bin/dbdst_report -S $ORACLE_SID -o audit \
startdate=2007-01-01,enddate=2007-03-01
```

Oracle Database Dynamic Storage Tiering use cases

This section discusses Oracle use cases for Dynamic Storage Tiering.

Migrating partitioned data and tablespaces

Perhaps the simplest application of multi-tier storage to databases is relocation of individual table partitions between different placement classes as usage requirements change. If exact relocation times are unpredictable, or if relocation

is infrequent, administrators may wish to relocate table partitions when necessary rather than defining strict periodic relocation schedules.

Ad hoc relocation of table partitions can be useful, for example, with databases that track sales and inventory for seasonal businesses such as sports equipment or outdoor furniture retailing. As the selling season for one type of inventory (for example, summer equipment or furniture) approaches, database table partitions that represent in-season goods can be relocated to high-performance storage, since they will be accessed frequently during the coming months. Similarly, partitions that represent out-of-season goods can be relocated to lower-cost storage, since activity against them is likely to be infrequent.

For example, sales are mostly catalog-driven for a large retailer specializing in sports equipment. Product details are saved in a large database and the product table is partitioned based on type of activity. Some of the products are seasonal and do not sell well at other times. For example, very few snow skis are sold during the summer. To achieve season-based migration, see the following example. Assume the table product_tab has two partitions, summer and winter. Each of these partitions is mapped to a separate data file.

First, you must set up your system to use Database Dynamic Storage Tiering.

To add the fast_storage and slow_storage storage classes

- Use the `dbdst_admin` command as follows:

```
$ /opt/VRTS/bin/dbdst_admin -S PROD -o addclass=\
fast_storage:"Fast Storage for Production DB"

$ /opt/VRTS/bin/dbdst_admin -S PROD -o addclass=\
slow_storage:"Slow Storage for Production DB"
```

To convert the database's file system and add volumes for use with Database Dynamic Storage Tiering

- Use the `dbdst_convert` command as follows:

```
$ /opt/VRTS/bin/dbdst_convert -S PROD \
-M /dev/vx/dsk/oradg/oradata -v new_vol1,new_vol2,new_vol3
```

To classify volumes into storage classes

- Use the `dbdst_classify` command as follows:

```
$ /opt/VRTS/bin/dbdst_classify -S PROD \
-M /dev/vx/dsk/oradg/oradata -v new_vol1:fast_storage

$ /opt/VRTS/bin/dbdst_classify -S PROD \
-M /dev/vx/dsk/oradg/oradata -v new_vol2:slow_storage,\
new_vol3:slow_storage
```

Once the volumes are configured, an administrator can define file placement policy rules that specify seasonal relocation of selected tablespaces and partitions and assign them to the database's file system.

To move summer data to slower storage and winter data to faster storage at the beginning of winter

- Use the `dbdst_partition_move` command as follows:

```
$ /opt/VRTS/bin/dbdst_partition_move -S PROD -T product_tab \
-p winter -c fast_storage

$ /opt/VRTS/bin/dbdst_partition_move -S PROD -T product_tab \
-p summer -c slow_storage
```

These commands relocate the files that comprise the winter partition of the product_tab table to placement class fast_storage, and the files that comprise the summer partition to placement class slow_storage. Database Dynamic Storage Tiering determines which files comprise the winter and summer partitions of product_tab, and uses underlying DST services to immediately relocate those files to the fast_storage and slow_storage placement classes respectively.

To move winter data to slower storage and summer data to faster storage at the beginning of summer

- Use the `dbdst_partition_move` command as follows:

```
$ /opt/VRTS/bin/dbdst_partition_move -S PROD -T product_tab \
-p summer -c fast_storage

$ /opt/VRTS/bin/dbdst_partition_move -S PROD -T product_tab \
-p winter -c slow_storage
```

Database Dynamic Storage Tiering formulates DST policy rules that unconditionally relocate the files containing the target partitions to the destination placement classes. It merges these rules into the database file system's active

policy, assigns the resulting composite policy to the file system, and enforces it immediately to relocate the subject files. Because the added policy rules precede any other rules in the active policy, the subject files remain in place until the dbdst_partition_move command is next executed, at which time the rules are removed and replaced with others.

Scheduling the relocation of archive and Flashback logs

Because they are the primary mechanism for recovering from data corruption, database logs are normally kept on premium storage, both for I/O performance and data reliability reasons. Even after they have been archived, logs are normally kept online for fast recovery, but the likelihood of referring to an archived log decreases significantly as its age increases. This suggests that archived database logs might be relocated to lower-cost volumes after a certain period of inactivity.

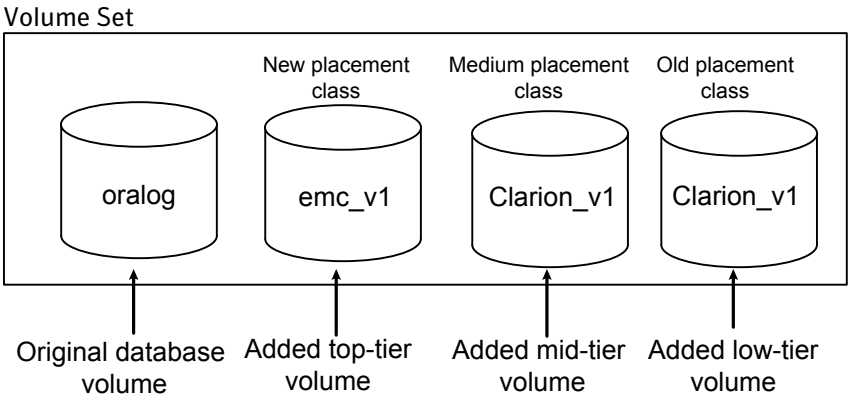
Similarly, Veritas Storage Foundation for DB Flashback technology creates logs that can be used for quick recovery from database corruption by restoring a database to its state at a previous time. Flashback logs are normally kept for a shorter period than archived database logs, if used at all, they are typically used within a few hours of creation. Two or three days are a typical Flashback log lifetime.

The rapidly decaying probability of use for archive and Flashback logs suggests that regular enforcement of a placement policy that relocates them to lower-cost storage after a period of inactivity can reduce an enterprise's average cost of online storage.

For example, a customer could be using a large OLTP Oracle database with thousands of active sessions, which needs to be up and running 24 hours a day and seven days a week with uptime of over 99%, and the database uses Flashback technology to correct any accidental errors quickly. The database generates large number of archive logs per day. If the database goes down for any reason, there is business requirement to bring the database back online and functional with in 15 minutes. To prevent Oracle log switch delays during transactions, the archive logs need to be created in a fast EMC array. Archive logs older than a week can be moved to a mid-range Clarion array. Archive logs older than 15 days can be moved to slow JBOD disks. Archive logs are purged after 30 days. Current Flashback logs are created manually by the database administrator on fast EMC storage and can be moved to Clarion storage after two days. The database administrator then deletes the Flashback logs after a week. To set up a system like this, see the following example. Assume that archive logs and Flashback logs are created on the same file system, /oralog. On the file system, /oralog/archive1 contains archive logs and /oralog/flashback contains Flashback logs.

Figure 6-1 illustrates a three-tier volume configuration that is suitable for automatic relocation and deletion of archive logs and Flashback logs.

Figure 6-1 Database storage configuration suitable for automatic relocation of archive and Flashback logs



The file system used by the production database in this example originally resides on the single volume oralog, which must be prepared by adding volumes and placement classes assigned to the volumes.

To add the NEW, MEDIUM, and OLD storage classes

- Use the `dbdst_admin` command as follows:

```
$ /opt/VRTS/bin/dbdst_admin -S PROD -o addclass=\
NEW:"EMC Storage for Production DB"

$ /opt/VRTS/bin/dbdst_admin -S PROD -o addclass=\
MEDIUM:"Clarion Storage for Production DB"

$ /opt/VRTS/bin/dbdst_admin -S PROD -o addclass=\
OLD:"JBOD Storage for Production DB"
```

To convert the database's file system and add volumes for use with Database Dynamic Storage Tiering

- Use the `dbdst_convert` command as follows:

```
$ /opt/VRTS/bin/dbdst_convert -S PROD \
-M /dev/vx/dsk/oradg/oralog -v emc_v1,clarion_v1,jbod_v1
```

To classify volumes into storage classes

- Use the `dbdst_classify` command as follows:

```
$ /opt/VRTS/bin/dbdst_classify -S PROD \
-M /dev/vx/dsk/oradg/oralog -v emc_v1:NEW

$ /opt/VRTS/bin/dbdst_classify -S PROD \
-M /dev/vx/dsk/oradg/oralog -v clarion_v1:MEDIUM

$ /opt/VRTS/bin/dbdst_classify -S PROD \
-M /dev/vx/dsk/oradg/oralog -v jbod_v1:OLD
```

Once the volumes are configured, an administrator can define file placement policy rules that specify access age-based relocation of selected files and assign them to the database's file system.

To define rules that periodically relocate Flashback and archive logs

- Use the `dbdst_file_move` command as follows:

```
$ /opt/VRTS/bin/dbdst_file_move -S PROD -o flashback -c MEDIUM:2
```

This command relocates files in the Flashback directory that have not been accessed for two days to the MEDIUM volume.

