



**Hitachi Freedom Storage™
Lightning 9900™ Subsystem**

**Hitachi Command Control Interface (CCI)
User and Reference Guide**

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For a description of the changes in this revision, please refer to the revision history of the Hitachi source document. This 9900 document incorporates all changes in revisions 19 through 26 of *RAID300/400 HORC/HOMRCF/HORCAsync RAID Manager Basic Specifications*.

Preface

The *Hitachi Command Control Interface (CCI) User and Reference Guide* describes and provides instructions for installing and using the CCI software with the Lightning 9900™ subsystem. The CCI software enables the user to issue Hitachi Open Remote Copy (HORC) and/or Open ShadowImage (HOMRCF) commands to the 9900 subsystem from the open-systems host (UNIX®-based or PC server). This document assumes that:

- the user has a background in data processing and understands disk subsystems and their basic functions,
- the user is familiar with the Hitachi Lightning 9900™ RAID subsystem,
- the user is familiar with the UNIX® and/or PC server operating system, and
- the user is familiar with the functionality of the HORC and Open ShadowImage (HOMRCF) features. For detailed information on HORC operations, please refer to the *Hitachi Open Remote Copy (HORC) User and Reference Guide* (MK-90RD010). For detailed information on HOMRCF operations, please refer to the *Hitachi Open ShadowImage (HOMRCF) User's Guide* (MK-90RD031).

For further information on the 9900 subsystem, please refer to the *Hitachi Lightning 9900™ User and Reference Guide* (MK-90RD008), or contact your Hitachi Data Systems account team. The Hitachi Data Systems worldwide web site (<http://www.hds.com>) also provides information on the 9900 subsystem and its features and options.

Note: The use of the CCI software and all other Hitachi Data Systems products is governed by the terms of your license agreement(s) with Hitachi Data Systems.

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Chapter 1 Overview of Hitachi Copy Solutions

1.1 Hitachi Command Control Interface (CCI)

The licensed Hitachi Command Control Interface (CCI) software product enables you to perform Hitachi Open Remote Copy (HORC) and Hitachi Open ShadowImage (HOMRCF) operations on the Hitachi Lightning 9900™ subsystem by issuing commands from the open-systems host to the 9900 subsystem. The CCI software interfaces with the system software and high-availability (HA) software on the open-systems host as well as the HORC/HOMRCF software on the 9900 subsystem. CCI provides failover and operation commands which support mutual hot standby in conjunction with industry-standard failover products (e.g., MC/ServiceGuard, FirstWatch®, HACMP). CCI also supports a scripting function for defining multiple HORC/HOMRCF operations in a script (or text) file. Using CCI scripting, you can set up and execute a large number of HORC and/or HOMRCF commands in a short period of time while integrating host-based high-availability control over remote copy operations.

HORC operations (see section 1.2) involve the primary (main) subsystems and the secondary (remote) subsystems. The primary subsystems contain the HORC primary volumes (P-VOLs), which are the original data volumes. The secondary subsystems contain the HORC secondary volumes (S-VOLs), which are the synchronous or asynchronous copies of the P-VOLs. When HORC is performed using CCI, you need to reserve and configure one volume on each subsystem as the CCI command device. HORC supports operations between 9900 subsystems and also between 9900 and 7700E subsystems.

Open ShadowImage (HOMRCF) operations (see section 1.3) involve primary and secondary volumes within one subsystem. The HOMRCF P-VOLs contain the original data, and the S-VOLs are the internal duplicate volumes. HOMRCF allows up to nine S-VOLs to be created for each P-VOL. Each S-VOL is paired with the P-VOL independently, allowing each S-VOL to be maintained as an independent copy set.

Note: The use of the CCI software and all other Hitachi Data Systems products is governed by the terms of your license agreement(s) with Hitachi Data Systems.

1.2 Hitachi Open Remote Copy (HORC)

The Hitachi Open Remote Copy (HORC) feature enables you to create and maintain remote copies of the data stored on the 9900 (and 7700E) subsystem for data backup and disaster recovery purposes. HORC operations can be performed across distances of up to 43 km (27 miles) using standard ESCON[®] support. Long-distance HORC solutions are provided, based on user requirements and workload characteristics, using approved channel extenders and communication lines.

HORC operations can be performed using the Hitachi Command Control Interface (CCI) software on the UNIX[®]/PC server host, or the licensed HORC software on the Remote Console PC. The CCI software on the UNIX[®]/PC server displays HORC information and allows you to perform HORC operations from the UNIX[®] command line or via a script file. The CCI software interfaces with the 9900 (and 7700E) subsystem through a dedicated LU called a command device. The HORC remote console software also displays HORC information and allows you to perform HORC operations via a Windows[®]-based GUI.

HORC can be used in conjunction with Open ShadowImage to maintain multiple copies of critical data at your primary and/or secondary (remote) sites. The CARE Copy suite and the Hitachi NanoCopy[™] solution include both Remote Copy and ShadowImage for maximum flexibility in data backup and duplication activities.

This user's guide does not cover HORC operations from the 9900 Remote Console PC. For information and instructions on performing HORC remote console operations, please refer to the *Hitachi Open Remote Copy (HORC) User and Reference Guide* (MK-90RD010).

1.3 Hitachi Open ShadowImage (HOMRCF)

The Hitachi Open ShadowImage data duplication feature enables you to set up and maintain multiple copies of logical volumes within the same 9900 subsystem. The RAID-protected Open ShadowImage duplicates are created and maintained at hardware speeds. Open ShadowImage operations for UNIX[®]/PC server-based data can be performed using either the Hitachi Command Control Interface (CCI) software on the UNIX[®]/PC server host, or the licensed Hitachi Open Multiple RAID Coupling Feature (HOMRCF) software on the 9900 Remote Console PC.

The Hitachi CCI software on the UNIX[®]/PC server displays Open ShadowImage information and allows you to perform Open ShadowImage operations by issuing commands from the UNIX[®] command line or by executing a script file. The CCI software interfaces with the 9900 subsystem through a dedicated LU called a command device. The HOMRCF remote console software also displays Open ShadowImage information and allows you to perform Open ShadowImage operations using a Windows[®]-based GUI. The HOMRCF software interfaces with the 9900 subsystem via its service processor (SVP).

Open ShadowImage can be used in conjunction with Hitachi Open Remote Copy (HORC) to maintain multiple copies of critical data at your primary and/or secondary (remote) sites. The CARE Copy suite and the Hitachi NanoCopy™ solution include both ShadowImage and Remote Copy for maximum flexibility in data backup and duplication activities.

This user's guide does not cover HOMRCF operations from the 9900 Remote Console PC. For information and instructions on performing HOMRCF remote console operations, please refer to the *Hitachi Open ShadowImage (HOMRCF) User's Guide* (MK-90RD031).

1.4 Hitachi Multiplatform Backup/Restore (HMBR)

The Hitachi Multiplatform Backup/Restore (HMBR) feature can also be used in conjunction with the HORC and HOMRCF features to provide S/390®-based backup of HORC/HOMRCF volumes. HMBR operations should be configured to back up the HOMRCF/HORC primary volumes (P-VOLs), since the secondary volumes (S-VOLs) are not available to hosts (except when the pair has been split/suspended). If you need to perform HMBR operations on S-VOLs, you must split or suspend the pairs first to allow host access.

1.5 HARBOR File-Level Backup/Restore

The HARBOR File-Level Backup/Restore multiplatform feature of the 9900 subsystem enables users to perform mainframe-based file-level backup/restore operations on the open-system data stored on the multiplatform 9900 subsystem. HARBOR File-Level Backup/Restore features an integrated architecture and includes:

- A host component on MVS,
- Integrated clients for desktops and servers,
- LAN-based distributed storage servers,
- High-speed HMDE file-level backup of open-system data, and
- Transparent network support.

Note: For further information on HARBOR File-Level Backup/Restore, please contact your Hitachi Data Systems account team.

Chapter 2 Overview of CCI Operations

CCI allows you to perform HORC and HOMRCF operations by issuing HORC and HOMRCF commands from the UNIX[®]/PC server host to the 9900 subsystem. HORC and HOMRCF operations are nondisruptive and allow the primary volume of each volume pair to remain online to all hosts for both read and write operations. Once established, HORC and HOMRCF operations continue unattended to provide continuous data backup.

This document covers the requirements for using HORC and HOMRCF in HA configurations. UNIX[®]/PC servers in HA configurations normally support disk duplicating functions to enhance disk reliability (e.g., mirroring provided by the LVM or device driver, RAID5 or equivalent function provided by the LVM). UNIX[®]/PC servers also feature hot standby and mutual hot standby functions in case of failures on the server side. However, mutual hot standby for disaster recovery has not yet been achieved, since it requires the remote mirroring function.

HORC supports the remote mirroring function, linkage function with the failover switch, and remote backup operation among servers, all of which are required by UNIX[®]/PC servers in HA configurations for disaster recovery. For detailed information on HORC operations, please refer to the *Hitachi Lightning 9900™ Hitachi Open Remote Copy (HORC) User and Reference Guide* (MK-90RD010).

HOMRCF (Open ShadowImage) supports the mirroring function within a subsystem. For detailed information on HOMRCF operations, please refer to the *Hitachi Lightning 9900™ Open ShadowImage (HOMRCF) User's Guide* (MK-90RD031).

2.1 Features of Paired Volumes

The logical volumes, which have been handled independently by server machines, can be combined or separated in a pair being handled uniformly by the HORC and/or HOMRCF pairing function. HORC and HOMRCF regard those two volumes to be combined or separated as unique paired logical volume used by the servers. It is possible to handle paired volumes as groups by grouping them in units of server software or in units of database and its attribute.

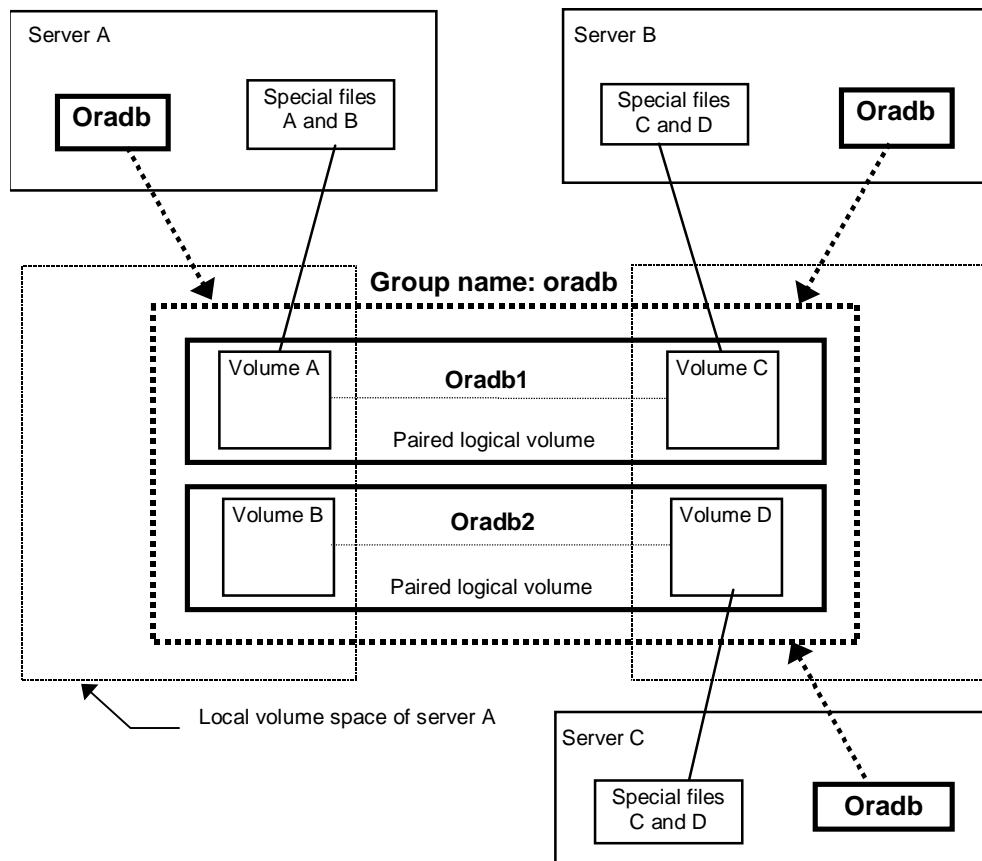


Figure 2.1 Concept of Paired Volumes

Addressing paired logical volumes: The correspondences between the paired logical volumes and physical volumes are defined by users by describing any intended paired logical volume names and group names in the configuration definition file of each server. It is possible to define a server for the paired logical volumes in units of group name. Each paired logical volume must belong to a group in order to determine the corresponding server.

Specification of volumes by commands: Volume names to be specified by the HORC commands must be given using the paired logical volume names or the group names.

2.1.1 HOMRCF Duplicated Mirroring

Duplicated mirroring of a single primary volume is possible when the HOMRCF feature is used. The duplicated mirror volumes of the P-VOL are expressed as virtual volumes using the mirror descriptors (MU#0-2) in the configuration definition file as shown below.

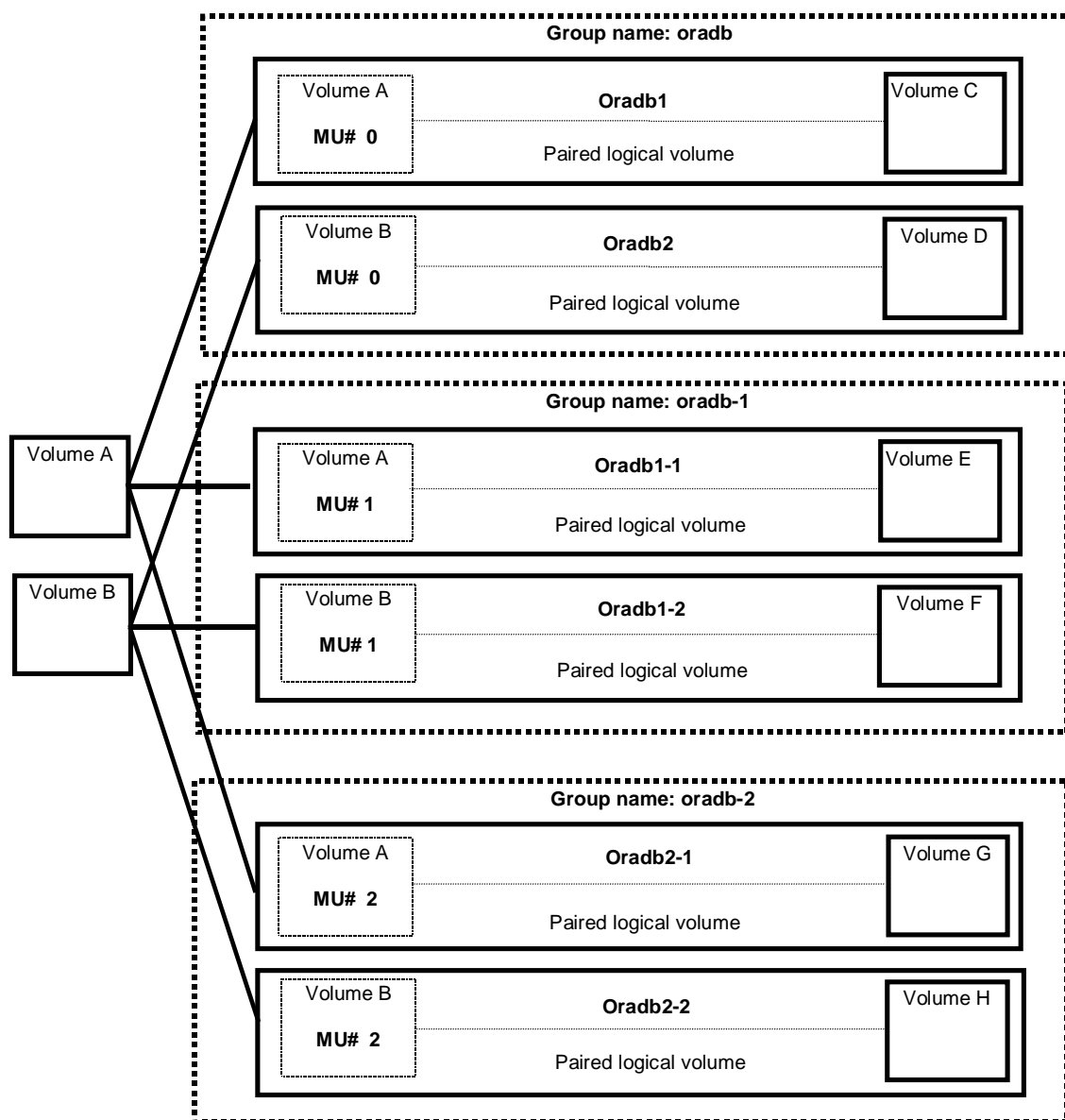


Figure 2.2 HOMRCF Duplicated Mirrors

2.1.2 HOMRCF Cascading Pairs

HOMRCF provides a cascading function for the HOMRCF S-VOL. The cascading mirrors of the S-VOL are expressed as virtual volumes using the mirror descriptors (MU#1-2) in the configuration definition file as shown below. The MU#0 of a mirror descriptor is used for connection of the S-VOL.

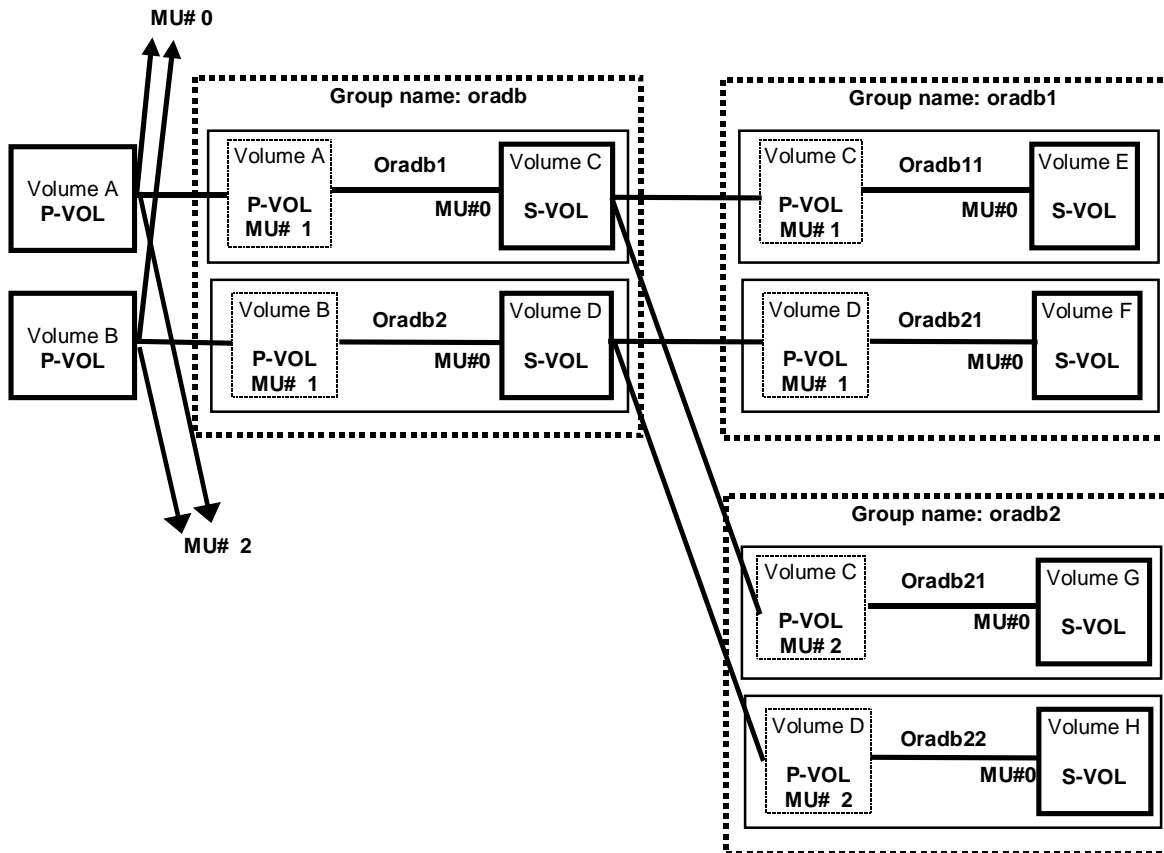
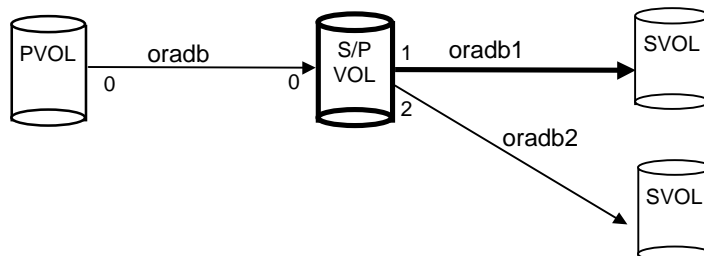


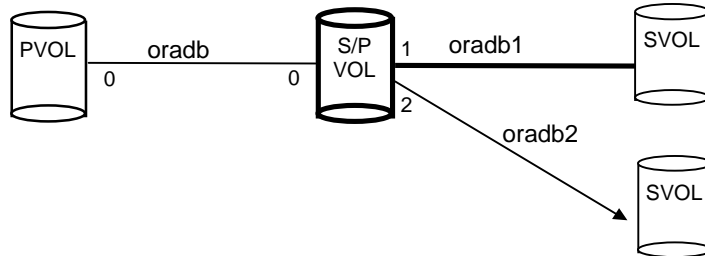
Figure 2.3 HOMRCF Cascade Volume Pairs

Restrictions for HOMRCF cascading volumes:

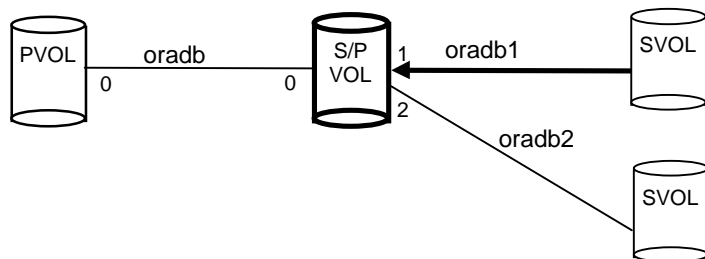
- Pair creation of SVOL (oradb1) can only be performed after the pair creation of S/PVOL (oradb). If pair creation of SVOL (oradb1) is performed at the SMPL or PSUS state of S/PVOL (oradb), paircreate will be rejected with EX_CMDRJE or EX_CMDIOE.



- Pair splitting of SVOL (oradb1) can only be performed after the SMPL or PSUS state condition of S/PVOL (oradb), due to HOMRCF asynchronous copy. If the pair splitting of SVOL (oradb1) is performed at the COPY or PAIR state of S/PVOL (oradb), the pairsplit command will be rejected with EX_CMDRJE or EX_CMDIOE.

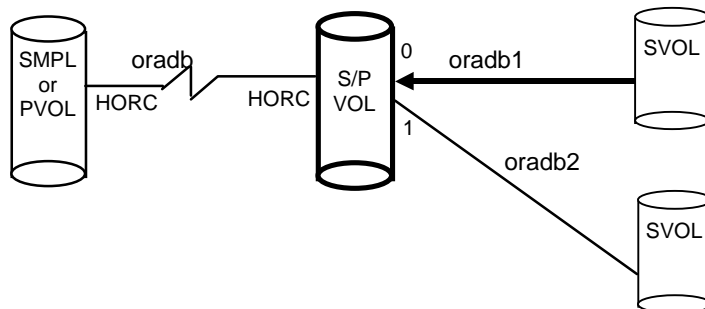


- Pair restore (resync from SVOL (oradb1) to S/PVOL) can only be performed at the state condition of SVOL (oradb) and another PVOL (oradb2) on the S/PVOL are SMPL or PSUS. If the pair restore of SVOL (oradb1) is performed at the COPY or PAIR state of S/PVOL (oradb or oradb2), the pairresync (-restore option) command will be rejected with EX_CMDRJE or EX_CMDIOE.



Restriction for HORC/HOMRCF cascading volumes:

- Pair restore (resynchronization from SVOL (oradb1) to S/PVOL) can only be performed when the HORC VOL (oradb) is SMPL, and another PVOL (oradb2) on the S/PVOL is SMPL or PSUS. If pairresync of S-VOL (oradb1) is performed when the S/PVOL (oradb or oradb2) is in any other state, the pairresync (-restore option) command will be rejected with EX_CMDRJE or EX_CMDIOE.



2.2 Overview of CCI HORC Operations

CCI HORC operates in conjunction with the software on the UNIX®/PC servers and the 9900 (and 7700E) HORC functions. The CCI software provides failover and other functions such as backup commands to allow mutual hot standby in cooperation with the failover product on the UNIX®/PC server (e.g., MC/ServiceGuard, FirstWatch®, HACMP). For the proper maintenance of HORC operations, it is important to find failures in paired volumes, recover the volumes from the failure as soon as possible, and continue operation in the original system.

Note: For detailed information on the operational requirements for HORC, please refer to the *Hitachi Lightning 9900™ HORC User and Reference Guide* (MK-90RD010).

2.2.1 HORC Takeover Commands

Figure 2.4 illustrates the server failover system configuration. When a server software error or a node error is detected, the operation of the failover software causes the Cluster Manager (CM) to monitor server programs, and causes the CM of the standby node to automatically activate the HA control script of the corresponding server program. The HA control script usually contains the database recovery procedures, server program activation procedures, and other procedures. The takeover commands provided by HORC are activated by the control HA script and execute the control needed for failover of the server.

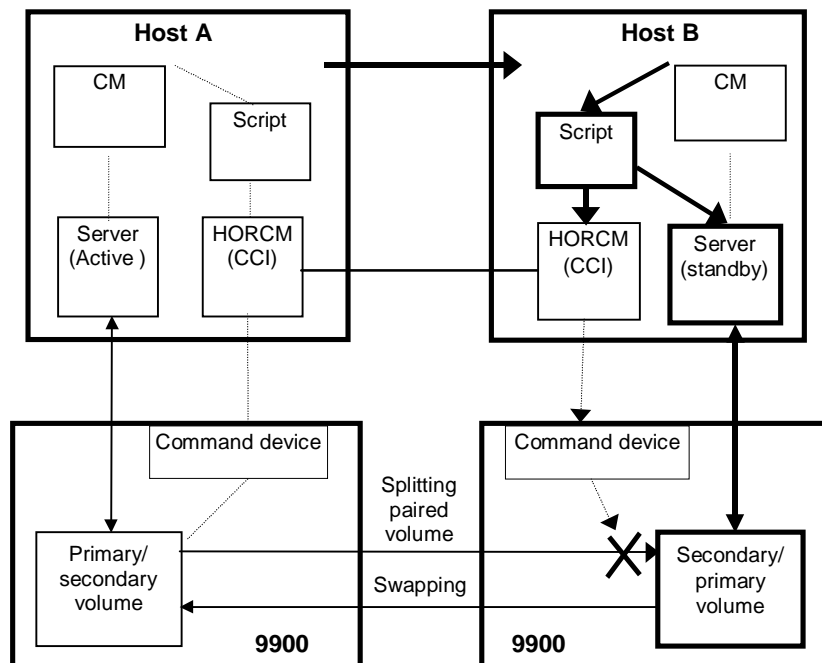


Figure 2.4 Server Failover System Configuration

In a high availability (HA) environment, a package is a group of applications that are scripted to run on the secondary host in the event of a primary host failure. When using the HA software (e.g., MC/ServiceGuard), the package can be transferred to the standby node as an operation executed by the system administrator (see Figure 2.5). However, if the operation is performed in an environment in which HORC is used, the volume is switched from primary to secondary as if an error has occurred, even though data consistency is assured. When returning the package to the current node, it is necessary to copy the secondary volume data into the primary volume, and this operation can take as much time as the initial copy operation for the pair. In actual operation, no package can be transferred when HORC is used. The secondary package is switched to the primary package, and vice versa, when the primary volume is switched to the secondary volume. Therefore, the primary and secondary HORC volumes should be switched depending on the package state.

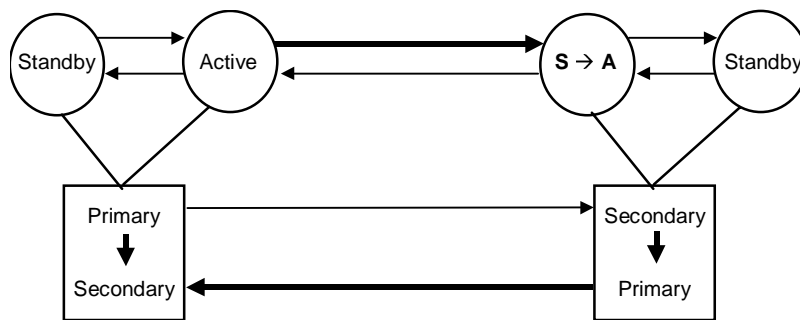


Figure 2.5 Package Transfer on High Availability (HA) Software

2.2.2 HORC Remote Commands

Figure 2.6 illustrates a HORC remote configuration. The HORC remote commands support a function which links the system operation for the purpose of volume backup among UNIX[®] servers with the operation management of the server system. The HORC remote pair commands are also used to copy volumes in the failover configuration of the servers and to recover the volumes after the takeover.

- **Pair creation command:** Creates a new volume pair. Volume pairs can be created in units of volume or group.
- **Pair splitting command:** Splits a volume pair and allows read and write access to the secondary volume.
- **Pair resynchronization command:** Resynchronizes a split volume pair based on the primary volume. The primary volume remains accessible during resynchronization.
 - **Swaps(p) option (HORC only).** Swaps volume from the SVOL(PVOL) to PVOL(SVOL) at suspending state on the SVOL(PVOL) side and resynchronizes the NEW_SVOL based on the NEW_PVOL. At the result of this operation, the volume attributes of own host (local host) become the attributes for the NEW_PVOL(SVOL).
- **Event waiting command:** Used to wait for completion of volume pair creation or resynchronization and to check the pair status.
- **Pair status display and configuration confirmation command:** Displays the pair status and configuration of the volume pairs, used for checking the completion of pair creation or pair resynchronization.

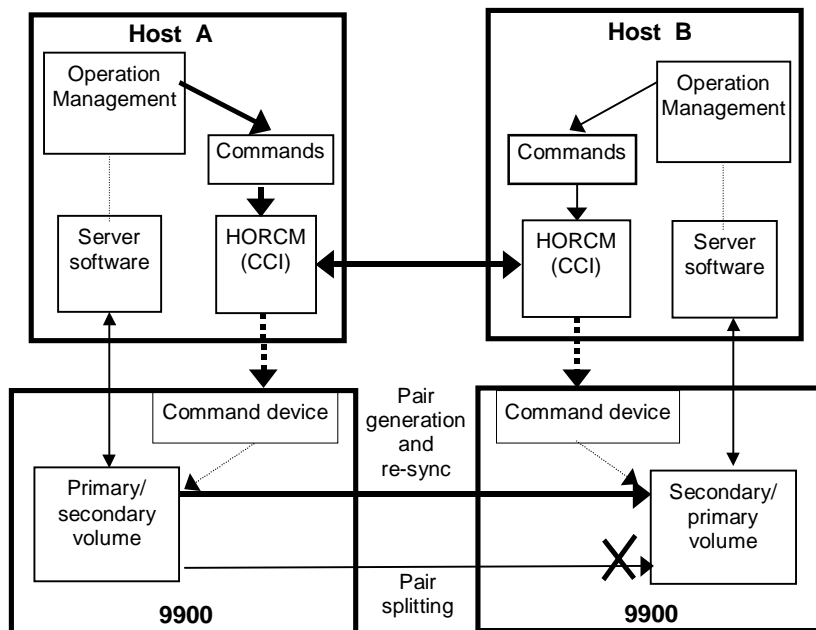


Figure 2.6 HORC Remote System Configuration

2.2.3 HORC Local Commands

Figure 2.7 illustrates a HORC local configuration. The HORC local commands support a function which links the system operation for the purpose of volume backup among UNIX[®] servers with the operation management of the server system. The HORC local commands perform the same functions as the remote commands only within one 9900 subsystem instead of between two 9900 subsystems (or between 9900 and 7700E subsystems).

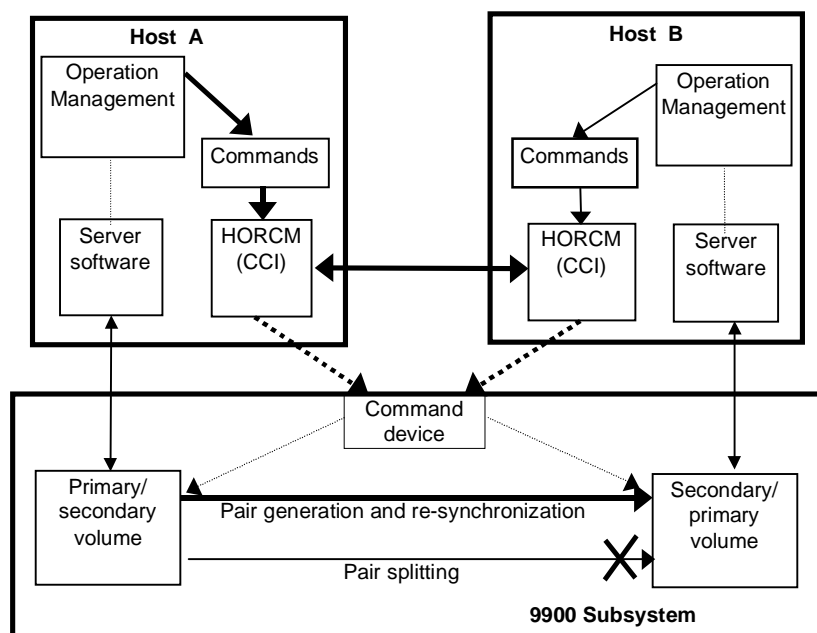


Figure 2.7 HORC Local System Configuration

2.3 Overview of CCI HOMRCF Operations

Figure 2.8 illustrates the HOMRCF configuration. The HOMRCF commands support a function which links the system operation for the purpose of volume backup among UNIX[®] servers with the operation management of the server system. For detailed information on the operational requirements for HOMRCF, please refer to the *Hitachi Lightning 9900™ Open ShadowImage (HOMRCF) User's Guide* (MK-90RD031).

- **Pair creation command:** Creates a new volume pair. Volume pairs can be created in units of volume or group.
- **Pair splitting command:** Splits a volume pair and allows read and write access to the secondary volume.
- **Pair resynchronization command:** Resynchronizes a split volume pair based on the primary volume. The primary volume remains accessible during resynchronization.
 - **Restore option:** Resynchronizes a split pair based on the secondary volume (reverse resync). The primary volume is not accessible during resync with restore option.
- **Event waiting command:** Used to wait for completion of volume pair creation or resynchronization and to check the pair status.
- **Pair status display and configuration confirmation command:** Displays the pair status and configuration of the volume pairs, used for checking the completion of pair creation or pair resynchronization.

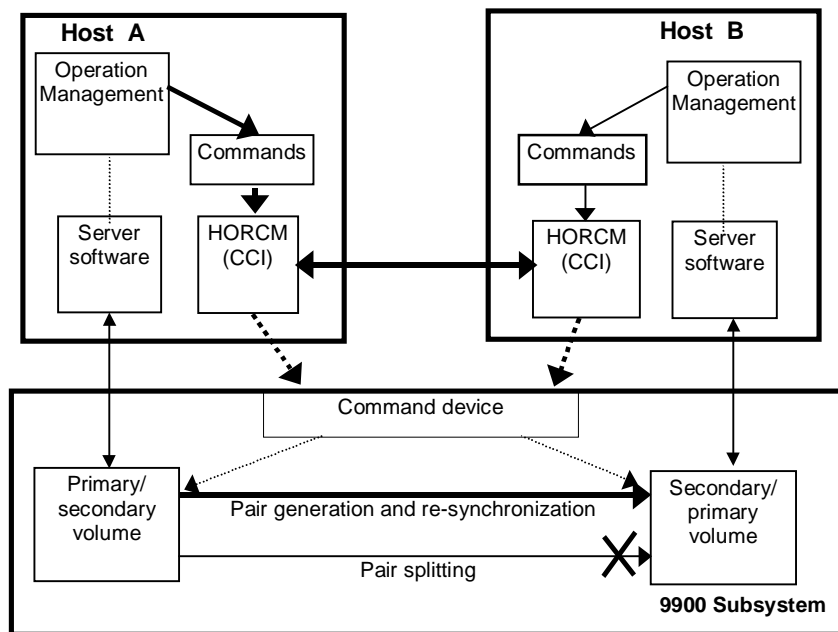


Figure 2.8 HOMRCF System Configuration

2.4 HORC/HOMRCF Volumes

HORC commands allow you to create volume pairs consisting of one primary volume (P-VOL) and one secondary volume (S-VOL). The HORC P-VOL and S-VOL can be in different subsystems. HORC provides synchronous and asynchronous copy modes. HORC Asynchronous can only be used between separate subsystems (not within one subsystem). For detailed information on HORC and HOMRCF volumes, please refer to the *Hitachi Lightning 9900™ HORC User and Reference Guide* (MK-90RD010) and the *Hitachi Lightning 9900™ Open ShadowImage (HOMRCF) User's Guide* (MK-90RD031).

HOMRCF commands allow you to create volume pairs consisting of one P-VOL and up to nine S-VOLs using the HOMRCF cascade function. HOMRCF pairs are contained within the same subsystem and are maintained using asynchronous update copy operations.

Each volume pair that you want to create must be registered in the CCI configuration file. HOMRCF volume pairs must include an MU (mirrored unit) number assigned to the S-VOL. The MU number indicates that the pair is an HOMRCF pair and not a HORC pair. Once the correspondence between the paired logical volumes has been defined in the HORCM_DEV section of the configuration file, you can use the configuration file to group the paired volumes into volume groups that can be managed by the host operating system's LVM (logical volume manager).

The host's LVM allows you to manage the HORC/HOMRCF volumes as individual volumes or by volume group. HORC/HOMRCF commands can specify individual logical volumes or group names. For LUSE volumes, you must enter commands for each volume (LDEV) within the expanded LU. If you define volume groups and you want to issue commands to those volume groups, you must register the volume groups in the configuration file. For further information on the LVM, refer to the user documentation for your operating system.

2.4.1 HORC/HOMRCF Volume Status

Each HORC pair consists of one P-VOL and one S-VOL, and each HOMRCF pair consists of one P-VOL and up to nine S-VOLs when the cascade function is used. Table 2.1 lists and describes the HORC and HOMRCF pair status terms. The P-VOL controls the pair status for the primary and secondary volumes. The major pair statuses are SMPL, PAIR, PSUS/PSUE, and COPY/RCPY. Read and write requests from the host are accepted or rejected depending on the pair status of the volume.

The pair status changes when a HORC/HOMRCF command is executed. The validity of the specified operation is checked according to the status of the volume (primary volume). Table 2.2 shows the relationship between pair status and HORC command acceptance. Table 2.3 shows the relationship between pair status and HOMRCF command acceptance.