```
$ /opt/VRTS/bin/dbdst_file_move -S PROD -o archive1 -c MEDIUM:7 \
-c OLD:15
```

This command relocates files in the archive1 directory that have not been accessed for seven days to the MEDIUM volume, and files that have not been accessed for 15 days to the OLD volume.

Database Dynamic Storage Tiering translates these commands into DST access age-based policy rules, merges them with the file system's placement policy, and assigns the resulting policy to the file system. By default, Database Dynamic Storage Tiering enforces the active policy daily. During enforcement, the new rules relocate qualifying files to the destination storage tiers specified in the `dbdst_file_move` commands used to create the policies.

Section 3

Performance and troubleshooting

Chapter 7

Investigating I/O performance using storage mapping

This chapter includes the following topics:

About Storage Mapping in SF Oracle RAC

The storage mapping feature is available with SF Oracle RAC and enables you to map datafiles to physical devices. You can obtain and view detailed storage topology information using the `vxstorage_stats` and `dbed_analyzer` commands.

Understanding Storage Mapping

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 SF Oracle RAC Storage Mapping option, you can map datafiles to physical devices. Veritas 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 Veritas 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 Mapping option supports a wide range of storage devices and allows for "deep mapping" into EMC, Hitachi, and IBM Enterprise Storage Server ("Shark") arrays. Before proceeding with storage mapping, consult the current compatibility list in the Veritas Technical Support website to confirm the compatibility of your hardware:

http://entsupport.symantec.com/docs/283161

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 following commands:

`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.
`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.

For information on the command line options, see details on storage mapping in the *Veritas Storage Foundation for Oracle Administrator's Guide.*

Verifying Veritas Storage Mapping set up

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.

```
# swlist VRTSvxmsa
```

Output similar to the following is displayed:

```
VRTSvxmsa              4.4-REVbuild010-2006.03.07 VxMS
Application Deployment Package
VRTSvxmsa.ADMIN        4.4-REVbuild010-2006.03.07 VERITAS
Federated Mapping Service
VRTSvxmsa.LIBRARIES    4.4-REVbuild010-2006.03.07 libraries
VRTSvxmsa.LOGGING      4.4-REVbuild010-2006.03.07 logging
VRTSvxmsa.PLUGINS      4.4-REVbuild010-2006.03.07 plugins
```

Using the vxstorage_stats command

The `vxstorage_stats` command displays detailed storage mapping information and I/O statistics about one or more VxFS files. 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 superuser.

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.
- The `-m` option displays the I/O topology for the specified file.
- For more information, see the `vxstorage_stats`(1m) online manual page.

Note: The `vxstorage_stats` command process can at times take up to 30 minutes to complete.

Displaying Storage Mapping information

Review the procedure to display 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, as oracle user enter the following command:

  ```
  $ /opt/VRTSdbed/bin/vxstorage_stats -m -f /oradata/system01.dbf
  ```

  Output similar to the following is displayed.

```
TY NAME       NSUB  DESCRIPTION    SIZE(sectors) OFFSET(sectors)  PROPERTIES
fi /oradata/system01.dbf     1     FILE           2621442048(B)4718592(B)
Extents:3 Sparse Extents:0
v myindex                    1     MIRROR         16777216            0
pl vxvm:mydb/myindex-01      3     STRIPE         16779264            0
Stripe_size:2048
rd /dev/vx/rdmp/c3t1d3s3     1     PARTITION      5593088             0
sd /dev/rdsk/c3t1d3s3        1     PARTITION      17674560            960
sd c3t1d3                    2     MIRROR         17677440            0
da EMC000184502242:02:0c:02  0     DISK           143113019           0
da EMC000184502242:31:0c:02  0     DISK           143113019           0
rd /dev/vx/rdmp/c3t1d15s4    1     PARTITION      5593088             0
sd /dev/rdsk/c3t1d15s4       1     PARTITION      17669760            5760
```

```
sd c3t1d15                    2     MIRROR          17677440            0
da EMC000184502242:01:0c:02   0     DISK            143113019           0
```

Note: For file type (fi), the SIZE column is number of bytes; for volume (v), plex (pl), dmp device (rd), 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

Review the procedure to display the 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, as oracle user enter the following command:

  ```
  $ /opt/VRTSdbed/bin/vxstorage_stats -s -f \
  /data/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
/data/system01.dbf        2          2479         8             5068810     0.00    53.28
/dev/vx/rdsk/mydb/myindex 101        2497         1592          5069056     12.18   52.78
vxvm:mydb/myindex-01      101        2497         1592          5069056     12.18   52.76
/dev/rdsk/c3t1d3s3        131        1656         2096          1689696     14.43   39.09
c3t1d3                    131        1656         2096          1689696     14.43   39.09
EMC000184502242:02:0c:02  8480       231019       275952        23296162    -       -
EMC000184502242:31:0c:02  3244       232131       54808         23451325    -       -
/dev/rdsk/c3t1d15s4       0          1652         0             1689606     0.00    46.47
c3t1d15                   0          1652         0             1689606     0.00    46.47
EMC000184502242:01:0c:02  23824      1188997      1038336       32407727    -       -
EMC000184502242:32:0c:02  5085       852384       135672        29956179    -       -
/dev/rdsk/c3t1d2s4        14         1668         200           1689834     18.57   34.19
c3t1d2                    14         1668         200           1689834     18.57   34.19
EMC000184502242:16:0c:02  4406       271155       121368        23463948    -       -
EMC000184502242:17:0c:02  3290       269281       55432         23304619    -       -
```

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. 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, enter the following command to display statistics two times with a time interval of two seconds:

  ```
  $ /opt/VRTSdbed/bin/vxstorage_stats -s -i2 -c2 \-f /data/system01.dbf
  ```

Using the dbed_analyzer command

You must have an understanding of which tablespaces reside on which disks to effectively perform a parallel backup. If two tablespaces reside on the same disk, for example, backing them up in parallel will not reduce their backup time.

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.

Note: The `dbed_analyzer` command process may take a significant amount of time to complete.

Obtaining Storage Mapping information for a list of tablespaces

Review the procedure to obtain 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, as oracle user enter the following command:

  ```
  $ /opt/VRTSdbed/bin/dbed_analyzer -S PROD -H /usr1/oracle \
  -o sort=tbs -f /tmp/tbsfile
  ```

  For a Solaris OS system, output similar to the following is displayed in the file tbsfile:

```
TBSNAME     DATAFILE                              DEVICE                 SIZE(sectors)
SYSTEM      /usr1/oracle/rw/DATA/PROD.dbf         c3t21000020379DBD5Fd0 819216
TEMP        /usr1/oracle/rw/DATA/temp_20000       c3t21000020379DBD5Fd0 1021968
TEMP        /usr1/oracle/rw/DATA/temp_20001       c3t21000020379DBD5Fd0 2048016
SYSAUX      /usr1/oracle/rw/DATA/sysaux.dbf       c3t21000020379DBD5Fd0 819216
ITEM        /usr1/oracle/rw/DATA/item_1000        c3t21000020379DBD5Fd0 1021968
ITM_IDX     /usr1/oracle/rw/DATA/itm_idx_2000     c3t21000020379DBD5Fd0 1021968
PRODID_IDX /usr1/oracle/rw/DATA/prodid_idx_3000 c3t21000020379DBD5Fd0     1021968
QTY_IDX     /usr1/oracle/rw/DATA/qty_idx_7000     c3t21000020379DBD5Fd0 1021968
ROLL_1      /usr1/oracle/rw/DATA/roll_1_5000      c3t21000020379DBD5Fd0 1021968
ROLL_2      /usr1/oracle/rw/DATA/roll_2_6000      c3t21000020379DBD5Fd0 1021968
ORDERS      /usr1/oracle/rw/DATA/orders_4000      c3t21000020379DBD5Fd0 1021968
ORD_IDX     /usr1/oracle/rw/DATA/ord_idx_10000 c3t21000020379DBD5Fd0 1021968
QTY_IDX     /usr1/oracle/rw/DATA/qty_idx_7001     c3t21000020379DBD5Fd0 1024016
ITM_IDX     /usr1/oracle/rw/DATA/itm_idx_2001     c3t21000020379DBD5Fd0 1024016
ROLL_1      /usr1/oracle/rw/DATA/roll_1_5001      c3t21000020379DBD5Fd0 1024016
QTY_IDX     /usr1/oracle/rw/DATA/qty_idx_7002     c3t21000020379DBD5Fd0 1024016
ROLL_2      /usr1/oracle/rw/DATA/roll_2_6001      c3t21000020379DBD5Fd0 1024016
ITEM        /usr1/oracle/rw/DATA/item_1001        c3t21000020379DBD5Fd0 4096016
```

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, as oracle user enter the following command:

```
$ /opt/VRTSdbed/bin/dbed_analyzer -S PROD -H /usr1/oracle \
-o sort=disk -f /tmp/tbsfile
```

For a Solaris OS system, output similar to the following is displayed in the file tbsfile:

```
DEVICE                TBSNAME    DATAFILE                              SIZE(sectors)
c3t21000020379DBD5Fd0 SYSTEM     /usr1/oracle/rw/DATA/PROD.dbf         819216
c3t21000020379DBD5Fd0 TEMP       /usr1/oracle/rw/DATA/temp_20000       1021968
c3t21000020379DBD5Fd0 TEMP       /usr1/oracle/rw/DATA/temp_20001       2048016
c3t21000020379DBD5Fd0 SYSAUX     /usr1/oracle/rw/DATA/sysaux.dbf       819216
c3t21000020379DBD5Fd0 ITEM  /usr1/oracle/rw/DATA/item_1000             1021968
c3t21000020379DBD5Fd0 ITM_IDX    /usr1/oracle/rw/DATA/itm_idx_2000     1021968
c3t21000020379DBD5Fd0 PRODID_IDX /usr1/oracle/rw/DATA/prodid_idx_3000 1021968
c3t21000020379DBD5Fd0 QTY_IDX    /usr1/oracle/rw/DATA/qty_idx_7000     1021968
c3t21000020379DBD5Fd0 ROLL_1     /usr1/oracle/rw/DATA/roll_1_5000      1021968
c3t21000020379DBD5Fd0 ROLL_2     /usr1/oracle/rw/DATA/roll_2_6000      1021968
c3t21000020379DBD5Fd0 ORDERS     /usr1/oracle/rw/DATA/orders_4000      1021968
c3t21000020379DBD5Fd0 ORD_IDX    /usr1/oracle/rw/DATA/ord_idx_10000    1021968
c3t21000020379DBD5Fd0 QTY_IDX    /usr1/oracle/rw/DATA/qty_idx_7001     1024016
c3t21000020379DBD5Fd0 ITM_IDX    /usr1/oracle/rw/DATA/itm_idx_2001     1024016
c3t21000020379DBD5Fd0 ROLL_1     /usr1/oracle/rw/DATA/roll_1_5001      1024016
c3t21000020379DBD5Fd0 QTY_IDX    /usr1/oracle/rw/DATA/qty_idx_7002     1024016
c3t21000020379DBD5Fd0 ROLL_2     /usr1/oracle/rw/DATA/roll_2_6001      1024016
c3t21000020379DBD5Fd0 ITEM       /usr1/oracle/rw/DATA/item_1001        4096016
```

About arrays for Storage Mapping and statistics

SF Oracle RAC 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 9.2.0.3. or later installed, but deep mapping is not supported for Oracle RAC 11g.

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.

For the most up-to-date array support information, see the appropriate hardware compatibility list (HCL) on the Veritas Technical Support Web page at:

http://entsupport.symantec.com/docs/283161

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 SF Oracle RAC can discover them.

For details on supported array models, see the *Veritas Array Integration Layer Array Configuration Guide*.

Oracle File Mapping (ORAMAP)

With Veritas 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. You can use this information to determine the exact location of an Oracle data block on a physical device and to help identify hot spots.

Note: Mapping functionality requires Oracle 9.2.0.3 or a later version, but is not supported for Oracle RAC 11g.

For the HP-UX OS, Veritas has defined and implemented two libraries:

These two libraries provide a mapping interface to Oracle RAC 9i release 2 or later release, but is not supported for Oracle RAC 11g.

These two libraries also serve as a bridge between the Oracle's set of storage APIs (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.

Mapping components

Review the mapping components in your Oracle documentation. 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 the following components:

- 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.

Table 7-1 provides brief descriptions of these views.

For more detailed information, refer to your Oracle documentation.

Table 7-1 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 set up

Verify the set up of Oracle file mapping.

To verify that $ORACLE_HOME is set up for Oracle file mapping (ORAMAP)

1 Verify whether $ORACLE_HOME is ready for Oracle file mapping (ORAMAP):

```
# 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 Confirm the following items and make the appropriate corrections:

- root owns fmputlhp and the setud bit is set.
- The permissions for fmputlhp are -r-sr-xr-x.

- The permissions for fmputl are -r-xr-x---.

3 If any of these items is not set as specified, make the appropriate corrections.

Enabling Oracle file mapping

After verifying the Oracle file mapping set up, enable 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.

Enter the following commands:

```
# cd $ORACLE_HOME/rdbms/filemap/etc

# cat filemap.ora
```

For the HP-UX OS and for 64-bit Oracle, the filemap.ora file should contain the following setting:

- For PA:

```
lib=VERITAS:/opt/VRTSdbed/lib/libvxoramap_64.so
```

- For IA:

```
lib=VERITAS:/opt/VRTSdbed/lib/libvxoramap_64.sl
```

2 After verifying that the system is using the Veritas library for Oracle storage mapping, set the file_mapping initialization parameter to true.

For example:

```
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.

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

Review the procedure to access dynamic performance views.

To access dynamic performance views

1 Confirm that the Veritas mapping library for Oracle file mapping has been enabled.

For example, enter the following SQL command:

```
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.

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, enter the following SQL command:

```
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, enter the following SQL command:

```
SQL> select * from v$map_file_extent;
```

- To display the contents of v$map_element, enter the following SQL command:

```
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, enter the following SQL command:

```
SQL> select * from v$map_subelement;
```

- To display all the elements within the I/O stack for a specific file, enter the following SQL command:

```
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$map_file_io_stack io, fv
9  where io.file_map_idx = fv.file_map_idx) fs
10 where el.elem_idx = sb.child_idx
11 and fs.elem_idx = el.elem_idx
12 start with sb.parent_idx in
13 (select distinct elem_idx
14 from v$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;
```

Using Oracle Enterprise Manager

Oracle Enterprise Manager is a web-based GUI for managing Oracle databases. You can use this GUI to perform a variety of administrative tasks such as creating tablespaces, tables, and indexes; managing user security; and backing up and recovering your database. You can also use Oracle Enterprise Manager to view performance and status information about your database instance.

From Oracle Enterprise Manager, you can view storage mapping information and a graphical display of the storage layout. Storage mapping information cannot be viewed with the Oracle RAC 10g version of the Oracle Enterprise Manager client. However, the Oracle RAC 9i version of Oracle Enterprise Manager can be used with Oracle RAC 10g to view storage mapping information.

For more information about Oracle Enterprise Manager, refer to your Oracle documentation.

To view storage information

1. To view storage information, start Oracle Enterprise Manager and select a database from the left navigational pane (the object tree) of the Oracle Enterprise Manager Console.
2. Expand the Databases icon and select the desired database.

   The Database Connect Information window appears.

3. Enter a user name and password to log in to the database and click **OK**.
4. In the object tree, expand the **Storage** icon.
5. Under the **Storage** icon, expand the **Datafiles** icon.
6. Select the datafile for which you want to view storage layout information.
7. In the right pane, click the **Storage Layout** tab.
8. Expand the objects to display their storage layout.

   Within the Oracle Enterprise Manager Console, you can point to an object on the screen and a description of the object is displayed in a pop-up field. If an object name or path appears truncated, point to it and the pop-up field will display the full object name and path.
9. By default, storage layout information appears in tabular format. That is, the **Tabular** Display icon is selected. To view a graphical display of the storage layout, click the **Graphical Display** icon.
10. Expand the objects to display their storage layout information graphically.
11. To exit, choose **Exit** from the **File** menu.

Chapter 8

Troubleshooting SF Oracle RAC

This chapter includes the following topics:

About troubleshooting SF Oracle RAC

SF Oracle RAC contains several component products, and as a result can be affected by any issue with component products. The first step in case of trouble should be to identify the source of the problem. It is rare to encounter problems in SF Oracle RAC itself; more commonly the problem can be traced to setup issues or problems in component products.

Use the information in this chapter to diagnose the source of problems. Indications may point to SF Oracle RAC set up or configuration issues, in which case solutions are provided wherever possible. In cases where indications point to a component

product or to Oracle as the source of a problem, it may be necessary to refer to the appropriate documentation to resolve it.

Running scripts for engineering support analysis

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 Symantec Tech Support can assist with analyzing and solving any problems.

getdbac

The getdbac script gathers information about the SF Oracle RAC modules. The file /tmp/vcsopslog.*time_stamp*.tar.Z contains the script's output.

To use the getdbac script, on each system enter:

```
# /opt/VRTSvcs/bin/getdbac -local
```

getcomms

The getcomms script gathers information about the GAB and LLT modules. The file /tmp/commslog.*time_stamp*.tar contains the script's output.

To use the getcomms script, on each system enter:

```
# /opt/VRTSgab/getcomms -local
```

hagetcf

The hagetcf 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 the hagetcf script, on each system enter:

```
# /opt/VRTSvcs/bin/hagetcf
```

Troubleshooting tips

The following files and command output may be required to determine the source of a problem:

- Oracle installation error log
- Veritas log files

- OS system log
- GAB port membership

Oracle installation error log

This file contains errors that occurred during installation. It clarifies the nature of the error and exactly when it occurred during the installation.

To check the Oracle installation error log

1 Access the following file:

```
$ORACLE_BASE/oraInventory/logs/installActions<date_time>.log
```

2 Verify if there are any installation errors logged in this file, since they may prove to be critical errors.

3 If there are any installation problems, send this file to Tech Support. It is required for debugging the issue.

Veritas log files

The Veritas log file contains all actions performed by `HAD`.

To check the Veritas log files

1 Access the following file:

```
/var/VRTSvcs/log/engine_A.log
```

2 Verify if there are any `CVM` or `PrivNIC` errors logged in this file, since they may prove to be critical errors.

There are additional log files pertaining to the agents for SF Oracle RAC components such as CVM and CFS in the /var/VRTSvcs/log directory, which are also helpful in diagnosing issues.

To check the agent log files for CVM:

```
# /var/VRTSvcs/log/CVMVolDg_A.log
```

To check the agent log files for CFS:

```
# /var/VRTSvcs/log/CFSMount_A.log
```

To check the agent log files for Oracle:

```
# /var/VRTSvcs/log/Oracle_A.log
```

OS system log

OS syslog files can provide valuable information for diagnosing problems. The system log can be checked in the following file:

```
/var/adm/syslog/syslog.log
```

CVM log files

The /var/VRTSvcs/log directory contains the agent log files.

```
# cd /var/VRTSvcs/log
# ls -l *CVM* engine_A.log
CVMCluster_A.log     # CVM Agent log
CVMVolDg_A.log       # CVM VolDg Agent log
CVMVxconfigd_A.log   # CVM vxconfigd Agent log
engine_A.log         # VCS log
```

You can use the vxconfigd.log file to troubleshoot CVM configuration issues. The file is located at /var/adm/ras/vxconfigd.log

You can use the cmdlog file to view the list of CVM commands that have been executed. The file is located at /var/adm/vx/cmdlog

See the *Veritas Volume Manager Administrator's Guide* for more information.

CFS agent log files

You can use the CFS agent log files that are located in the directory /var/VRTSvcs/log to debug CFS issues.

```
# cd /var/VRTSvcs/log
# ls
CFSMount_A.log
CFSfsckd_A.log
engine_A.log
```

The agent framework information is located in the engine_A.log file while the agent entry point information is located in the CFSMount_A.log and CFSfsckd_A.log files.

I/O Fencing kernel logs

I/O Fencing kernel logs contain useful information to troubleshoot intricate I/O fencing issues. The logs can be collected using the following command:

```
# /opt/VRTSvcs/vxfen/bin/vxfendebug -p
```

Collecting important CVM logs

You need to stop and restart the cluster to collect detailed CVM logs.

- Stop the cluster.
  `# hastop -all`
- On all the nodes in the cluster, perform the following steps.
  - Edit the `/opt/VRTSvcs/bin/CVMCluster/online` script.
    Insert the '-T' option to the following string.
    Original string: `clust_run=`$VXCLUSTADM -m vcs -t $TRANSPORT startnode 2> $CVM_ERR_FILE``
    Modified string: **`clust_run=`$VXCLUSTADM -m vcs -t $TRANSPORT -T startnode 2> $CVM_ERR_FILE``**
  - Enable logging on vxconfigd daemon.
    `# vxdctl debug 9 /var/adm/vx/vxconfigd_debug.out`
- Start the cluster
  `# hastart`

The debug information that is enabled is accumulated in the system console log and in the text file /var/adm/vx/vxconfigd_debug.out

The CVM kernel message dump can be collected on a live node as follows:

`#/etc/vx/diag.d/kmsgdump -k 2000 >/var/adm/vx/kmsgdump.out`

GAB port membership

To check GAB port membership

Enter the following command:

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

Port b must exist on the local system.

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
```

Table 8-1 defines each GAB port's function.

For illustration of different GAB ports, See Figure 1-6 on page 29.

Table 8-1 GAB port function

Port	Function
a	This port is used for GAB internally.
b	This port is used for I/O fencing communications.
d	ODM uses this port when communicating with other ODM instances to support the file management features of Oracle Managed Files (OMF) cluster wide.
f	CFS uses this port for GLM lock and metadata communication.
h	VCS uses this port. VCS communicates the status of resources running on each system to all systems in the cluster.
o	This port is used by the VCSMM driver or VCS Membership Module .
v	CVM uses this port for kernel-to-kernel communication.
w	`vxconfigd` configuration daemon (module for CVM) uses this port for messaging.

Troubleshooting I/O fencing

The following sections discuss troubleshooting the I/O fencing problems. Review the symptoms and recommended solutions.

SCSI reservation errors during bootup

When restarting a node of an SF Oracle RAC cluster, SCSI reservation errors may be observed such as:

```
date system name 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. This message may be safely ignored.

The vxfentsthdw utility fails when SCSI TEST UNIT READY command fails

While running the vxfentsthdw utility, you may see a message that resembles as follows:

```
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 the Hitachi Data Systems 99XX arrays if bit 186 of the system mode option is not enabled.

Node is unable to join cluster while another node is being ejected

A cluster that is currently fencing out (ejecting) a node from the cluster prevents a new node from joining the cluster until the fencing operation is completed. The following are example messages that appear on the console for the new node:

```
...VxFEN ERROR V-11-1-25 ... Unable to join running cluster
since cluster is currently fencing
a node out of the cluster.
```

If you see these messages when the new node is booting, the vxfen startup script on the node makes up to five attempts to join the cluster.

To manually join the node to the cluster when I/O fencing attempts fail

- If the vxfen script fails in the attempts to allow the node to join the cluster, restart vxfen driver with the command:

  ```
  # /sbin/init.d/vxfen start
  ```

  If the command fails, restart the new node.

System panics to prevent potential data corruption

When a node 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.
```

See "How vxfen driver checks for pre-existing split-brain condition" on page 250.

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 system 1 and system 2 is functioning normally when the private network links are broken. Also suppose system 1 is the ejected system. When system 1 restarts before the private network links are restored, its membership configuration does not show system 2; however, when it attempts to register with the coordinator disks, it discovers system 2 is registered with them. Given this conflicting information about system 2, system 1 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!
```

Note: During the system boot, because the HP-UX rc sequencer redirects the stderr of all rc scripts to the file /etc/rc.log, the error messages will not be printed on the console. It will be logged in the /etc/rc.log file.

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
```

Note: If syslogd is configured with the `-D` option, then the informational message will not be printed on the console. The messages will be logged in the system buffer. The system buffer can be read with the `dmesg` command.

However, the same error can occur when the private network links are working and both systems go down, system 1 restarts, and system 2 fails to come back up.

From the view of the cluster from system 1, system 2 may still have the registrations on the coordinator disks.

To resolve actual and apparent potential split brain conditions

- Depending on the split brain condition that you encountered, do the following:

Actual potential split brain condition—system 2 is up and system 1 is ejected	1 Determine if system1 is up or not. 2 If system 1 is up and running, shut it down and repair the private network links to remove the split brain condition. 3 Restart system 1.
Apparent potential split brain condition—system 2 is down and system 1 is ejected	1 Physically verify that system 2 is down. 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. 2 Clear the keys on the coordinator disks as well as the data disks using the `vxfenclearpre` command. See "Clearing keys after split brain using vxfenclearpre command" on page 251. 3 Make any necessary repairs to system 2. 4 Restart system 2.

Clearing keys after split brain using vxfenclearpre command

If you have encountered a pre-existing 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.

See "About vxfenclearpre utility" on page 70.

Registered keys are lost on the coordinator disks

If the coordinator disks lose the keys that are registered, the cluster might panic when a cluster reconfiguration occurs.

To refresh the missing keys

- Use the vxfenswap utility to replace the coordinator disks with the same disks. The vxfenswap utility registers the missing keys during the disk replacement.

  See "Refreshing lost keys on coordinator disks" on page 80.

Replacing defective disks when the cluster is offline

If the disk becomes defective or inoperable and you want to switch to a new diskgroup in a cluster that is offline, then perform the following procedure.

In a cluster that is online, you can replace the disks using the vxfenswap utility.

See "About vxfenswap utility" on page 72.

Review the following information to replace coordinator disk in the coordinator disk group, or to destroy a coordinator disk group.

Note the following about the procedure:

- When you add a disk, add the disk to the disk group vxfencoorddg and retest the group for support of SCSI-3 persistent reservations.
- You can destroy the coordinator disk group such that no registration keys remain on the disks. The disks can then be used elsewhere.

To replace a disk in the coordinator disk group when the cluster is offline

1. Log in as superuser on one of the cluster nodes.
2. If VCS is running, shut it down:

   ```
   # hastop -all
   ```

   Make sure that the port h is closed on all the nodes. Run the following command to verify that the port h is closed:

   ```
   # gabconfig -a
   ```

3. Stop the VCSMM driver on each node:

   ```
   # /sbin/init.d/vcsmm stop
   ```

4. Stop I/O fencing on each node:

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

   This removes any registration keys on the disks.

5 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 node 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 locks are removed.

6 To remove disks from the disk group, use the VxVM disk administrator utility, vxdiskadm.

You may also destroy the existing coordinator disk group. For example:

- Verify whether the coordinator attribute is set to on.

```
# vxdg list vxfencoorddg |  grep flags: | grep coordinator
```

- If the coordinator attribute value is set to on, you must turn off this attribute for the coordinator disk group.

```
# vxdg -g vxfencoorddg set coordinator=off
```

- Destroy the disk group.

```
# vxdg destroy vxfencoorddg
```

7 Add the new disk to the node, initialize it as a VxVM disk, and add it to the vxfencoorddg disk group.

8 Test the recreated disk group for SCSI-3 persistent reservations compliance.

See "Testing the coordinator disk group using vxfentsthdw -c option" on page 62.

9 After replacing disks in a coordinator disk group, deport the disk group:

```
# vxdg deport `cat /etc/vxfendg`
```

10 On each node, start the I/O fencing driver:

```
# /sbin/init.d/vxfen start
```

11 On each node, start the VCSMM driver:

```
# /sbin/init.d/vcsmm start
```

12 If necessary, restart VCS on each node:

```
# hastart
```

Troubleshooting CVM

This section discusses troubleshooting CVM problems.

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<0
Please make sure that CVM and vxfen are configured
and operating correctly
```

First, make sure that CVM is running. You can see the CVM nodes in the cluster by running the vxclustadm nidmap command.

```
# vxclustadm nidmap
Name          CVM Nid     CM Nid      State
galaxy         1           0           Joined: Master
nebula         0           1           Joined: Slave
```

This above ouput shows that CVM is healthy, with system galaxy as the CVM master. If CVM is functioning correctly, then the output above 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.

Error 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.

For information about removing keys written to the disk:

See "Removing preexisting keys" on page 71.

Unable to start 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.

For information about removing keys written to the disk:

See "Removing preexisting keys" on page 71.

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.

Troubleshooting the repository database

This section describes the sfua_db_config script commands that can be used to troubleshoot repository database issues.

sfua_db_config script command options

Table 8-2 describes the sfua_db_config script command options. Use these command options when troubleshooting repository database issues.

Table 8-2 sfua_db_config script command options

Command option	Description
`-ssh`	Use this command option with the `sfua_db_config` command in a high availability (HA) configuration. This command option indicates that ssh and scp are to be used for communication between systems. **Note:** 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`	The `sfua_db_config -o dropdb` command drops the repository database.
`-o unconfig_cluster`	The `sfua_db_config -o unconfig_cluster` command unconfigures the repository database from the VCS cluster.
`-o dbstatus`	The `sfua_db_config -o dbstatus` command verifies the status of the database and database server.
`-o stopserver`	The `sfua_db_config -o stopserver` command stops the database server.
`-o startserver`	The `sfua_db_config -o startserver` command starts the database server.
`-o serverstatus`	The `sfua_db_config -o serverstatus` command reports the status of the database server.
`-o stopdb`	The `sfua_db_config -o stopdb` command detaches the repository database from the database server.
`-o startdb`	The `sfua_db_config -o startdb` command attaches the repository database to the database server.

Switching the repository database from one node to another

Sometimes, it is helpful to switch the high availability repository database from one node to another.

One way of switching the repository is as follows:

Take the repository database offline on one node:

```
# hagrp -offline Sfua_Base -sys nebula
```

Bring the repository database online on the other node:

```
# hagrp -online Sfua_Base -sys galaxy
```

Troubleshooting Database Dynamic Storage Tiering commands

If the Database Dynamic Storage Tiering commands fail as in the following example, then review the tsdb_debug.log.

The tsdb_debug.log is located at:

```
/var/vx/vxdba/logs/tsdb_debug.log
```

For example, when the following message appears after issuing a `dbdst_addvol` command review the tsdb_debug.log:

```
$ /opt/VRTS/bin/dbdst_addvol -S BLM21 -M /dev/vx/dsk/nobody_data1/\
data1vol -v new_vol1:fast_storage,new_vol2:slow_storage,new_vol3:slow_storage

SFORA dbdst_addvol ERROR V-81-6222 Could not add volume new_vol1 to vset
```

The tsdb_debug.log file contains information that resembles the following:

```
# view /var/vx/vxdba/logs/tsdb_debug.log
1216606 Tue May 13 10:11:05 2008
 /opt/VRTS/bin/dbdst_addvol -S BLM21 -M /dev/vx/dsk/nobody_data1/data1vol -v
new _vol1:fast_storage,new_vol2:slow_storage,
new_vol3:slow_storage
1216606 Tue May 13 10:11:09 2008
RACmaster = editor
1216606 Tue May 13 10:11:09 2008
editor:/opt/VRTSdbcom/.dba/tsdb_setup.sh -g nobody_data1 -o addvol -d\
data1vol - v new_vol1 -m /oradata1 -t vxfs.placement_class.FAST_STORAGE
1216606 Tue May 13 10:11:09 2008
command failed, ret=1

1216606 Tue May 13 10:11:09 2008
tsdb_setup.sh arguments -g nobody_data1 -o addvol -d data1vol -v
 new_vol1 -m /or
adata1 -t vxfs.placement_class.FAST_STORAGE
05/13/08@17:08:11
size of volume  new_vol1 is 204800
VxVM vxvset ERROR V-5-1-10035 Volume set data1vol contains volume(s)
in snapshot chain.
This can cause inconsistencies in the snapshot hierarchy. Specify "-f" option
```

```
to force the operation.
^^^^ NOTE: here is the reason for the failure, barried in this log file:
^^^^ /var/vx/vxdba/logs/tsdb_debug.log
Can not add  to data1vol, ERR 1
ERROR:1
```

Troubleshooting VCSIPC

This section discusses troubleshooting VCSIPC problems.

VCSIPC wait warning messages in Oracle trace/log files

When Gigabit Ethernet interconnections are used, a high load can cause LMX/LLT to flow-control VCSIPC, resulting in warning messages to be reported in the Oracle trace file. The default location for the trace file is $ORACLE_HOME/rdbms/log; it may have changed if the parameters `background_dump_dest` or `user_dump_dest` have been changed. The messages resemble:

```
.
   Unix process pid; 9560, image: oracle@MCB4800 (LMS0)
   *** 2003-03-22 10:18:46.370
   *** SESSION ID:(5.1) 2003-03-22 10:18:44.387
   VCSIPC wait: WARNING: excessive poll done, 1001 times
   VCSIPC wait: WARNING: excessive poll done, 1001 times
   VCSIPC wait: WARNING: excessive poll done, 1002 times
   VCSIPC wait: WARNING: excessive poll done, 1003 times
   VCSIPC wait: WARNING: excessive poll done, 1004 times
   VCSIPC wait: WARNING: excessive poll done, 1005 times
   .
```

As a workaround, you can change the LLT lowwater mark, highwater mark, and window values for flow control. Please contact Veritas support for more information about changing these values.

VCSIPC errors in Oracle trace/log files

If you see any VCSIPC errors in the Oracle trace/log files, check the `/var/adm/syslog/syslog.log` file for any LMX error messages.

If you see messages that contain any of the following:

```
. . . out of buffers
```

```
. . . out of ports
. . . no minors available
```

See "About LMX tunable parameters" on page 273.

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 interconnects

This section discusses troubleshooting interconnect problems.

Restoring communication between host and disks after cable disconnection

If a fiber 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. On all nodes, issue the following `vxdctl` command to force the VxVM configuration daemon `vxconfigd` to rescan the disks:

```
# vxdctl enable
```

Troubleshooting Oracle

This section discusses troubleshooting Oracle.

Oracle user must be able to read /etc/lltab File

Check the permissions of the file `/etc/lltab`. 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 while starting the Oracle instance that resembles:

```
ORA-29702: error occurred in Cluster Group Operation
```

To start the VCSMM driver, enter the following command:

```
# /sbin/init.d/vcsmm start
```

Clearing Oracle group faults

If the Oracle group faults, you can clear the faults and bring the group online by running the following commands:

```
# hagrp -clear grp10g -sys galaxy

# hagrp -clear grp10g -sys nebula

# hagrp -online grp10g -sys galaxy

# hagrp -online grp10g -sys nebula
```

Oracle log files show shutdown called even when not shutdown manually

The Oracle enterprise agent calls shutdown if monitoring of the Oracle resources fails. On all cluster nodes, review 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
```

Resolving ASYNCH_IO errors

If ASYNCH_IO errors occur during select and update queries on the Oracle database, the workaround involves setting the MLOCK privilege for the dba user.

To set MLOCK privilege for DBA user

1 Give the MLOCK privilege to the dba group:

```
# setprivgrp dba MLOCK
```

2 Create the `/etc/privgroup` file and add the line:

```
dba MLOCK
```

3 Verify the availability of MLOCK privilege for the dba group:

```
# /usr/bin/getprivgrp dba
```

Oracle Clusterware processes fail to startup

Verify that the correct private IP address is configured on the private link using the PrivNIC or MultiPrivNIC agent. Check the CSS log files to learn more. You can find the CSS log files at $CRS_HOME/log/*node_name*/cssd/*

Consult the Oracle RAC documentation for more information.

Oracle Clusterware fails after restart

If the Oracle Clusterware fails to start after boot up, check for the occurrence of the following strings in the `/var/adm/syslog/syslog.log` messages file.

String value in the file:

```
Oracle CSSD failure. Rebooting for cluster integrity
```

Oracle Clusterware may fail due to Oracle CSSD failure. The Oracle CSSD failure may be caused by one of the following events:

- Communication failure occurred and Oracle Clusterware fenced out the node.
- OCR and Vote disk became unavailable.
- `ocssd` was killed manually.
- Killing the `init.cssd` script.

String value in the file:

```
Waiting for file system containing
```

The Oracle Clusterware installation is on a shared disk and the `init` script is waiting for that file system to be made available.

String value in the file:

```
Oracle Cluster Ready Services disabled by corrupt install
```

The following file is not available or has corrupt entries:

```
/var/opt/oracle/scls_scr/hostname/root/crsstart
```

String value in the file:

```
OCR initialization failed accessing OCR device
```

The shared file system containing the OCR is not available and Oracle Clusterware is waiting for it to become available.

Removing Oracle Clusterware if installation fails

The following procedure provides instructions to remove Oracle Clusterware. Make sure that you consult the Oracle Clusterware documentation for complete steps.

To remove Oracle Clusterware

1 Run the `rootdelete.sh` script (in this example, $CRS_HOME is '/crshome'):

```
# cd /crshome/install

# ./rootdelete.sh
```

Run the `rootdeinstall.sh` script:

```
# cd /crshome/install

# ./rootdeinstall.sh
```

2 Copy the file `inittab.orig` back to the name and remove other `init` files:

```
# cd /sbin/init.d

# cp inittab.orig inittab

# rm init.crs init.crsd init.cssd init.evmd

# rm /etc/rc.d/rc2.d/K96init.crs

# rm /etc/rc.d/rc2.d/S96init.crs

#  rm -rf /var/opt/oracle/
```

3 Remove the oratab file from the /etc directory:

```
# rm /etc/oratab
```

4 Remove files from $CRS_HOME and Oracle Inventory after taking a backup of your current files.

If your $CRS_HOME is located at '/crshome', perform the following steps:

```
# cd /crshome

# mkdir crs.old

# mv * crs.old
```

If your $CRS_HOME is located at '/crshome/crs', perform the following steps:

```
# cd /crshome

# mv crs crs.old
```

You can remove the 'crs.old' directory at a later time.

5 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
```

6 Reboot the systems to make sure no CRS daemons are running.

For instructions on reinstalling Oracle Clusterware at a later time, see the *Veritas Storage Foundation for Oracle RAC Installation and Configuration Guide*.

Troubleshooting the Virtual IP (VIP) Configuration

When troubleshooting issues with the VIP configuration, use the following commands and files:

- Check for network problems on all nodes:

```
/usr/sbin/ifconfig nic_name
```

- Make sure the virtual host name is registered with the DNS server:

```
/usr/bin/nslookup virtual_host_name
```

- Verify the `/etc/hosts` file on each node.
- Check the output of the following command:

```
$CRS_HOME/bin/crs_stat
```

- On the problem node, use the command:

```
$ srvctl start nodeapps -n node_name
```

OCR and Vote disk related issues

Verify that the permissions are set appropriately as given in the Oracle installation guide.

See "Oracle Clusterware fails after restart" on page 261.

Troubleshooting ODM

This section discusses troubleshooting ODM.

File System configured incorrectly for ODM shuts down Oracle

Review the instructions on creating the link and confirming that Oracle uses the libraries. Shared file systems in RAC clusters without ODM libraries linked to Oracle RAC 9i 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 following command and review the output:

```
# 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 ODM should be supporting the cluster files:

- Make sure that the `VRTSgms` (group messaging service) package is installed.
  Run the following command:

  ```
  # swlist VRTSgms
  ```

- Verify that the gms module is loaded:

  ```
  # kcmodule -v vxgms
  ```

- Restart ODM:

  ```
  # /sbin/init.d/odm stop
  # /sbin/init.d/odm start
  ```

Chapter 9

Prevention and recovery strategies

This chapter includes the following topics:

Prevention and recovery strategies

The following topics are useful diagnostic tools and strategies for preventing and recovering from the various problems that can occur in the SF Oracle RAC environment.