Table 2.1 HORC and HOMRCF Pair Status

Status	HORC Pair Status	HOMRCF Pair Status	Primary	Secondary
SMPL	Unpaired volume.	Unpaired volume.	R/W enabled.	R/W enabled.
PAIR	Paired volume. Initial copy is complete. Updates are processed synchronously or asynchronously.	Paired volume. Initial copy is complete. Updates are processed asynchronously.	R/W enabled.	R enabled.*
COPY	In paired state, but initial copy, pairsplit, or resync operation is not complete. Includes COPY(PD), COPY(SP), and COPY(RS) status.	In paired state, but initial copy, pairsplit, or resync operation is not complete. Includes COPY(PD), COPY(SP), and COPY(RS) status.	R/W enabled.	R enabled.*
RCPY	Not used for HORC.	In paired state, but reverse resync operation is not complete. Includes COPY(RS-R) status.	R enabled.*	R enabled.
PSUS (split)	In paired state, but updates to the S-VOL data are suspended due to user-requested pairsplit. The 9900 keeps track of P-VOL and S-VOL updates while the pair is split.	In paired state, but updates to the S-VOL data are suspended due to user-requested pairsplit. The 9900 keeps track of P-VOL and S-VOL updates while the pair is split.	R/W enabled.	R/W enabled when using write enable pairsplit option.
PSUE (error)	In paired state, but updates to the S-VOL data are suspended due to an error condition.	In paired state, but updates to the S-VOL volume data are suspended due to an error condition. When a PSUE pair is resynced, the 9900 copies the entire P-VOL to the S-VOL (same as initial copy).	R/W enabled if no error has occurred in the primary volume.	R enabled.*
PDUB	Used for HORC LUSE pairs only. In paired state, but updates to one or more LDEVs within the LUSE pair are suspended due to an error condition.	Not used for HOMRCF.	R/W enabled if no error has occurred in the primary volume.	R enabled

* Read is disabled when the **-m noread** option of the paircreate command is specified.

LEGEND for

Accepted = Accepted and executed. When operation terminates normally, the status changes to the indicated number.
 Acceptable = Accepted but no operation is executed.
 Rejected = Rejected and operation terminates abnormally.

Table 2.2 Pair Status versus HORC Command

#	Status	HORC Command					
		Paircreate		Pairsplit			Pairresync Resync
		Copy	Nocopy	-r or -rw option	-P option	-S option	
①	SMPL	Accepted ②	Accepted ③	Rejected	Rejected	Acceptable	Rejected
②	COPY	Acceptable	Acceptable	Accepted ④	Rejected	Accepted ①	Acceptable
③	PAIR	Acceptable	Acceptable	Accepted ④	Accepted ④	Accepted ①	Acceptable
④	PSUS	Rejected	Rejected	Acceptable	Acceptable	Accepted ①	Accepted ② (see note 1)
⑤	PSUE	Rejected	Rejected	Rejected	Rejected	Accepted ①	Accepted ② (see note 1)
⑥	PDUB	Rejected	Rejected	Rejected	Rejected	Accepted ①	Accepted ② (see note 1)

Note: Pairsplit of a HORC Asynchronous volume will be returned after verification of state transition that waits until delta data is synchronized from P-VOL to S-VOL.

Note 1: In case of the SSWS state after SVOL-SSUS takeover, pairresync command (from PVOL to SVOL) is rejected because the delta data for SVOL becomes dominant, and its state expect to be using -swaps(p) option of pairresync. If the pairresync command (from PVOL to SVOL) is rejected, confirm this special state using the -fc option of the pairdisplay command.

Table 2.3 Pair Status versus HOMRCF Commands

Pair Status	HOMRCF Command					
	Paircreate		Pairsplit			Pairresync Resync
	No-split	-split	-E option	-C option	-S option	
① SMPL	Accepted ②	Accepted ②→④	Rejected	Rejected	Acceptable	Rejected
② COPY RCPY	Acceptable	Accepted* ②→④	Accepted ⑤	Accepted* ②→④	Accepted ①	Acceptable
③ PAIR	Acceptable	Accepted ②→④	Accepted ⑤	Accepted ②→④	Accepted ①	Acceptable
④ PSUS	Rejected	Acceptable	Accepted ⑤	Acceptable	Accepted ①	Accepted ②
⑤ PSUE	Rejected	Rejected	Acceptable	Rejected	Accepted ①	Accepted ②

Note: If the PVOL does not have Write in the PAIR state, then data identical with an SVOL is guaranteed. Therefore, in case of using the SVOL with the SMPL state, after stopping Write to the PVOL, generate a paired volume, and then split the paired volume after confirming that the paired volume has the PAIR status. In the PSUE state, HOMRCF does not manage differential data at the PVOL or SVOL. Therefore, pairresync issued to a pair in the PSUE state is all copy performance, but the copy progress rate returned by the -fc option of the pairdisplay command indicates "0%".

Note 1: The state change (②→④) is effective COPY state only that is changed without specification of -split for paircreate command.

Note 2: The (②→④) state change is displayed as PVOL_PSUS & SVOL_COPY (see display example below), and reading and writing are enabled for SVOL in SVOL_COPY state.

```
# pairsplit -g oradb
# pairdisplay -g oradb -fc
Group PairVol(L/R) (Port#,TID,LU-M), Seq#, LDEV#.P/S, Status, %, P-LDEV# M
oradb oradev3(L) (CL2-N , 3, 4-0) 8071 28..P-VOL PSUS, 100 29 W
oradb oradev3(R) (CL2-N , 3, 5-0) 8071 29..S-VOL COPY, 97 28 -
```


2.4.2 HORC Asynchronous Volumes

HORC Asynchronous (HORCA) provides paired volumes which utilize asynchronous transfer to ensure the sequence of writing data between the primary volume and secondary volume. The sequence of writing data between the primary and secondary volumes is guaranteed within each consistency (CT) group (see Figure 2.9). A CT group is created by paircreate command as the group that corresponds to the configuration definition file. The maximum number of CT groups is 64 for 9900 (CTGID0 to CTGID63) and 16 for 7700E (CTGID0 to CTGID15), and the volumes in a group must all be contained within the same 9900 or 7700E subsystem. HORC Asynchronous pair command will be terminated with EX_ENOCTG when the maximum number of CT groups is exceeded.

HORCA volumes have the following characteristics:

- **PAIR state:** A HORCA pair changes to the PAIR status as soon as all pending recordsets have been placed in the queue at the primary volume, without waiting for the updates to complete at the secondary volume.
- **Pair splitting:** When a HORCA pair is split or deleted, all pending recordsets at the primary volume are sent to the secondary volume, and then the pair status changes to PSUS or SMPL. For pairsplit only, updates for the primary volume which occur during and after the pairsplit operation are marked on the bitmap of the primary volume.
- **Pair resynchronization:** The pairresync command resynchronizes the secondary volume based on the primary volume. This resynchronization does not guarantee the sequenced data transfer.
- **Error suspending:** Pending recordsets which have not yet been sent to the secondary volume are marked on the bitmap of the primary volume and then deleted from the queue, and then the pair status changes to PSUE.
- **Group operations:** HORCM registers CTGID to 9900 subsystem automatically when paired volumes are created by the paircreate command, and groups of configuration file are mapped to CTGID. If more than one group defined in the configuration definition file is assigned to the same CT group ID, then pair operations of the group specification apply to the entire CT group.

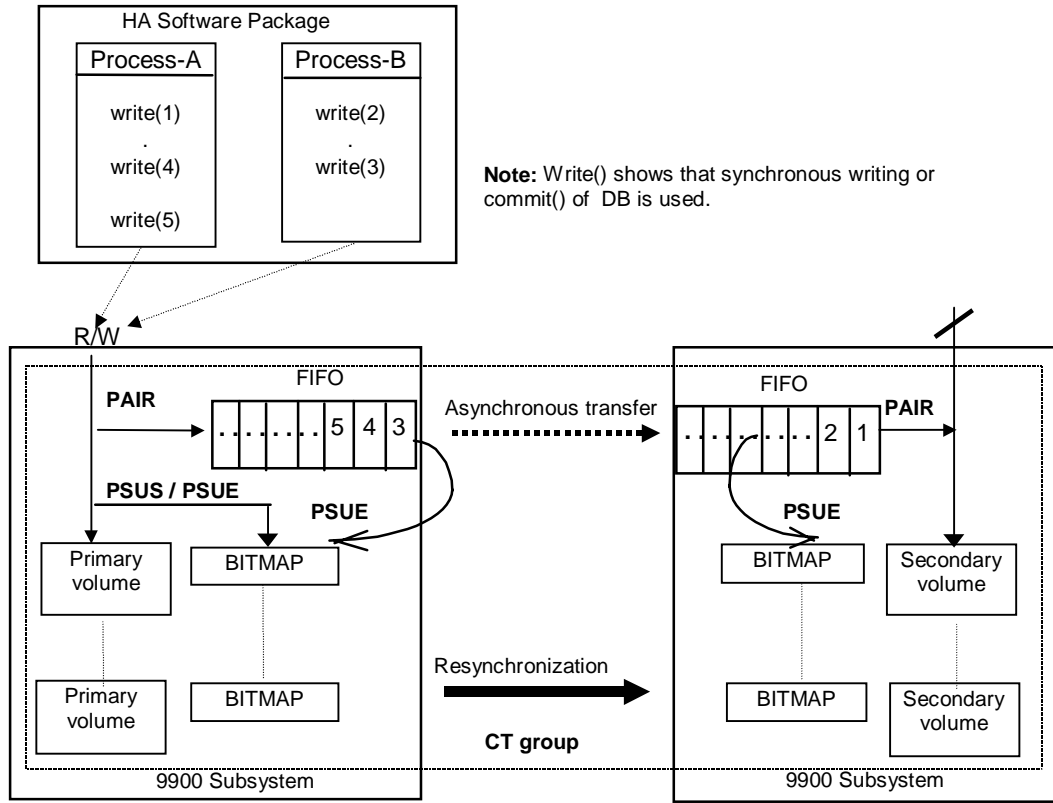


Figure 2.9 HORC Asynchronous Consistency Groups

Sidefile Cache for HORC Asynchronous

The FIFO queue of each CT group is placed in an area of cache called the sidefile. The sidefile is used for transferring HORCA recordsets to the RCU. The sidefile is not a fixed area in cache but has variable capacity for write I/Os for the primary volume. If the host write I/O rate is high and the MCU cannot transfer the HORCA recordsets to the RCU fast enough, then the sidefile capacity expands gradually. The sidefile has a threshold to control the quantity of data transfer of host side write I/O. Host side write I/Os are controlled by delaying response when the sidefile exceeds the constant quantity limit on cache in the subsystem (see Figure 2.10).

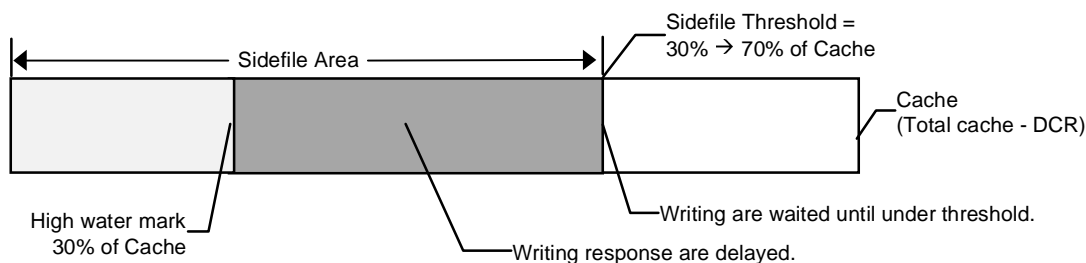


Figure 2.10 Sidefile Quantity Limit

Sidefile area: Sidefile area = 30% to 70% of cache as set on the Remote Console PC (or SVP) (default sidefile = 50%).

Write I/O control at high water mark (HWM): When the quantity of data in sidefile reaches 30% of cache, the HORCA pair status is HWM of PAIR state, and the host write I/Os receive delayed response in the range of 0.5 seconds to 4 seconds.

Write I/O control at sidefile threshold: When the quantity of data in sidefile reaches the defined sidefile area, host write I/Os are delayed until there is enough sidefile space to store the next new write data. The copy pending timeout group option, defined on the Remote Console PC (or SVP), specifies the maximum delay between the M-VOL update and the corresponding R-VOL update. If the timeout occurs during this waiting state, the pair status changes from PAIR to PSUS (sidefile full), and host write I/Os continue with updates being managed by the cylinder bitmap. **Important:** The copy pending timeout value should be less than the I/O timeout value of the host system.

HORC Asynchronous Transition States

HORC Async volumes have special states for sidefile control during status transitions. Table 2.4 shows the transition states for HORC Synchronous and HORC Asynchronous volumes.

The **suspending** and **deleting** states are temporary internal states within the 9900 subsystem. CCI cannot detect these transition states, because these states are reported on the previous state from the subsystem. These states are therefore concealed inside the pairsplit command. After the pairsplit command is accepted, host write I/Os for the P-VOL are managed by the cylinder bitmap (normal), non-transmitted data remaining in the P-VOL's FIFO queue is transferred to the S-VOL's FIFO queue, and the pair status is then set to PSUS [SMPL] state when all data in the P-VOL's FIFO queue has been transmitted.

PFUL. If the quantity of data in sidefile cache exceeds 30% of cache storage, the internal status of the 9900 subsystem is PFUL, and host write I/Os receive delayed response in the range of 0.5 seconds to 4 seconds.

PFUS. If the quantity of data in sidefile cache exceeds the user-defined sidefile area (30%-70%), then host write I/Os are waited for enough sidefile space to store the next new write data. If the copy pending timeout occurs during this waiting state, then the pair status changes from PAIR to PFUS, host write I/Os are accepted, and write data is managed by bitmap.

The CCI software can detect and report the PFUL and PFUS states as follows:

- As a return code of the **pairvolchk** command.
- As the status code displayed to code item by the **pairmon** command.
- As the paired status displayed to status item using **-fc** option of **pairdisplay** command.

HORC Async ERROR State

In the case of an ESCON[®] failure, the S-VOL FIFO queue is missing a data block that was transferred from the P-VOL FIFO queue. The RCU waits to store the next sequenced data block in the S-VOL FIFO queue until the HORC Async copy pending timeout occurs (defined using HORC remote console software). If the timeout occurs during this waiting state, the pair status is changed from PAIR to PSUE, and non-sequenced data blocks are managed by the S-VOL bitmap. The missing data block can be recovered using the pairresync command, which merges the S-VOL bitmap with the P-VOL bitmap. shows its situation on the secondary side.

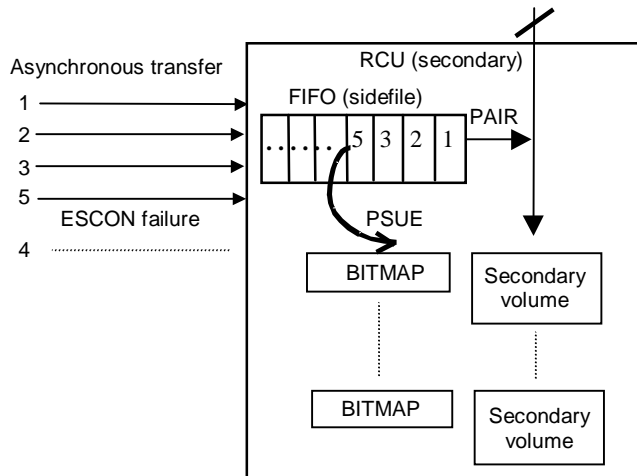


Figure 2.11 HORC Async Suspension Condition

Table 2.4 State Table for HORC Sync vs HORC Async

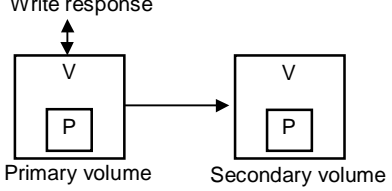
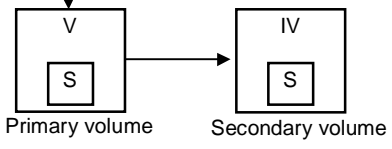
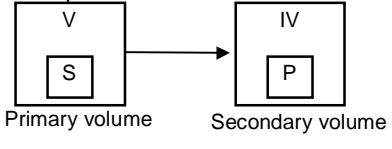
Pair Status	Internal Status	HORC Sync Description	HORC Async Description		*Write control for HORC Async Volume
SMPL	SMPL	SMPL	SMPL		Normal
COPY	COPY	COPY	COPY		Sidefile
PAIR	Deleting	None	Deleting from COPY by using [pairsplit -S]		Normal
	Suspending	None	Suspending from COPY by using [pairsplit]		Bitmap
	PAIR	Synchronized	Asynchronized sidefile in use	Less than HWM	Normal response
	PFUL	None		HWM to Threshold	Delayed response
				Over Threshold	Wait under Threshold
	Deleting	None	Deleting from PAIR by using [pairsplit -S]		Normal and Transfer of Sidefile
	Suspending	None	Suspending from PAIR	Using [pairsplit]	Bitmap and Transfer of Sidefile
				Timeout of Over Threshold	
PSUS	PSUS	PSUS	PSUS		Bitmap
	PFUS	None	Timeout of Over Threshold		Bitmap
PSUE	PSUE	PSUE	PSUE		Bitmap
PDUB	PDUB	PDUB	PDUB		Bitmap

* Bitmap: Host write data is managed by cylinder BITMAP of delta data.
Normal: Host write data is not managed by BITMAP or sidefile.
HWM (High Water Mark): Sidefile quantity is over 30% of cache storage.

2.4.3 HORC Synchronous Fence-Level Settings

HORC volume pairs are assigned a fence level for write I/Os to ensure the mirroring consistency of critical volumes. Accordingly, when the secondary volume takes over from the primary volume, the takeover action is determined according to the pair status and fence level of the corresponding secondary volume. Table 2.5 shows the relationship between HORC pair status and fence level.

Table 2.5 Relationship between HORC Pair Status and Fence Level

HORC Pair Status of Volume	Fence Level and Write Response			
	Data [1]	Status [2]	Never [3]	Async [4]
Write response  Primary volume Secondary volume	OK	OK	OK	OK
	Mirroring consistency assured	Mirroring consistency assured	Mirroring consistency assured	Mirroring consistency not assured
Write response  Primary volume Secondary volume	ERROR	OK	OK	OK
	Mirroring consistency assured	Mirroring consistency not assured	Mirroring consistency not assured	Mirroring consistency not assured
Write response  Primary volume Secondary volume	ERROR	ERROR	OK	OK
	Mirroring consistency assured	Mirroring consistency assured	Mirroring consistency not assured	Mirroring consistency not assured

[1] When fence level is **data**, the P-VOL returns a write error whenever data consistency is lost, so mirroring consistency is assured. The S-VOL can continue operation, regardless of its status.

[2] When fence level is **status**, the S-VOL pair status changes to PSUE whenever data consistency is lost, so the currency of the S-VOL can be evaluated by its status:

S: The secondary volume is dubious.

P: The secondary volume can continue operation.

[3] When fence level is **never**, writing is enabled whenever data consistency is lost, whether or not the S-VOL status is updated. Thus, the currency of the S-VOL can be evaluated as follows:

S: The secondary volume is dubious.

P: The secondary volume is substantially dubious, since it can continue operation and is also dubious. The P-VOL status must be checked to confirm the mirroring consistency.

[4] When fence level is **async**, the HORCA function ensures the sequence of writing data between the P-VOL and the S-VOL, and writing is enabled whether or not the S-VOL status is updated. Thus, the mirroring consistency of the S-VOL is dubious:

S: The mirroring consistency is not assured, but this state is suspended state that ensure the sequence of writing data as the volume group. Writing data of the primary volume is managed by the delta table after the suspended state (PSUE).

P: The mirroring consistency is not assured, but this state is paired state that ensures the sequence of writing data as the volume group.

How to Set the Fence Level

Figure 2.12 shows the relations between redo log files (journal) and data files. If the S-VOL takes over from the P-VOL in the status shown in Figure 2.12 (where two errors have occurred), the secondary host leaves data (V) unprocessed in the roll-back processing and cannot be recovered completely. Therefore, the fence level of a redo log file must be defined as **data**. Once the fence level is set to **data**, the P-VOL returns an error if data may possibly be inconsistent when a write request is issued by the host. Since the writing into the data file has not been executed due to a write error of the redo log file, the log file stays consistent with the data file. However, when the fence level is set to **data**, a write I/O error occurs even in the case where operation is suspended due to an error in the S-VOL. Accordingly, the duplication becomes meaningless when the S-VOL takes over. Thus, applications using paired volumes with the **data** fence level should be able to handle write I/O errors properly. For example, Oracle creates multiple redo log files by itself (three by default). The fence level can be set to **data** in this case in which disk errors are permissible by creating multiple file.

Since most UNIX[®]-based file systems (excluding JFS and VxFS) have no journal files, the fence level should be defined as **Never**. When a takeover by the S-VOL occurs, **fsck** is executed on the volume and the file system is cleaned up, even if the S-VOL is undefined at the secondary host. The data that will be lost depends on how much differential data is contained in the P-VOL when the S-VOL is suspended. During operation, error recovery should be performed when the suspended status (PSUE or PDUB) is detected (when one error occurs).

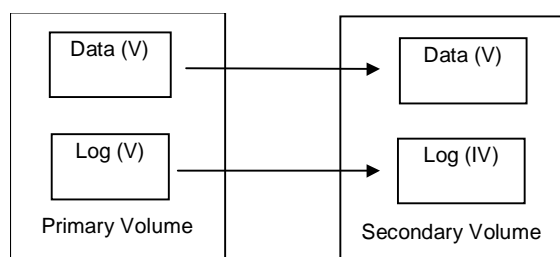


Figure 2.12 Relation between Logs and Data in Paired Status

2.5 Applications of HORC/HOMRCF Commands

This section provides examples of tasks which can be performed using HORC and/or HOMRCF commands (see Figures 2.13-2.18):

- Back up secondary volume in paired status (HORC or HOMRCF),
- Restore secondary volume to primary volume in split status (HORC or HOMRCF),
- Swapping paired volume for duplex operation (HORC only)
- Restoring secondary volume for duplex operation (HORC only).

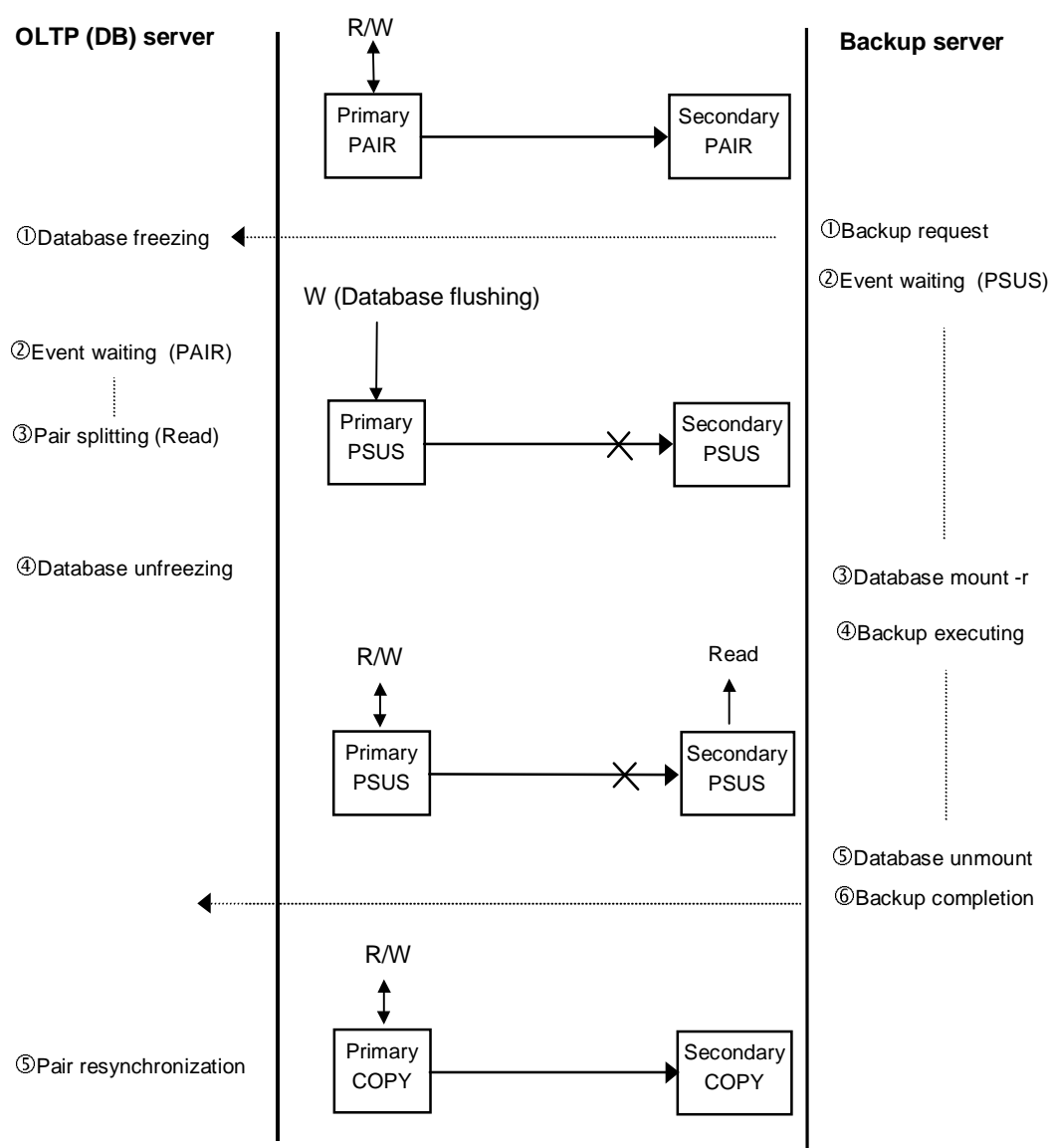


Figure 2.13 Backing Up S-VOL in Paired Status Using HORC

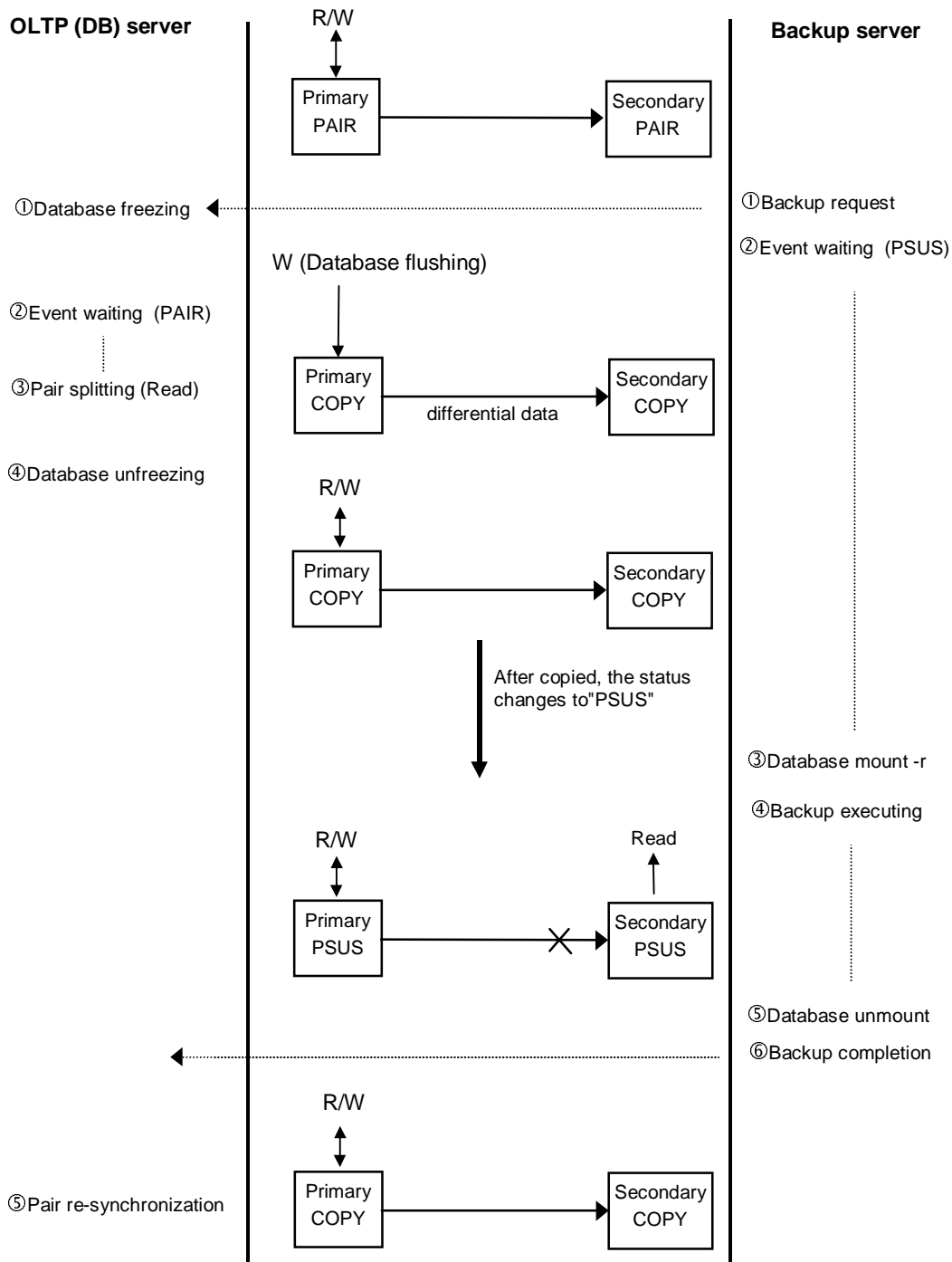


Figure 2.14 Backing Up S-VOL in Paired Status Using HOMRCF

Note: When you issue the pairsplit command to an HOMRCF paired volume, the pair status changes to COPY, and the differential data due to asynchronous copy is copied to the secondary volume. When this copy is finished, the pair status changes to PSUS. The primary volume remains write-enabled throughout the pairsplit operation (COPY and PSUS status).

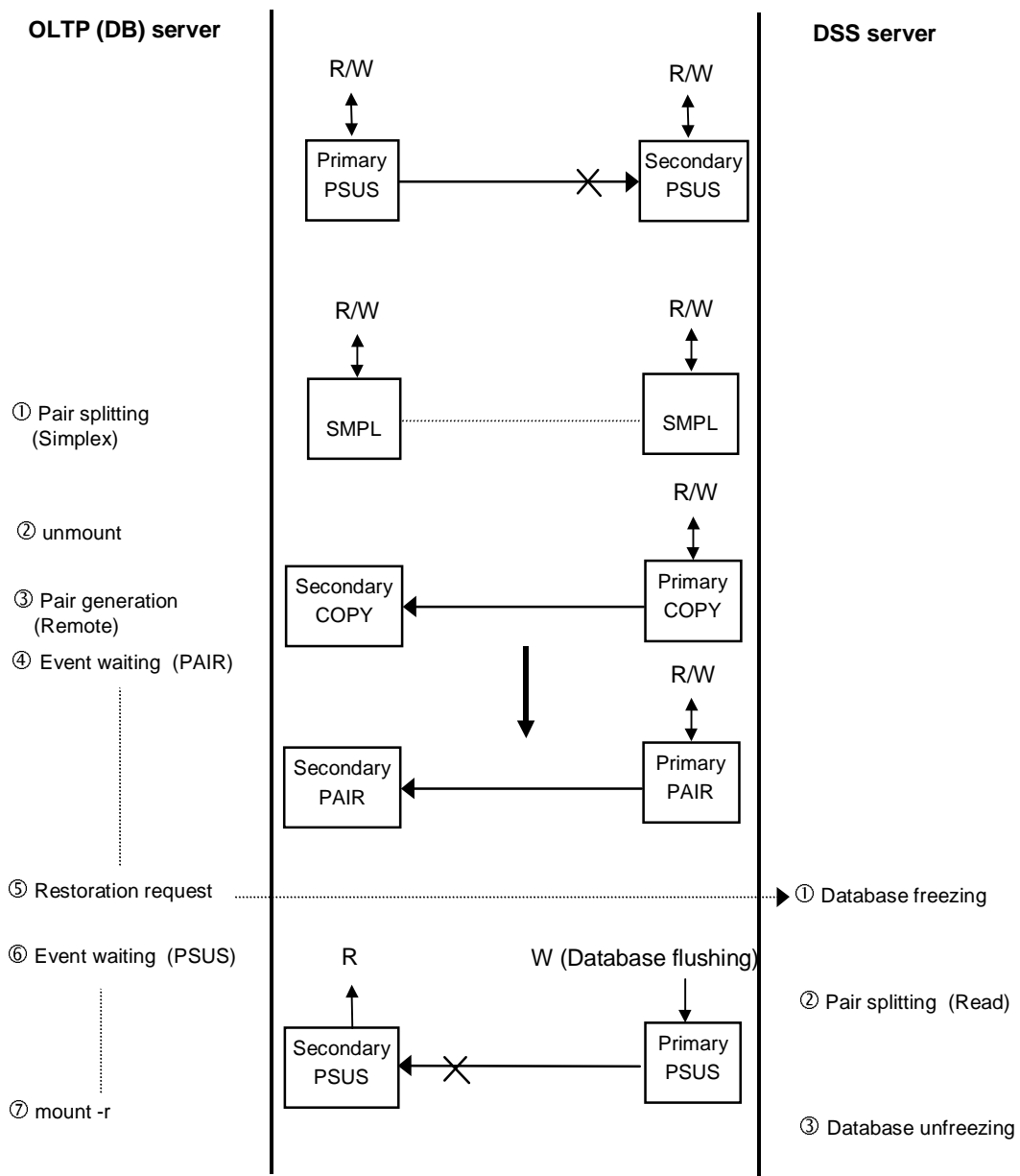


Figure 2.15 Restoring S-VOL to P-VOL in Split Status Using HORC

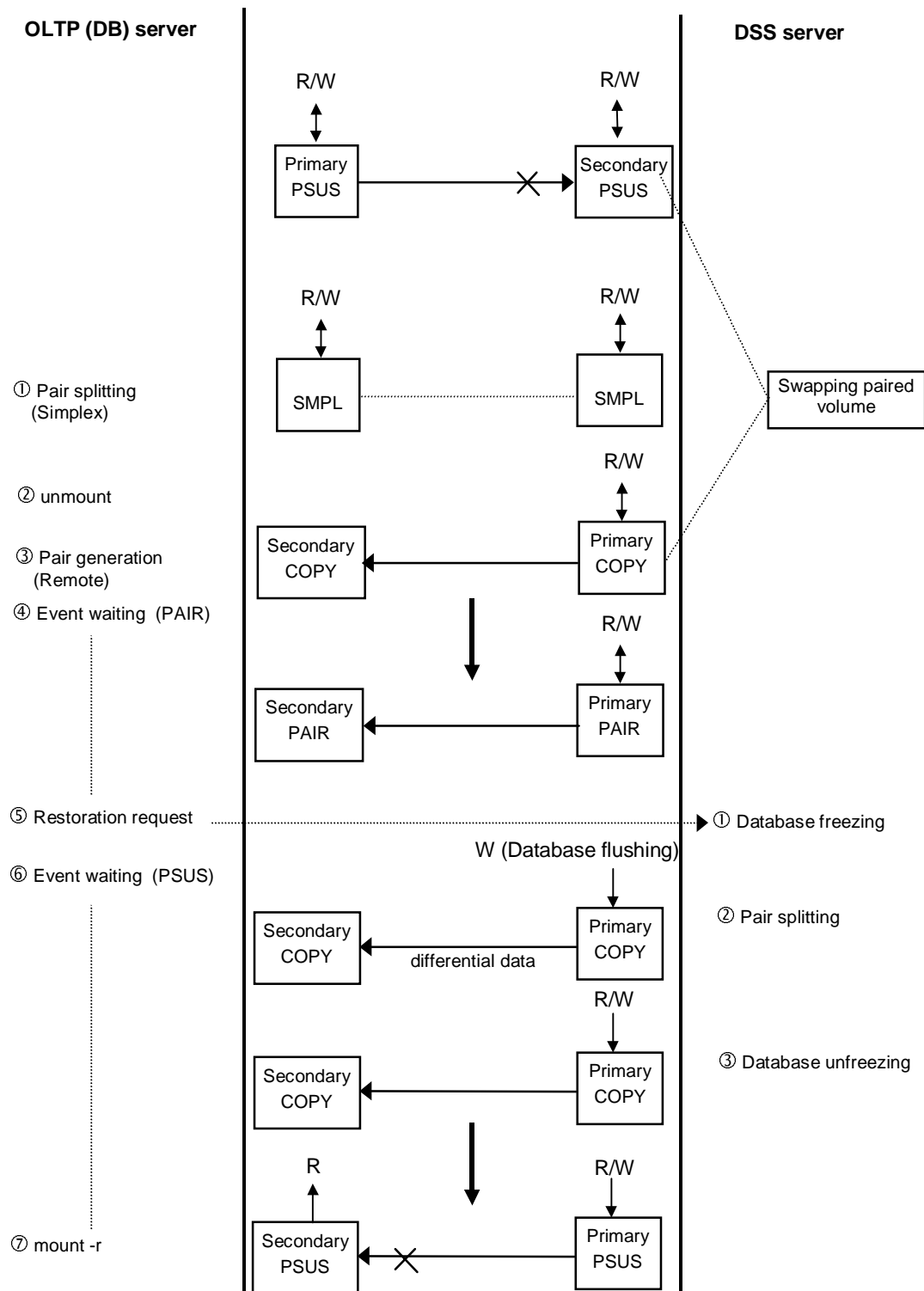


Figure 2.16 Restoring S-VOL to P-VOL in Split Status Using HOMRCF

Note: When a swap of the primary/secondary is performed, only one paired volume is possible.

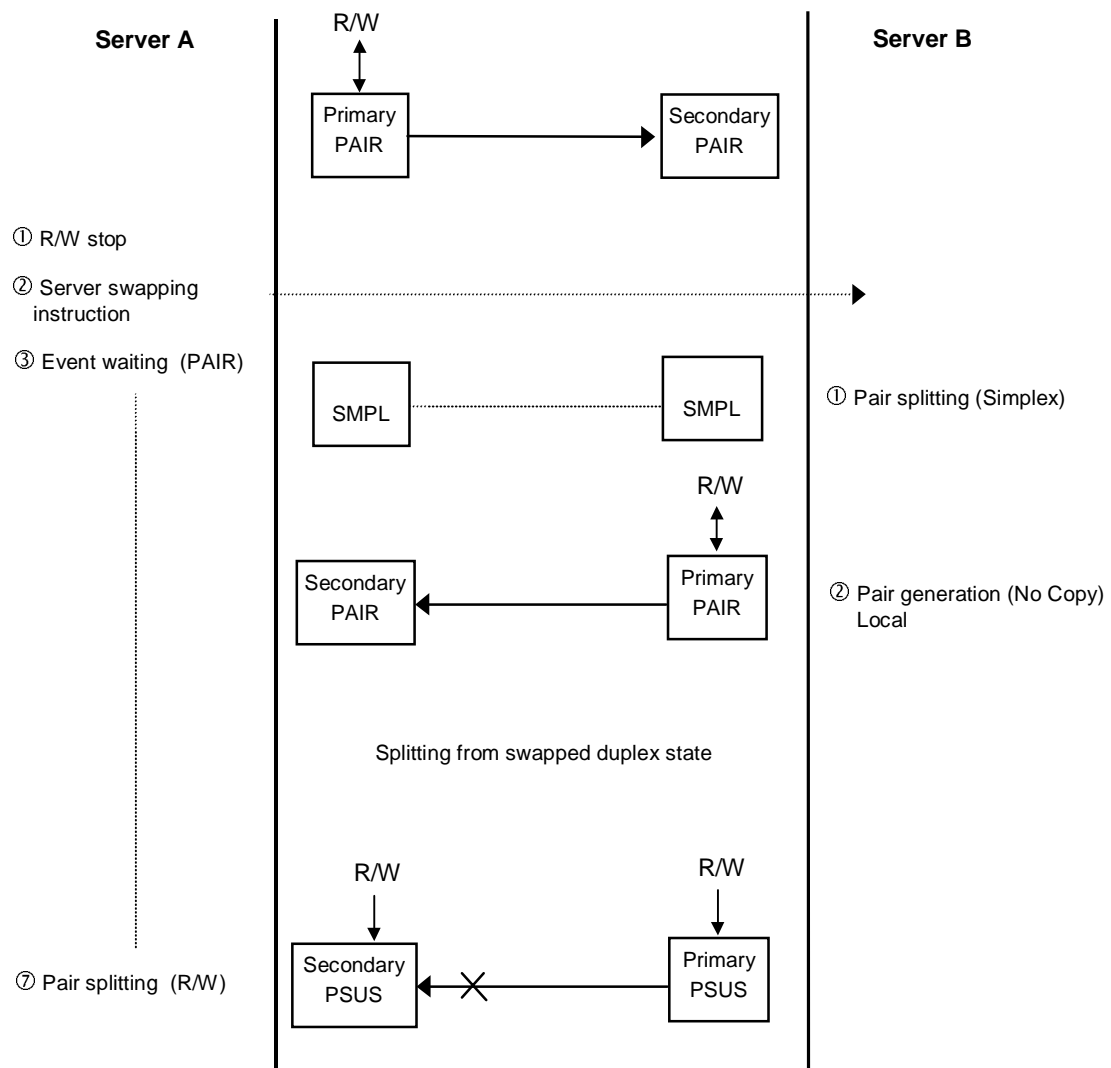


Figure 2.17 Swapping Paired Volume for Duplex Operation -- HORC Only

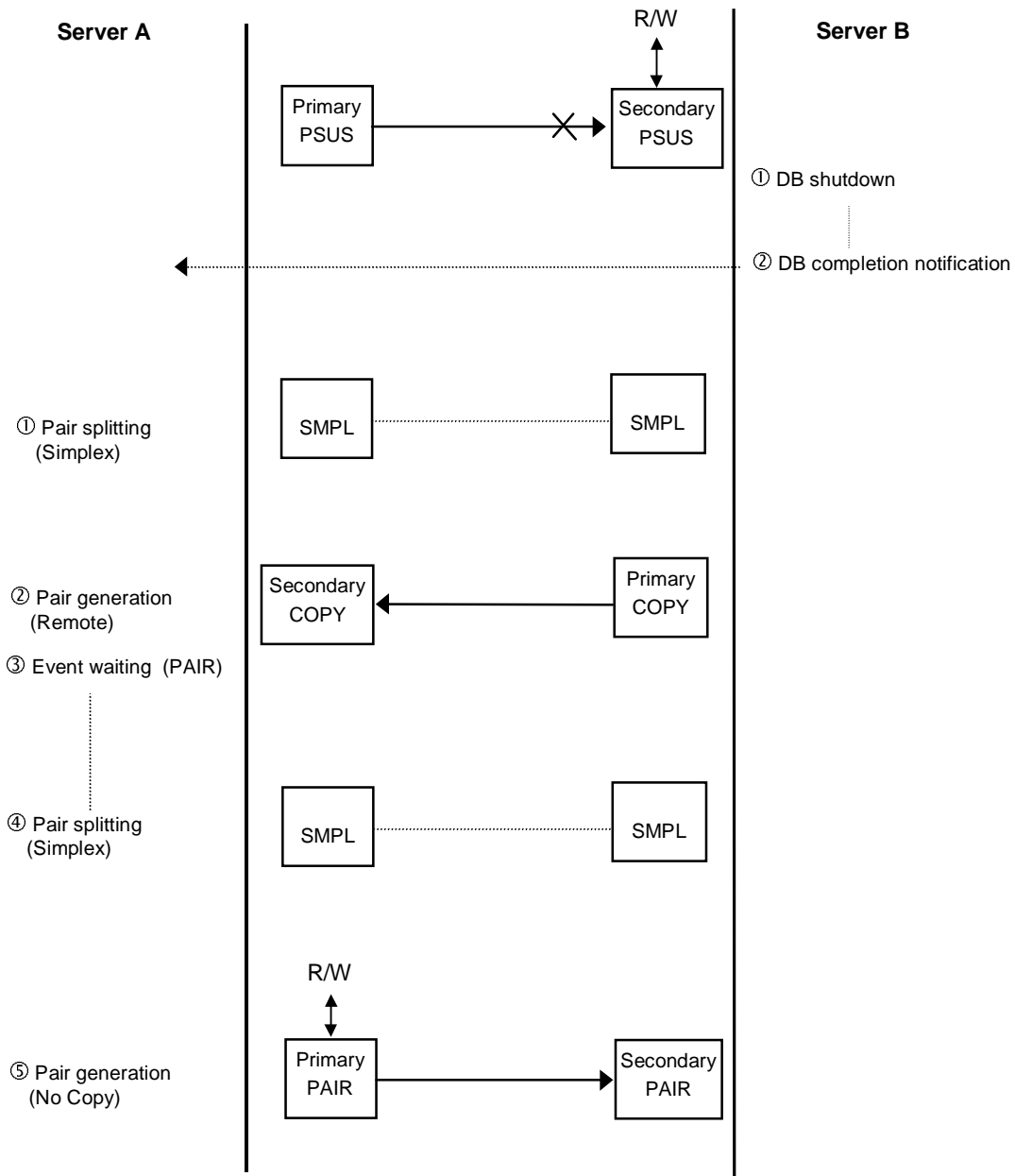


Figure 2.18 Restoring S-VOL for Duplex Operation (HORC Only)

2.6 CCI Software Structure

Figure 2.19 illustrates the CCI software structure: the CCI components on the 9900 subsystem, and the CCI instance on the UNIX[®]/PC server. The CCI components on the 9900 subsystem include the command device(s) and the HORC and/or HOMRCF volumes. Each CCI instance on a UNIX[®]/PC server includes:

- HORC Manager (HORCM):
 - Log and trace files
 - A command server
 - Error monitoring and event reporting files
 - A configuration management feature
- Configuration definition file (defined by the user).
- The HORC and/or HOMRCF user execution environments, which contain the HORC/HOMRCF commands, a command log, and a monitoring function.

2.6.1 HORCM Operational Environment

The HORCM operates as a daemon process on the host server and is activated automatically when the server machine starts up or manually by the start-up script. HORCM refers to the definitions in the configuration file when it is activated. The environmental variable HORCM_CONF is used to define the configuration file to be referred to.

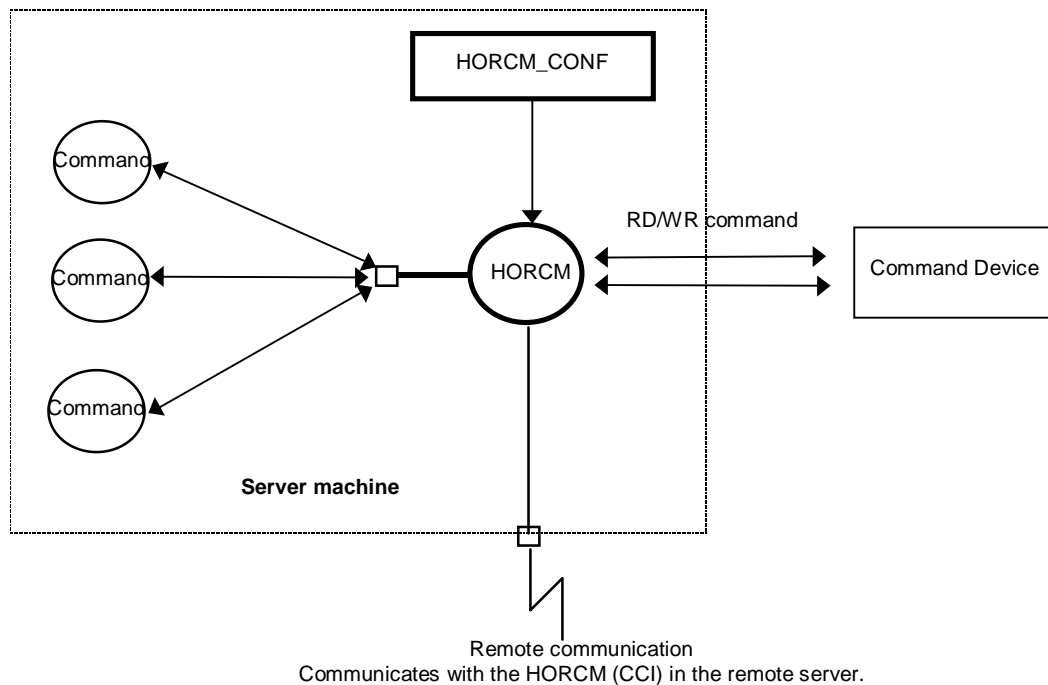


Figure 2.19 HORCM Operational Environment

2.6.2 CCI Instance Configurations

The basic unit of the CCI software structure is the CCI instance. Each copy of CCI on a server is a CCI instance. Each instance uses a defined configuration file to manage volume relationships while maintaining awareness of the other CCI instances. Each CCI instance normally resides on one server (one node). If two or more nodes are run on a single server (e.g., for test operations), it is possible to activate two or more instances using instance numbers. The CCI command, HORC or HOMRCF, is selected by the environment variable (HORCC_MRCF). The default command execution environment for CCI is HORC.

The CCI instance shown in Figure 2.20 has a remote execution link and a connection to the 9900 subsystem. The remote execution link is a network connection to another PC to allow you to execute CCI functions remotely. The connection between the CCI instance and the 9900 illustrates the connection between the CCI software on the host and the command device. The command device accepts both HORC and HOMRCF CCI commands and communicates read and write I/Os between the host and the volumes on the 9900. The host does not communicate HORC or HOMRCF commands directly to the volumes on the 9900. The CCI commands are always sent through the 9900 command device.

Note: The 9900 command device must be defined using the LUN Manager remote console software (please refer to the *Hitachi Lightning 9900™ LUN Manager User's Guide*).

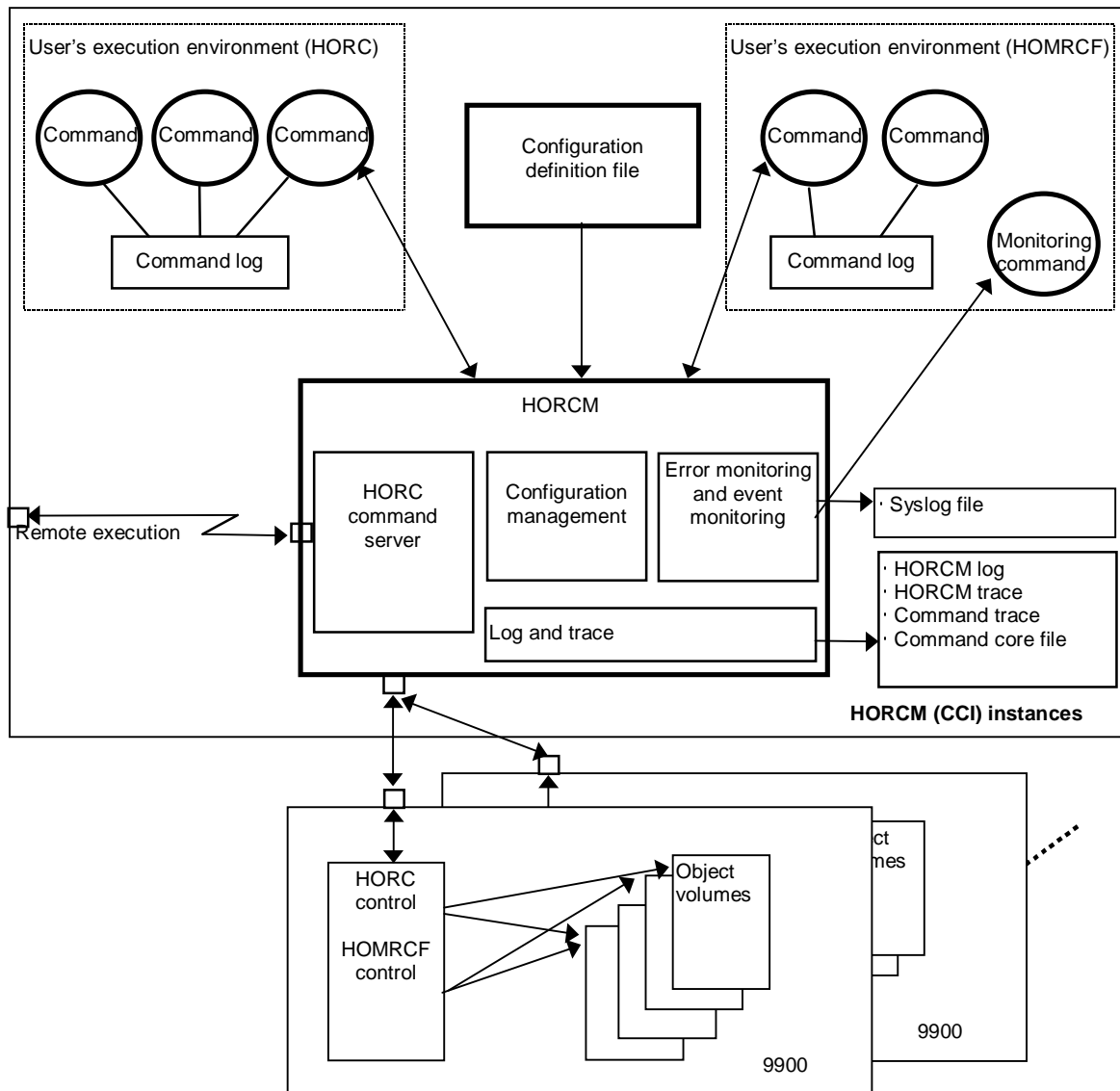


Figure 2.20 CCI Software Structure

Connecting the host to one 9900 subsystem allows you to maintain multiple copies of your data for testing purposes or offline backup. Connecting the host to two 9900 subsystems enables you to migrate data or implement disaster recovery by maintaining duplicate sets of data in two different subsystems. You can implement disaster recovery solutions by placing the subsystems in different geographic areas. Having two attached hosts, one for the primary volume and one for the secondary volume, allows you to maintain and administer the primary volumes while the secondary volumes can be taken offline for testing. Two hosts connected to two subsystems also allows the most flexible disaster recovery plan, because both sets of data are administered by different hosts, which guards against subsystem as well as host failure.

The four possible CCI instance configurations are:

- **One host connected to one subsystem.** Each CCI instance has its own operation manager, server software, and scripts and commands, and each CCI instance communicates independently with the command device. The 9900 subsystem contains the command device which communicates with the CCI instances as well as the primary and secondary volumes of both CCI instances.
- **One host connected to two subsystems.** Each CCI instance has its own operation manager, server software, and scripts and commands, and each CCI instance communicates independently with the 9900 command device. Each 9900 subsystem has a command device which communicates with each CCI instance independently. Each subsystem contains the primary volumes of its connected CCI instance and the secondary volumes of the other CCI instance (located on the same host in this case).
- **Two hosts connected to one subsystem.** The CCI instances are connected via the LAN so that they can maintain awareness of each other. The 9900 subsystem contains the command device which communicates with both CCI instances and the primary and secondary volumes of both CCI instances.
- **Two hosts connected to two subsystems.** The CCI instances are connected via the LAN so that they can maintain awareness of each other. Each 9900 subsystem has a command device which communicates with each CCI instance independently. Each subsystem contains the primary volumes of its connected CCI instance and the secondary volumes of the other CCI instance (located on a different host in this case).

2.6.3 Configuration Definition File

The CCI configuration definition file is the text file which defines connected hosts and the volumes and groups known to the CCI instance. Physical volumes (special files) used independently by the servers are combined when paired logical volume names and group names are given to them. The configuration definition file describes the correspondence between the physical volumes used by the servers and the paired logical volumes and the names of the remote servers connected to the volumes. See section 2.7 for sample CCI configurations and their configuration definition file(s). See Chapter 3 for instructions on creating the CCI configuration file.

Figure 2.21 illustrates the configuration definition of paired volumes. Figure 2.22 shows a sample configuration file for a UNIX[®]-based operating system. Figure 2.23 shows a sample configuration file for the Windows NT[®] or Windows[®] 2000 operating system.

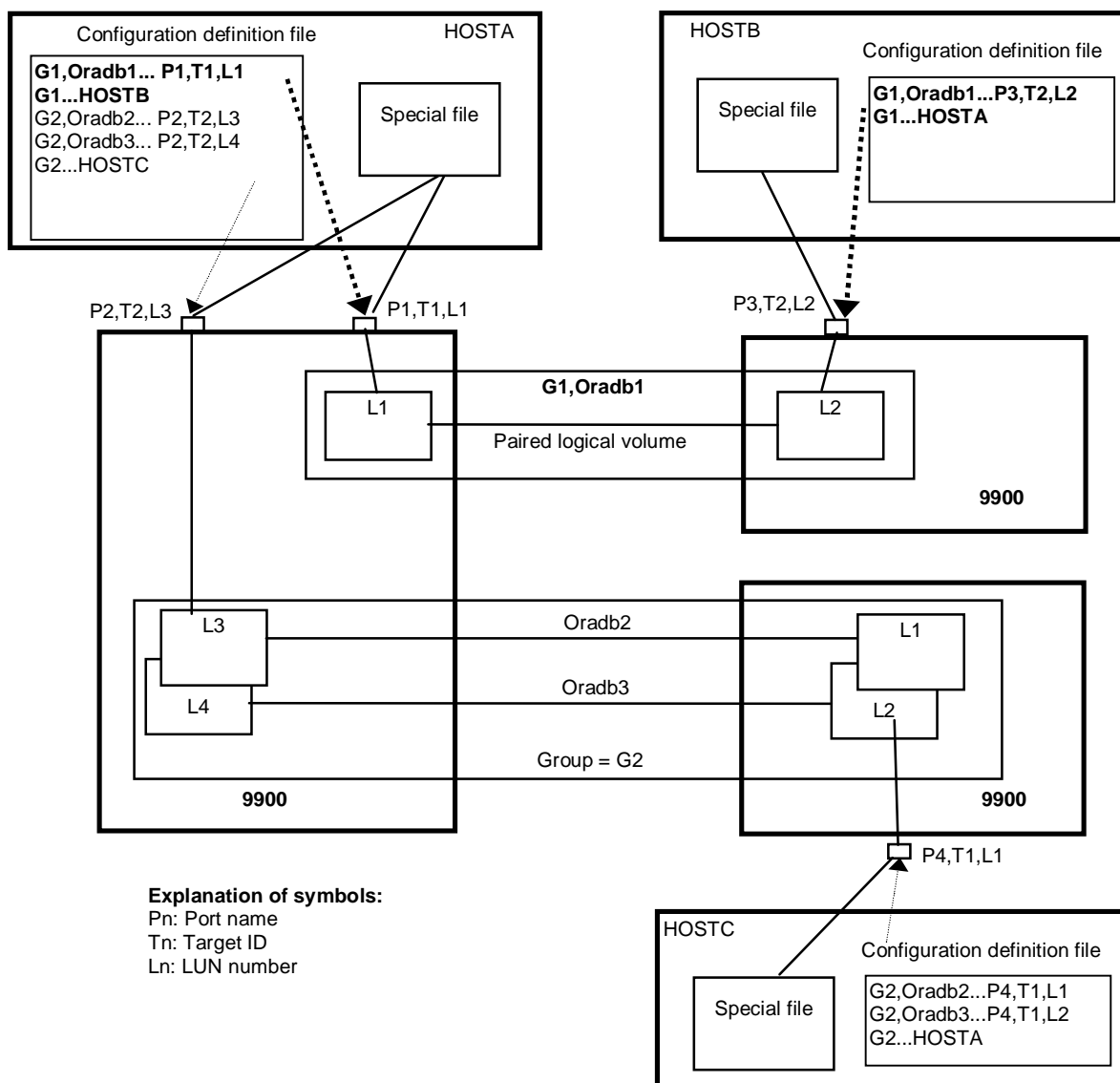


Figure 2.21 Configuration Definition of Paired Volumes

```

HORCM_MON
#ip_address      service      poll(10ms)      timeout(10ms)
HST1             horcm        1000            3000

HORCM_CMD
#unitID 0... (seq#30014)
#dev_name        dev_name      dev_name
/dev/rdsd/c0t0d0
#unitID 1... (seq#30015)
#dev_name        dev_name      dev_name
/dev/rdsd/c1t0d0

HORCM_DEV
#dev_group      dev_name      port#      TargetID      LU#      MU#
oradb           oradb1       CL1-A      3             1        0
oradb           oradb2       CL1-A      3             1        1
oralog          oralog1      CL1-A      5             0
oralog          oralog2      CL1-A1     5             0
oralog          oralog3      CL1-A1     5             1

HORCM_INST
#dev_group      ip_address      service
oradb           HST2            horcm
oradb           HST3            horcm
oralog          HST3            horcm

```

← UnitID 1.

← Note unitID 1.

←

Figure 2.22 Configuration File Example -- UNIX®-Based Servers

```

horcm0.conf - Notepad
File Edit Search Help

HORCM_MON
#ip_address      service      poll(10ms)      timeout(10ms)
POLLUX          horcm0        1000            3000

HORCM_CMD
#dev_name        dev_name      dev_name
\\.\PHYSICALDRIVE2

HORCM_DEV
#dev_group      dev_name      port#      TargetID      LU#
VGG01          kate1         CL1-A      0             0
#VGG02          kate2         CL1-C      4             0
#VGG02          oradb3        CL1-B      2             4

HORCM_INST
#dev_group      ip_address      service
VGG01          POLLUX          horcm1

```

Figure 2.23 Configuration File Example -- Windows® NT/2000 Servers

HORCM_MON. The monitor parameter (HORCM_MON) defines the following values:

- **Ip_address:** The IP address of the local host. When HORCM has to two or more network addresses on different subnets for communication, this item must be NONE.
- **Service:** The port name assigned to the CCI service (registered in the `/etc/services` file). The service parameter defines the CCI instance that runs on the local host. If a port number is specified instead of a port name, the port number will be used.
- **Poll:** The interval for monitoring paired volumes. To reduce the HORCM daemon load, make this interval longer. If this interval is set to -1, the paired volumes are not monitored. The value of -1 is specified when two or more CCI instances run on a single machine.
- **Timeout:** The time-out period of communication with the remote server.

HORCM_CMD. The command parameter (HORCM_CMD) defines the UNIX[®] device path or Windows[®] physical device number of the 9900 command device. The command device must be mapped to the SCSI/fibre using the LUN Manager remote console software (or SVP). You can define more than one command device to provide failover in case the original command device becomes unavailable (see section 2.6.5).

When a server is connected to two or more 9900 subsystems, the HORCM identifies each 9900 using the unitID (see Figure 2.24). The unitID is assigned sequentially in the order described in this section of the configuration definition file. The server must be able to verify that unit ID is the same Serial# (Seq#) with among server when the 9900 is shared by two or more servers. This can be verified using the raidqry command.

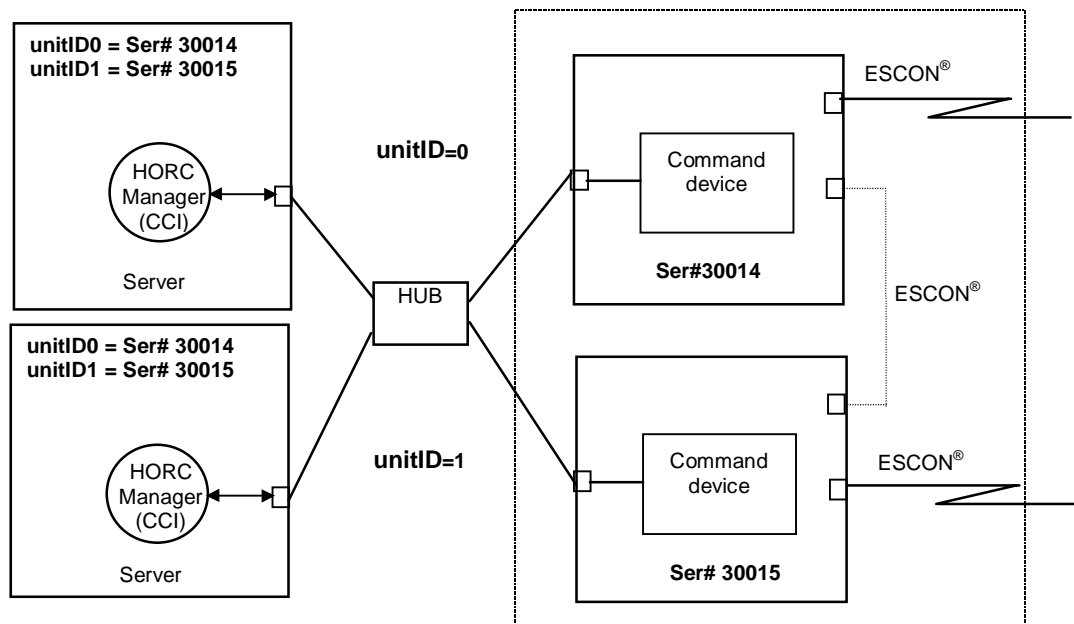


Figure 2.24 Configuration and Unit IDs for Multiple 9900 Subsystems

HORCM_DEV. The device parameter (HORCM_DEV) defines the 9900 device addresses for the paired logical volume names. When the server is connected to two or more 9900 subsystems, the 9900 unit ID is expressed by port# extension. Each group name is a unique name discriminated by a server which uses the volumes, the attributes of the volumes (such as database data, redo log file, UNIX® file), recovery level, etc. The group and paired logical volume names described in this item must reside in the remote server. The hardware SCSI/fibre bus, target ID, and LUN as hardware components need not be the same.

The following values are defined in the HORCM_DEV parameter:

- **dev_group:** Names a group of paired logical volumes. A command is executed for all corresponding volumes according to this group name.
- **dev_name:** Names the paired logical volume within a group (i.e., name of the special file or unique logical volume). The name of paired logical volume must be different than the “dev name” on another group.
- **Port #:** Defines the 9900 port number of the volume that corresponds with the dev_name volume. The following “n” shows unit ID when the server is connected to two or more subsystems (e.g., CL1-A1 = CL1-A in unit ID 1). If the “n” option is omitted, unit ID is 0.

	Basic				Option				Option				Option			
CL1	An	Bn	Cn	Dn	En	Fn	Gn	Hn	Jn	Kn	Ln	Mn	Nn	Pn	Qn	Rn
CL2	An	Bn	Cn	Dn	En	Fn	Gn	Hn	Jn	Kn	Ln	Mn	Nn	Pn	Qn	Rn

- **Target ID:** Defines the SCSI/fibre target ID number of the physical volume on the specified port. See Appendix D for further information on fibre address conversion.
- **LU #:** Defines the SCSI/fibre logical unit number (LU#) of the physical volume on the specified target ID and port.

Note: In case of fibre channel, if the target ID and LU# displayed on the system are different than the target ID on the fibre address conversion table, then you must use the target ID and LU# indicated by the raidscan command in the CCI configuration file.

- **MU #:** Defines the remote copy number (0 - 2) of HOMRCF volumes. If this number is omitted it is assumed to be zero (0). The cascaded mirroring of the S-VOL is expressed as virtual volumes using the mirror descriptors (MU#1-2) in the configuration definition file. The MU#0 of a mirror descriptor is used for connection of the S-VOL. When defining HORC volumes, omit this number.

HORCM_INST. The instance parameter (HORCM_INST) defines the network address (IP address) of the remote server (active or standby). It is used to refer to or change the status of the paired volume in the remote server (active or standby). When the primary volume is shared by two or more servers, there are two or more remote servers using the secondary volume. Thus, it is necessary to describe the addresses of all of these servers.

The following values are defined in the HORCM_INST parameter:

- **dev_group:** The server name described in dev_group of HORC_DEV.
- **ip_address:** The network address of the specified remote server.
- **service:** The port name assigned to the HORCM communication path (registered in the /etc/services file). If a port number is specified instead of a port name, the port number will be used.

When HORCM has two or more network addresses on different subnets for communication, the ip_address of HORCM_MON must be NONE. This configuration for multiple networks can be found using **raidqry -r <group>** command option on each host. The current network address of HORCM can be changed using **horcctl -NC <group>** on each host.

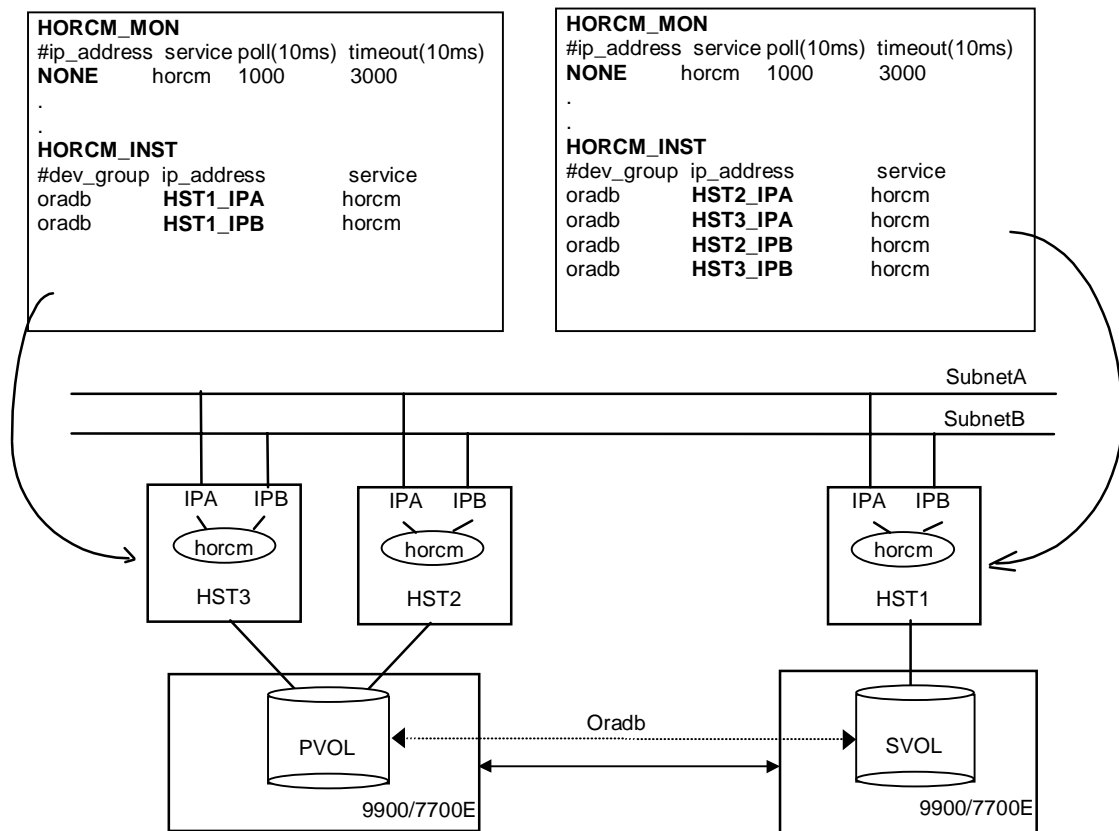


Figure 2.25 Configuration for Multiple Networks

2.6.4 Command Device

The HORC/HOMRCF commands are issued by the HORC Manager (HORCM) to the 9900 command device. The command device is a user-selected, dedicated logical volume on the 9900 subsystem which functions as the interface to the CCI software on the UNIX®/PC host. The command device is dedicated to CCI communications and cannot be used by any other applications. The command device accepts HORC and HOMRCF read and write commands that are executed by the 9900 subsystem. The command device also returns read requests to the UNIX®/PC host. The volume designated as the command device is used only by the 9900 and is blocked from the user. The command device uses 16 MB, and the remaining volume space is reserved for CCI and its utilities. The command device can be any OPEN-*x* device (e.g., OPEN-3, OPEN-8) that is accessible by the host. An LU Size Expansion (LUSE) volume cannot be used as a command device. A Virtual LUN (CVS) volume (as small as 36 MB) can be used as a command device.

WARNING: Make sure that the volume to be selected as the command device does not contain any user data. The command device will be inaccessible to the UNIX®/PC server host.

The CCI software on the host issues read and write commands to the 9900 command device. When CCI receives an error notification in reply to a read or write request to the 9900, the CCI software will switch to an alternate command device, if one is defined. If a command device is blocked (e.g., online maintenance), you can switch to an alternate command device manually. If no alternate command device is defined or available, all HORC and HOMRCF commands will terminate abnormally, and the host will not be able to issue commands to the subsystem. The user must set one or more alternate command devices to avoid data loss and subsystem downtime.

Each command device must be set using the LUN Manager remote console software. If the remote LUN Manager feature is not installed, please ask your Hitachi Data Systems representative about LUN Manager configuration services. Each command device must also be defined in the HORCM_CMD section of the configuration file for the CCI instance on the attached host. If an alternate command device is not defined in the configuration file, the CCI software may not be able to use the device. See section 3.7 for instructions on setting and defining command devices.

2.6.5 Alternate Command Device Function

The CCI software issues commands to the 9900 command device via the UNIX[®]/PC raw I/O interface. If the command device fails in any way, all HORC/HOMRCF commands are terminated abnormally, and the user cannot use any commands. Because the use of alternate I/O pathing depends on the platform, restrictions are placed upon it. For example, on HP-UX[®] systems only devices subject to the LVM can use the alternate path PV-LINK. To avoid command device failure, CCI supports an alternate command device function.

- **Definition of alternate command devices.** To use an alternate command device, you must define two or more command devices for the HORCM_CMD item in the configuration definition file (see sections 2.6.3 and 2.7). When two or more devices are defined, they are recognized as alternate command devices.
- **Timing of alternate command devices.** When the HORCM receives an error notification in reply from the operating system via the raw I/O interface, the command device is alternated. It is possible to alternate the command device forcibly by issuing an alternating command provided by HORC (**horcctl -C**).
- **Operation of alternating command.** If the command device will be blocked due to online maintenance (e.g., microcode replacement), the alternating command should be issued in advance. When the alternating command is issued again after completion of the online maintenance, the previous command device is activated again.
- **Multiple command devices on HORCM startup.** If at least one command device is available during one or more the command devices which was described to the configuration definition file, then HORCM will be able to start with warning message to startup log by using available command device. The user needs to confirm that all command devices can be changed by using **horcctl -C** command option, or HORCM has been started without warning message to the HORCM start up log.

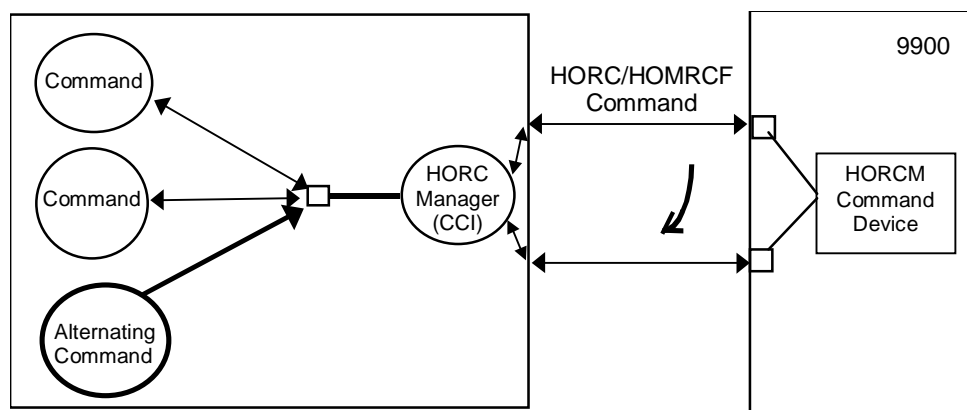


Figure 2.26 Alternate Command Device Function

2.6.6 Command Interface with HORC/HOMRCF

When the HORC control commands are converted into SCSI commands of a special format, a SCSI through driver which can send such special SCSI commands to the 9900 is needed. As a result, it is quite possible that support by HORC depends on the OS supplier. Accordingly, it is necessary to use read/write command that can easily be issued by many UNIX[®]/PC server platforms. `Ioctl()` is used for only HP-UX[®], Linux[®], and Solaris[®] systems.

Format of SCSI commands used. Use the RD/WR command. They should be RD/WR command valid for special LDEV, since they should be discriminated from the normal RD/WR command.

Recognition of control command area (LBA#). The host issues control commands through a special file for raw I/O of a special LDEV. Since the specific LU (command device) receiving these commands is a normal disk viewed from the SCSI interface, the operating system may access the control area of its local. The 9900 must distinguish such accesses from the control command accesses. Normally, several megabytes of the OS control area is used from the initial LAB#. To avoid using this area, a specific LBA# area is decided and control commands are issued within this area. The command LAB# recognized by the 9900 is shown below, provided the maximum OS control area is 16 MB.

$32768 \leq \text{LBA\#} \leq 32768 * 2$ (In units of block; 512 bytes per block)
The host seeks $32768 * 512$ bytes and issues a command.

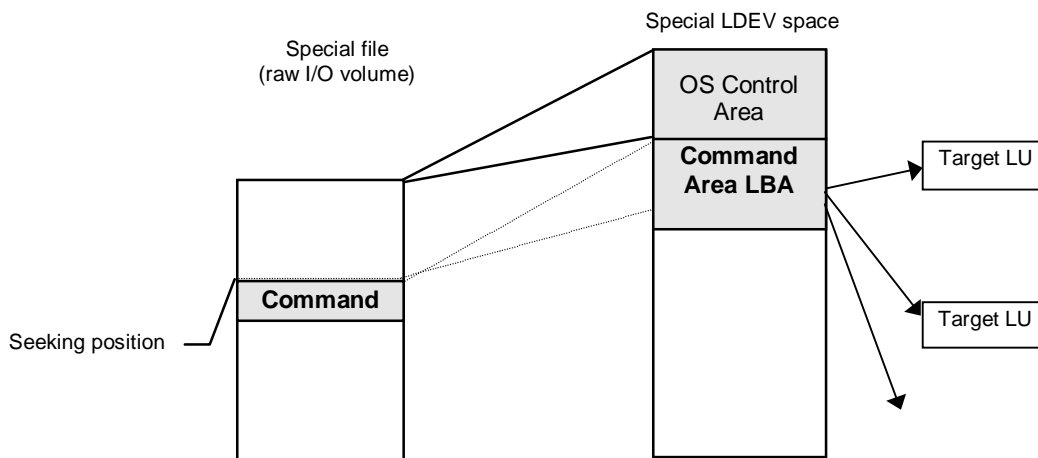


Figure 2.27 Relation between Special File and Special LDEV

Acceptance of commands. A command is issued in the LBA area of the special LDEV explained above. The RD/WR command meeting this requirement should be received especially as the HORC control command. A command is issued in the form of WR or WR-RD. When a command is issued in the form of RD, it is regarded as an inquiry (equivalent to an SCSI inquiry), and a HORC recognition character string is returned.