Verification of GAB ports in SF Oracle RAC cluster

The following 8 ports need to be up on all the nodes of SF Oracle RAC cluster:

- GAB
- I/O fencing
- ODM
- CFS
- VCS ('had')
- vcsmm (membership module for SF Oracle RAC)
- CVM (kernel messaging)
- CVM (vxconfigd)

The following command can be used to verify the state of GAB ports:

```
# gabconfig -a
```

GAB Port Memberships

```
Port a gen 7e6e7e05 membership 01
Port b gen 58039502 membership 01
Port d gen 588a7d02 membership 01
Port f gen 1ea84702 membership 01
Port h gen cf430b02 membership 01
Port o gen de8f0202 membership 01
Port v gen db411702 membership 01
Port w gen cf430b02 membership 01
```

The data indicates that all the GAB ports are up on the cluster having nodes 0 and 1.

For more information on the GAB ports in SF Oracle RAC cluster, see the *Veritas Storage Foundation for Oracle RAC Installation and Configuration Guide.*

Examining GAB seed membership

The number of systems that participate in the cluster is specified as an argument to the `gabconfig` command in /etc/gabtab. In the following example, two nodes are expected to form a cluster:

```
# cat /etc/gabtab

/sbin/gabconfig -c -n2
```

GAB waits until the specified number of nodes becomes available to automatically create the port “a” membership. Port “a” indicates GAB membership for an SF Oracle RAC cluster node. Every GAB reconfiguration, such as a node joining or leaving increments or decrements this seed membership in every cluster member node.

A sample port ‘a’ membership as seen in `gabconfig -a` is shown:

```
Port a gen 7e6e7e01 membership 01
```

In this case, 7e6e7e01 indicates the “membership generation number” and 01 corresponds to the cluster’s “node map”. All nodes present in the node map reflects the same membership ID as seen by the following command:

```
# gabconfig -a | grep "Port a"
```

The semi-colon is used as a placeholder for a node that has left the cluster. In the following example, node 0 has left the cluster:

```
# gabconfig -a | grep "Port a"

Port a gen 7e6e7e04 membership ;1
```

When the last node exits the port “a” membership, there are no other nodes to increment the membership ID. Thus the port “a” membership ceases to exist on any node in the cluster.

When the last and the final system is brought back up from a complete cluster cold shutdown state, the cluster will seed automatically and form port “a” membership on all systems. Systems can then be brought down and restarted in any combination so long as at least one node remains active at any given time.

The fact that all nodes share the same membership ID and node map certifies that all nodes in the node map participates in the same port “a” membership. This consistency check is used to detect “split-brain” and “pre-existing split-brain” scenarios.

Split-brain occurs when a running cluster is segregated into two or more partitions that have no knowledge of the other partitions. The pre-existing network partition is detected when the "cold" nodes (not previously participating in cluster) start and are allowed to form a membership that might not include all nodes (multiple sub-clusters), thus resulting in a potential split-brain.

Manual GAB membership seeding

It is possible that one of the nodes does not come up when all the nodes in the cluster are restarted, due to the "minimum seed requirement" safety that is enforced by GAB. Human intervention is needed to safely determine that the other node is in fact not participating in its own mini-cluster.

The following should be carefully validated before manual seeding, to prevent introducing split-brain and subsequent data corruption:

- Verify that none of the other nodes in the cluster have a port “a” membership
- Verify that none of the other nodes have any shared disk groups imported
- Determine why any node that is still running does not have a port “a” membership

Run the following command to manually seed GAB membership:

```
# gabconfig -cx
```

Refer to gabconfig (1M) for more details.

Verifying normal functioning of VCS I/O fencing

It is mandatory to have VCS I/O fencing enabled in SF Oracle RAC cluster to protect against split-brain scenarios. VCS I/O fencing can be assumed to be running normally in the following cases:

- Fencing port 'b' enabled on both nodes

```
# gabconfig -a
```

- Registered keys present on the coordinator disks

```
# vxfenadm -g all -f /etc/vxfentab
```

Managing SCSI-3 PR keys in SF Oracle RAC cluster

I/O Fencing places the SCSI-3 PR keys on coordinator LUNs. The format of the key follows the naming convention wherein ASCII “A” is prefixed to the LLT ID of the system that is followed by 7 dash characters.

For example:

node 0 uses A-------

node 1 uses B-------

In an SF Oracle RAC/SF CFS/SF HA environment, VxVM/CVM registers the keys on data disks, the format of which is ASCII “A” prefixed to the LLT ID of the system followed by the characters “PGRxxxx” where ‘xxxx’ = i such that the disk group is the ith shared group to be imported.

For example: node 0 uses APGR0001 (for the first imported shared group).

In addition to the registration keys, VCS/CVM also installs a reservation key on the data LUN. There is one reservation key per cluster as only one node can reserve the LUN.

See “About SCSI-3 Persistent Reservations” on page 41.

The following command lists the keys on a data disk group:

```
# vxdg list |grep data

galaxy_data1 enabled,shared,cds 1201715530.28.pushover
```

Select the data disk belonging to galaxy_data1:

```
# vxdisk -o alldgs list |grep sybdata_101

c1t2d0s2  auto:cdsdisk    c1t2d0s2        galaxy_data1  online shared
c1t2d1s2 auto:cdsdisk    c1t2d1s2       galaxy_data1  online shared
c1t2d2s2 auto:cdsdisk    c1t2d2s2       galaxy_data1  online shared
```

The following command lists the PR keys:

```
# vxdisk -o listreserve list c1t2d0s2
```

.....

.....

```
Multipathing information:
numpaths:   1
hdisk6  state=enabled
Reservations:
BPGR0000 (type: Write Exclusive Registrants Only, scope: LUN(0x0))
2 registered pgr keys
BPGR0004
APGR0004
```

Alternatively, the PR keys can be listed using `vxfenadm` command:

```
# echo "/dev/vx/dmp/c1t2d0s2" > /tmp/disk71

# vxfenadm -g all -f /tmp/

Device Name: /dev/vx/dmp/c1t2d0s2
Total Number Of Keys: 2
key[0]:
        Key Value [Numeric Format]:  66,80,71,82,48,48,48,52
        Key Value [Character Format]: BPGR0004
key[1]:
        Key Value [Numeric Format]:  65,80,71,82,48,48,48,52
        Key Value [Character Format]: APGR0004
```

Evaluating the number of SCSI-3 PR keys on a coordinator LUN, if there are multiple paths to the LUN from the hosts

The utility vxfenadm (1M) can be used to display the keys on the coordinator LUN. The key value identifies the node that corresponds to each key. Each node installs a registration key on all the available paths to the LUN. Thus, the total number of registration keys is the sum of the keys that are installed by each node in the above manner.

See "About vxfenadm utility" on page 68.

Detecting accidental SCSI-3 PR key removal from coordinator LUNs

The keys currently installed on the coordinator disks can be read using the following command:

```
# vxfenadm -g all -f /etc/vxfentab
```

There should be a key for each node in the operating cluster on each of the coordinator disks for normal cluster operation.

Identifying a faulty coordinator LUN

The utility vxfentsthdw (1M) provided with I/O Fencing can be used to identify faulty coordinator LUNs. This utility must be run from any two nodes in the cluster. The coordinator LUN, which needs to be checked, should be supplied to the utility.

See "About vxfentsthdw utility" on page 59.

Listing all the CVM shared disks

You can use the following command to list all the CVM shared disks:

```
# vxdisk -o alldgs list |grep shared
```

Chapter 10

Tunable parameters

This chapter includes the following topics:

About SF Oracle RAC tunable parameters

Tunable parameters can be configured to enhance the performance of specific SF for Oracle RAC features. This chapter discusses how to configure the following SF Oracle RAC tunables:

- LMX
- VXFEN

Symantec recommends that the user not change the tunable kernel parameters without assistance from Veritas support personnel. Several of the tunable parameters preallocate memory for critical data structures, and a change in their values could increase memory use or degrade performance.

Warning: Do not adjust the SF Oracle RAC tunable parameters for LMX and VXFEN as described below to enhance performance without assistance from Veritas support personnel.

About LMX tunable parameters

The section describes the LMX tunable parameters and how to reconfigure the LMX module.

LMX tunable parameters

Table 10-1 describes the LMX driver tunable parameters.

Table 10-1 LMX Tunable parameters

LMX parameter	Default value	Maximum value	Description
lmx_minor_max	8192	65535	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 to specify the value in the lmx.conf file.
lmx_port_max	4096	65535	Specifies the number of communication endpoints for transferring messages from the sender to receiver in a uni-directional manner.
lmx_buffer_max	4096	65535	Specifies the number of addressable regions in memory to copy LMX data.

If you see the message "no minors available" on one node, add a configuration parameter that increases the value for the maximum number of contexts.

Note: The error message may contain the term "minors," but you must use the term "contexts" when changing the parameter value.

Warning: Increasing the number of contexts on a specific system has some impact on the resources of that system.

To reconfigure the LMX module

This section discusses how to reconfigure the LMX module on the node. For the parameter changes to take effect, you must reconfigure the LMX module.

1 Configure the tunable parameter.

```
# /usr/sbin/kctune tunable=value
```

For example:

```
# /usr/sbin/kctune lmx_minor_max=16384
```

2 If you use Oracle RAC 10g or Oracle RAC 11g , stop Oracle Clusterware (if Oracle Clusterware is not under VCS control) and verify that Oracle Clusterware is stopped. You must also stop applications which are not under VCS control.

3 Unmount the CFS mounts (if mounts are not under VCS control).

4 Stop VCS by entering the following command:

```
# /opt/VRTSvcs/bin/hastop -local
```

5 Check that this node is registered at gab ports a, b, d, and o only.

Ports f, h, v, and w should not be seen on this node.

```
# gabconfig -a
GAB Port Memberships
===============================================================
Port a gen ada401 membership 0123
Port b gen ada40d membership 0123
Port d gen ada409 membership 0123
Port o gen ada406 membership 0123
```

6 Restart the node by entering the following command:

```
galaxy> # /usr/sbin/shutdown -r
```

CFS mounts controlled by VCS are automatically remounted, but you must manually remount CFS mounts which are not under VCS control.