Command competition. The HORC control commands are asynchronous commands issued via the SCSI interface. Accordingly, if several processes issue these commands to a single LDEV, the 9900 confuses and cannot take the proper action. To avoid such a trouble, two or more WR commands should not be issued to a single LDEV. The command initiators should not issue two or more WR commands to a single LDEV unless the 9900 can receive commands with independent initiator number * LDEV number simultaneously.

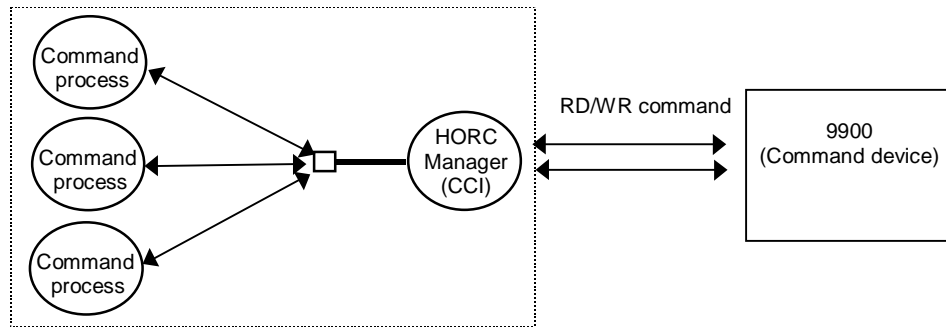


Figure 2.28 HORCM and Command Issue Process

Flow of command issue. Figure 2.29 shows the flow of RD/WR command control in a specified LBA#.

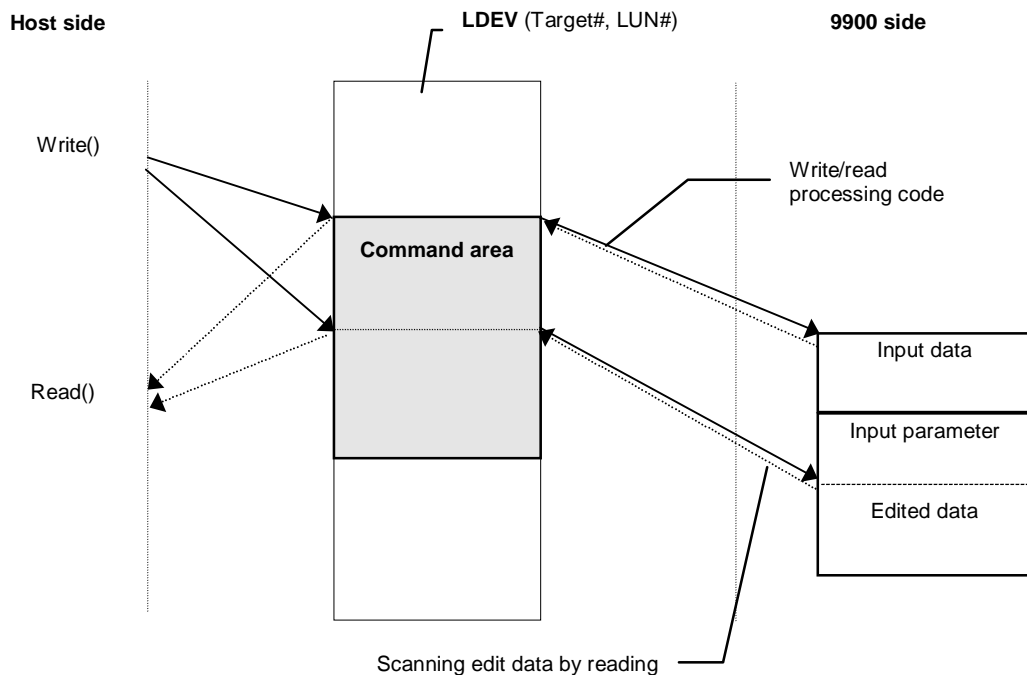


Figure 2.29 Flow of Command Issue

Issuing command for LDEV(s) within a LUSE device. A LUSE device is a group of LDEVs regarded as a single logical unit. Since it is necessary to know about the configuration of the LDEVs when issuing a command, a new command is used. This command specifies a target LU and acquires LDEV configuration data (Figure 2.30).

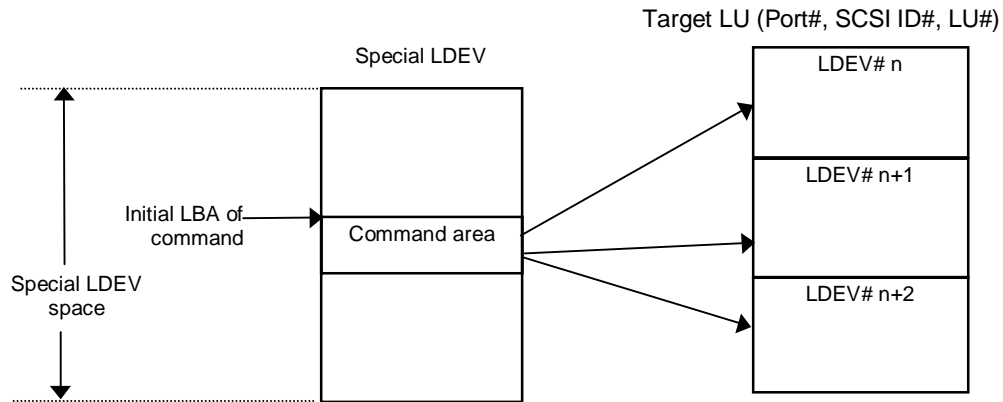


Figure 2.30 LUSE Device and Command Issue

2.6.7 CCI Software Files

The CCI software product consists of files supplied to the user, log files created internally, and files created by the user. These files are stored on the local disk in the server machine. Table 2.6 lists the CCI files which are provided for UNIX®-based systems. Table 2.7 lists the CCI files which are provided for Windows®-based systems.

Table 2.6 CCI Files for UNIX®-based Systems

No.	Title	File name	Command name	Mode	User*	Group
01	HORCM	/etc/horcmgr	horcmd	0544	root	sys
02	HORCM_CONF	/HORCM/etc/horcm.conf	–	0444	root	sys
03	Takeover	/usr/bin/horctakeover	horctakeover	0544	root	sys
04	Accessibility check	/usr/bin/paircurchk	paircurchk	0544	root	sys
05	Pair generation	/usr/bin/paircreate	paircreate	0544	root	sys
06	Pair splitting	/usr/bin/pairsplit	pairsplit	0544	root	sys
07	Pair resynchronization	/usr/bin/pairresync	pairresync	0544	root	sys
08	Event waiting	/usr/bin/pairevtwait	pairevtwait	0544	root	sys
09	Error notification	/usr/bin/pairmon	pairmon	0544	root	sys
10	Volume check	/usr/bin/pairvolchk	pairvolchk	0544	root	sys
11	Pair configuration confirmation	/usr/bin/pairdisplay	pairdisplay	0544	root	sys
12	RAID scanning	/usr/bin/raidscan	raidscan	0544	root	sys
13	RAID activity reporting	/usr/bin/raidar	raidar	0544	root	sys
14	Connection confirming	/usr/bin/raidqry	raidqry	0544	root	sys
15	Trace control	/usr/bin/horcctl	horcctl	0544	root	sys
16	HORCM activation script	/usr/bin/horcmstart.sh	horcmstart.sh	0544	root	sys
17	HORCM shutdown script	/usr/bin/horcmshutdown.sh	horcmshutdown.sh	0544	root	sys
18	Connection confirming Note: Provided only for Linux®, HP-UX®, and Solaris® systems.	/HORCM/usr/bin/inqraid	inqraid	0544	root	sys
019	Synchronous waiting	/usr/bin/pairsyncwait	pairsyncwait	0544	root	sys

***Note:** For information and instructions on changing the UNIX® user for the CCI software, please see section 3.3.3.

Table 2.7 CCI Files Windows®-based Systems

No.	Title	File name	Command name
01	HORCM	\\HORCM\\etc\\horcmgr.exe	horcmd
02	HORCM_CONF	\\HORCM\\etc\\horcm.conf	--
03	Takeover	\\HORCM\\etc\\horctakeover.exe	horctakeover
04	Accessibility check	\\HORCM\\etc\\paircurchk.exe	paircurchk
05	Pair generation	\\HORCM\\etc\\paircreate.exe	paircreate
06	Pair splitting	\\HORCM\\etc\\pairsplit.exe	pairsplit
07	Pair resynchronization	\\HORCM\\etc\\pairresync.exe	pairresync
08	Event waiting	\\HORCM\\etc\\pairevtwait.exe	pairevtwait
09	Error notification	\\HORCM\\etc\\pairmon.exe	pairmon
10	Volume check	\\HORCM\\etc\\pairvolchk.exe	pairvolchk
11	Pair configuration confirmation	\\HORCM\\etc\\pairedisplay.exe	pairedisplay
12	RAID scanning	\\HORCM\\etc\\raidscan.exe	raidscan
13	RAID activity reporting	\\HORCM\\etc\\raidar.exe	raidar
14	Connection confirmation	\\HORCM\\etc\\raidqry.exe	raidqry
15	Trace control	\\HORCM\\etc\\horcctl.exe	horcctl
16	HORCM activation script	\\HORCM\\etc\\horcmstart.exe	horcmstart
17	HORCM shutdown script	\\HORCM\\etc\\horcmshutdown.exe	horcmshutdown
18	Synchronous waiting	\\HORCM\\etc\\pairsyncwait.exe	
19	Takeover	\\HORCM\\usr\\bin\\horctakeover.exe	horctakeover
20	Accessibility check	\\HORCM\\usr\\bin\\paircurchk.exe	paircurchk
21	Pair generation	\\HORCM\\usr\\bin\\paircreate.exe	paircreate
22	Pair splitting	\\HORCM\\usr\\bin\\pairsplit.exe	pairsplit
23	Pair resynchronization	\\HORCM\\usr\\bin\\pairresync.exe	pairresync
24	Event waiting	\\HORCM\\usr\\bin\\pairevtwait.exe	pairevtwait
25	Volume check	\\HORCM\\usr\\bin\\pairvolchk.exe	pairvolchk
26	Synchronous waiting	\\HORCM\\usr\\bin\\pairsyncwait.exe	pairsyncwait

Note: The \\HORCM\\etc\\ commands are used in case of executing from the console window. If these commands are executed without an argument, the interactive mode will start up. The \\HORCM\\usr\\bin commands have no console window, and can therefore be used in case of executing from user application.

2.6.8 Log and Trace Files

The CCI software (HORCM) and HORC/HOMRCF commands maintain start-up log files, execution log files, and trace files which can be used to identify the causes of errors and keep records of the status transition history of the paired volumes. Please refer to Appendix B for a complete description of the CCI log and trace files.

2.6.9 User-Created Files

Script Files. CCI supports scripting to provide automated and unattended copy operations. A CCI script contains a list of CCI commands which describes a series of HORC and/or HOMRCF operations. The scripted commands for UNIX[®]-based platforms are defined in a shell script file. The scripted commands for Windows[®]-based platforms are defined in a text file. The host reads the script file and sends the commands to the 9900 command device to execute the HORC/HOMRCF operations automatically. The CCI scripts are:

- **HORCM startup script** (horcmstart.sh, horcmstart.exe): A script which starts HORCM (/etc/horcmgr), sets environmental variables as needed (e.g., HORCM_CONF, HORCM_LOG, HORCM_LOGS), and starts HORCM.
- **HORCM shutdown script** (horcmshutdown.sh, horcmshutdown.exe): A script for stopping the HORCM (/etc/horcmgr).
- **HA control script:** A script for executing takeover processing automatically when the cluster manager (CM) detects a server error.

When constructing the HORCM environment, the system administrator should make a copy of the **HORCM_CONF** file. The copied file should be set according to the system environment and registered as the following file (* is the instance number):

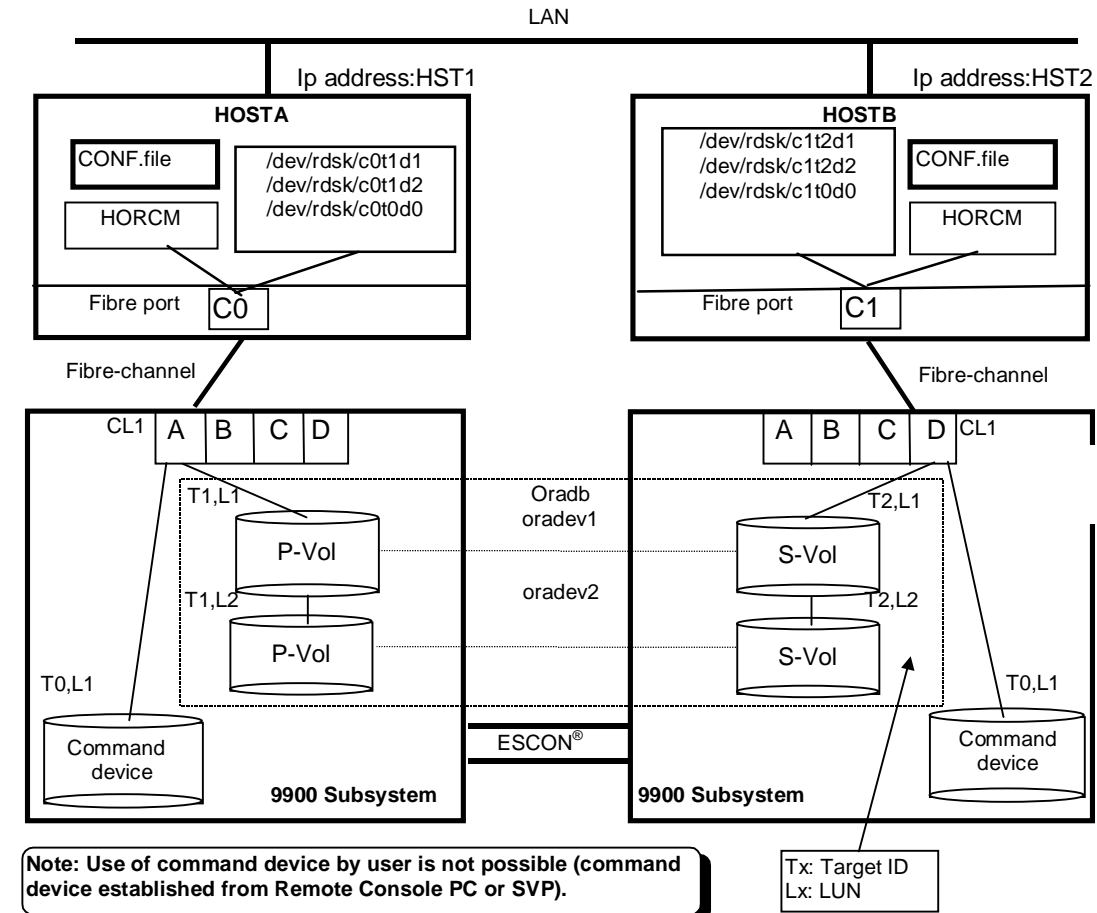
UNIX[®]-based systems: /etc/horcm.conf or /etc/horcm*.conf
Windows[®]-based systems: \WINNT\horcm.conf or \WINNT\horcm*.conf

2.7 Configuration Definition File

Figures 2.31 through 2.36 show examples of CCI configurations, the configuration definition file(s) for each configuration, and examples of CCI command use for each configuration.

The command device is defined using the system raw device name (character-type device file name). For example, the command devices for Figure 2.31 would be:

- HP-UX[®]: HORCM_CMD for HOSTA = /dev/rdisk/c0t0d1
HORCM_CMD for HOSTB = /dev/rdisk/c1t0d1
- Solaris[®]: HORCM_CMD for HOSTA = /dev/rdisk/c0t0d1s2
HORCM_CMD for HOSTB = /dev/rdisk/c1t0d1s2
- AIX[®]: HORCM_CMD of HOSTA = /dev/rhdiskXX
HORCM_CMD of HOSTB = /dev/rhdiskXX
where XX = device number assigned by AIX[®]
- Tru64[®] UNIX[®]: HORCM_CMD of HOSTA = /dev/rrzbXXc
HORCM_CMD of HOSTB = /dev/rrzbXXc
where XX = device number assigned by Tru64[®] UNIX[®]
- DYNIX/ptx[®]: HORCM_CMD of HOSTA = /dev/rdisk/sdXX
HORCM_CMD of HOSTB = /dev/rdisk/sdXX
where XX = device number assigned by DYNIX/ptx[®]
- Windows[®] NT/2000: HORCM_CMD of HOSTA = \\.\PhysicalDriveX
HORCM_CMD of HOSTB = \\.\PhysicalDriveX
where X = device number assigned by Windows[®] NT/2000
- Linux[®]: HORCM_CMD of HOSTA = /dev/sdX
HORCM_CMD of HOSTB = /dev/sdX
where X = device number assigned by Linux[®]



Configuration file for HOSTA (/etc/horcm.conf)

```

HORCM_MON
#ip_address service poll(10ms) timeout(10ms)
HST1 horcm 1000 3000

HORCM_CMD
#dev_name
/dev/xxx [Note 1]

HORCM_DEV
#dev_group dev_name port# TargetID LU#
Oradb oradev1 CL1-A 1 1
Oradb oradev2 CL1-A 1 2

HORCM_INST
#dev_group ip_address service
Oradb HST2 horcm

```

Configuration file for HOSTB (/etc/horcm1.conf)

```

HORCM_MON
#ip_address service poll(10ms) timeout(10ms)
HST2 horcm 1000 3000

HORCM_CMD
#dev_name
/dev/xxx [Note 1]

HORCM_DEV
#dev_group dev_name port# TargetID LU#
Oradb oradev1 CL1-D 2 1
Oradb oradev2 CL1-D 2 2

HORCM_INST
#dev_group ip_address service
Oradb HST1 horcm

```

Figure 2.31 HORC Remote Configuration Example

Example of CCI commands with HOSTA:

- Designate a group name (Oradb) and a local host P-VOL a case.
paircreate -g Oradb -f never -vl
This command creates pairs for all LUs assigned to group **Oradb** in the configuration definition file (two pairs for the configuration in Figure 2.31).
- Designate a volume name (oradev1) and a local host P-VOL a case.
paircreate -g Oradb -d oradev1 -f never -vl
This command creates pairs for all LUs designated as **oradev1** in the configuration definition file (CL1-A,T1,L1 and CL1-D,T2,L1 for the configuration in Figure 2.31).
- Designate a group name and display pair status.
pairdisplay -g Oradb

Group	PairVol(L/R)	(P,T#,L#)	Seq#	LDEV#..P/S	Status	Fence	Seq#	P-LDEV#	M
oradb	oradev1(L)	(CL1-A, 1,1)	30053	18..	P-VOL	COPY NEVER	,30054	19	-
oradb	oradev1(R)	(CL1-D, 2,1)	30054	19..	S-VOL	COPY NEVER	,-----	18	-
oradb	oradev2(L)	(CL1-A, 1,2)	30053	20..	P-VOL	COPY NEVER	,30054	21	-
oradb	oradev2(R)	(CL1-D, 2,2)	30054	21..	S-VOL	COPY NEVER	,-----	20	-

Example of CCI commands with HOSTB:

- Designate a group name and a remote host P-VOL a case.
paircreate -g Oradb -f never -vr
This command creates pairs for all LU designated as **Oradb** in the configuration definition file (two pairs for the configuration in Figure 2.31).
- Designate a volume name (oradev1) and a remote host P-VOL a case.
paircreate -g Oradb -d oradev1 -f never -vr
This command creates pairs for all LUs designated as **oradev1** in the configuration definition file (CL1-A,T1,L1 and CL1-D,T2,L1 for the configuration in Figure 2.31).
- Designate a group name and display pair status.
pairdisplay -g Oradb

Group	PairVol(L/R)	(P,T#,L#)	Seq#	LDEV#..P/S	Status	Fence	Seq#	P-LDEV#	M
oradb	oradev1(L)	(CL1-D, 2,1)	30054	19..	S-VOL	COPY NEVER	,-----	18	-
oradb	oradev1(R)	(CL1-A, 1,1)	30053	18..	P-VOL	COPY NEVER	,30054	19	-
oradb	oradev2(L)	(CL1-D, 2,2)	30054	21..	S-VOL	COPY NEVER	,-----	20	-
oradb	oradev2(R)	(CL1-A, 1,2)	30053	20..	P-VOL	COPY NEVER	,30054	21	-

The command device is defined using the system raw device name (character-type device file name). For example, the command devices for Figure 2.32 would be:

- HP-UX[®]: HORCM_CMD for HOSTA = /dev/rdsk/c0t0d1
HORCM_CMD for HOSTB = /dev/rdsk/c1t0d1
- Solaris[®]: HORCM_CMD for HOSTA = /dev/rdsk/c0t0d1s2
HORCM_CMD for HOSTB = /dev/rdsk/c1t0d1s2
- AIX[®]: HORCM_CMD of HOSTA = /dev/rhdiskXX
HORCM_CMD of HOSTB = /dev/rhdiskXX
where XX = device number assigned by AIX[®]
- Tru64[®] UNIX[®]: HORCM_CMD of HOSTA = /dev/rrzbXXc
HORCM_CMD of HOSTB = /dev/rrzbXXc
where XX = device number assigned by Tru64[®] UNIX[®]
- DYNIX/ptx[®]: HORCM_CMD of HOSTA = /dev/rdsk/sdXX
HORCM_CMD of HOSTB = /dev/rdsk/sdXX
where XX = device number assigned by DYNIX/ptx[®]
- Windows[®] NT/2000: HORCM_CMD of HOSTA = \\.\PhysicalDriveX
HORCM_CMD of HOSTB = \\.\PhysicalDriveX
where X = device number assigned by Windows[®] NT/2000
- Linux[®]: HORCM_CMD of HOSTA = /dev/sdX
HORCM_CMD of HOSTB = /dev/sdX
where X = device number assigned by Linux[®]

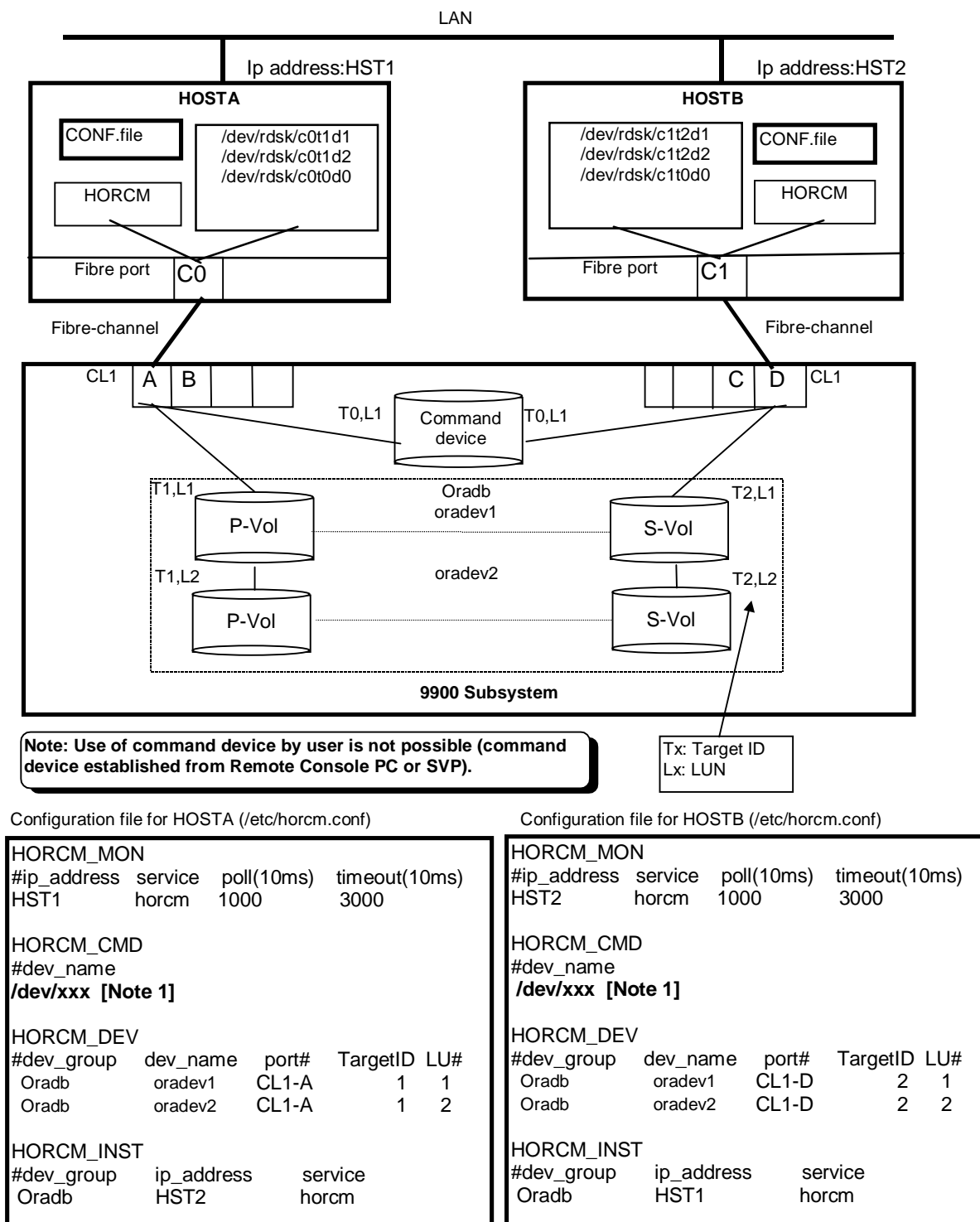


Figure 2.32 HORC Local Configuration Example

Example of CCI commands with HOSTA:

- Designate a group name (Oradb) and a local host P- VOL a case.
paircreate -g Oradb -f never -vl
This command creates pairs for all LUs assigned to group **Oradb** in the configuration definition file (two pairs for the configuration in Figure 2.32).

- Designate a volume name (oradev1) and a local host P-VOL a case.
paircreate -g Oradb -d oradev1 -f never -vl
This command creates pairs for all LUs designated as **oradev1** in the configuration definition file (CL1-A,T1,L1 and CL1-D,T2,L1 for the configuration in Figure 2.32).

- Designate a group name and display pair status.

pairdisplay -g Oradb

Group	PairVol(L/R)	(P,T#,L#)	Seq#	LDEV#..P/S	Status	Fence	Seq#	P-LDEV#	M
oradb	oradev1(L)	(CL1-A, 1,1)	30053	18..	P-VOL	COPY NEVER	,30053	19	-
oradb	oradev1(R)	(CL1-D, 2,1)	30053	19..	S-VOL	COPY NEVER	,-----	18	-
oradb	oradev2(L)	(CL1-A, 1,2)	30053	20..	P-VOL	COPY NEVER	,30053	21	-
oradb	oradev2(R)	(CL1-D, 2,2)	30053	21..	S-VOL	COPY NEVER	,-----	20	-

Example of CCI commands with HOSTB:

- Designate a group name and a remote host P-VOL a case.
paircreate -g Oradb -f never -vr
This command creates pairs for all LU designated as **Oradb** in the configuration definition file (two pairs for the configuration in Figure 2.32).

- Designate a volume name (oradev1) and a remote host P-VOL a case.
paircreate -g Oradb -d oradev1 -f never -vr
This command creates pairs for all LUs designated as **oradev1** in the configuration definition file (CL1-A,T1,L1 and CL1-D,T2,L1 for the configuration in Figure 2.32).

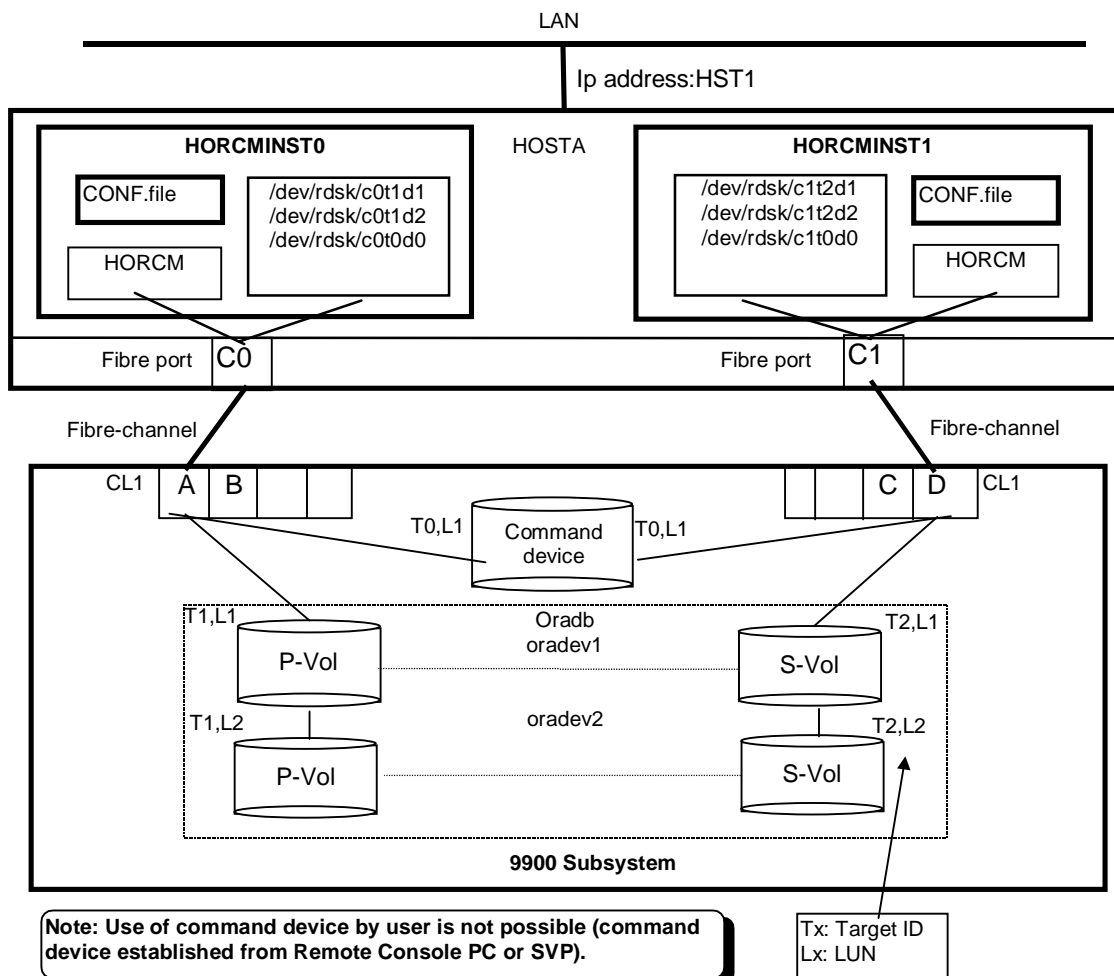
- Designate a group name and display pair status.

pairdisplay -g Oradb

Group	PairVol(L/R)	(P,T#,L#)	Seq#	LDEV#..P/S	Status	Fence	Seq#	P-LDEV#	M
oradb	oradev1(L)	(CL1-D, 2,1)	30053	19..	S-VOL	COPY NEVER	,-----	18	-
oradb	oradev1(R)	(CL1-A, 1,1)	30053	18..	P-VOL	COPY NEVER	,30053	19	-
oradb	oradev2(L)	(CL1-D, 2,2)	30053	21..	S-VOL	COPY NEVER	,-----	20	-
oradb	oradev2(R)	(CL1-A, 1,2)	30053	20..	P-VOL	COPY NEVER	,30053	21	-

The command device is defined using the system raw device name (character-type device file name). The command device defined in the configuration definition file must be established in a way to be following either every instance. If one command device is used between different instances on the same SCSI port, then the number of instances is up to 16 per command device. If this restriction is exceeded, then use a different SCSI path for each instance. For example, the command devices for Figure 2.33 would be:

- HP-UX[®]: HORCM_CMD for HORCMINST0 = /dev/rdisk/c0t0d1
HORCM_CMD for HORCMINST1 = /dev/rdisk/c1t0d1
- Solaris[®]: HORCM_CMD for HORCMINST0 = /dev/rdisk/c0t0d1s2
HORCM_CMD for HORCMINST1 = /dev/rdisk/c1t0d1s2
- AIX[®]: HORCM_CMD of HORCMINST0 = /dev/rhdiskXX
HORCM_CMD of HORCMINST1 = /dev/rhdiskXX
where XX = device number assigned by AIX[®]
- Tru64[®] UNIX[®]: HORCM_CMD of HORCMINST0 = /dev/rrzbXXc
HORCM_CMD of HORCMINST1 = /dev/rrzbXXc
where XX = device number assigned by Tru64[®] UNIX[®]
- DYNIX/ptx[®]: HORCM_CMD of HORCMINST0 = /dev/rdisk/sdXX
HORCM_CMD of HORCMINST1 = /dev/rdisk/sdXX
where XX = device number assigned by DYNIX/ptx[®]
- Windows[®] NT/2000: HORCM_CMD of HORCMINST0 = \\.\PhysicalDriveX
HORCM_CMD of HORCMINST1 = \\.\PhysicalDriveX
where X = device number assigned by Windows[®] NT/2000
- Linux[®]: HORCM_CMD of HORCMINST0 = /dev/sdX
HORCM_CMD of HORCMINST1 = /dev/sdX
where X = device number assigned by Linux[®]



Configuration file for HORCMINST0 (**horcm0.conf**)

```

HORCM_MON
#ip_address  service  poll(10ms)  timeout(10ms)
HST1        horcm0    1000        3000

HORCM_CMD
#dev_name
/dev/xxx [Note 1]

HORCM_DEV
#dev_group  dev_name  port#  TargetID  LU#
Oradb       oradev1   CL1-A    1         1
Oradb       oradev2   CL1-A    1         2

HORCM_INST
#dev_group  ip_address  service
Oradb       HST1        horcm1
  
```

Configuration file for HORCMINST1 (**horcm1.conf**)

```

HORCM_MON
#ip_address  service  poll(10ms)  timeout(10ms)
HST1        horcm1    1000        3000

HORCM_CMD
#dev_name
/dev/xxx [Note 1]

HORCM_DEV
#dev_group  dev_name  port#  TargetID  LU#
Oradb       oradev1   CL1-D    2         1
Oradb       oradev2   CL1-D    2         2

HORCM_INST
#dev_group  ip_address  service
Oradb       HST1        horcm0
  
```

Figure 2.33 HORC Configuration Example for Two Instances

Example of CCI commands with Instance-0 on HOSTA:

- When the command execution environment is not set, set an instance number.
For C shell: # **setenv HORCMINST 0**
For Windows®: **set HORCMINST=0**
- Designate a group name (Oradb) and a local instance P- VOL a case.
paircreate -g Oradb -f never -vl
This command creates pairs for all LUs assigned to group **Oradb** in the configuration definition file (two pairs for the configuration in Figure 2.33).
- Designate a volume name (oradev1) and a local instance P-VOL a case.
paircreate -g Oradb -d oradev1 -f never -vl
This command creates pairs for all LUs designated as **oradev1** in the configuration definition file (CL1-A,T1,L1 and CL1-D,T2,L1 for the configuration in Figure 2.33).
- Designate a group name and display pair status.
pairdisplay -g Oradb

Group	PairVol(L/R)	(P,T#,L#)	Seq#	LDEV#..P/S	Status	Fence	Seq#	P-LDEV#	M
oradb	oradev1(L)	(CL1-A, 1,1)	30053	18.. P-VOL	COPY	NEVER	,30053	19	-
oradb	oradev1(R)	(CL1-D, 2,1)	30053	19.. S-VOL	COPY	NEVER	,-----	18	-
oradb	oradev2(L)	(CL1-A, 1,2)	30053	20.. P-VOL	COPY	NEVER	,30053	21	-
oradb	oradev2(R)	(CL1-D, 2,2)	30053	21.. S-VOL	COPY	NEVER	,-----	20	-

Example of CCI commands with Instance-1 on HOSTA:

- When the command execution environment is not set, set an instance number.
For C shell: # **setenv HORCMINST 1**
For Windows®: **set HORCMINST=1**
- Designate a group name and a remote instance P-VOL a case.
paircreate -g Oradb -f never -vr
This command creates pairs for all LU designated as **Oradb** in the configuration definition file (two pairs for the configuration in Figure 2.33).
- Designate a volume name (oradev1) and a remote instance P-VOL a case.
paircreate -g Oradb -d oradev1 -f never -vr
This command creates pairs for all LUs designated as **oradev1** in the configuration definition file (CL1-A,T1,L1 and CL1-D,T2,L1 for the configuration in Figure 2.33).
- Designate a group name and display pair status.
pairdisplay -g Oradb

Group	PairVol(L/R)	(P,T#,L#)	Seq#	LDEV#..P/S	Status	Fence	Seq#	P-LDEV#	M
oradb	oradev1(L)	(CL1-D, 2,1)	30053	19.. S-VOL	COPY	NEVER	,-----	18	-
oradb	oradev1(R)	(CL1-A, 1,1)	30053	18.. P-VOL	COPY	NEVER	,30053	19	-
oradb	oradev2(L)	(CL1-D, 2,2)	30053	21.. S-VOL	COPY	NEVER	,-----	20	-
oradb	oradev2(R)	(CL1-A, 1,2)	30053	20.. P-VOL	COPY	NEVER	,30053	21	-

The command device is defined using the system raw device name (character-type device file name). For example, the command devices for Figure 2.34 would be:

- HP-UX®: HORCM_CMD of HOSTA = /dev/rdisk/c0t0d1
HORCM_CMD of HOSTB = /dev/rdisk/c1t0d1
HORCM_CMD of HOSTC = /dev/rdisk/c1t0d1
HORCM_CMD of HOSTD = /dev/rdisk/c1t0d1
- Solaris®: HORCM_CMD of HOSTA = /dev/rdisk/c0t0d1s2
HORCM_CMD of HOSTB = /dev/rdisk/c1t0d1s2
HORCM_CMD of HOSTC = /dev/rdisk/c1t0d1s2
HORCM_CMD of HOSTD = /dev/rdisk/c1t0d1s2
- AIX®: HORCM_CMD of HOSTA = /dev/rhdiskXX
HORCM_CMD of HOSTB = /dev/rhdiskXX
HORCM_CMD of HOSTC = /dev/rhdiskXX
HORCM_CMD of HOSTD = /dev/rhdiskXX
where XX = device number assigned by AIX®
- Tru64® UNIX®: HORCM_CMD of HOSTA = /dev/rrzbXXc
HORCM_CMD of HOSTB = /dev/rrzbXXc
HORCM_CMD of HOSTC = /dev/rrzbXXc
HORCM_CMD of HOSTD = /dev/rrzbXXc
where XX = device number assigned by Tru64® UNIX®
- DYNIX/ptx®: HORCM_CMD of HOSTA = /dev/rdisk/sdXX
HORCM_CMD of HOSTB = /dev/rdisk/sdXX
HORCM_CMD of HOSTC = /dev/rdisk/sdXX
HORCM_CMD of HOSTD = /dev/rdisk/sdXX
where XX = device number assigned by DYNIX/ptx®
- Windows® NT/2000: HORCM_CMD of HOSTA = \\.\PhysicalDriveX
HORCM_CMD of HOSTB = \\.\PhysicalDriveX
HORCM_CMD of HOSTC = \\.\PhysicalDriveX
HORCM_CMD of HOSTD = \\.\PhysicalDriveX
where X = device number assigned by Windows® NT/2000
- Linux®: HORCM_CMD of HOSTA = /dev/sdX
HORCM_CMD of HOSTB = /dev/sdX
HORCM_CMD of HOSTC = /dev/sdX
HORCM_CMD of HOSTD = /dev/sdX
where X = device number assigned by Linux®

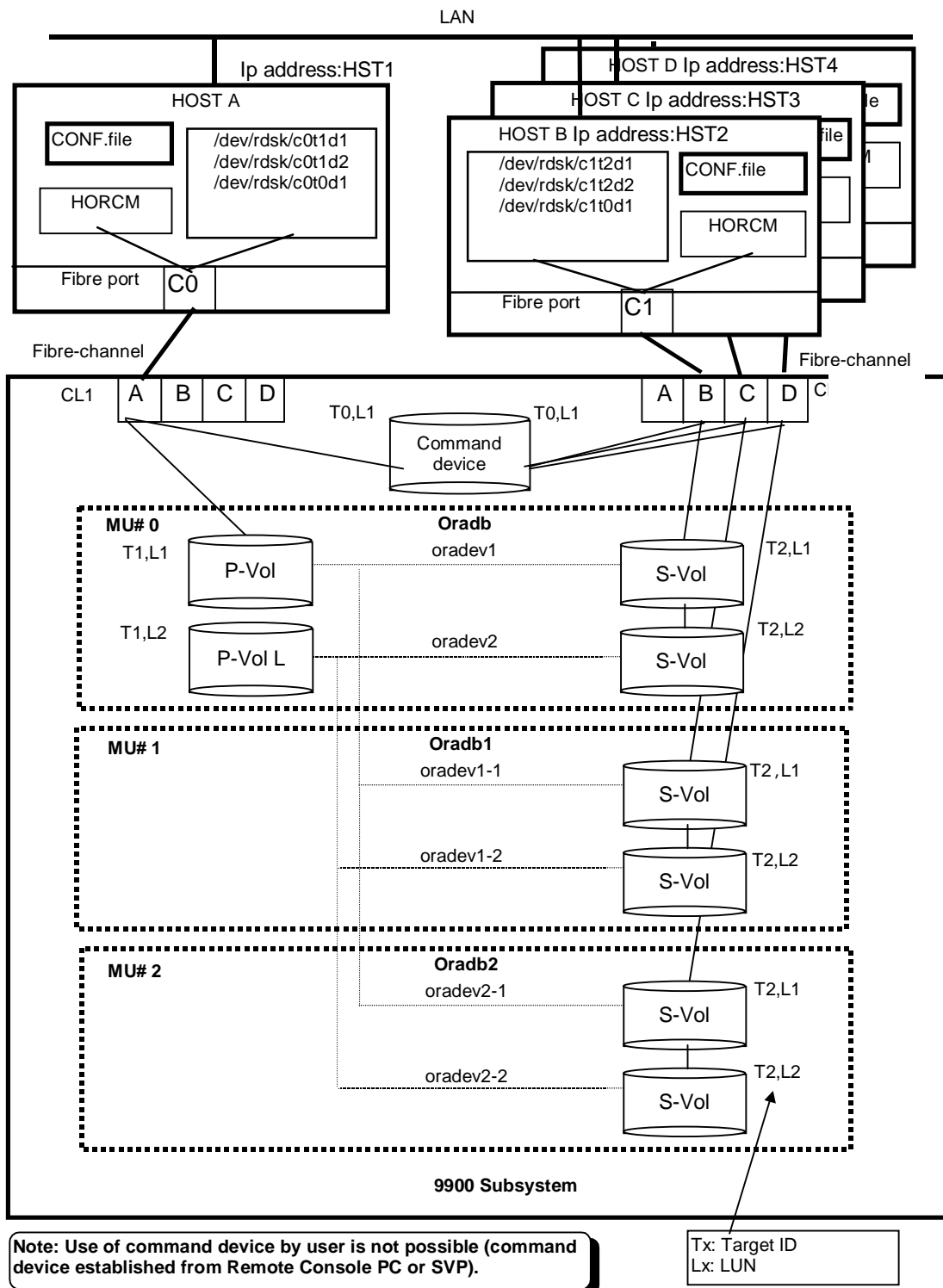


Figure 2.34 HOMRCF Configuration Example

Configuration file for HOSTA (/etc/horcm.conf)

```

HORCM_MON
#ip_address service poll(10ms) timeout(10ms)
HST1 horcm 1000 3000

HORCM_CMD
#dev_name
/dev/xxx [Note 1]

HORCM_DEV
#dev_group dev_name port# TargetID LU# MU#
Oradb oradev1 CL1-A 1 1 0
Oradb oradev2 CL1-A 1 2 0

Oradb1 oradev1-1 CL1-A 1 1 1
Oradb1 oradev1-2 CL1-A 1 2 1

Oradb2 oradev2-1 CL1-A 1 1 2
Oradb2 oradev2-2 CL1-A 1 2 2

HORCM_INST
#dev_group ip_address service
Oradb HST2 horcm
Oradb1 HST3 horcm
Oradb2 HST4 horcm

```

configuration file for HOSTB (/etc/horcm.conf)

```

HORCM_MON
#ip_address service poll(10ms) timeout(10ms)
HST2 horcm 1000 3000

HORCM_CMD
#dev_name
/dev/xxx [Note 1]

HORCM_DEV
#dev_group dev_name port# TargetID LU# MU#
Oradb oradev1 CL2-B 2 1
Oradb oradev2 CL2-B 2 2

HORCM_INST
#dev_group ip_address service
Oradb HST1 horcm

```

configuration file for HOSTC (/etc/horcm.conf)

```

HORCM_MON
#ip_address service poll(10ms) timeout(10ms)
HST3 horcm 1000 3000

HORCM_CMD
#dev_name
/dev/xxx [Note 1]

HORCM_DEV
#dev_group dev_name port# TargetID LU# MU#
Oradb1 oradev1-1 CL2-C 2 1
Oradb1 oradev1-2 CL2-C 2 2

HORCM_INST
#dev_group ip_address service
Oradb1 HST1 horcm

```

Configuration file for HOSTD (/etc/horcm.conf)

```

HORCM_MON
#ip_address service poll(10ms) timeout(10ms)
HST4 horcm 1000 3000

HORCM_CMD
#dev_name
/dev/xxx [Note 1]

HORCM_DEV
#dev_group dev_name port# TargetID LU# MU#
Oradb2 oradev2-1 CL2-D 2 1
Oradb2 oradev2-2 CL2-D 2 2

HORCM_INST
#dev_group ip_address service
Oradb2 HST1 horcm

```

Figure 2.34 HOMRCF Configuration Example (continued)

Example of CCI commands with HOSTA (group Oradb):

- When the command execution environment is not set, set HORCC_MRCF to the environment variable.
For C shell: # **setenv HORCC_MRCF 1**
Windows®: **set HORCC_MRCF=1**
- Designate a group name (Oradb) and a local host P-VOL a case.
paircreate -g Oradb -vl
This command creates pairs for all LUs assigned to group **Oradb** in the configuration definition file (two pairs for the configuration in Figure 2.34).
- Designate a volume name (oradev1) and a local host P-VOL a case.
paircreate -g Oradb -d oradev1 -vl
This command creates pairs for all LUs designated as **oradev1** in the configuration definition file (CL1-A,T1,L1 and CL1-D,T2,L1 for the configuration in Figure 2.34).
- Designate a group name and display pair status.
pairdisplay -g Oradb

Group	PairVol(L/R)	(Port#,TID,LU-M)	Seq#	LDEV#..P/S	Status	Seq#	P-LDEV#	M
oradb	oradev1(L)	(CL1-A, 1, 1 - 0)	30053	18..P-VOL COPY	30053	20	-	
oradb	oradev1(R)	(CL2-B, 2, 1 - 0)	30053	20..S-VOL COPY	----	18	-	
oradb	oradev2(L)	(CL1-A, 1, 2 - 0)	30053	19..P-VOL COPY	30053	21	-	
oradb	oradev2(R)	(CL2-B, 2, 2 - 0)	30053	21..S-VOL COPY	----	19	-	

Example of CCI commands with HOSTB (group Oradb)

- When the command execution environment is not set, set HORCC_MRCF to the environment variable.
For C shell: # **setenv HORCC_MRCF 1**
Windows®: **set HORCC_MRCF=1**
- Designate a group name and a remote host P-VOL a case.
paircreate -g Oradb -vr
This command creates pairs for all LUs assigned to group **Oradb** in the configuration definition file (two pairs for the configuration in Figure 2.34).
- Designate a volume name (oradev1) and a remote host P-VOL a case.
paircreate -g Oradb -d oradev1 -vr
This command creates pairs for all LUs designated as **oradev1** in the configuration definition file (CL1-A,T1,L1 and CL1-D,T2,L1 for the configuration in Figure 2.34).
- Designate a group name and display pair status.
pairdisplay -g Oradb

Group	PairVol(L/R)	(Port#,TID,LU-M)	Seq#	LDEV#..P/S	Status	Seq#	P-LDEV#	M
oradb	oradev1(L)	(CL2-B, 2, 1 - 0)	30053	20..S-VOL COPY	----	18	-	
oradb	oradev1(R)	(CL1-A, 1, 1 - 0)	30053	18..P-VOL COPY	30053	20	-	
oradb	oradev2(L)	(CL2-B, 2, 2 - 0)	30053	21..S-VOL COPY	----	19	-	
oradb	oradev2(R)	(CL1-A, 1, 2 - 0)	30053	19..P-VOL COPY	30053	21	-	

Example of CCI commands with HOSTA (group Oradb1):

- When the command execution environment is not set, set HORCC_MRCF to the environment variable.
For C shell: # **setenv HORCC_MRCF 1**
For Windows®: **set HORCC_MRCF=1**
- Designate a group name (Oradb1) and a local host P-VOL a case.
paircreate -g Oradb1 -vl
This command creates pairs for all LUs assigned to group **Oradb1** in the configuration definition file (two pairs for the configuration in Figure 2.34).
- Designate a volume name (oradev1-1) and a local host P-VOL a case.
paircreate -g Oradb1 -d oradev1-1 -vl
This command creates pairs for all LUs designated as **oradev1-1** in the configuration definition file (CL1-A,T1,L1 and CL1-D,T2,L1 for the configuration in Figure 2.34).
- Designate a group name, and display pair status.
pairdisplay -g Oradb1

Group	PairVol(L/R)	(Port#,TID,LU-M)	Seq#	LDEV#..P/S	Status	Seq#	P-LDEV#	M
oradb1	oradev1-1(L)	(CL1-A, 1, 1 - 1)	30053	18..P-VOL COPY	30053	22	-	
oradb1	oradev1-1(R)	(CL2-C, 2, 1 - 0)	30053	22..S-VOL COPY	----	18	-	
oradb1	oradev1-2(L)	(CL1-A, 1, 2 - 1)	30053	19..P-VOL COPY	30053	23	-	
oradb1	oradev1-2(R)	(CL2-C, 2, 2 - 0)	30053	23..S-VOL COPY	----	19	-	

Example of CCI commands with HOSTC (group Oradb1):

- When the command execution environment is not set, set HORCC_MRCF to the environment variable.
For C shell: # **setenv HORCC_MRCF 1**
For Windows®: **set HORCC_MRCF=1**
- Designate a group name and a remote host P-VOL a case.
paircreate -g Oradb1 -vr
This command creates pairs for all LUs assigned to group **Oradb1** in the configuration definition file (two pairs for the configuration in Figure 2.34).
- Designate a volume name (oradev1-1) and a remote host P-VOL a case.
paircreate -g Oradb1 -d oradev1-1 -vr
This command creates pairs for all LUs designated as **oradev1-1** in the configuration definition file (CL1-A,T1,L1 and CL1-D,T2,L1 for the configuration in Figure 2.34).
- Designate a group name and display pair status.
pairdisplay -g Oradb1

Group	PairVol(L/R)	(Port#,TID,LU-M)	Seq#	LDEV#..P/S	Status	Seq#	P-LDEV#	M
oradb1	oradev1-1(L)	(CL2-C, 2, 1 - 0)	30053	22..S-VOL COPY	----	18	-	
oradb1	oradev1-1(R)	(CL1-A, 1, 1 - 1)	30053	18..P-VOL COPY	30053	22	-	
oradb1	oradev1-2(L)	(CL2-C, 2, 2 - 0)	30053	23..S-VOL COPY	----	19	-	
oradb1	oradev1-2(R)	(CL1-A, 1, 2 - 1)	30053	19..P-VOL COPY	30053	23	-	

Example of CCI commands with HOSTA (group Oradb2):

- When the command execution environment is not set, set HORCC_MRCF to the environment variable.
For C shell: # **setenv HORCC_MRCF 1**
For Windows®: **set HORCC_MRCF=1**
- Designate a group name (Oradb2) and a local host P-VOL a case.
paircreate -g Oradb2 -vl
This command creates pairs for all LUs assigned to group **Oradb2** in the configuration definition file (two pairs for the configuration in Figure 2.34).
- Designate a volume name (oradev2-1) and a local host P-VOL a case.
paircreate -g Oradb2 -d oradev2-1 -vl
This command creates pairs for all LUs designated as **oradev2-1** in the configuration definition file (CL1-A,T1,L1 and CL1-D,T2,L1 for the configuration in Figure 2.34).
- Designate a group name and display pair status.
pairdisplay -g Oradb2

Group	PairVol(L/R)	(Port#,TID,LU-M)	Seq#	LDEV#..P/S	Status	Seq#	P-LDEV#	M
oradb2	oradev2-1(L)	(CL1-A, 1, 1 - 2)	30053	18..P-VOL COPY	30053	24	-	
oradb2	oradev2-1(R)	(CL2-D, 2, 1 - 0)	30053	24..S-VOL COPY	----	18	-	
oradb2	oradev2-2(L)	(CL1-A, 1, 2 - 2)	30053	19..P-VOL COPY	30053	25	-	
oradb2	oradev2-2(R)	(CL2-D, 2, 2 - 0)	30053	25..S-VOL COPY	----	19	-	

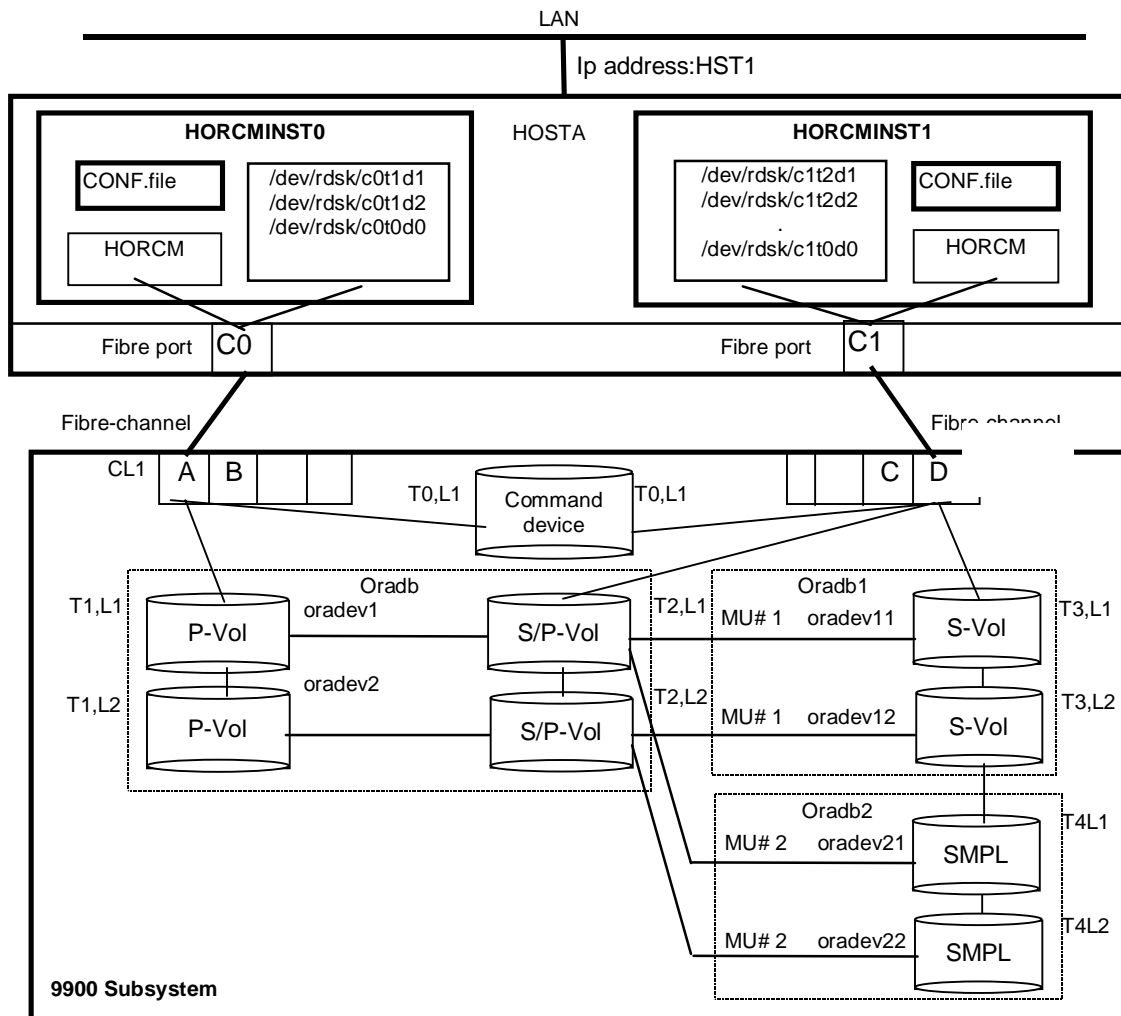
Example of CCI commands with HOSTD (group Oradb2):

- When the command execution environment is not set, set HORCC_MRCF to the environment variable.
For C shell: # **setenv HORCC_MRCF 1**
For Windows®: **set HORCC_MRCF=1**
- Designate a group name and a remote host P-VOL a case.
paircreate -g Oradb2 -vr
This command creates pairs for all LUs assigned to group **Oradb2** in the configuration definition file (two pairs for the configuration in Figure 2.34).
- Designate a volume name (oradev2-1) and a remote host P-VOL a case.
paircreate -g Oradb2 -d oradev2-1 -vr
This command creates pairs for all LUs designated as **oradev2-1** in the configuration definition file (CL1-A,T1,L1 and CL1-D,T2,L1 for the configuration in Figure 2.34).
- Designate a group name and display pair status.
pairdisplay -g Oradb2

Group	PairVol(L/R)	(Port#,TID,LU-M)	Seq#	LDEV#..P/S	Status	Seq#	P-LDEV#	M
oradb2	oradev2-1(L)	(CL2-D, 2, 1 - 0)	30053	24..S-VOL COPY	----	18	-	
oradb2	oradev2-1(R)	(CL1-A, 1, 1 - 2)	30053	18..P-VOL COPY	30053	24	-	
oradb2	oradev2-2(L)	(CL2-D, 2, 2 - 0)	30053	25..S-VOL COPY	----	19	-	
oradb2	oradev2-2(R)	(CL1-A, 1, 2 - 2)	30053	19..P-VOL COPY	30053	25	-	

The command device is defined using the system raw device name (character-type device file name). The command device defined in the configuration definition file must be established in a way to be following either every instance. If one command device is used between different instances on the same SCSI port, then the number of instances is up to 16 per command device. If this restriction is exceeded, then use a different SCSI path for each instance. For example, the command devices for Figure 2.35 would be:

- HP-UX[®]: HORCM_CMD for HORCMINST0 = /dev/rdisk/c0t0d1
HORCM_CMD for HORCMINST1 = /dev/rdisk/c1t0d1
- Solaris[®]: HORCM_CMD for HORCMINST0 = /dev/rdisk/c0t0d1s2
HORCM_CMD for HORCMINST1 = /dev/rdisk/c1t0d1s2
- AIX[®]: HORCM_CMD of HORCMINST0 = /dev/rhdiskXX
HORCM_CMD of HORCMINST1 = /dev/rhdiskXX
where XX = device number assigned by AIX[®]
- Tru64[®] UNIX[®]: HORCM_CMD of HORCMINST0 = /dev/rrzbXXc
HORCM_CMD of HORCMINST1 = /dev/rrzbXXc
where XX = device number assigned by Tru64[®] UNIX[®]
- DYNIX/ptx[®]: HORCM_CMD of HORCMINST0 = /dev/rdisk/sdXX
HORCM_CMD of HORCMINST1 = /dev/rdisk/sdXX
where XX = device number assigned by DYNIX/ptx[®]
- Windows[®] NT/2000: HORCM_CMD of HORCMINST0 = \\.\PhysicalDriveX
HORCM_CMD of HORCMINST1 = \\.\PhysicalDriveX
where X = device number assigned by Windows[®] NT/2000
- Linux[®]: HORCM_CMD of HORCMINST0 = /dev/sdX
HORCM_CMD of HORCMINST1 = /dev/sdX
where X = device number assigned by Linux[®]



Configuration file for HOSTA (/etc/horcm0.conf)

```
HORCM_MON
#ip_address service poll(10ms) timeout(10ms)
HST1 horcm0 1000 3000
```

```
HORCM_CMD
#dev_name
/dev/xxx [Note 1]
```

```
HORCM_DEV
#dev_group dev_name port# TargetID LU# MU#
Oradb oradev1 CL1-A 1 1 0
Oradb oradev2 CL1-A 1 2 0
Oradb1 oradev11 CL1-D 3 1 0
Oradb1 oradev12 CL1-D 3 2 0
Oradb2 oradev21 CL1-D 4 1 0
Oradb2 oradev22 CL1-D 4 2 0
```

```
HORCM_INST
#dev_group ip_address service
Oradb HST1 horcm1
Oradb1 HST1 horcm1
Oradb2 HST1 horcm1
```

Configuration file for HOSTB (/etc/horcm1.conf)

```
HORCM_MON
#ip_address service poll(10ms) timeout(10ms)
HST1 horcm1 1000 3000
```

```
HORCM_CMD
#dev_name
/dev/xxx [Note 1]
```

```
HORCM_DEV
#dev_group dev_name port# TargetID LU# MU#
Oradb oradev1 CL1-D 2 1 0
Oradb oradev2 CL1-D 2 2 0
Oradb1 oradev11 CL1-D 2 1 1
Oradb1 oradev12 CL1-D 2 2 1
Oradb2 oradev21 CL1-D 2 1 2
Oradb2 oradev22 CL1-D 2 2 2
```

```
HORCM_INST
#dev_group ip_address service
Oradb HST1 horcm0
Oradb1 HST1 horcm0
Oradb2 HST1 horcm0
```

Figure 2.35 HOMRCF Configuration Example with Cascade Pairs

Note: See section 2.7.1 for further information on HOMRCF cascade configurations.

Example of CCI commands with Instance-0 on HOSTA:

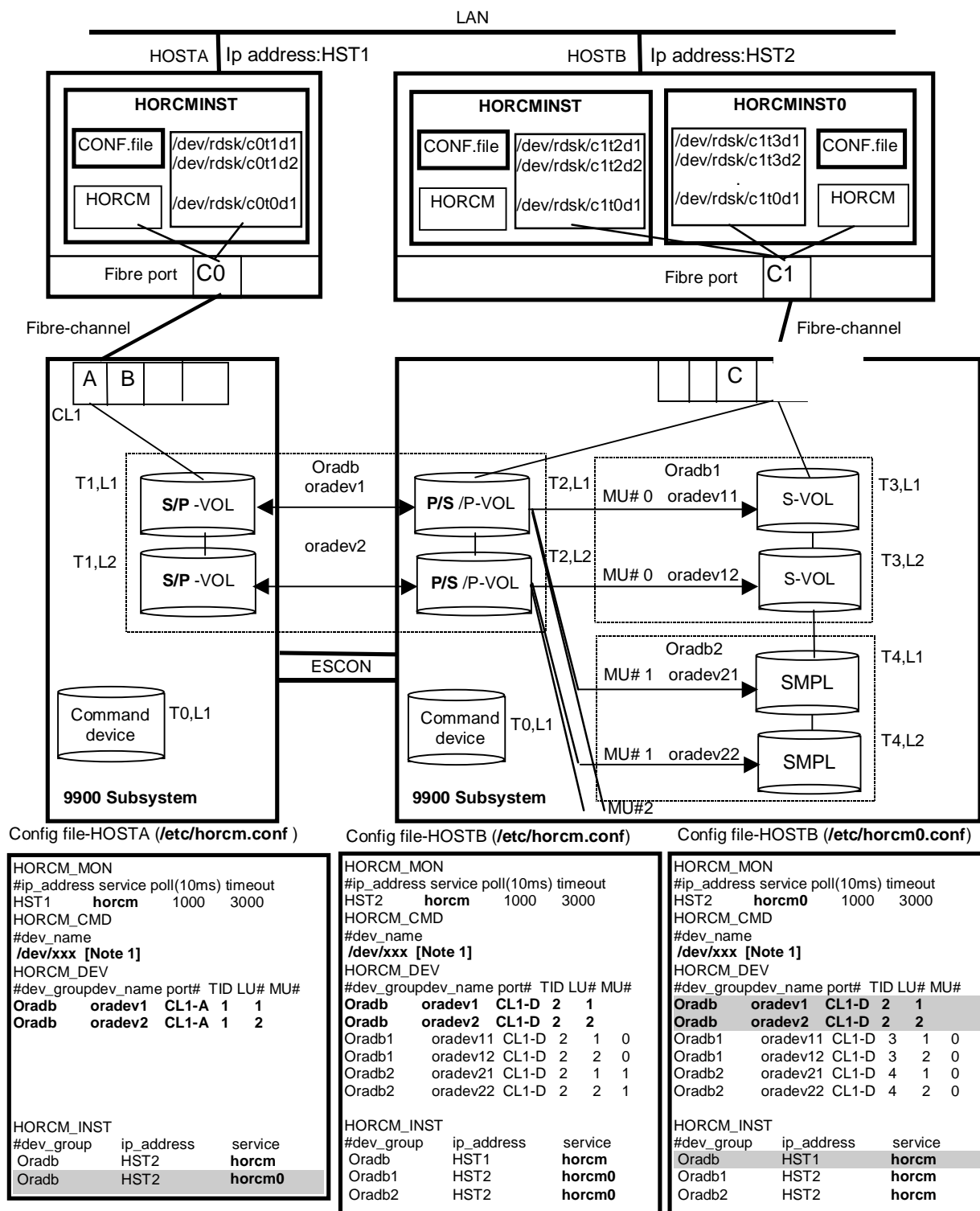
- When the command execution environment is not set, set an instance number.
For C shell: **# setenv HORCMINST 0**
 # setenv HORCC_MRCF 1
For Windows®: **set HORCMINST=0**
 set HORCC_MRCF=1
- Designate a group name (Oradb) and a local instance P- VOL a case.
paircreate -g Oradb -vl
paircreate -g Oradb1 -vr
These commands create pairs for all LUs assigned to groups **Oradb** and **Oradb1** in the configuration definition file (four pairs for the configuration in Figure 2.35).
- Designate a group name and display pair status.
pairedisplay -g oradb -m cas
Group PairVol(L/R) (Port#,TID,LU-M),Seq#,LDEV#.P/S,Status, Seq#,P-LDEV# M
oradb oradev1(L) (CL1-A , 1, 1-0) 30053 266.. P-VOL PAIR, 30053 268 -
oradb oradev1(R) (CL1-D , 2, 1-0) 30053 268.. S-VOL PAIR, ----- 266 -
oradb1 oradev11(R) (CL1-D , 2, 1-1) 30053 268.. P-VOL PAIR, 30053 270 -
oradb2 oradev21(R) (CL1-D , 2, 1-2) 30053 268.. SMPL ----,----- ---- -
oradb oradev2(L) (CL1-A , 1, 2-0) 30053 267.. P-VOL PAIR, 30053 269 -
oradb oradev2(R) (CL1-D , 2, 2-0) 30053 269.. S-VOL PAIR, ----- 267 -
oradb1 oradev12(R) (CL1-D , 2, 2-1) 30053 269.. P-VOL PAIR, 30053 271 -
oradb2 oradev22(R) (CL1-D , 2, 2-2) 30053 269.. SMPL ----,----- ---- -

Example of CCI commands with Instance-1 on HOSTA:

- When the command execution environment is not set, set an instance number.
For C shell: **# setenv HORCMINST 1**
 # setenv HORCC_MRCF 1
For Windows®: **set HORCMINST=1**
 set HORCC_MRCF=1
- Designate a group name and a remote instance P-VOL a case.
paircreate -g Oradb -vr
paircreate -g Oradb1 -vl
These commands create pairs for all LUs assigned to groups **Oradb** and **Oradb1** in the configuration definition file (four pairs for the configuration in Figure 2.35).
- Designate a group name and display pair status.
pairedisplay -g oradb -m cas
Group PairVol(L/R) (Port#,TID,LU-M),Seq#,LDEV#.P/S,Status, Seq#,P-LDEV# M
oradb oradev1(L) (CL1-D , 2, 1-0)30053 268..S-VOL PAIR,----- 266 -
oradb1 oradev11(L) (CL1-D , 2, 1-1)30053 268..P-VOL PAIR,30053 270 -
oradb2 oradev21(L) (CL1-D , 2, 1-2)30053 268..SMPL ----,----- ---- -
oradb oradev1(R) (CL1-A , 1, 1-0)30053 266..P-VOL PAIR,30053 268 -
oradb oradev2(L) (CL1-D , 2, 2-0)30053 269..S-VOL PAIR,----- 267 -
oradb1 oradev12(L) (CL1-D , 2, 2-1)30053 269..P-VOL PAIR,30053 271 -
oradb2 oradev22(L) (CL1-D , 2, 2-2)30053 269..SMPL ----,----- ---- -
oradb oradev2(R) (CL1-A , 1, 2-0)30053 267..P-VOL PAIR,30053 269 -

The command device is defined using the system raw device name (character-type device file name). The command device defined in the configuration definition file must be established in a way to be following either every instance. If one command device is used between different instances on the same SCSI port, then the number of instances is up to 16 per command device. If this restriction is exceeded, then use a different SCSI path for each instance. For example, the command devices for Figure 2.36 would be:

- HP-UX[®]: HORCM_CMD of HOSTA (/etc/horcm.conf) ... /dev/rdisk/c0t0d1
HORCM_CMD of HOSTB (/etc/horcm.conf) ... /dev/rdisk/c1t0d1
HORCM_CMD of HOSTB (/etc/horcm0.conf) ... /dev/rdisk/c1t0d1
- Solaris[®]: HORCM_CMD of HOSTA (/etc/horcm.conf) ... /dev/rdisk/c0t0d1s2
HORCM_CMD of HOSTB (/etc/horcm.conf) ... /dev/rdisk/c1t0d1s2
HORCM_CMD of HOSTB (/etc/horcm0.conf) ... /dev/rdisk/c1t0d1s2
- AIX[®]: HORCM_CMD of HOSTA (/etc/horcm.conf) ... /dev/rhdiskXX
HORCM_CMD of HOSTB (/etc/horcm.conf) ... /dev/rhdiskXX
HORCM_CMD of HOSTB (/etc/horcm0.conf) ... /dev/rhdiskXX
where XX = device number assigned by AIX[®]
- Tru64[®] UNIX[®]: HORCM_CMD of HOSTA (/etc/horcm.conf) ... /dev/rrzbXXc
HORCM_CMD of HOSTB (/etc/horcm.conf) ... /dev/rrzbXXc
HORCM_CMD of HOSTB (/etc/horcm0.conf) ... /dev/rrzbXXc
where XX = device number assigned by Tru64[®] UNIX[®]
- DYNIX/ptx[®]: HORCM_CMD of HOSTA (/etc/horcm.conf) ... /dev/rdisk/sdXX
HORCM_CMD of HOSTB (/etc/horcm.conf) ... /dev/rdisk/sdXX
HORCM_CMD of HOSTB (/etc/horcm0.conf) ... /dev/rdisk/sdXX
where XX = device number assigned by DYNIX/ptx[®]
- Windows[®] NT/2000: HORCM_CMD of HOSTA (/etc/horcm.conf) ... \\.\PhysicalDriveX
HORCM_CMD of HOSTB (/etc/horcm.conf) ... \\.\PhysicalDriveX
HORCM_CMD of HOSTB (/etc/horcm0.conf) ... \\.\PhysicalDriveX
where X = device number assigned by Windows[®] NT/2000
- Linux[®]: HORCM_CMD of HOSTA (/etc/horcm.conf) ... /dev/sdX
HORCM_CMD of HOSTB (/etc/horcm.conf) ... /dev/sdX
HORCM_CMD of HOSTB (/etc/horcm0.conf) ... /dev/sdX
where X = device number assigned by Linux[®]



Shaded portions: If HORCMINST0 needs to operate HORC's paired volume, then describe oradb.

Figure 2.36 HORC/HOMRCF Configuration Example with Cascade Pairs

Note: See section 2.7.1 for further information on HOMRCF cascade configurations.

Example of CCI commands with HOSTA and HOSTB:

- Designate a group name (Oradb) on HORC environment of HOSTA.
paircreate -g Oradb -vl
- Designate a group name (Oradb1) on HOMRCF environment of HOSTB. When the command execution environment is not set, set HORCC_MRCF.
For C shell: **# setenv HORCC_MRCF 1**
For Windows®: **set HORCC_MRCF=1**
paircreate -g Oradb1 -vl
These commands create pairs for all LUs assigned to groups **Oradb** and **Oradb1** in the configuration definition file (four pairs for the configuration in Figure 2.36).

- Designate a group name and display pair status on HOSTA.

pairedisplay -g oradb -m cas

```
Group PairVol(L/R) (Port#,TID,LU-M),Seq#,LDEV#.P/S,Status, Seq#,P-LDEV# M
oradb oradev1(L) (CL1-A , 1, 1-0)30052 266..SMPL ----,----- ---- -
oradb oradev1(L) (CL1-A , 1, 1) 30052 266..P-VOL COPY,30053 268 -
oradb1 oradev11(R) (CL1-D , 2, 1-0)30053 268..P-VOL COPY,30053 270 -
oradb2 oradev21(R) (CL1-D , 2, 1-1)30053 268..SMPL ----,----- ---- -
oradb oradev1(R) (CL1-D , 2, 1) 30053 268..S-VOL COPY,----- 266 -
oradb oradev2(L) (CL1-A , 1, 2-0)30052 267..SMPL ----,----- ---- -
oradb oradev2(L) (CL1-A , 1, 2) 30052 267..P-VOL COPY,30053 269 -
oradb1 oradev12(R) (CL1-D , 2, 2-0)30053 269..P-VOL COPY,30053 271 -
oradb2 oradev22(R) (CL1-D , 2, 2-1)30053 269..SMPL ----,----- ---- -
oradb oradev2(R) (CL1-D , 2, 2) 30053 269..S-VOL COPY,----- 267 -
```

Example of CCI commands with HOSTB:

- Designate a group name (oradb) on HORC environment of HOSTB.
paircreate -g Oradb -vr
- Designate a group name (Oradb1) on HOMRCF environment of HOSTB. When the command execution environment is not set, set HORCC_MRCF.
For C shell: **# setenv HORCC_MRCF 1**
For Windows®: **set HORCC_MRCF=1**
paircreate -g Oradb1 -vl
This command creates pairs for all LUs assigned to group **Oradb1** in the configuration definition file (four pairs for the configuration in Figure 2.36).

- Designate a group name and display pair status on HORC environment of HOSTB.

pairedisplay -g oradb -m cas

```
Group PairVol(L/R) (Port#,TID,LU-M),Seq#,LDEV#.P/S,Status, Seq#,P-LDEV# M
oradb1 oradev11(L) (CL1-D , 2, 1-0)30053 268..P-VOL PAIR,30053 270 -
oradb2 oradev21(L) (CL1-D , 2, 1-1)30053 268..SMPL ----,----- ---- -
oradb oradev1(L) (CL1-D , 2, 1) 30053 268..S-VOL PAIR,----- 266 -
oradb oradev1(R) (CL1-A , 1, 1-0)30052 266..SMPL ----,----- ---- -
oradb oradev1(R) (CL1-A , 1, 1) 30052 266..P-VOL PAIR,30053 268 -
oradb1 oradev12(L) (CL1-D , 2, 2-0)30053 269..P-VOL PAIR,30053 271 -
oradb2 oradev22(L) (CL1-D , 2, 2-1)30053 269..SMPL ----,----- ---- -
oradb oradev2(L) (CL1-D , 2, 2) 30053 269..S-VOL PAIR,----- 267 -
oradb oradev2(R) (CL1-A , 1, 2-0)30052 267..SMPL ----,----- ---- -
oradb oradev2(R) (CL1-A , 1, 2) 30052 267..P-VOL PAIR,30053 269 -
```

- Designate a group name and display pair status on HOMRCF environment of HOSTB.

pairedisplay -g oradb1 -m cas

```
Group PairVol(L/R) (Port#,TID,LU-M),Seq#,LDEV#.P/S,Status, Seq#,P-LDEV# M
oradb1 oradev11(L) (CL1-D , 2, 1-0)30053 268..P-VOL PAIR,30053 270 -
oradb2 oradev21(L) (CL1-D , 2, 1-1)30053 268..SMPL ----,----- ---- -
oradb oradev1(L) (CL1-D , 2, 1) 30053 268..S-VOL PAIR,----- 266 -
oradb1 oradev11(R) (CL1-D , 3, 1-0)30053 270..S-VOL PAIR,----- 268 -
oradb1 oradev12(L) (CL1-D , 2, 2-0)30053 269..P-VOL PAIR,30053 271 -
oradb2 oradev22(L) (CL1-D , 2, 2-1)30053 269..SMPL ----,----- ---- -
oradb oradev2(L) (CL1-D , 2, 2) 30053 269..S-VOL PAIR,----- 267 -
oradb1 oradev12(R) (CL1-D , 3, 2-0)30053 271..S-VOL PAIR,----- 269 -
```

- Designate a group name and display pair status on HOMRCF environment of HOSTB (HORCMINST0).

pairedisplay -g oradb1 -m cas

```
Group PairVol(L/R) (Port#,TID,LU-M),Seq#,LDEV#.P/S,Status, Seq#,P-LDEV# M
oradb1 oradev11(L) (CL1-D , 3, 1-0)30053 270..S-VOL PAIR,----- 268 -
oradb1 oradev11(R) (CL1-D , 2, 1-0)30053 268..P-VOL PAIR,30053 270 -
oradb2 oradev21(R) (CL1-D , 2, 1-1)30053 268..SMPL ----,----- ---- -
oradb oradev1(R) (CL1-D , 2, 1) 30053 268..S-VOL PAIR,----- 266 -
oradb1 oradev12(L) (CL1-D , 3, 2-0)30053 271..S-VOL PAIR,----- 269 -
oradb1 oradev12(R) (CL1-D , 2, 2-0)30053 269..P-VOL PAIR,30053 271 -
oradb2 oradev22(R) (CL1-D , 2, 2-1)30053 269..SMPL ----,----- ---- -
oradb oradev2(R) (CL1-D , 2, 2) 30053 269..S-VOL PAIR,----- 267 -
```

2.7.1 Configuration Definition for Cascade Volume Pairs

The CCI software (HORCM) manages each group to against four mirror descriptors of LDEV. CCI can be assigned four groups to into entity of LU that describes four mirror descriptors for a configuration definition file by this management.