Applications which are outside of VCS control must be manually restarted.

About VXFEN tunable parameters

The section describes the VXFEN tunable parameters and how to reconfigure the VXFEN module.

Table 10-2 describes the tunable parameters for the VXFEN driver.

Table 10-2 VXFEN tunable 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

Table 10-2 VXFEN tunable parameters *(continued)*

vxfen Parameter	Description and Values: Default, Minimum, and Maximum
vxfen_max_delay	Specifies the maximum number of seconds that the smaller sub-cluster waits before racing with larger sub-clusters for control of the coordinator disks when a split brain occurs. This value must be greater than the vxfen_max_delay value. ■ Values Default: 60 Minimum: 1 Maximum: 600
vxfen_min_delay	Specifies the minimum number of seconds that the smaller sub-cluster waits before racing with larger sub-clusters for control of the coordinator disks when a split brain occurs. This value must be smaller than the vxfen_max_delay value. ■ Values Default: 1 Minimum: 1 Maximum: 600

In the event of a network partition, the smaller sub-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.

Configuring the VXFEN module parameters

After adjusting the tunable kernel driver parameters, you must reconfigure the VXFEN module for the parameter changes to take effect.

The following example procedure changes the value of the vxfen_min_delay parameter.

To configure the VxFEN parameters and reconfigure the VxFEN module

1 Configure the tunable parameter.

```
# /usr/sbin/kctune tunable=value
```

For example:

```
# /usr/sbin/kctune vxfen_min_delay=100
```

2 If you use Oracle 10g or Oracle 11g, stop CRS (if CRS is not under VCS control) and verify that CRS is stopped.

3 Unmount CFS mounts (if mounts are not under VCS control).

Determine the file systems to unmount by checking the /etc/mnttab file.

```
# mount | grep vxfs | grep cluster
```

To unmount the mount points listed in teh output, enter:

```
# umount mount_point
```

4 Stop VCS.

```
# /opt/VRTSvcs/bin/hastop -local
```

5 Check that this node is registered at gab ports a, b, d, and o only.

Ports f, h, v, and w should not be seen on this node.

```
# gabconfig -a
GAB Port Memberships
===============================================================
Port a gen ada401 membership 0123
Port b gen ada40d membership 0123
Port d gen ada409 membership 0123
Port o gen ada406 membership 0123
```

6 Reboot the node.

```
# /usr/sbin/shutdown -r
```

Section 4

Reference

Appendix A

Database FlashSnap status information

This appendix includes the following topics:

About Database FlashSnap status information

Veritas Database FlashSnap functionality provides the following information for the various snapplan stages and snapshot procedures:

- Snapshot status information
- Snapshot database status information

You can view this information using either the command line interface (CLI) or the GUI.

For additional information about Database FlashSnap GUI functionality, see the *Veritas Storage Foundation for Database Graphical User Interface Guide*

Database FlashSnap status information from the GUI

You can obtain both the snapshot status and the database status from the GUI. The tables in this section provide detailed information regarding the various status values.

Snapshot status information from the GUI

To view snapshot status information from the GUI, click on a specific snapplan in the object tree. The snapshot status can be seen on the right side of the window in the **Snapplan State** field.

Table A-1 displays information regarding the various snapshot status values.

Note: The values in the Snapshot status column below are displayed as seen in the Snapplan State field of the GUI.

Note: SF Oracle RAC does not support Database FlashSnap reverse resynchronization.

Table A-1 Snapshot status information from the GUI

Snapshot status	Complete operations	Allowed operations
`init_full`	■ Modify/Validate Snapplan (successful) ■ Resync Snapshot (successful)	Create snapshot
`snapshot_start`	Create Snapshot (failed)	If the Create Snapshot operation failed, contact your system administrator for help. You can use the VxVM utilities to create a snapshot and resynchronize the snapshot volumes, then use the Create Snapshot operation with the **Force snapshot creation** option for the subsequent snapshot.
`snapshot_end`	Create Snapshot (successful)	■ Resync Snapshot ■ Create Snapshot Database with the **Create database o**ption

Table A-1 Snapshot status information from the GUI *(continued)*

Snapshot status	Complete operations	Allowed operations
`resync_start`	Resync Snapshot (failed)	If the Resync Snapshot operation failed, contact your system administrator for help. You can use the VxVM utilities to resynchronize the snapshot volumes, then use the Create Snapshot operation with the **Force snapshot creation** option for the subsequent snapshot.
`restartdb_start`	Start Up Snapshot Database with the **Restart database** option (failed)	Try to start the snapshot database manually.
`restartdb_end`	Create Snapshot Database with the **Restart database** option (successful)	Shut Down Database with the **unmount** option
`mountdb_start`	`dbed_vmclonedb -o mountdb` command failed from the CLI **Note:** This option is not supported in the GUI.	Recover the snapshot database manually, then run the `dbed_vmclonedb -o update_status` command from the CLI **Note:** This option is not supported in the GUI.
`mountdb_end`	`dbed_vmclonedb -o mountdb` command from the CLI was successful **Note:** This option is not supported in the GUI.	■ Umount Database **FlashSnap** ■ `dbed_vmclonedb -o update_status` command from the CLI **Note:** This option is not supported in the GUI.
`recoverdb_start`	Create Snapshot Database with the **Restart database** option (failed).	Recover the snapshot database manually, then run the `dbed_vmclonedb -o update_status` command from the CLI **Note:** This option is not supported in the GUI.

Table A-1 Snapshot status information from the GUI *(continued)*

Snapshot status	Complete operations	Allowed operations
`recoverdb_end`	Create Snapshot Database with the **Restart database** option (successful)	Shut Down Database with the **umount** option
`umount_start`	`dbed_vmclonedb -o umount` command failed from the CLI	Verify that your file system(s) are not busy and retry the command.
`umount_end`	`dbed_vmclonedb -o umount` command from the CLI was successful **Note:** This option is not supported in the GUI.	■ Start Up Snapshot Database with the **restart database** option ■ Resync Snapshot

Snapshot database status information from the GUI

To view the Snapshot database status information from the GUI, click on a specific snapplan in the object tree. The Snapshot database status can be seen on the right side of the window in the **Database Status** field.

Table A-2 below displays information regarding the various status values.

Note: The values in the Snapshot database status column below are displayed as seen in the Snapplan State field of the GUI.

Note: SF Oracle RAC does not support Database FlashSnap reverse resynchronization.

Table A-2 Snapshot database status information from the GUI

Database status	Completed operations
`init`	■ Modify/Validate Snapplan (successful) ■ Create Snapshot (successful)
`init Db`	■ Modify/Validate Snapplan (successful) ■ Create Snapshot (successful)
`database_recovered`	Start up the Snapshot Database with the **startup database** option (successful)

Table A-2 Snapshot database status information from the GUI *(continued)*

Database status	Completed operations
`database_recovered`	Create Snapshot Database with the **Create database** option (successful)

Database FlashSnap Snapshot status information from the CLI

To view snapshot status information from the command line interface (CLI), use the `dbed_vmchecksnap` command with the `-o list` option to list all available snapplans for a specified database. Snapshot status information is displayed in the command output under the column heading `SNAP_STATUS`.

Note: The snapshot status and snapshot database status information may also appear in error messages.

Snapshot status information from the CLI

Table A-3 shows detailed information about each snapshot status (`SNAP_STATUS`) value.

Note: SF Oracle RAC does not support Database FlashSnap reverse resynchronization.

Table A-3 Snapshot status information from the CLI

SNAP_STATUS	Completed operations	Allowed operations
`init_full`	■ `dbed_vmchecksnap -o validate` (successful) ■ `dbed_vmsnap -o resync` (successful)	`dbed_vmsnap -o snapshot`
`init_db`	`dbed_vmchecksnap -o validate -f` *`snapplan`* (failed)	Ensure that your storage configuration has been set up correctly.

Table A-3 Snapshot status information from the CLI *(continued)*

SNAP_STATUS	Completed operations	Allowed operations
snapshot_start	dbed_vmsnap -o snapshot (failed)	Contact your system administrator for help. Use Veritas Volume Manager commands to resynchronize the snapshot volumes, and use dbed_vmsnap -o snapshot -F to force snapshot creation.
snapshot_end	■ dbed_vmsnap -o snapshot (successful)	■ dbed_vmsnap -o resync ■ dbed_vmclonedb -o mount|mountdb|recoverdb
snapshot_vol_start snapshot_vol_end resync_dg_start resync_dg_end	dbed_vmsnap -o snapshot (failed)	Re-run dbed_vmsnap -o snapshot
resync_vol_start resync_vol_end snapshot_dg_start snapshot_dg_end	dbed_vmsnap -o resync (failed)	Re-run dbed_vmsnap -o resync
resync_start	dbed_vmsnap -o resync (failed)	Contact your system administrator for help. Use Veritas Volume Manager commands to resynchronize the snapshot volumes, and use dbed_vmsnap -o snapshot -F to force snapshot creation.
mount start	dbed_vmclonedb -o mount (failed)	dbed_vmclonedb -o -umount
mount_end	dbed_vmclonedb -o mount (successful)	dbed_vmclonedb -o umount

Table A-3 Snapshot status information from the CLI *(continued)*

SNAP_STATUS	Completed operations	Allowed operations
`restartdb_start`	`dbed_vmclonedb -o restartdb` (failed)	■ `dbed_vmclonedb -o umount` ■ Start the snapshot database manually.
`restartdb_end`	`dbed_vmclonedb -o restartdb` (successful)	`dbed_vmclonedb -o umount`
`mountdb_start`	`dbed_vmclonedb -o mountdb` (failed)	Recover the snapshot database manually, then run `dbed_vmclonedb -o update_status`
`mountdb_end`	`dbed_vmclonedb -o mountdb` (successful)	■ `dbed_vmclonedb -o update_status` ■ `dbed_vmclonedb -o umount`
`recoverdb_start`	`dbed_vmclonedb -o recoverdb` (failed)	■ Recover the snapshot database manually, then run `dbed_vmclonedb -o update_status` ■ `dbed_vmclonedb -o umount`
`recoverdb_end`	`dbed_vmclonedb -o recoverdb` (successful)	`dbed_vmclonedb -o umount`
`umount_start`	`dbed_vmclonedb -o umount` (failed)	Verify that your file system(s) are not busy and retry the command.
`umount_end`	`dbed_vmclonedb -o umount` (successful)	■ `dbed_vmclonedb -o mount` ■ `dbed_vmclonedb -o restartdb` ■ `dbed_vmsnap -o resync`

Snapshot database status information from the CLI

To view snapshot database status information from the command line, use the `dbed_vmchecksnap` command with the `-o list` option to list all available snapplans for a specified database. Snapshot database status information is displayed in the command output under the column heading `DB_STATUS`.