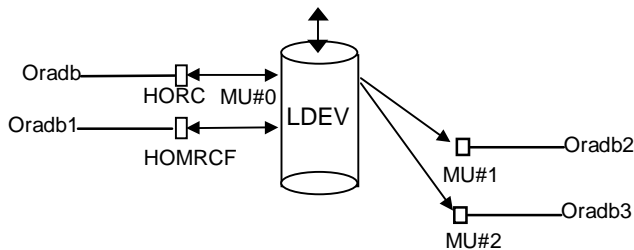


Figure 2.37 Mirror Descriptors and Group Assignment

Correspondence of the configuration file and mirror descriptors. The group name and MU# which described in HORCM_DEV of a configuration definition file is assigned to each corresponding mirror descriptors with table 7.4.1. MU # 0 are specially. "Omission of MU#" is handled as MU#0, and the specified group is registered to MU#0 on HOMRCF and HORC. The sequence that describes in HORCM_DEV is possible with irregular order (random).

Table 2.8 Mirror Descriptors and Group Assignment

HORCM_DEV Parameter in Configuration File	MU#0		HOMRCF Only	
	HORC	HOMRCF	MU#1	MU#2
HORCM_DEV #dev_group dev_name port# TargetID LU# MU# Oradb oradev1 CL1-D 2 1	oradb oradev1	oradb oradev1		
HORCM_DEV #dev_group dev_name port# TargetID LU# MU# Oradb oradev1 CL1-D 2 1 Oradb1 oradev11 CL1-D 2 1 1 Oradb2 oradev21 CL1-D 2 1 2	oradb oradev1	oradb oradev1	oradb1 oradev11	oradb2 oradev21
HORCM_DEV #dev_group dev_name port# TargetID LU# MU# Oradb oradev1 CL1-D 2 1 Oradb1 oradev11 CL1-D 2 1 0 Oradb2 oradev21 CL1-D 2 1 1 Oradb3 oradev31 CL1-D 2 1 2	oradb oradev1	oradb1 oradev11	oradb2 oradev21	oradb3 oradev31
HORCM_DEV #dev_group dev_name port# TargetID LU# MU# Oradb oradev1 CL1-D 2 1 0		oradb oradev1		
HORCM_DEV #dev_group dev_name port# TargetID LU# MU# Oradb oradev1 CL1-D 2 1 0 Oradb1 oradev11 CL1-D 2 1 1 Oradb2 oradev21 CL1-D 2 1 2		oradb oradev1	oradb1 oradev11	oradb2 oradev21

Cascade function and configuration files. A volume of the cascading connection describes entity in a configuration definition file on the same instance, and classifies connection of volume through the mirror descriptor. In case of HORC/HOMRCF cascading connection, too, the volume entity describes to a configuration definition file on the same instance. Figure 2.38 shows an example of this.

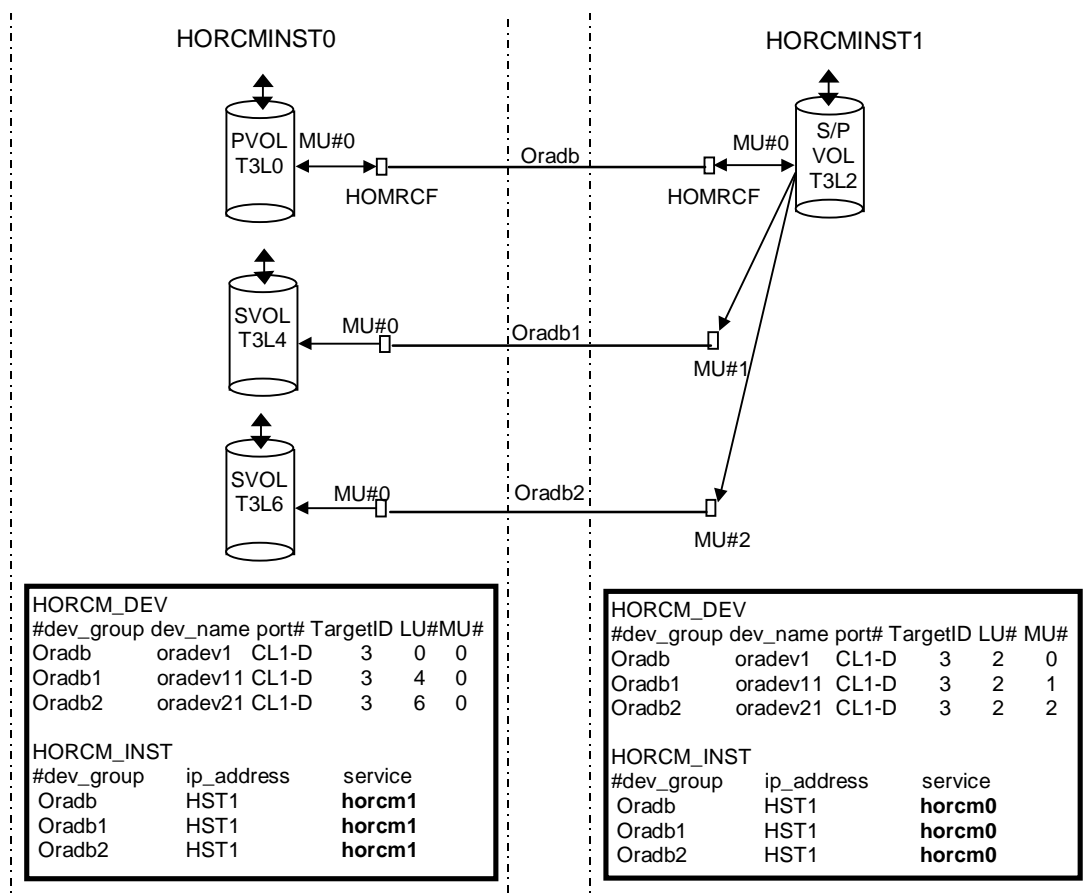
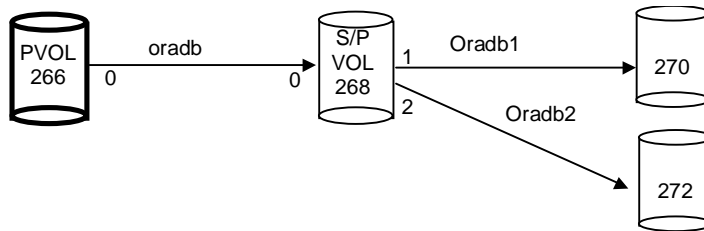


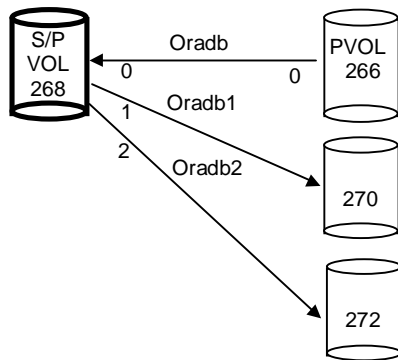
Figure 2.38 HOMRCF Cascade Connection and Configuration File

HOMRCF. HOMRCF is a mirror configuration within one 9900 subsystem. Therefore, HOMRCF can be described a volume of the cascading connection according to two configuration definition files. In case of cascading connection of HOMRCF only, the specified group is assigned to the mirror descriptor (MU#) of HOMRCF that describes definitely “0” as MU# for HOMRCF. Figures 2.39-2.42 show HOMRCF cascade configurations and the paired display information for each configuration.



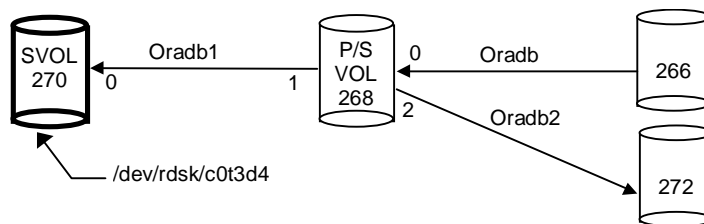
```
# pairdisplay -g oradb -m cas
Group PairVol(L/R) (Port#,TID,LU-M),Seq#,LDEV#.P/S,Status, Seq#,P-LDEV# M
oradb oradev1(L) (CL1-D , 3, 0-0)30053 266..P-VOL PAIR,30053 268 -
oradb oradev1(R) (CL1-D , 3, 2-0)30053 268..S-VOL PAIR,----- 266 -
oradb1 oradev11(R) (CL1-D , 3, 2-1)30053 268..P-VOL PAIR,30053 270 -
oradb2 oradev21(R) (CL1-D , 3, 2-2)30053 268..P-VOL PAIR,30053 272 -
```

Figure 2.39 Pairdisplay on HORCMINST0



```
# pairdisplay -g oradb -m cas
Group PairVol(L/R) (Port#,TID,LU-M),Seq#,LDEV#.P/S,Status, Seq#,P-LDEV# M
oradb oradev1(L) (CL1-D , 3, 2-0)30053 268..S-VOL PAIR,----- 266 -
oradb1 oradev11(L) (CL1-D , 3, 2-1)30053 268..P-VOL PAIR,30053 270 -
oradb2 oradev21(L) (CL1-D , 3, 2-2)30053 268..P-VOL PAIR,30053 272 -
oradb oradev1(R) (CL1-D , 3, 0-0)30053 266..P-VOL PAIR,30053 268 -
```

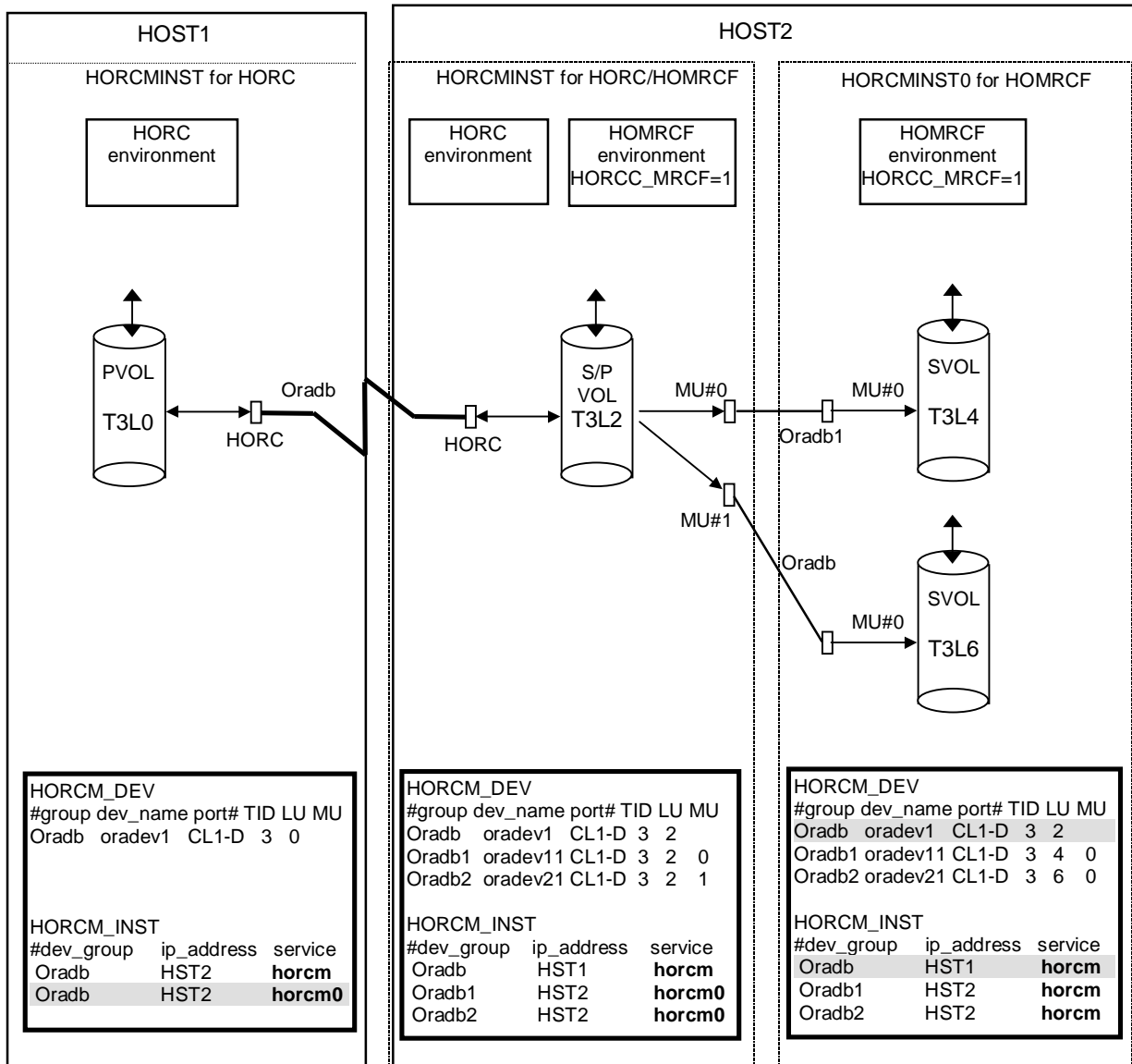
Figure 2.40 Pairdisplay on HORCMINST1



```
# pairdisplay -d /dev/rdisk/c0t3d4 -m cas
Group PairVol(L/R) (Port#,TID,LU-M),Seq#,LDEV#.P/S,Status, Seq#,P-LDEV# M
oradb1 oradev11(L) (CL1-D , 3, 4-0)30053 270..S-VOL PAIR,----- 268 -
oradb1 oradev11(R) (CL1-D , 3, 2-1)30053 268..P-VOL PAIR,30053 270 -
oradb oradev1(R) (CL1-D , 3, 2-0)30053 268..S-VOL PAIR,----- 266 -
oradb2 oradev21(R) (CL1-D , 3, 2-2)30053 268..P-VOL PAIR,30053 272 -
```

Figure 2.41 Pairdisplay on HORCMINST0

Cascading of HORC and HOMRCF. The cascading connection of HORC/HOMRCF can be described by using three configuration definition files that describe the cascading volume entity in a configuration definition file on the same instance. The mirror descriptor of HOMRCF describes definitely “0” as MU# for classify mirror descriptors of HOMRCF and HORC, and the mirror descriptor of HORC does not describe “0” as MU#.



Note: Shaded portions: For that purpose, if HORCMINST0 needs to operate HORC's paired volume, then describes "oradb".

Figure 2.42 HORC/HOMRCF Cascade Connection and Configuration File

Figures 2.43-2.46 show HORC/HOMRCF cascade configurations and the pairedisplay information for each configuration.

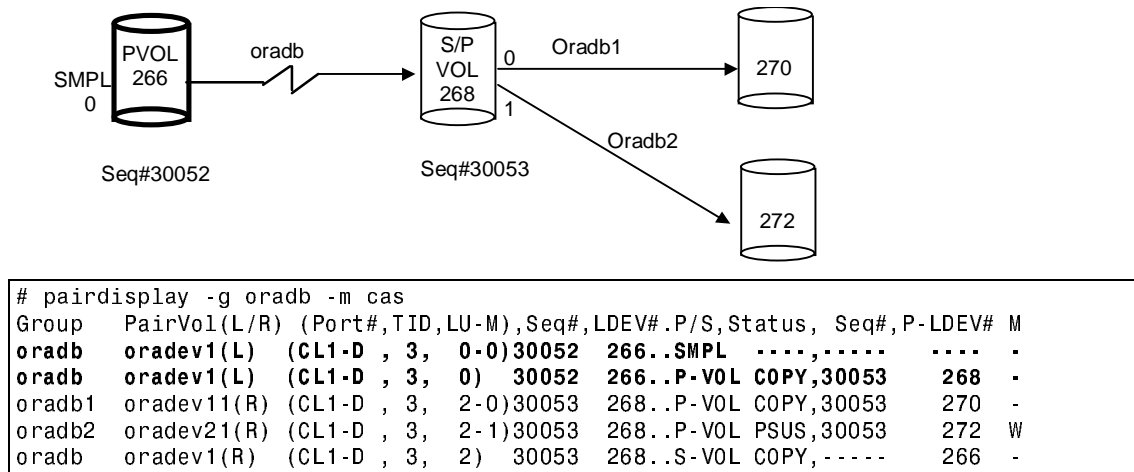


Figure 2.43 Pairedisplay for HORC on HOST1

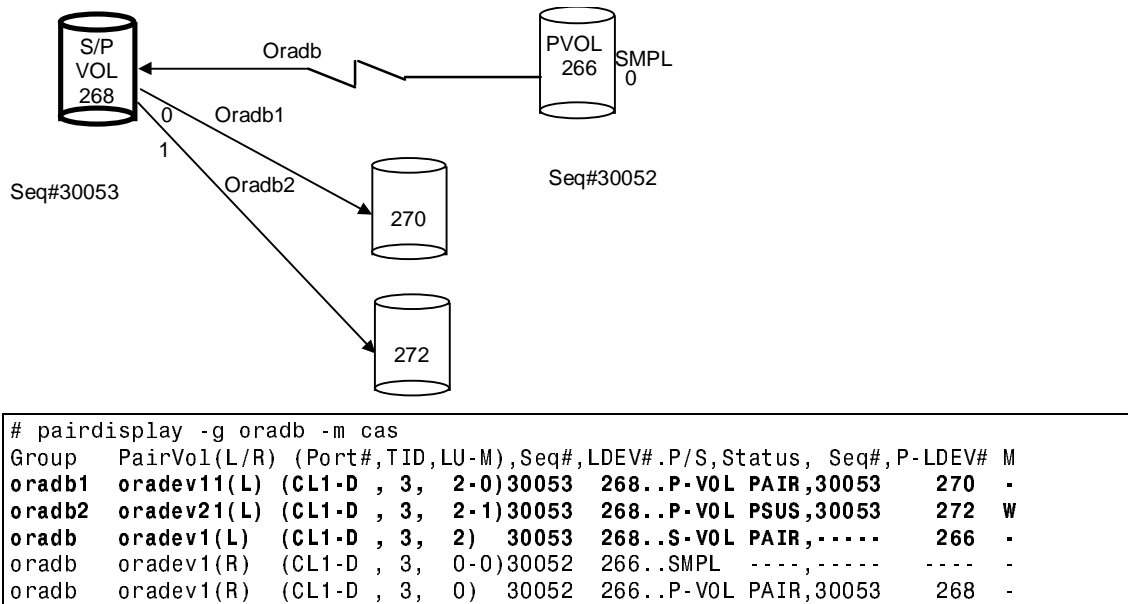
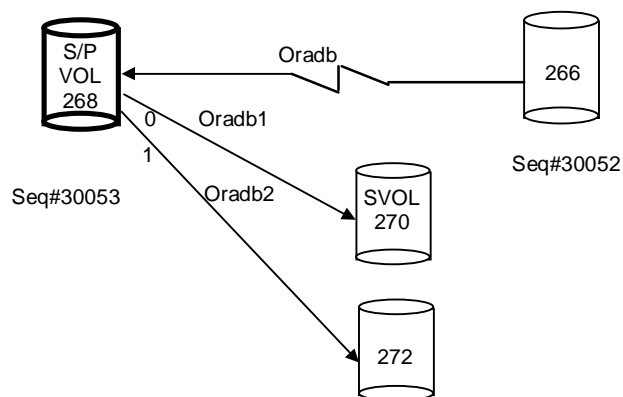
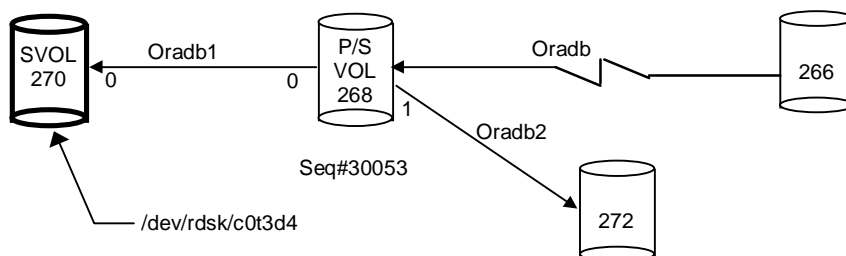


Figure 2.44 Pairedisplay for HORC on HOST2 (HORCMINST)



```
# pairdisplay -g oradb1 -m cas
Group PairVol(L/R) (Port#,TID,LU-M),Seq#,LDEV#.P/S,Status, Seq#,P-LDEV# M
oradb1 oradev11(L) (CL1-D , 3, 2-0)30053 268..P-VOL PAIR,30053 270 -
oradb2 oradev21(L) (CL1-D , 3, 2-1)30053 268..P-VOL PSUS,30053 272 W
oradb oradev1(L) (CL1-D , 3, 2) 30053 268..S-VOL PAIR,----- 266 -
oradb1 oradev11(R) (CL1-D , 3, 4-0)30053 270..S-VOL PAIR,----- 268 -
```

Figure 2.45 Pairdisplay for HOMRCF on HOST2 (HORCMINST)



```
# pairdisplay -g oradb1 -m cas
Group PairVol(L/R) (Port#,TID,LU-M),Seq#,LDEV#.P/S,Status, Seq#,P-LDEV# M
oradb1 oradev11(L) (CL1-D , 3, 4-0)30053 270..S-VOL PAIR,----- 268 -
oradb1 oradev11(R) (CL1-D , 3, 2-0)30053 268..P-VOL PAIR,30053 270 -
oradb2 oradev21(R) (CL1-D , 3, 2-1)30053 268..P-VOL PSUS,30053 272 W
oradb oradev1(R) (CL1-D , 3, 2) 30053 268..S-VOL PAIR,----- 266 -

# pairdisplay -d /dev/rdsk/c0t3d4 -m cas
Group PairVol(L/R) (Port#,TID,LU-M),Seq#,LDEV#.P/S,Status, Seq#,P-LDEV# M
oradb1 oradev11(L) (CL1-D , 3, 4-0)30053 270..S-VOL PAIR,----- 268 -
oradb1 oradev11(R) (CL1-D , 3, 2-0)30053 268..P-VOL PAIR,30053 270 -
oradb2 oradev21(R) (CL1-D , 3, 2-1)30053 268..P-VOL PSUS,30053 272 W
oradb oradev1(R) (CL1-D , 3, 2) 30053 268..S-VOL PAIR,----- 266 -
```

Figure 2.46 Pairdisplay for HOMRCF on HOST2 (HORCMINST0)

2.8 Error Monitoring and Configuration Confirmation

HORC supports error monitoring and configuration confirmation commands for linkage with the system operation management of the UNIX[®]/PC server.

2.8.1 Paired Volume Error Monitoring

The HORC Manager (HORCM) monitors all volumes defined in the configuration definition file at a certain interval regardless of the HORC/HOMRCF commands.

- **Objects and scope of monitoring:** The HORCM operates as a daemon process on the host server and monitors all the paired volumes defined in the configuration definition file, not the volume groups. The HORC Manager's monitoring applies to the primary volumes only (since the primary volumes control the status). The HORC Manager monitors the changes in the pair status of these volumes. Only when the PAIR status changes to the PSUS status and that change is caused by an error (such as PVol error or SVol SUS), the HORC Manager regards the change as an error.
- **Monitoring time and interval:** This command always issues I/O instructions to the 9900 in order to obtain information for the monitoring. It is possible to specify the monitoring interval in the configuration definition file in order to adjust the daemon load.
- **Error notification by HORCM:** If the mirroring status is suspended in the normal HORC operation, an error message is displayed on the SVP console. However, no error message may be displayed, depending on the system operation form. Since the operation management of the UNIX[®] server checks Syslog to find system errors in many cases, HORC error messages are output to Syslog for linkage with the system operation management.
- **Error notification command:** The HORC supports the error notification function using commands in order to allow the UNIX[®] server client to monitor errors. This command is connected to the HORCM (daemon) to obtain the transition of the pairing status and report it. When an error is detected, this command outputs an error message. This command waits until an error occurs or reports that "No" error occurs if it finds no errors in pairing status transition queue of the HORCM's pairing monitor. These operations can be specified using the options. If the command finds the status transition data in the status transition queue, it displays the data of all volumes. Data in the HORCM's status transition queue can be erased by specifying the option of this command.

2.8.2 Pair Status Display and Configuration Confirmation

The HORC pairing function (configuration definition file) combines the physical volumes in the 9900 used independently by the servers. Therefore, you should make sure that the servers' volumes are combined as intended by the server system administrator.

The pairdisplay command displays the pairing status to enable you to verify the completion of pair creation or pair resynchronization (see Figure 2.47). This command is also used to confirm the configuration of the paired volume connection path (physical link of paired volumes among the servers). For further information on the pairdisplay command, see section 4.8.

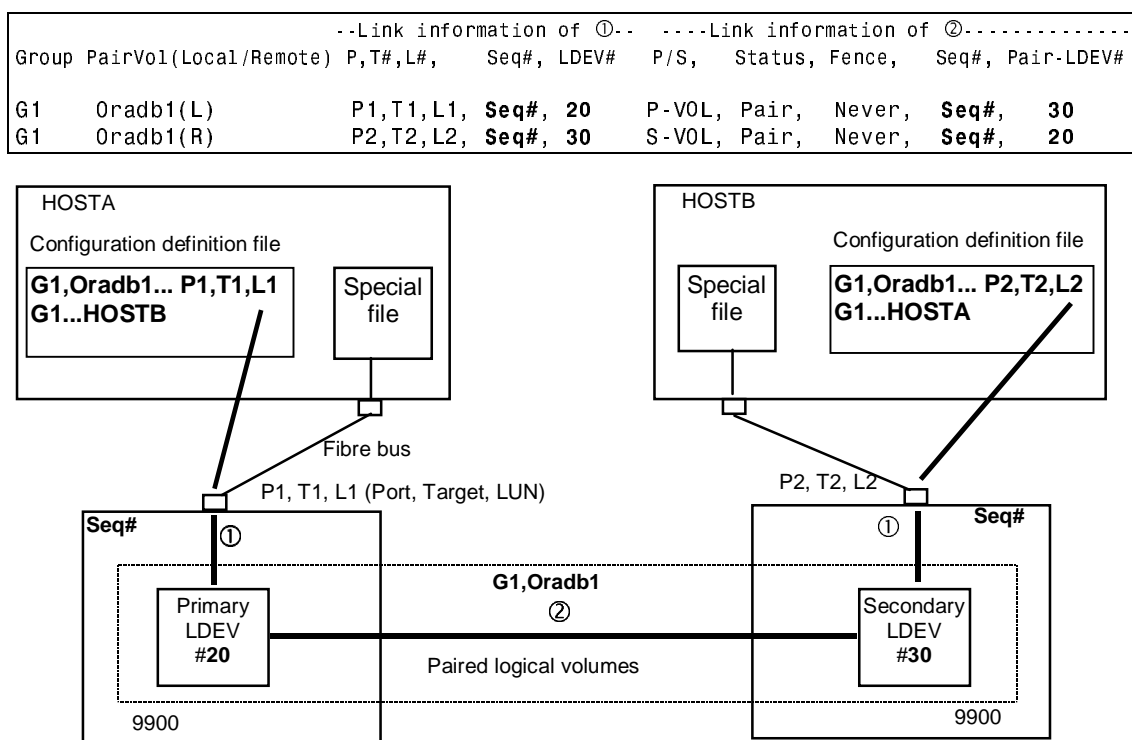


Figure 2.47 Example of Pair Configuration Confirmation (Pairdisplay)

The raidscan command displays the SCSI port, target ID, LDEVs mapped to LUNs, and status of those LDEVs, regardless of the configuration definition file (see Figure 2.48). When a port number is specified, this command displays information about all target IDs and LUNs of that port. For further information on the raidscan command, see section 4.11.1.

Port#,	TargetID#,	Lun#	Number of LDEVs,LDEV#,	P/S,	Status,	Fence,	LDEV#	Seq#,	Pair-LDEV#
CL1-A	3	1	3(3,5,6)	P-VOL,	Pair,	Never,	3	Seq#,	30

Figure 2.48 Example of Raidscan Command

2.9 Recovery Procedures for HA Configurations

After configuring and starting HORC operations, the system administrator should conduct operational tests for possible failures in the system. In normal operation, service personnel obtain information for identifying the failure cause on the SVP. However, a motive for the action above should be given by the HORC operation command. Figure 2.49 shows the system failover and recovery procedure. Figure 2.50 shows the regression and HORC recovery procedure.

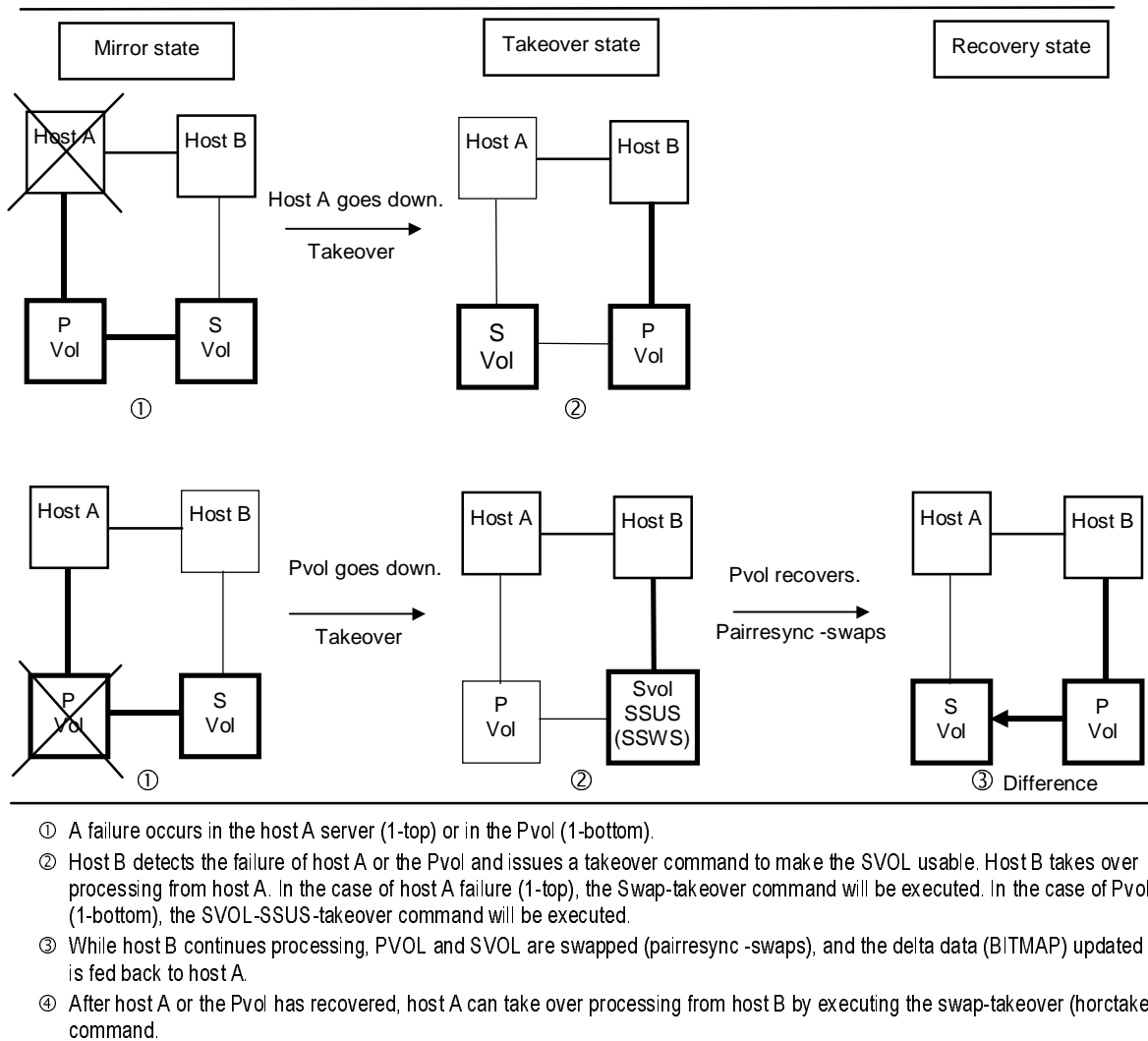
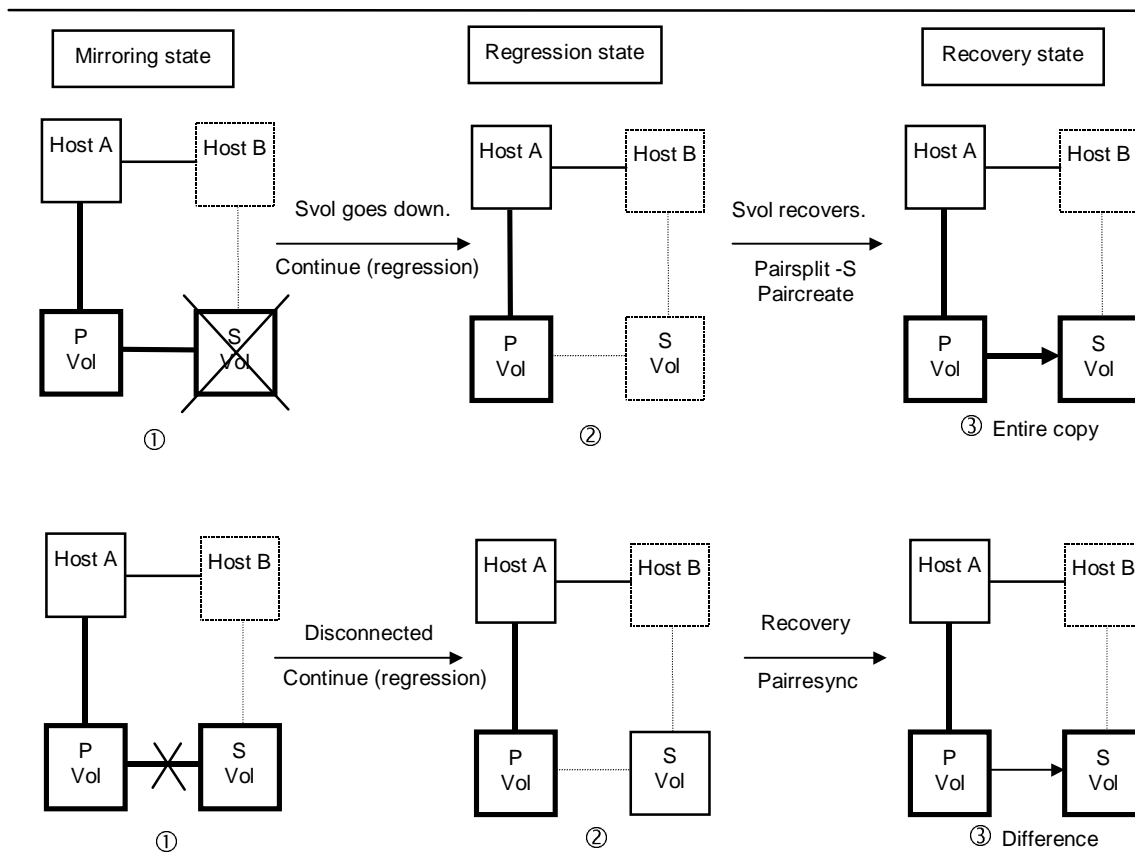


Figure 2.49 System Failover and Recovery



- ① The PVOL detects a failure in the SVOL and causes suspension of the duplicated writing. (The fence level determines whether host A continues processing or host B takes over the processing from host A.)
- ② The PVOL changes the paired volume status to PSUE and keeps track of the difference data. The HORCM detects the status change and outputs a message to syslog. If the client of host A has initiated the monitoring command, the message concerned is displayed on the screen of the client.
- ③ The SVOL recovers from the failure. The host A issues the pairsplit -S, paircreate -v, or pairresync command to update the PVOL data by copying entire data or copying differential data only. The updated data is fed back to the SVOL.

Figure 2.50 Degeneracy and Recovery in Case of System Error

Chapter 3 Preparing for CCI Operations

3.1 System Requirements

CCI operations involve the CCI software on the UNIX[®]/PC server host and the 9900 subsystem(s) containing the command device(s) and the HORC and/or HOMRCF primary and secondary volumes. The system requirements for CCI are:

- **CCI software product.** The CCI software is supplied on CD-ROM or floppy diskette. The CCI software files take up 2.5 MB of space. The log files can take up to 3 MB of space.
- **Host platform.** CCI is supported on several UNIX[®]-based and PC server platforms, including Solaris[®], HP-UX[®], AIX[®], Linux[®], DYNIX/ptx[®], Windows[®] 2000, and Windows NT[®] systems. HORC Async platform support may vary, and 9900/7700E platform support may vary. Please contact your Hitachi Data Systems account team for the latest information on 9900 (and 7700E) platform support for CCI.
 - Root/administrator access to the host is required to perform CCI operations.
 - Static memory capacity: minimum = 300 kB, maximum = 500 kB
Dynamic memory capacity (set in HORCM_CONF): maximum = 500 kB per unit ID.
 - The system which runs and operates HORC in an HA configuration must be a duplex system having a hot standby configuration or mutual hot standby (mutual takeover) configuration. The remote copy system must be designed for remote backup among servers and must be configured so that servers cannot share the primary and secondary volumes at the same time. The information in this document does not apply to fault-tolerant system configurations such as Oracle Parallel Server (OPS) in which nodes execute parallel accesses. However, two or more nodes can share the primary volumes of the shared OPS database, and must use the secondary volumes as backup volumes.
 - Host servers which are combined when paired logical volumes are defined should run on the operating system of the same architecture. If not, one host may not be able to recognize a paired volume of another host, even though HORCM can run properly.
- **9900 (and 7700E) subsystem(s).** The 9900 and 7700E subsystems support CCI operations. HORC Synchronous and Asynchronous is supported between the 9900 and 7700E subsystems. Please contact your Hitachi Data Systems representative for further information on 9900/7700E subsystem configurations.
 - The 9900 (7700E) command device must be defined and accessed as a raw device (no file system, no mount operation).
 - For HORC (sync and async):
HORC must be installed and enabled on the 9900/7700E subsystems.
Bi-directional swap must be enabled between the primary and secondary volumes.
The port modes (LCP/RCP) and MCU-RCU paths must be defined.
 - HOMRCF must be installed and enabled on the 9900 subsystem(s).
- **Remote Console PC, LUN Manager and HORC remote console software.** The LUN Manager remote console software is used to define the LUs and the CCI command device. The HORC remote console software is used to set the port modes (LCP/RCP) and add the MCU-RCU paths. If remote LUN Manager and/or HORC is not installed, ask your Hitachi Data Systems representative about LUN Manager and/or HORC configuration services.

3.2 Hardware Installation

Installation of the hardware required for CCI is performed by the user and the Hitachi Data Systems representative. To install the hardware required for CCI operations:

1. **User:**
 - a) Identify the HORC and/or HOMRCF primary and secondary volumes, so that the CCI hardware and software components can be installed and configured properly.
 - b) Make sure that the UNIX[®]/PC server hardware and software are properly installed and configured (see section 3.1 for configuration requirements for HORC).
2. **Hitachi Data Systems representative:**
 - a) Connect the 9900 subsystem(s) to the UNIX[®]/PC server host(s). Please refer to the 9900 Maintenance Manual and the 9900 configuration guide for the platform (e.g., *9900 Windows NT[®] Configuration Guide*, *9900 IBM[®] AIX[®] Configuration Guide*).
 - b) Install and enable the HORC and HOMRCF features on the 9900 subsystem(s).
 - c) Configure the 9900 subsystems which will contain the HORC and/or HOMRCF primary volumes to report sense information to the host(s).
 - d) Set the SVP clock to local time so the HORC/HOMRCF time stamps will be correct.
 - e) HORC only: install the remote copy connections between the HORC main and remote control units (MCUs and RCUs). For detailed information on installing the HORC remote copy connections, please refer to the *Hitachi Lightning 9900[™] Hitachi Open Remote Copy (HORC) User and Reference Guide* (MK-90RD010).
3. **User and Hitachi Data Systems Rep:** Install, configure, and connect the 9900 Remote Console PC to the 9900 subsystems via the 9900-internal LAN. Install the Remote Console Main (RMCMAIN) software, and enable the remote LUN Manager and remote HORC options (see the *Lightning 9900[™] Remote Console User's Guide* for instructions). You do not need to enable the HOMRCF remote console software, because all HOMRCF functions can be performed using CCI. If the remote HORC option cannot be installed, please ask your Hitachi Data Systems representative about HORC configuration services.
4. **User:** For HORC only, you must configure the 9900 for HORC operations as follows before you can create HORC volume pairs using CCI. For detailed instructions on configuring HORC operations, please refer to the *Lightning 9900[™] Hitachi Open Remote Copy (HORC) User and Reference Guide*.
 - a) Add all HORC MCUs to the 9900 Remote Console PC at the main site.
 - b) Change the MCU remote copy ports to remote control port (RCP) mode.
 - c) Establish the MCU-RCU paths.

3.3 Software Installation

Installation of the CCI software on the host server(s) is performed by the user, with assistance as needed from the Hitachi Data Systems representative.

3.3.1 Software Installation for UNIX® Systems

If you are installing CCI from CD-ROM, please use the **RMinstsh** and **RMuninst** scripts on the CD-ROM to automatically install and uninstall the CCI software. For other media, please use the following instructions. **Note:** The following instructions refer to UNIX® commands which may be different on your platform. Please consult your operating system documentation (e.g., UNIX® man pages) for platform-specific command information.

New Installation into Root Directory:

1. Insert the installation medium into the proper I/O device.
2. Move to the current root directory: **# cd /**
3. Copy all files from the installation medium using the **cpio** command:
cpio -idmu < /dev/XXXX XXXX = I/O device
Preserve the directory structure (**d** flag) and file modification times (**m** flag), and copy unconditionally (**u** flag). For floppy disks, load them sequentially, and repeat the command. An I/O device name of floppy disk designates a surface partition of the raw device file (unpartitioned raw device file).
4. Execute the HORCM installation command: **# /HORCM/horcminstall.sh**
5. Verify installation of the proper version using the **raidqry** command:
raidqry -h
Model: RAID-Manager/HP-UX
Ver&Rev: 01-05-03/00
Usage: raidqry [options]

New Installation into Non-Root Directory:

1. Insert the installation medium (e.g., CD-ROM) into the proper I/O device.
2. Move to the desired directory for CCI. The specified directory must be mounted by a partition of except root disk or an external disk.
cd /Specified Directory
3. Copy all files from the installation medium using the **cpio** command:
cpio -idmu < /dev/XXXX XXXX = I/O device
Preserve the directory structure (**d** flag) and file modification times (**m** flag), and copy unconditionally (**u** flag). For floppy disks, load them sequentially, and repeat the command. An I/O device name of floppy disk designates a surface partition of the raw device file (unpartitioned raw device file).
4. Make a symbolic link for /HORCM:
ln -s /Specified Directory/HORCM /HORCM

(Instructions continue on the next page.)

5. Execute the HORCM installation command: **# /HORCM/horeminstall.sh**
6. Verify installation of the proper version using the **raidqry** command:
raidqry -h
Model: RAID-Manager/HP-UX
Ver&Rev: 01-05-03/00
Usage: raidqry [options]

Version Up. To install a new version of the CCI software:

1. Confirm that HORCM is not running. If it is running, shut it down:
One CCI instance: **# horcmshutdown.sh**
Two CCI instances: **# horcmshutdown.sh 0 1**
If HORC/HOMRCF commands are running in the interactive mode, terminate the interactive mode and exit these commands using **-q** option.
2. Insert the installation medium (e.g., CD-ROM) into the proper I/O device.
3. Move to the directory containing the HORCM directory (e.g., **# cd /** for root directory).
4. Copy all files from the installation medium using the **cpio** command:
cpio -idmu < /dev/XXXX XXXX = I/O device
Preserve the directory structure (**d** flag) and file modification times (**m** flag) and copy unconditionally (**u** flag). For floppy disks, load them sequentially, and repeat the command. An input/output device name of floppy disk designates a surface partition of the raw device file (unpartitioned raw device file).
5. Execute the HORCM installation command: **# /HORCM/horeminstall.sh**
6. Verify installation of the proper version using the **raidqry** command:
raidqry -h
Model: RAID-Manager/HP-UX
Ver&Rev: 01-05-03/00
Usage: raidqry [options]

De-installation. To de-install (remove) the CCI software:

1. Confirm that HORCM is not running. If it is running, shut it down:
One CCI instance: **# horcmshutdown.sh**
Two CCI instances: **# horcmshutdown.sh 0 1**
If HORC/HOMRCF commands are running in the interactive mode, terminate the interactive mode and exit these commands using **-q** option.
2. When HORCM is installed in the root directory (/HORCM is not a symbolic link):
Execute the horcmuninstall command: **# /HORCM/horcmuninstall.sh**
Move to the root directory: **# cd /**
Delete the product using the **rm** command: **# rm -rf /HORCM**
3. When HORCM is not installed in the root directory (/HORCM is a symbolic link):
Execute the horcmuninstall command: **# /Directory/HORCM/horcmuninstall.sh**
Move to the root directory: **# cd /**
Delete the symbolic link for /HORCM: **# rm /HORCM**
Delete the product using the **rm** command: **# rm -rf /Directory/HORCM**

3.3.2 Software Installation for Windows® NT/2000 Systems

Make sure to install CCI on all servers involved in CCI operations. If network (TCP/IP) is not established, install a network of Windows® NT/2000 attachment, and add TCP/IP protocol.

To install the CCI software on a Windows® NT/2000 system:

1. If a previous version of CCI is already installed, de-install (remove) it as follows:
 - a) Confirm that HORCM is not running. If it is running, shut it down:
One CCI instance: **D:\HORCM\etc> horcmshutdown**
Two CCI instances: **D:\HORCM\etc> horcmshutdown 0 1**
 - b) If HORC/HOMRCF commands are running in the interactive mode, terminate the interactive mode and exit these commands using **-q** option.
 - c) Remove the previous version of CCI using the **Add/Remove Programs** control panel.
2. Insert the installation medium (e.g., CD-ROM) into the proper I/O device.
3. Run **Setup.exe**, and follow the instructions on screen to complete the installation.
4. Verify installation of the proper version using the **raidqry** command:
D:\HORCM\etc> raidqry -h
Model: RAID-Manager/HP-UX
Ver&Rev: 01-05-03/00
Usage: raidqry [options]

3.3.3 Changing the CCI User

The CCI software is initially configured to allow only the **root** user (system administrator) to execute CCI commands. If desired (e.g., CCI administrator does not have **root** access), the system administrator can change the CCI user from **root** to another user name.

To change the CCI user:

1. Change the owner of the following CCI files from the **root** user to the desired user name:
/HORCM/etc/horcmgr
All CCI commands in the /HORCM/usr/bin directory
All CCI log directories in the /HORCM/log* directories
2. Change the owner of the raw device file of the HORCM_CMD command device in the configuration definition file from the **root** user to the desired user name.
3. **Optional:** Establishing the HORCM (/etc/horcmgr) start environment. If users have designation of the full environment variables (HORCM_LOG HORCM_LOGS), then they start horcmstart.sh command without an argument. In this case, the HORCM_LOG and HORCM_LOGS directories must be owned by the CCI administrator. The environment variable (HORCMINST, HORCM_CONF) establishes as the need arises.
4. **Optional:** Establishing the command execution environment. If users have designation of the environment variables (HORCC_LOG), then the HORCC_LOG directory must be owned by the CCI administrator. The environment variable (HORCMINST) establishes as the need arises.

3.4 Creating/Editing the Configuration File

The configuration definition file is a text file which is created and/or edited using any standard text editor (e.g., UNIX® vi editor, Windows® Notepad). A sample configuration definition file, HORCM_CONF (/HORCM/etc/horcm.conf), is included with the CCI software. This file should be used as the basis for creating your configuration definition file(s). The system administrator should copy the sample file, set the necessary parameters in the copied file, and place the copied file in the proper directory. See sections 2.6.3 and 2.7 and for a detailed description of the configuration definition file(s) for sample CCI configurations.

Caution: Do not edit the configuration definition file while HORCM is running. Shut down HORCM, edit the configuration file as needed, and then restart HORCM.

Table 3.1 lists the parameters defined in the configuration file and specifies the default value, type, and limit for each parameter.

Table 3.1 Configuration (HORCM_CONF) Parameters

Parameter	Default value	Type	Limit
ip_address	None	Character string	64 characters
service	None	Character string or numeric value	15 characters
poll (10 ms)	1000	Numeric value*	None
timeout (10 ms)	3000	Numeric value*	None
dev_name	None	Character string	31 characters Recommended value = 8 or less.
dev_group	None	Character string	31 characters Recommended value = 8 or less.
port #	None	Character string	31 characters
target ID	None	Numeric value*	7 characters
LU#	None	Numeric value*	7 characters
MU#	0	Numeric value*	7 characters

***Note:** Use decimal notation for numeric values (not hexadecimal).

3.5 CCI Startup

After you have installed the CCI software (see section 3.3) and set the configuration definition file(s) (see section 3.4), you can begin using the CCI software (HORCM) to perform HORC and/or HOMRCF operations on the attached 9900 subsystems.

3.5.1 Startup for UNIX® Systems

One Instance. To start up one instance of CCI on a UNIX® system:

1. Modify **/etc/services** to register the port name/number (service) of the configuration definition file. Make the port name/number the same on all servers.
horcm xxxxx/udp xxxxx = the port name/number of horcm.conf
2. If you want HORCM to start automatically each time the system starts up, add **/etc/horcmstart.sh** to the system automatic start-up file (e.g., **/sbin/rc**).
3. Execute the **horcmstart.sh** script manually to start the CCI instance:
horcmstart.sh
4. Set the log directory (**HORCC_LOG**) in the command execution environment as needed.
5. If you want to perform HORC operations, do not set the **HORCC_MRCF** environment variable. If you want to perform HOMRCF operations, set the **HORCC_MRCF** environment variable for the HORCM execution environment.

For B shell:

```
# HORCC_MRCF=1
# export HORCC_MRCF
```

For C shell:

```
# setenv HORCC_MRCF 1
```

```
# pairedisplay -g xxxx           xxx...group-name
```

Two Instances. To start up two instances of CCI on a UNIX[®] system:

1. Modify **/etc/services** to register the port name/number (service) of each configuration definition file. The port name/number must be different for each CCI instance.

horcm0 **xxxxx/udp** xxxxx = the port name/number for horcm0.conf

horcm1 **yyyyy/udp** yyyyy = the port name/number for horcm1.conf

2. If you want HORCM to start automatically each time the system starts up, add **/etc/horcmstart.sh 0 1** to the system automatic start-up file (e.g., **/sbin/rc**).

3. Execute the **horcmstart.sh** script manually to start the CCI instances:

horcmstart.sh 0 1

4. Set an instance number to the environment which executes a command:

For B shell:

HORCMINST=X X = instance number = 0 or 1

export HORCMINST

For C shell:

setenv HORCMINST X

5. Set the log directory (**HORCC_LOG**) in the command execution environment as needed.

6. If you want to perform HORC operations, do not set the **HORCC_MRCF** environment variable. If you want to perform HOMRCF operations, set the **HORCC_MRCF** environment variable for the HORCM execution environment.

For B shell:

HORCC_MRCF=1

export HORCC_MRCF

For C shell:

setenv HORCC_MRCF 1

pairedisplay -g xxxx xxxx = group-name

3.5.2 Startup for Windows® Systems

One Instance. To start up one instance of CCI on a Windows® NT/2000 system:

1. Modify `\WINNT\system32\drivers\etc\services` to register the port name/number (service) of the configuration definition file. Make the port name/number the same on all servers: **horcm xxxxx/udp** xxxxx = the port name/number of horcm.conf
2. If you want HORCM to start automatically each time the system starts up, add `\HORCM\etc\horcmstart` to the system automatic start-up file (e.g., `\autoexec.bat`).
3. Execute the **horcmstart** script manually to start CCI: **D:\HORCM\etc> horcmstart**
4. Set the log directory (**HORCC_LOG**) in the command execution environment as needed.
5. If you want to perform HRC operations, do not set the **HORCC_MRCF** environment variable. If you want to perform HOMRCF operations, set the **HORCC_MRCF** environment variable for the HORCM execution environment:

D:\HORCM\etc> set HORCC_MRCF=1

D:\HORCM\etc> pairdisplay -g xxxx xxxx = group name

Two Instances. To start up two instances of CCI on a Windows® NT/2000 system:

1. Modify `\WINNT\system32\drivers\etc\services` to register the port name/number (service) of the configuration definition files. Make sure that the port name/number is different for each instance:
horcm0 **xxxxx/udp** xxxxx = the port name/number of horcm0.conf
horcm1 **xxxxx/udp** xxxxx = the port name/number of horcm1.conf
2. If you want HORCM to start automatically each time the system starts up, add `\HORCM\etc\horcmstart 0 1` to the system automatic start-up file (e.g., `\autoexec.bat`).
3. Execute the **horcmstart** script manually to start CCI: **D:\HORCM\etc> horcmstart 0 1**
4. Set an instance number to the environment which executes a command:
D:\HORCM\etc> set HORCMINST=X X = instance number = 0 or 1
5. Set the log directory (**HORCC_LOG**) in the command execution environment as needed.
6. If you want to perform HORC operations, do not set the **HORCC_MRCF** environment variable. If you want to perform HOMRCF operations, set the **HORCC_MRCF** environment variable for the HORCM execution environment:
D:\HORCM\etc> set HORCC_MRCF=1

D:\HORCM\etc> pairdisplay -g xxxx xxxxx = group name

Chapter 4 Performing CCI Operations

4.1 Environmental Variables

When activating the HORCM or initiating a command, users can specify any of the environmental variables shown in Table 4.1.

Table 4.1 HORCM, HORC, and HOMRCF Variables

Variable	Functions
HORCM (/etc/horcmgr) environmental variables	<p>\$HORCM_CONF: Names the HORCM configuration file, default = /etc/horcm.conf.</p> <p>\$HORCM_LOG: Names the HORCM log directory, default = /HORCM/log/curllog.</p> <p>\$HORCM_TRCSZ: Specifies the size of the HORCM trace file in kB, default = 1 MB. The trace file size cannot be changed using the horcctl command.</p> <p>\$HORCM_TRCLVL: Specifies the HORCM trace level (0 - 15), default = 4. If a negative value is specified, trace mode is canceled. The trace level can be changed using the horcctl -c -l command.</p> <p>\$HORCM_TRCBUF: Specifies the HORCM trace mode. If this variable is specified, data is written in the trace file in the non-buffer mode. If not, data is written in the buffer mode. The trace mode can be changed using the horcctl -c -b command.</p> <p>\$HORCM_TRCUENV: Specifies whether or not to succeed the trace control parameters (TRCLVL and TRCBUF) as they are when a command is issued. When this variable is specified, the HORC default trace control parameters are used to the trace control parameters of HORCM as global parameters. If not, the default trace control parameters for HORC commands are used and tracing level = 4, trace mode = buffer mode.</p> <p>\$HORCMFCTBL: Changes the fibre address conversion table number, used when the target ID indicated by the raidscan command is different than the TID on the system.</p>
HORC command environmental variables	<p>\$HORCC_LOG: Specifies the command log directory name, default = /HORCM/log* (* = instance number).</p> <p>\$HORCC_TRCSZ: Specifies the size of the command trace file in kB, default = HORCM trace file size. The default HORC trace file size can be changed using horcctl -d -s.</p> <p>\$HORCC_TRCLVL: Specifies the command trace level (0 = 15), default = 4 or the specified HORCM trace level. If a negative value is specified, trace mode is canceled. The default trace level for HORC commands can be changed using the horcctl -d -l.</p> <p>\$HORCC_TRCBUF: Specifies the command trace mode. If specified, data is written in the trace file in the non-buffer mode. If not, the HORCM trace mode is used. The default trace mode for HORC commands can be changed using the horcctl -d -b.</p>
HORC instance environmental variable	<p>\$HORCMINST: Specifies the instance number when using two or more CCI instances on the same server. The command execution environment and the HORCM activation environment require an instance number to be specified. Set the configuration definition file (HORCM_CONF) and log directories (HORCM_LOG and HORCC_LOG) for each instance.</p>
HOMRCF command environmental variables	<p>\$HORCC_MRCF: Sets the execution environment of the HOMRCF commands. The selection whether the command functions as that of the HORC or the HOMRCF is made according to this variable. The HORCM is not affected by this variable. When issuing a HORC command, do not set the HORCC_MRCF variable for the execution environment of the command. When issuing an HOMRCF command, set the environmental variable HORCC_MRCF=1 for the execution environment of the command.</p>

4.2 Creating Pairs (Paircreate)

WARNING: Use the paircreate command with caution. The paircreate command starts the HORC/HOMRCF initial copy operation, which overwrites all data on the secondary/target volume. If the primary and secondary volumes are not identified correctly, or if the wrong options are specified (e.g., **vl** instead of **vr**), data will be transferred in the wrong direction.

The paircreate command generates a new volume pair from two unpaired volumes. The paircreate command can create either a paired logical volume or a group of paired volumes. The paircreate command allows you to specify the direction (local or remote) of the pair generation (see Figure 4.1). If local (**vl** option) is specified, the server issuing the paircreate command has the primary volume. If remote (**vr** option) is specified, the remote server has the primary volume. The **-split** option of the paircreate command (HOMRCF only) allows you to simultaneously create and split pairs using a single CCI command. When **-split** is used, the pair status changes from COPY to PSUS (instead of PAIR) when the initial copy operation is complete. Table 4.2 lists and describes the paircreate command parameters and returned values.

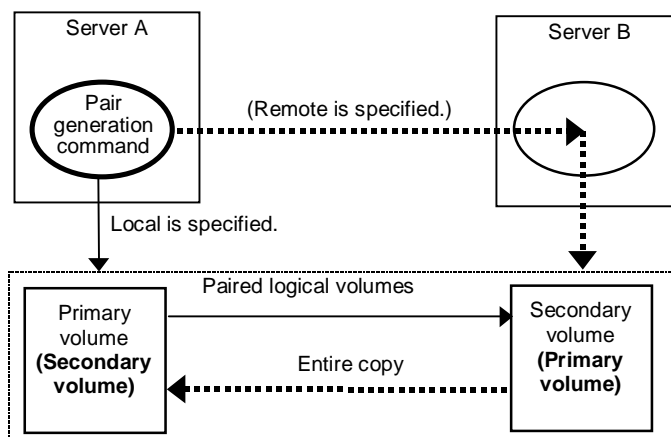


Figure 4.1 Pair Creation

Before issuing the paircreate command, make sure that the secondary volume is not mounted on any system. If the secondary volume is found to be mounted after paircreate, delete the pair (pairsplit -S), unmount the secondary volume, and then reissue the paircreate command.

Note: The paircreate command terminates before the initial copy operation is complete (except when the **nocopy** option is specified). Use the pair event waiting or pair display command to verify that the initial copy operation completed successfully (status changes from COPY to PAIR, or from COPY to PSUS if the **-split** option was specified). The execution log file also shows completion of the initial copy operation.

HORC only: The paircreate command cannot execute copy rejection in case of an error condition which made the target volume is accompanied by maintenance work.

Table 4.2 Paircreate Command Parameters

Parameter	Value
Command Name	paircreate
Format	paircreate { -h -q -z -g <group> -d <pair Vol> -d[g] <raw_device> [MU#] -d[g] <seq#> <LDEV#> [MU#] -f <fence> [CTGID] -v -c <size> -nocopy -nomsg -split [-m <mode>] }
Options	<p>-h: Displays Help/Usage and version information.</p> <p>-q: Terminates the interactive mode and exits the command.</p> <p>-z or -zx: Makes the paircreate command enter the interactive mode. The -zx option guards performing of the HORCM in the interactive mode. When this option detects a HORCM shut down, interactive mode terminates.</p> <p>-g <group>: Specifies a group name defined in the configuration definition file. The command is executed for the specified group unless the -d <pair Vol> option is specified.</p> <p>-d <pair Vol>: Specifies paired logical volume name defined in the configuration definition file. When this option is specified, the command is executed for the specified paired logical volume.</p> <p>-d[g] <raw_device> [MU#] (HP-UX®, Linux®, Windows® NT/2000, Solaris® only): Searches a group on the configuration definition file (local instance) for the specified raw_device, and if the specified raw_device is contained in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified the raw_device is contained in two or more groups, the command is executed on the first group.</p> <p>-d[g] <seq#> <LDEV#> [MU#]: Searches a group on the configuration definition file (local instance) for the specified LDEV, and if the specified LDEV is contained in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified LDEV is contained in two or more groups, the command is executed on the first group. The <seq #> <LDEV #> values can be specified in hexadecimal (by addition of "0x ") or decimal notation.</p> <p>-f <fence> [CTGID] (HORC only): Specifies the level for assuring the consistency of paired volume data. A fence level of "data", "status", "never", or "async" (HORC async only) must be specified. This option is required for HORC. If the CTGID (CT group ID) option is not specified, the pair is automatically assigned to a new group. If CTGID is not specified and the maximum number of CT groups (16) exists, the "async" fence option will be terminated with EX_ENOCTG. The CTGID option is used to make paired volumes of specified group forcibly by given CTGID of another group. CTGID is enabled only when "async" is specified as fence level (otherwise it is ignored).</p> <p>-vl or -vr: Specifies the data flow direction and must always be specified. The -vl option specifies "local" and the host which issues the command possesses the primary volume. The -vr option specifies "remote" and the remote host possesses the primary volume while the local host possesses the secondary volume.</p> <p>-c <size>: Specifies the number of extents (1 - 15) to be used for the initial data copy. If this option is not specified a default value is used.</p> <p>-nocopy: Creates paired volumes without copying data in the case in which the data consistency of simplex volumes is assured by the user.</p> <p>-nomsg: Suppresses messages to be displayed when this command is executed. It is used to execute this command from a user program. This option must be specified at the beginning of a command argument. The command execution log is not affected by this option.</p> <p>split (HOMRCF only): Splits the paired volume after the initial copy operation is complete.</p> <p>-m <noread> (HOMRCF only): Specifies the noread mode for hiding the secondary volume. The secondary volume becomes read-disabled when this mode option is specified. The secondary volume is read-enabled when this mode option is omitted. The primary volume becomes read-disabled only during a reverse resync operation (restore option of pairresync command).</p>
Returned values	<p>Normal termination: 0. When creating groups, 0 = normal termination for all pairs.</p> <p>Abnormal termination: other than 0, refer to the execution logs for error details.</p>

4.3 Splitting and Deleting Pairs (Pairsplit)

The pairsplit command stops updates to the secondary volume of a pair and can either maintain (status = PSUS) or delete (status = SMPL) the pairing status of the volumes (see Figure 4.2). The pairsplit command can be applied to a paired logical volume or a group of paired volumes. The pairsplit command allows read access or read/write access to the secondary volume, depending on the selected options. When the pairsplit command is specified, acceptance of write requests to the primary volume depends on the fence level of the pair (data, status, never, or async). Table 4.3 lists and describes the pairsplit command parameters and returned values.

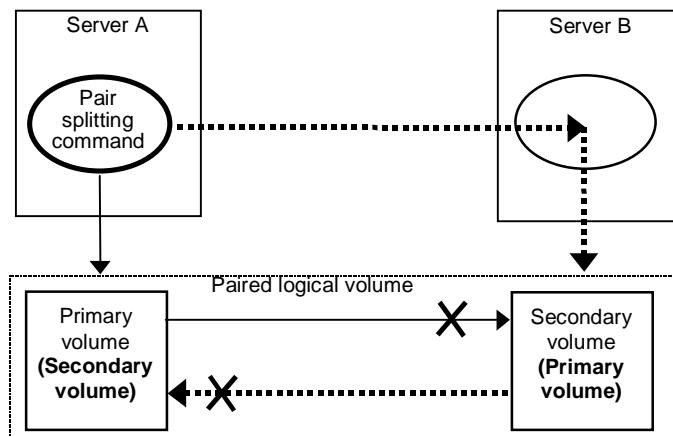


Figure 4.2 Pair Splitting

The primary volume's server is automatically detected by the pairsplit command, so the server does not need to be specified in the pairsplit command parameters. If the -S option (simplex) is used, the volume pair is deleted, the volumes are returned to the simplex state, and the primary and secondary volume status is lost. Paired volumes are split as soon as the pairsplit command is issued. If you want to synchronize the volumes, the pairsplit command must be issued after write I/Os to the paired volume have completed (see section 4.2.1 for examples).

Note: You can create and split HOMRCF pairs simultaneously using the **-split** option of the paircreate command (refer to section 4.1).

Table 4.3 Pairsplit Command Parameters

Parameter	Value
Command Name	pairsplit
Format	pairsplit {-h -q -z -g <group> -d <pair Vol> -d[g] <raw_device> [MU#] -FHORC -FMRCF [MU#] -d[g] <seq#> <LDEV#> [MU#] -r -rw -S -R -P -I -nomsg -C <size> -E }
Options Note: Only one pairsplit option (-r, -rw, -S, -R, or -P) can be specified. If more than one option is specified, only the last option will be executed.	<p>-h: Displays Help/Usage and version information.</p> <p>-q: Terminates the interactive mode and exits this command.</p> <p>-z or -zx: Makes the pairsplit command enter the interactive mode. The -zx option guards performing of the HORCM in the interactive mode. When this option detects a HORCM shut down, interactive mode terminates.</p> <p>-g <group>: Specifies a group name defined in the configuration definition file. This option must always be specified. The command is executed for the specified group unless the -d <pair Vol> option is specified.</p> <p>-d <pair Vol>: Specifies the paired logical volume name defined in the configuration definition file. When this option is specified, the command is executed for the specified paired logical volumes.</p> <p>-d[g] <raw_device> [MU#] (HP-UX®, Linux®, Windows® NT/2000, Solaris® only): Searches a group on the configuration definition file (local instance) for the specified raw_device, and if the specified raw_device is contained in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified the raw_device is contained in two or more groups, the command is executed on the first group.</p> <p>FHORC or -FCA: Forcibly specifies a cascading HORC volume for specified pair logical volumes on HOMRCF environment (see example in Figure 4.3). If the -I option is specified, this option splits a cascading HORC volume on a local host (near site). If no -I option is specified, this option splits a cascading HORC volume on a remote host (far site). The target HORC volume must be a P-VOL and the -R option cannot be specified.</p> <p>-FMRCF [MU#] or -FBC [MU#]: Forcibly specifies a cascading HOMRCF volume for specified pair logical volumes on HORC environment (see example in Figure 4.4). If the -I option is specified, this option splits a cascading HOMRCF volume on a local host (near site). If no -I option is specified, this option splits a cascading HOMRCF volume on a remote host (far site). The target HOMRCF volume must be a P-VOL and the -E option cannot be specified.</p> <p>-d[g] <seq#> <LDEV#> [MU#]: Searches a group on the configuration definition file (local instance) for the specified LDEV, and if the specified LDEV is in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified LDEV is contained in two or more groups, the command is executed on the first group. The <seq #> <LDEV #> values can be specified in hexadecimal (by addition of "0x ") or decimal notation.</p> <p>-r or -rw: Specifies a mode of access to the SVOL after paired volumes are split. The -r option (default) allows read-only from the SVOL. The -rw option enables read and write access for the SVOL.</p> <p>-S: Selects simplex mode (deletes the pair). When the pairing direction is reversed among the hosts (e.g., disaster recovery), this mode is established once, and then the paircreate command is issued.</p> <p>-R: Brings the secondary volume into the simplex mode forcibly. It is issued by the secondary host, if the host possessing the primary volume is down or has failed.</p> <p>-P: Brings the primary volume into the blocking mode forcibly. It is issued by the secondary host to suppress data updating by the host possessing the primary volume.</p> <p>-I: When this command cannot utilize the remote host for host down, this option used for enables a pairsplit operation by local host only. Except the -R option the target volume of local host must be PVOL.</p> <p>-nomsg: Suppresses messages to be displayed when this command is executed. It is used to execute a command from a user program. This option must be specified at the beginning of a command argument. The command execution log is not affected by this option.</p> <p>-C <size> (HOMRCF only): Copies difference data retained in the primary volume into the secondary volume, then enables reading and writing from/to the secondary volume after completion of the copying. (This is the default option.) For <size>, specify the copy pace for the pairsplit (range = 1 to 15 track extents). If not specified, the value used for paircreate is used.</p> <p>-E (HOMRCF only): Suspends a paired volume forcibly when a failure occurs. Not normally used.</p>
Returned values	<p>Normal termination: 0. When splitting groups, 0 = normal termination for all pairs.</p> <p>Abnormal termination: other than 0, refer to the execution logs for error details.</p>

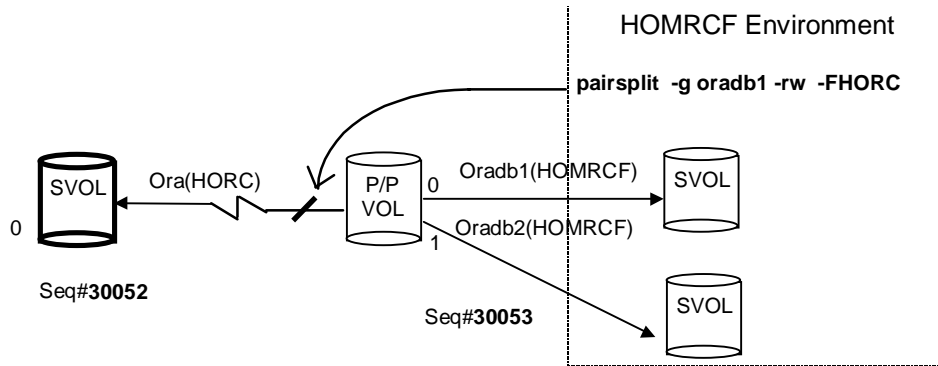


Figure 4.3 Example of -FHORC Option for Pairsplit

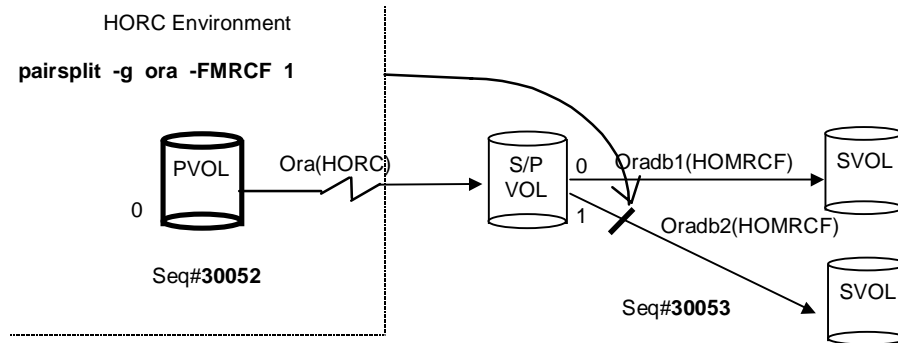


Figure 4.4 Example of -FMRCF Option for Pairsplit

4.3.1 Timing Pairsplit Operations

The pairsplit command terminates after verifying that the status has changed according to the pairsplit command options (to PSUS or SMPL). If you want to synchronize the volume pair, the non-written data (in the host buffer) must be written before you issue the pairsplit command. When the pairsplit command is specified, acceptance of write requests to the primary volume depends on the fence level of the pair (data, status, never, or async). Some examples are shown below.

Instantaneous offline backup of UNIX[®] file system:

- Unmount the primary volume, and then split the volume pair.
- Mount the primary volume (**mount -rw**).
- Verify that the pairsplit is complete, and mount the secondary volume (**mount -r**).
- Execute the backup.
- Restore the volumes to their previous state, and resynchronize the volume pair.

Online backup of UNIX[®] file system:

- Issue the **sync** command to a mounted primary volume to flush the file system buffer, and then split the volume pair using the **-rw** option.
- Verify that the pairsplit is complete, and then use the **fsck** command to check the consistency of the secondary volume file system.
- Mount (**mount -r**) the secondary volume.
- Execute the backup.
- Restore the volumes to their previous state, and resynchronize the volume pair.

Instantaneous offline backup of Windows[®] file system:

- Execute **-x umount** of the primary volume, and then split the volume pair using the **-rw** option.
- Execute **x-mount** of the primary volume.
- *Windows NT[®]*: Verify that the pairsplit is complete, then execute **-x mount** of the secondary volume.
Windows[®] 2000: Verify that the pairsplit is complete, then execute **-x mount -x sync** of the secondary volume.
- Execute the backup.
- Restore the volumes to their previous state, and resynchronize the volume pair.

Note: If the primary volume is divided by LVM or partition, the control information of LVM or partition on the primary volume is also copied to the secondary volume. In case of executing the backup from the secondary volume, it is required to import this control information, and to execute pairsplit with the **-rw** option when activating the secondary volume.

4.3.2 Deleting Pairs (Pairsplit -S)

The pair delete operation is executed by using the **-S** option of the **pairsplit** command. When the **pairsplit -S** command is issued, the specified HORC or HOMRCF pair is deleted, and each volume is changed to SMPL (simplex) mode. If you want to re-establish a pair which has been deleted, you must use the **paircreate** command (not **pairresync**).

4.4 Resynchronizing Pairs (Pairresync)

The **pairresync** command re-establishes a split pair and then restarts the update copy operations to the secondary volume (see Figure 4.5). The **pairresync** command can resynchronize either a paired logical volume or a group of paired volumes. The normal direction of resynchronization is from the primary volume to the secondary volume. If the **-restore** option is specified (HOMRCF only), the pair is resynchronized in the reverse direction (i.e., secondary volume to primary volume). Figure 4.6 shows the normal and restore resync operations. The primary volume remains accessible during **pairresync**, except when the **-restore** option is specified. The secondary volume becomes write-disabled when the **pairresync** command is issued. Table 4.4 lists and describes the **pairresync** command parameters and returned values. The primary volume's server is automatically detected by the **pairresync** command, so the server does not need to be specified in the **pairresync** command parameters.

The **pairresync** command terminates before resynchronization of the secondary (or primary) volume is complete. Use the **pair** event waiting or **pair display** command to verify that the resync operation completed successfully (status changes from COPY to PAIR). The execution log file also shows completion of the resync operation. The status transition of the paired volume is judged by the status of the primary volume. The fence level is not changed.

If no data was written to the secondary volume while the pair was split, the differential data on the primary volume is copied. If data was written to the secondary volume, the differential data on the primary volume and secondary volume is copied. This process is reversed when the HOMRCF **-restore** option is specified.

Before issuing the **pairresync** command (normal or reverse direction), make sure that the secondary volume is not mounted on any UNIX[®] system. Before issuing a reverse **pairresync** command, make sure that the primary volume is not mounted on any UNIX[®] system.

HORC only: The **swaps(p)** option is used to swap volume from the SVOL(PVOL) to PVOL(SVOL) at suspending state on the SVOL(PVOL) side, and resynchronize the NEW_SVOL based on the NEW_PVOL. At the result of this operation, the volume attributes of own host (local host) become the attributes for the NEW_PVOL(SVOL). The **paircreate** command cannot execute copy rejection in case of an error condition which made the target volume is accompanied by maintenance work. The **swaps(p)** option will:

- Ignore the **-l** option.
- Use a default of **three** for number of copy tracks (**-c size**) when **-c size** option is omitted.
- Execute at PAIR state as well as PSUS/PSUE state (not applicable to COPY and SMPL).
- Since the target volume of the local host has been already the PVOL(SVOL), this target volume is skipped a operation.