Table A-4 shows detailed information about each database status (`DB_STATUS`) value.

Note: SF Oracle RAC does not support Database FlashSnap reverse resynchronization.

Table A-4 Snapshot database status information from the CLI

DB_STATUS	Completed operations
`init`	■ `dbed_vmchecksnap -o validate` (successful) ■ `dbed_vmsnap -o snapshot` (successful)
`database_recovered`	`dbed_vmclonedb -o recoverdb` (successful)

Appendix B

Using third party software to back up files

This appendix includes the following topics:

About using third party software to back up files

SF Oracle RAC supports the use of third party software for backing up files. However, Quick I/O is not supported for SF Oracle RAC.

Using third party software to back up files

If you are using third party backup software other than Veritas NetBackup, ensure that it can back up and restore VxFS extent attributes. This is important because restored Oracle Disk Manager (ODM) files rely on proper extent layouts for best performance.

Backing up and restoring Oracle Disk Manager files using Oracle RMAN

Oracle allocates Oracle Disk Manager files with contiguous extent layouts for good database performance. When you restore database files they are allocated using these extent attributes. If you are using Oracle RMAN's conventional backup method with any backup software, datafiles are also restored with the proper extent layouts.

If you are using RMAN's “proxy copy” backup method with a backup software other than NetBackup, the extent attributes may not be backed up. To ensure the

restored datafiles have proper extent layouts, preallocate the lost datafiles using the `odmmkfile` command. This command preallocates contiguous space for files prior to restoring them.

For example, to preallocate an Oracle datafile with size 100M, assuming the Oracle database block size is 8K, use the `odmmkfile` command and enter:

```
# /opt/VRTS/bin/odmmkfile -h 8k -s 100m filename
```

For additional information about the `odmmkfile` command, see the `odmmkfile(1)` manual page.

Appendix C

Error messages

This appendix includes the following topics:

About error messages

Error messages can be generated by the following software modules:

- LLT Multiplexer (LMX)
- Veritas Volume Manager (VxVM)
- Veritas Fencing (VXFEN) driver

LMX error messages

There are two types of LMX error messages: critical and non-critical.

Gather information about systems and configurations for Symantec support personnel.

LMX critical error messages

The messages in Table C-1 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.

Table C-1 lists the critical LMX kernel module error messages.

Table C-1 LMX 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
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
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 non-critical error messages

If the message displays in Table C-2 creates errors while running an Oracle application, use the `lmxconfig` command to turn off the display. For example:

```
# /sbin/lmxconfig -e 0
```

To re-enable message displays, type:

```
# /sbin/lmxconfig -e 1
```

Table C-2 contains LMX error messages that may appear during run-time.

Table C-2 LMX non-critical error messages

Message ID	LMX Message
06001	lmxreqlink duplicate kreq= 0xaddress, req= 0xaddress
06002	lmxreqlink duplicate ureq= 0xaddress kr1= 0xaddress, kr2= 0xaddress req type = number
06003	lmxrequnlink not found kreq= 0xaddress from= number
06004	lmxrequnlink_l not found kreq= 0xaddress from= number
06101	lmxpollreq not in doneq CONN kreq= 0xaddress
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 error messages

Table C-3 contains VxVM error messages that are related to I/O fencing.

Table C-3 VxVM error messages for 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 is not configured. Follow the instructions to set up these disks and start I/O fencing. You can then clear the faulted resources and bring the service groups online.
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 C-4 contains VXFEN driver error messages. In addition to VXFEN driver error messages, informational messages can also be displayed.

See "VXFEN driver informational message" on page 295.

See "Node ejection informational messages" on page 295.

Table C-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 displayed.
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."

VXFEN driver informational message

The following informational message appears when a node is ejected from the cluster to prevent data corruption when a split-brain occurs.

```
VXFEN CRITICAL V-11-1-20 Local cluster node ejected from cluster
to prevent potential data corruption
```

Node ejection informational messages

Informational messages may appear on the console of one of the cluster nodes when a node is ejected from a disk or LUN.

These informational messages can be ignored.

Glossary

Agent	A process that starts, stops, and monitors all configured resources of a type, and reports their status to VCS.
Authentication Broker	The VERITAS Security Services component that serves, one level beneath the root broker, as an intermediate registration authority and a certification authority. The authentication broker can authenticate clients, such as users or services, and grant them a certificate that will become part of the VERITAS credential. An authentication broker cannot, however, authenticate other brokers. That task must be performed by the root broker.
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.
CVM (cluster volume manager)	The cluster functionality of Veritas Volume Manager.
Disaster Recovery	Administrators with clusters in physically disparate areas can set the policy for migrating applications from one location to another if clusters in one geographic area become unavailable due to an unforeseen event. Disaster recovery requires heartbeating and replication.
disk array	A collection of disks logically arranged into an object. Arrays tend to provide benefits such as redundancy or improved performance.
DMP (Dynamic Multipathing)	A feature of Veritas Volume Manager designed to provide greater reliability and performance by using path failover and load balancing for multiported disk arrays connected to host systems through multiple paths. DMP detects the various paths to a disk using a mechanism that is specific to each supported array type. DMP can also differentiate between different enclosures of a supported array type that are connected to the same host system.
DST (Dynamic Storage Tiering)	A feature with which administrators of multi-volume VxFS file systems can manage the placement of files on individual volumes in a volume set by defining placement policies that control both initial file location and the circumstances under which existing files are relocated. These placement policies cause the files to which they apply to be created and extended on specific subsets of a file system's volume set, known as placement classes. The files are relocated to volumes in other placement

	classes when they meet specified naming, timing, access rate, and storage capacity-related conditions. See also Veritas File System (VxFS)
Failover	A failover occurs when a service group faults and is migrated to another system.
GAB (Group Atomic Broadcast)	A communication mechanism of the VCS engine that manages cluster membership, monitors heartbeat communication, and distributes information throughout the cluster.
HA (high availability)	The concept of configuring the SF Manager to be highly available against system failure on a clustered network using Veritas Cluster Server (VCS).
HAD (High Availability Daemon)	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.
IP address	An identifier for a computer or other device on a TCP/IP network, written as four eight-bit numbers separated by periods. Messages and other data are routed on the network according to their destination IP addresses. See also virtual IP address
Jeopardy	A node is in jeopardy when 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.
latency	For file systems, this typically refers to the amount of time it takes a given file system operation to return to the user.
LLT (Low Latency Transport)	A communication mechanism of the VCS engine that provides kernel-to-kernel communications and monitors network communications.
logical volume	A simple volume that resides on an extended partition on a basic disk and is limited to the space within the extended partitions. A logical volume can be formatted and assigned a drive letter, and it can be subdivided into logical drives. See also LUN
LUN	A LUN, or logical unit, can either correspond to a single physical disk, or to a collection of disks that are exported as a single logical entity, or virtual disk, by a device driver or by an intelligent disk array's hardware. VxVM and other software modules may be capable of automatically discovering the special characteristics of LUNs, or you can use disk tags to define new storage attributes. Disk tags are administered by using the `vxdisk` command or the graphical user interface.
main.cf	The file in which the cluster configuration is stored.

mirroring	A form of storage redundancy in which two or more identical copies of data are maintained on separate volumes. (Each duplicate copy is known as a mirror.) Also RAID Level 1.
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.
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 group or network interface card, a software component such as a database server 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.
root broker	The first authentication broker, which has a self-signed certificate. The root broker has a single private domain that holds only the names of brokers that shall be considered valid.
SAN (storage area network)	A networking paradigm that provides easily reconfigurable connectivity between any subset of computers, disk storage and interconnecting hardware such as switches, hubs and bridges.
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.
shared volume	A volume that belongs to a shared disk group and is open on more than one node at the same time.
SFCFS (Storage Foundation Cluster File System)	
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.
Storage Checkpoint	A facility that provides a consistent and stable view of a file system or database image and keeps track of modified data blocks since the last Storage Checkpoint.
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
types.cf	A file that describes standard resource types to the VCS engine; specifically, the data required to control a specific resource.
VCS (Veritas Cluster Server)	An open systems clustering solution designed to eliminate planned and unplanned downtime, simplify server consolidation, and allow the effective management of a wide range of applications in multiplatform environments.
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.
VxFS (Veritas File System)	A component of the Veritas Storage Foundation product suite that provides high performance and online management capabilities to facilitate the creation and maintenance of file systems. A file system is a collection of directories organized into a structure that enables you to locate and store files.
VxVM (Veritas Volume Manager)	A Symantec product installed on storage clients that enables management of physical disks as logical devices. VxVM enhances data storage management by controlling space allocation, performance, data availability, device installation, and system monitoring of private and shared systems.
VVR (Veritas Volume Replicator)	A data replication tool designed to contribute to an effective disaster recovery plan.

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