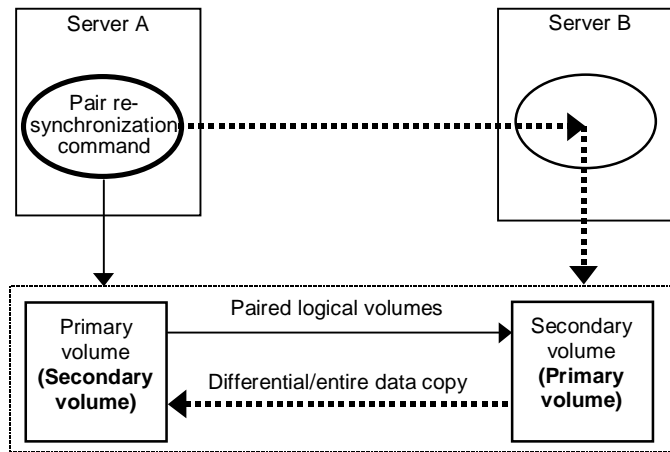


Figure 4.5 Pair Resynchronization

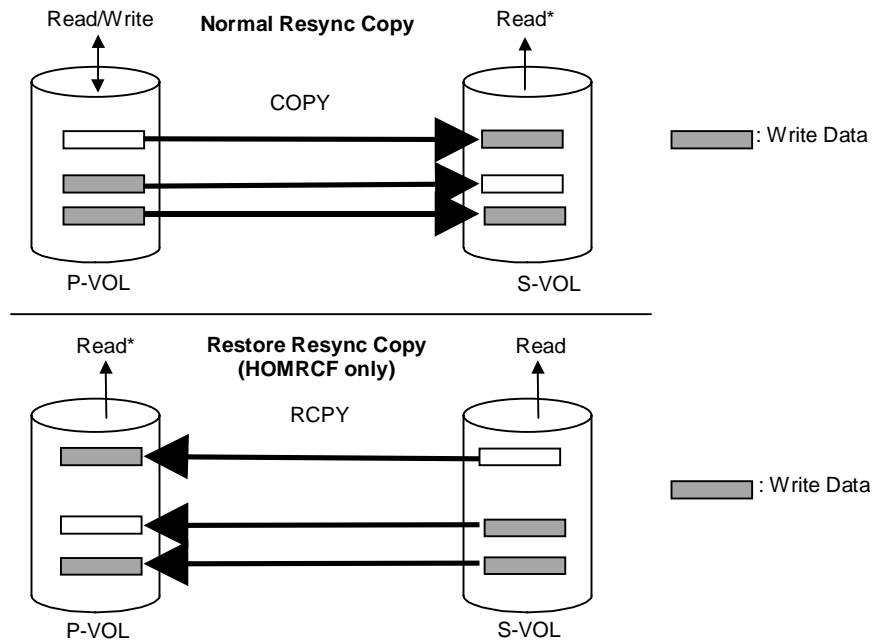


Figure 4.6 Normal Resync and HOMRCF Restore Resync

Table 4.4 Pairresync Command Parameters

Parameter	Value
Command Name	pairresync
Format	pairresync { -h -q -z -g <group> -d <pair Vol> -d[g] <raw_device> [MU#] -FHORC -FMRCF [MU#] -d[g] <seq#> <LDEV#> [MU#] -c <size> -nomsg -l -restore -swaps -swapp }
Options	<p>-h: Displays Help/Usage and version information.</p> <p>-q: Terminates the interactive mode and exits this command.</p> <p>-z or -zx: Makes the pairresync command enter the interactive mode. The -zx option guards performing of the HORCM in the interactive mode. When this option detects a HORCM shut down, interactive mode terminates.</p> <p>-g <group>: This option is used to specify a group name defined in the configuration definition file. This option must always be specified. The command is executed for the specified group unless the -d <pair Vol> option is specified.</p> <p>-d <pair Vol>: Specifies a paired logical volume name defined in the configuration definition file. When this option is specified, the command is executed for the specified paired logical volumes.</p> <p>-d[g] <raw_device> [MU#] (HP-UX®, Linux®, Windows®NT/2000, Solaris® only): Searches a group on the configuration definition file (local instance) for the specified raw_device, and if the specified raw_device is contained in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified the raw_device is contained in two or more groups, the command is executed on the first group.</p> <p>-FHORC or -FCA: Forcibly specifies a cascading HARC volume for specified pair logical volumes on HOMRCF environment (see example in Figure 4.7). If the -l option is specified, this option resyncs a cascading HARC volume on a local host (near site). If no -l option is specified, this option resyncs a cascading HARC volume on a remote host (far site). The target HARC volume must be a P-VOL, and the -swaps/swapp option cannot be specified.</p> <p>-FMRCF [MU#] or -FBC [MU#]: Forcibly specifies a cascading HOMRCF volume for specified pair logical volumes on HARC environment (see example in Figure 4.8). If the -l option is specified, this option resyncs a cascading HOMRCF volume on a local host (near site). If no -l option is specified, this option resyncs a cascading HOMRCF volume on a remote host (far site). The target HOMRCF volume must be a P-VOL.</p> <p>-d[g] <seq#> <LDEV#> [MU#]: Searches a group on the configuration definition file (local instance) for the specified LDEV, and if the specified LDEV is contained in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified LDEV is contained in two or more groups, the command is executed on the first group. The <seq #> <LDEV #> values can be specified in hexadecimal (by addition of "0x ") or decimal notation.</p> <p>-c <size>: Specify the copy pace for the resync operation (range = 1 to 15 track extents). If not specified, the value used for paircreate is used.</p> <p>-nomsg: Suppresses messages to be displayed when this command is executed. It is used to execute this command from a user program. This option must be specified at the beginning of a command argument. The command execution log is not affected by this option.</p> <p>-l: When this option can't utilize the remote host for host down, this option used for enables a pairresync operation by the local host only. The target volume of the local host must be P-VOL.</p> <p>-restore (HOMRCF only): Performs reverse resync (from secondary volume to primary volume).</p> <p>swaps (HARC only): Executed from the SVOL side when there is no host on the PVOL side to help. Typically executed in PSUS state to facilitate "fast failback" without requiring a full copy. In Figure 4.9, the left side shows T0 for both the PVOL and SVOL (before command execution), and the right side shows T1, after the command has executed. For both -swaps and -swapp, the delta data from the original SVOL becomes dominant and is copied to the original PVOL, then the S/PVOL designations are swapped.</p> <p>swapp (HARC only): Executes the equivalent of a -swaps from the original PVOL side. Unlike -swaps, -swapp does require the cooperation of hosts at both sides.</p>
Returned values	<p>Normal termination: 0. When resyncing groups, 0 = normal termination for all pairs.</p> <p>Abnormal termination: other than 0, refer to the execution logs for error details.</p>

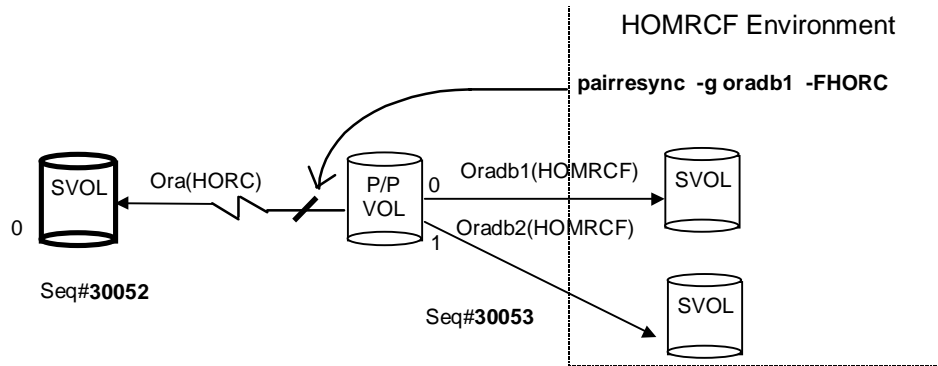


Figure 4.7 Example of -FHORC Option for Pairresync

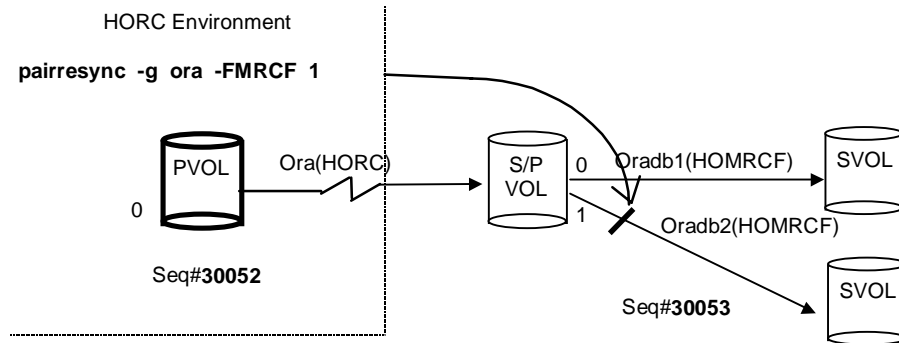


Figure 4.8 Example of -FMRCF Option for Pairresync

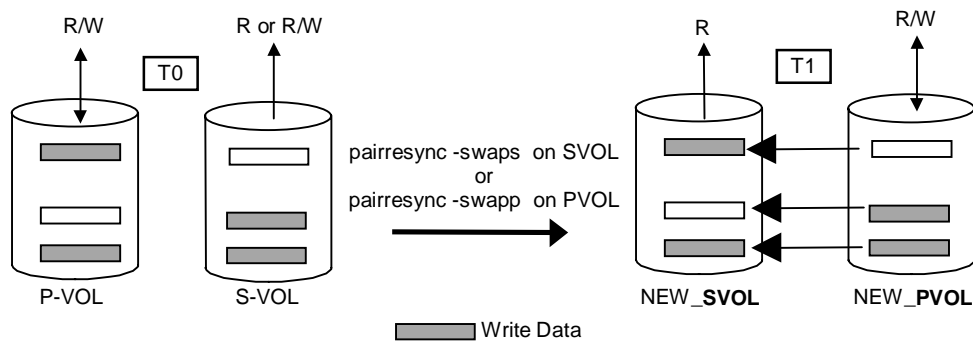


Figure 4.9 Swap Operation

4.5 Confirming Pair Operations (Pairevtwait)

The pair event waiting (**pairevtwait**) command is used to wait for completion of pair creation and pair resynchronization and to check the status (see Figure 4.10). It waits (“sleeps”) until the paired volume status becomes identical to a specified status and then completes. The **pairevtwait** command can be used for a paired logical volume or a group of paired volumes. The primary volume’s server is automatically detected by the pair event waiting command, so the server does not need to be specified in the pair event waiting command parameters. Table 4.5 lists and describes the pair event waiting command parameters and returned values.

The pair event waiting command waits until the specified status is established, and terminates abnormally if an abnormal status is detected. The transition of the paired volume status is judged by the status of the primary volume. If the event waiting command is issued for a group, the command waits until the status of each volume in the group becomes identical to the specified status. When the event waiting command with the **-nowait** option is issued for a group, the status is returned if the status of each volume in the group is identical. For HOMRCF pairs, this command must be used to confirm a pair status transition.

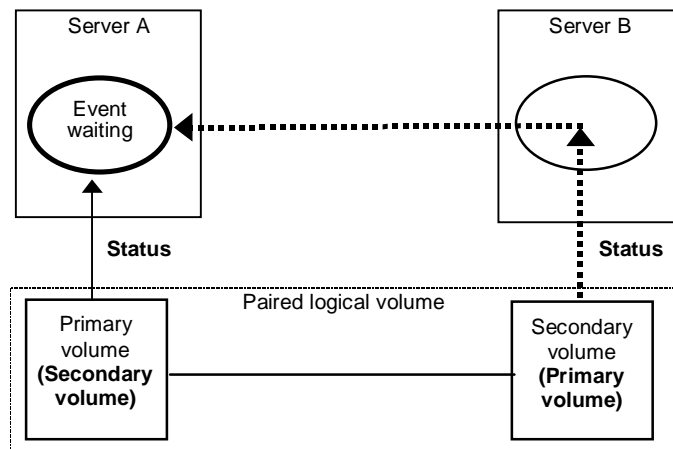


Figure 4.10 Pair Event Waiting

Table 4.5 Pairevtwait Command Parameters

Parameter	Value
Command Name	pairevtwait
Format	pairevtwait { -h -q -z -g <group> -d <pair Vol> -d[g] <raw_device> [MU#] -FHORC -FMRCF [MU#] -d[g] <seq#> <LDEV#> [MU#] -s <status> ... -t <timeout>[interval] -nowait -i -nomsg }
Options	<p>-h: Displays Help/Usage and version information.</p> <p>-q: Terminates the interactive mode and exits this command.</p> <p>-z or -zx: Makes the pairevtwait command enter the interactive mode. The -zx option guards performing of the HORCM in the interactive mode. When this option detects a HORCM shut down, interactive mode terminates.</p> <p>-g <group>: Specifies a group name defined in the configuration definition file. This option must always be specified. The command is executed for the specified group unless the -d <pair Vol> option is specified.</p> <p>-d <pair Vol>: Specifies a paired logical volume name defined in the configuration definition file. When this option is specified, the command is executed for the specified paired logical volumes.</p>

Table 4.5 Pairevtwait Command Parameters (continued)

Parameter	Value
Options (continued)	<p>-d[g] <raw_device> [MU#] (HP-UX®, Linux®, Windows® NT/2000, Solaris® only): Searches a group on the configuration definition file (local instance) for the specified raw_device, and if the specified raw_device is contained in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified the raw_device is contained in two or more groups, the command is executed on the first group.</p> <p>-FHORC or -FCA: Forcibly specifies a cascading HORC volume for specified pair logical volumes on HOMRCF environment (see example in). If the -l option is specified, this option tests status of a cascading HORC volume on a local host (near site). If no -l option is specified, this option tests status of a cascading HORC volume on a remote host (far site). The target HORC volume must be P-VOL or SMPL.</p> <p>-FMRCF [MU#] or -FBC [MU#]: Forcibly specifies a cascading HOMRCF volume for specified pair logical volumes on HORC environment (see example in). If the -l option is specified, this option tests status of a cascading HOMRCF volume on a local host (near site). If no -l option is specified, this option tests status of a cascading HOMRCF volume on a remote host (far site). The target HOMRCF volume must be P-VOL or SMPL.</p> <p>-d[g] <seq#> <LDEV#> [MU#]: Searches a group on the configuration definition file (local instance) for the specified LDEV, and if the specified LDEV is contained in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified LDEV is contained in two or more groups, the command is executed on the first group. The <seq #> <LDEV #> values can be specified in hexadecimal (by addition of "0x ") or decimal notation.</p> <p>-s <status>: ..Specifies the waiting status, which is "smpl", "copy/rcpy", "pair", "psus", or "psue/pdub". If two or more statuses are specified following -s, waiting is done according to the logical OR of the specified statuses. This option is valid when the -nowait option is not specified.</p> <p>-t <timeout> [interval]: Specifies the interval of monitoring a status specified using the -s option and the time-out period in units of 1 sec. Unless [interval] is specified, the default value is used. This option is valid when the -nowait option is not specified.</p> <p>-nowait: When this option is specified, the pair status at that time is reported without waiting. The pair status is set as a returned value for this command. When this option is specified, the -t and -s options are not needed.</p> <p>-l: When this command cannot utilize a remote host for host down, this option executes this command by a local host only. The target volume of a local host must be SMPL or P-VOL.</p> <p>-nomsg: Suppresses messages to be displayed when this command is executed. It is used to execute a command from a user program. This option must be specified at the beginning of a command argument. The command execution log is not affected by this option.</p>
Returned values	<p>When the -nowait option is specified:</p> <p>Normal termination:</p> <ol style="list-style-type: none"> 1: The status is SMPL. 2: The status is COPY or RCPY. 3: The status is PAIR. 4: The status is PSUS. 5: The status is PSUE. <p>When monitoring groups, 1/2/3/4/5 = normal termination for all pairs.</p> <p>Abnormal termination: other than 0 to 127, refer to the execution logs for error details.</p> <p>When the -nowait option is not specified:</p> <p>Normal termination: 0. When monitoring groups, 0 = normal termination for all pairs.</p> <p>Abnormal termination: other than 0 to 127, refer to the execution logs for error details.</p>

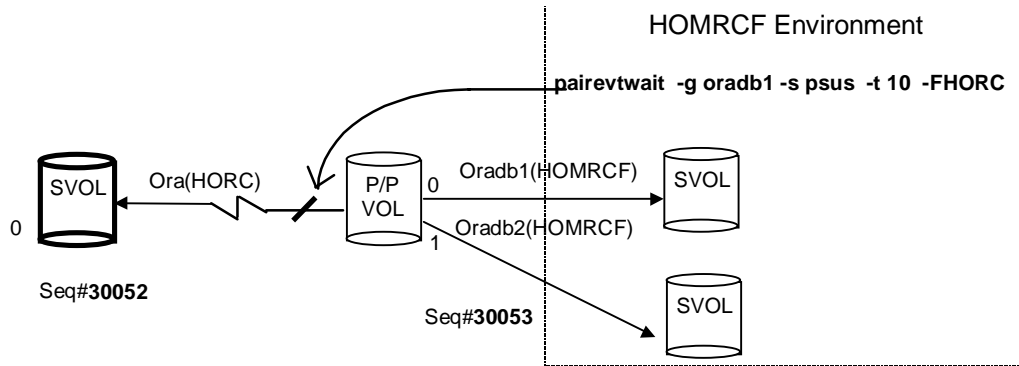


Figure 4.11 Example of -FHORC Option for Pairevwait

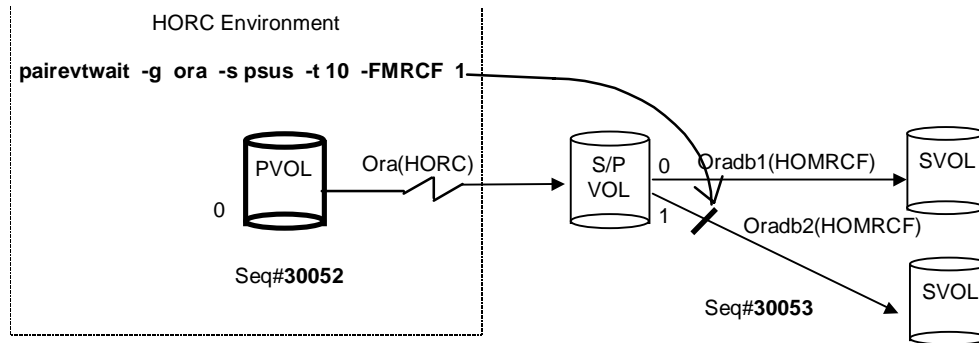


Figure 4.12 Example of -FMRCF Option for Pairevwait

4.6 Monitoring Pair Activity (Pairmon)

The pairmon command, which is connected to the HORCM daemon, obtains the pair status transition of each volume pair and reports it. If the pair status changes (due to an error or a user-specified command), the pairmon command issues a message. Table 4.6 lists and describes the pairmon command parameters. Figure 4.13 shows an example of the pairmon command and its output. Table 4.7 specifies the results of the command options.

The pair status transition events exist in the HORCM pair state transfer queue. The **-resevt** option (reset event) deletes one/all events from the HORCM pair state transfer queue. If reset event is not specified, the pair state transfer queue is maintained. If the **-s** option is not specified, pairmon displays all events for which it receives information from HORCM. If the **-s** option is specified, only the specified status transitions are displayed.

The CCI software supports the error monitoring and configuration confirmation commands for linkage with the system operation management of the UNIX[®] server.

Table 4.6 Pairmon Command Parameters

Parameter	Value
Command Name	pairmon
Format	pairmon { -h -q -z -D -allsnd -resevt -nowait -s <status> ... }
Options	<p>-h: Displays Help/Usage and version information.</p> <p>-q: Terminates the interactive mode and exits this command.</p> <p>-z or -zx: Makes the pairmon command enter the interactive mode. The -zx option guards performing of the HORCM in the interactive mode. When this option detects a HORCM shut down, interactive mode terminates.</p> <p>-D: Selects the default report mode. In the default mode, if there is pair status transition information to be reported, one event is reported and the event is reset. If there is no pair status transition information to be reported, the command waits. The report mode consists of the three flags: -allsnd, -resevt, and -nowait options.</p> <p>-allsnd: Reports all events if there is pair status transition information.</p> <p>-resevt: Reports events if there is pair status transition information, and then resets all events.</p> <p>-nowait: When this option is specified, the command does not wait when there is no pair status transition information.</p> <p>-s <status> ...: Specifies the pair status transition to be reported: smpl, copy (includes rcpy), pair, psus, psue. If two or more statuses are specified following -s, masking is done according to the logical OR of the specified statuses. If this option is not specified, pairmon displays all events which received information from HORCM.</p>

# pairmon -allsnd -nowait								
Group	Pair vol	Port	targ#	lun#	LDEV#...	Oldstat	code → Newstat	code
oradb	oradb1	CL1-A	1	5	145...	SMPL	0x00 → COPY	0x01
oradb	oradb2	CL1-A	1	6	146...	PAIR	0x02 → PSUS	0x04

Figure 4.13 Pairmon Command Example

The output of the pairmon command includes:

- **Group:** This column shows the group name (dev_group) which is described in the configuration definition file.
- **Pair vol:** This column shows the paired volume name (dev_name) in the specified group which is described in the configuration definition file.
- **Port targ# lun#:** These columns show the port ID, TID, and LUN which is described in the configuration definition file. For further information on fibre-to-SCSI address conversion, see Appendix D.
- **LDEV#:** This column shows the 9900 LDEV ID for the specified device.
- **Oldstat:** This column shows the old pair status when the status of the volume is changed.
- **Newstat:** This column shows the new pair status when the status of the volume is changed.
- **code:** This column shows the 9900-internal code for the specified status.

Table 4.7 Results of Pairmon Command Options

-D	-nowait	-resevt	-allsnd	Actions
-D				When HORCM doesn't have an event, this option waits until an event occurs. If one or more events exist, then it reports one event and resets the event which it reported.
Invalid			-allsnd	When HORCM doesn't have an event, this option waits until an event occurs. If one or more events exist, then it reports all events.
Invalid		-resevt		When HORCM doesn't have an event, this option waits until an event occurs. If one or more events exist, then it reports one event and resets all events.
Invalid		-resevt	-allsnd	When HORCM doesn't have an event, this option waits until an event occurs. If one or more events exist, then it reports all events and resets all events.
Invalid	-nowait			When HORCM doesn't have an event, this option reports event nothing. If one or more events exist, then it reports one event and resets the event which it reported.
Invalid	-nowait		-allsnd	When HORCM doesn't have an event, this option reports event nothing. If one or more events exist, then it reports all events.
Invalid	-nowait	-resevt		When HORCM doesn't have an event, this option reports event nothing. If one or more events exist, then it reports one event and resets all events.
Invalid	-nowait	-resevt	-allsnd	When HORCM doesn't have an event, this option reports event nothing. If one or more events exist, then it reports all events and resets all events.

4.7 Checking Attribute and Status (Pairvolchk)

The pairvolchk command acquires and reports the attribute of a volume or group connected to the local host (issuing the command) or remote host. The volume attribute is SMPL (simplex), P-VOL (primary volume), or S-VOL (secondary volume). The -s[s] option reports the pair status in addition to the attribute. Figure 4.14 shows an example of the pairvolchk command and its output. Table 4.8 lists and describes the pairvolchk command parameters and returned values. Table 4.9 shows the truth table for pairvolchk group status display. Table 4.10 provides the state transition table for an HA control script using the pairvolchk and horctakeover commands. Table 4.11 lists the error codes of the pairvolchk and horctakeover commands.

```
# pairvolchk -g oradb
Pairvolchk : Volstat is P-VOL.[status = PAIR fence = ASYNC CTGID = 2]
```

Figure 4.14 Pairvolchk Command Example (HORC Asynchronous shown)

Table 4.8 Pairvolchk Command Parameters (continues on the next page)

Parameter	Value
Command Name	pairvolchk
Format	pairvolchk { -h -q -z -g <group> -d <pair Vol> -d[g] <raw_device> [MU#] -FHORC -FMRCF [MU#] -d[g] <seq#> <LDEV#> [MU#] -c -s[s] -nomsg }
Options	<p>-h: Displays Help/Usage and version information.</p> <p>-q: Terminates the interactive mode and exits the pair volume check command.</p> <p>-z or -zx: Makes the pairvolchk command enter the interactive mode. The -zx option guards performing of the HORCM in the interactive mode. When this option detects a HORCM shut down, interactive mode terminates.</p> <p>-g <group>: Specifies the group name defined in the configuration definition file. This option must always be specified. The command is executed for the specified group unless the -d <pair Vol> option is specified.</p> <p>-d <pair Vol>: This option is used to specify the paired logical volume name defined in the configuration definition file. When this option is specified, the command is executed for the specified paired logical volumes.</p> <p>-d[g] <raw_device> [MU#] (HP-UX®, Linux®, Windows® NT/2000, Solaris® only): Searches a group on the configuration definition file (local instance) for the specified raw_device, and if the specified raw_device is contained in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified the raw_device is contained in two or more groups, the command is executed on the first group.</p> <p>-d[g] <seq#> <LDEV#> [MU#]: Searches a group on the configuration definition file (local instance) for the specified LDEV, and if the specified LDEV is contained in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified LDEV is contained in two or more groups, the command is executed on the first group. The <seq #> <LDEV #> values can be specified in hexadecimal (by addition of "0x ") or decimal notation.</p> <p>-c: Checks the conformability of the paired volumes of the local and remote hosts and reports the volume attribute of the remote host. If this option is not specified, the volume attribute of the local host is reported.</p> <p>-s[s]: Used to acquire the pair status of a volume in addition to the volume attribute. If this option is not specified, only the volume attribute is reported.</p> <p>-nomsg: Suppresses messages to be displayed when this command is executed. It is used to execute a command from a user program. This option must be specified at the beginning of a command argument. The command execution log is not affected by this option.</p>

Table 4.8 Pairvolchk Command Parameters (continued)

Parameter	Value
Options (cont.)	<p>-FHORC or -FCA: Forcibly specifies a cascading HORC volume for specified pair logical volumes on HOMRCF environment (see example in Figure 4.15). If no -c option is specified, this option acquires the attributes of a cascading HORC volume on a local host (near site). If the -c option is specified, this option acquires the attributes of a cascading HORC volume on a remote host (far site).</p> <p>-FMRCF [MU#] or -FBC [MU#]: Forcibly specifies a cascading HOMRCF volume for specified pair logical volumes on HORC environment (see example in Figure 4.16). If no -c option is specified, this option acquires the attributes of a cascading HOMRCF volume on a local host (near site). If the -c option is specified, this option acquires the attributes of a cascading HOMRCF volume on a remote host (far site).</p>
Returned values	<p>When the -s[s] option is not specified: Normal termination: 1: The volume attribute is SMPL. 2: The volume attribute is P-Vol. 3: The volume attribute is S-Vol.</p> <p>When the -s[s] option is specified: Normal termination: 11: The status is SMPL. HORC Sync / HOMRCF 22: The status is PVOL_COPY or PVOL_RCPY. 23: The status is PVOL_PAIR. 24: The status is PVOL_PSUS. 25: The status is PVOL_PSUE. 26: The status is PVOL_PDUB (HORC & LUSE volume only). 29: The status is PVOL_INCSTG (inconsistent status in group). Not returned.</p> <p> 32: The status is SVOL_COPY or SVOL_RCPY. 33: The status is SVOL_PAIR. 34: The status is SVOL_PSUS. 35: The status is SVOL_PSUE. 36: The status is SVOL_PDUB (HORC & LUSE volume only). 39: The status is SVOL_INCSTG (inconsistent status in group). Not returned.</p> <p>To identify HORC Async, the pairvolchk command returns a value which is 20 more than the HORC Sync status code and also indicates PFUL and PFUS states to identify sidefile status of HORC Async. HORC Async 42: The status is PVOL_COPY. 43: The status is PVOL_PAIR. 44: The status is PVOL_PSUS. 45: The status is PVOL_PSUE. 46: The status is PVOL_PDUB. (HORC & LUSE volume only) 47: The status is PVOL_PFUL. 48: The status is PVOL_PFUS.</p> <p> 52: The status is SVOL_COPY or SVOL_RCPY. 53: The status is SVOL_PAIR. 54: The status is SVOL_PSUS. 55: The status is SVOL_PSUE. 56: The status is SVOL_PDUB. (HORC & LUSE volume only) 57: The status is SVOL_PFUL. 58: The status is SVOL_PFUS.</p> <p>For group status, see Table 4.9 below.</p> <p>Abnormal termination: other than 0 to 127, refer to the execution log files for error details. 236: EX_ENQVOL 237: EX_CMDIOE 235: EX_EVOLCE ... When the -c option is specified only. 242: EX_ENORMT... When the -c option is specified only. 216: EX_EXTCTG 214: EX_EXQCTG</p>

Figure 4.15 shows a **pairvolchk** example that acquires the status (PVOL_PSUS) of the intermediate P/Pvol through specified pair group on HOMRCF environment. Figure 4.16 shows a **pairvolchk** example that acquires the status (PVOL_PSUS) of the intermediate S/Pvol (MU#1) through specified pair group on HORC environment.

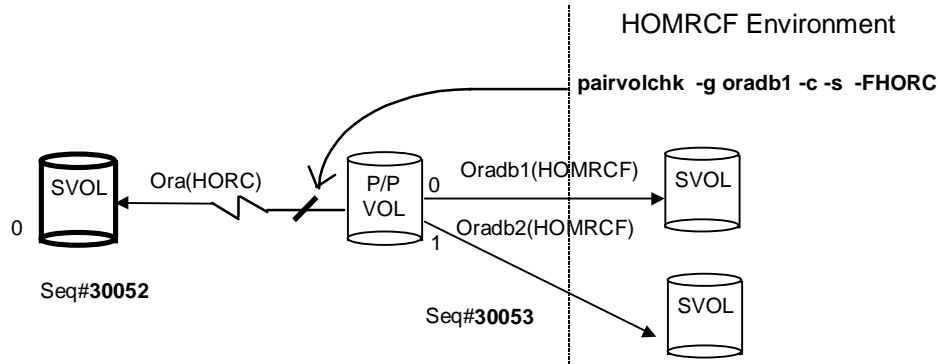


Figure 4.15 Example of -FHORC Option for Pairvolchk

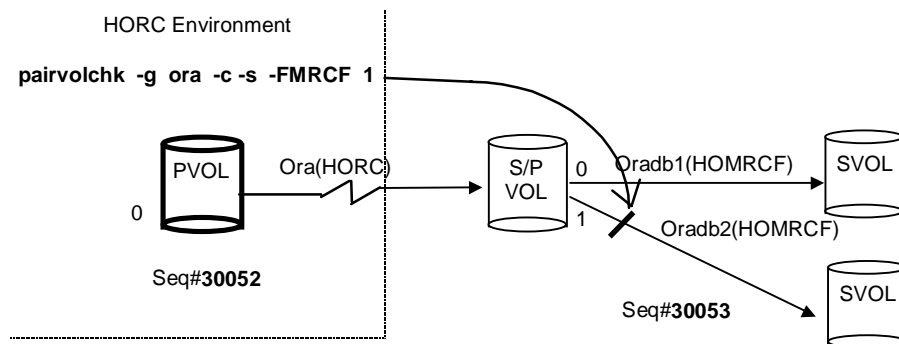


Figure 4.16 Example of -FMRCF Option for Pairvolchk

Table 4.9 Truth Table for Pairvolchk Group Status Display

Option	Status of Each Volume in the Group							Group Status
	COPY*	PSUE	PDUB	PFUS	PSUS	PFUL	PAIR	
-s	TRUE	x	x	x	x	x	x	COPY*
	false	TRUE	x	x	x	x	x	PSUE
	false	false	TRUE	x	x	x	x	PDUB
	false	false	false	TRUE	x	x	x	PFUS
	false	false	false	false	TRUE	x	x	PSUS
	false	false	false	false	false	TRUE	x	PFUL
	false	false	false	false	false	false	TRUE	PAIR
-ss	TRUE	x	x	x	x	x	x	COPY*
	false	TRUE	x	x	x	x	x	PSUE
	false	false	TRUE	x	x	x	x	PDUB
	false	false	false	x	x	TRUE	x	PFUL
	false	false	false	x	x	false	TRUE	PAIR
	false	false	false	TRUE	false	false	false	PFUS
	false	false	false	false	TRUE	false	false	PSUS

*COPY = COPY or RCPY

x = true or false (does not matter).

Note:

- The PFUL state is displayed as PAIR by all commands (except the **-fc** option of the pairdisplay command), since PFUL indicates PAIR state with sidefile at the HWM.
- The PFUS state is displayed as PSUS by all commands (except the **-fc** option of the pairdisplay command), since PFUS indicates SUSPENDED state due to sidefile full.

Table 4.10 State Transition Table for HA Control Script

State No.	Volume Attributes and Pair Status				Results Executing pairvolchk and horctakeover from DC1(DC2)						
	DC1(DC2)		DC2(DC1)		pairvolchk -s (local volume)	pairvolchk -s -c (remote volume)	Pair Status	Horctakeover result			
1	SMPL or SVOL-PSUS (SSWS)		SMPL		SMPL or SVOL-PSUS	SMPL	SMPL	EX_VOLCRE			
2			P-VOL	COPY		PVOL_XXX	XXX	Nop			
3				PAIR/PFUL							
4				PSUS							
4-1				PFUS							
5				PSUE							
6				PDUB							
8			S-VOL						EX_EVOLCE		EX_EVOLCE
9			Unknown						EX_ENORMT or EX_CMDIOE		(EX_ENORMT) (EX_CMDIOE)
10	P-VOL		SMPL		PVOL_XXX				SMPL	XXX	EX_VOLCRE
11	P-VOL		P-VOL			EX_EVOLCE		EX_EVOLCE			
12	data or status & PSUE or PDUB	S-VOL		SVOL_YYY		XXX	PVOL-PSUE → 12 or PVOL-SMPL → 8				
	Other			Nop							
13	data or status & PSUE or PDUB	Unknown		EX_ENORMT or EX_CMDIOE		XXX	PVOL-PSUE → 13 or PVOL-SMPL → 9				
	Other			Nop							
14	S-VOL		SMPL			SVOL_YYY	EX_EVOLCE		EX_EVOLCE		
15			P-VOL	COPY			PVOL_XXX	XXX	SVOL_E* → 4,5 SVOL_E* Swap → 12 SVOL_E → 4 SVOL → 4-1 SVOL → 5,6 SVOL_E → 5,6 SVOL → 5,6		
16				PAIR/PFUL							
17				PSUS							
18				PFUS							
				PSUE PDUB	data						
					status						
					never						
											async
21			S-VOL		EX_EVOLCE						EX_EVOLCE
22			COPY		Unknown					EX_ENORMT or EX_CMDIOE	YYY
23	PAIR/ PFUL	data	SVOL → 4								
		status	SVOL → 4								
		never	SVOL_E → 4								
		async	SVOL → 4								
24	PSUS		SVOL_E → 4								
	PFUS		SVOL → 4-1								
25	PSUE PDUB	data	SVOL → 5,6								
		status	SVOL_E → 5,6								
		never	SVOL_E → 5,6								
		async	SVOL → 5,6								

Note: Please see the next page for an explanation of the terms used in this table.

Explanation of terms in Table 4.10:

XXX = Pair status of P-VOL returned by “pairvolchk -s” or “pairvolchk -s -c” command.

YYY = Pair status of S-VOL returned by “pairvolchk -s” or “pairvolchk -s -c” command.

PAIR STATUS = Since the P-VOL controls status, PAIR STATUS is reported as PVOL_XXX (except when the P-VOL’s status is Unknown).

PVOL-PSUE = PVOL-PSUE-takeover.

PVOL-SMPL = PVOL-SMPL-takeover.

Nop = Nop-takeover.

Swap = Swap-takeover. When the horctakeover command execution succeeds, the state transitions to the indicated (→) state number.

SVOL = **SVOL-SSUS** takeover or **Swap**-takeover. In case of a host failure, this function executes Swap-takeover. In case of an ESCON® or P-VOL site failure, this function executes SVOL-SSUS-takeover.

SVOL_E = Execute **SVOL-SSUS** takeover and return **EX_VOLCUR**.

SVOL_E* = Return **EX_VOLCUR**.

When the horctakeover command execution succeeds, the state transitions to the indicated (→) state number. For example, if the HA control script sees svol_pair at the local (near) volume and pvol_pair at the remote (far) volume (like state 16 above), it will perform a swap takeover which will result in a state 12 situation.

Table 4.11 Error Codes for Pairvolchk and Horctakeover

Error Code	Error Message	Return Value
EX_ENORMT	No remote host alive to accept commands, or remote CCI might be blocked (sleeping) while performing I/O.	242
EX_CMDIOE	Control command I/O error.	237
	Control command I/O error, or rejected.	
EX_ENQVOL	Unmatched volume status within the group.	236
EX_EVOLCE	Pair volume combination error.	235
EX_INCSTG	Inconsistent status in group.	229
EX_VOLCUR	S-VOL currency error.	225
EX_VOLCUE	Local volume currency error.	224
EX_VOLCRE	Local and remote volume currency error.	223
EX_EXTCTG	Extended CT group between subsystems.	216
EX_ENQCTG	Unmatched CTGID within the group.	214

4.7.1 Recovery in Case of SVOL-Takeover

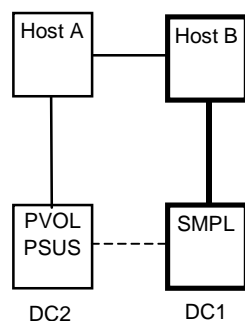
While the DC1 is conducting processing (normally state = 4), and when the DC2 has recovered from the failure, the following commands must be issued to make PVOL on the DC1 side:

In case of operations on the DC1 side:

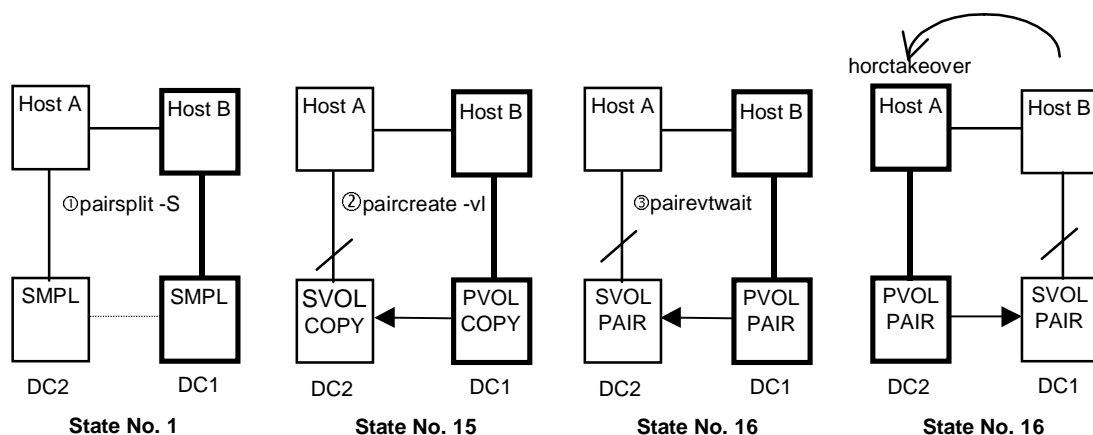
- ① pairsplit -S
- ② paircreate -vl
- ③ pairevtwait (wait for PAIR)

In case of operations on the DC2 side:

- ① pairsplit -S
- ② paircreate -vr
- ③ pairevtwait (wait for PAIR)



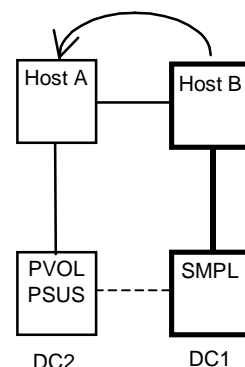
State No. 4



After operations (state is No.16), when the DC2 takes over processing from the DC1, the horctakeover command will execute a swap-takeover operation due to (DC2)SVOL & (DC1)PVOL_PAIR on the (DC2) side.

If the DC1 side has NO this operation, and when the DC2 takes over processing from the DC1, horctakeover command will be returned with **EX_VOLCRE** due to (DC2)PVOL & (DC1)SMPL on the (DC2) side.
→ state is No. 10.

In this case, pairvolchk (-s) command will be returned with **PVOL_PSUS** on the (DC2) side, and pairvolchk (-s -c) command will be returned with **SMPL** on the (DC2) side.



State No. 10

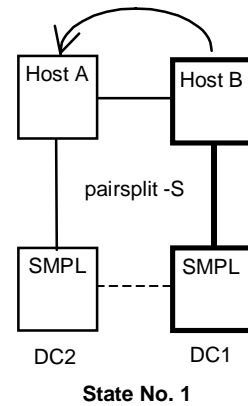
If after pairsplit operation, and when the DC2 takes over processing from the DC1, the horctakeover command will be returned with **EX_VOLCRE** due to (DC2)SMPL & (DC1)SMPL on the (DC2) side.

→ state is No. 1.

As for other case:

If the DC2 takes over processing from the DC1 on processing pairsplit operation, horctakeover command will be returned with **EX_ENQVOL (Unmatch volume status on the group)** due to the group's volume attribute is not the same on each volume ((DC2)SMPL & (DC2)PVOL) on the (DC2) side.

In this case, pairvolchk (-s) command will be returned with **EX_ENQVOL** on the (DC2) side.



When the DC1 side has this operation and while the DC1 has COPY state DC1 (PVOL-COPY) & DC2(SVOL-COPY), if the DC2 takes over processing from the DC1, and then it will be needed that ask operator for decision, and/or pairevtwait (wait for PAIR) on the (DC2) side.

→ state is No. 15.

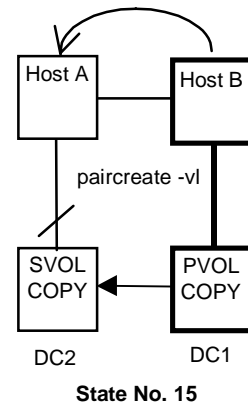
If the DC2 takes over processing from the DC1 without their confirmation operations, horctakeover command will be returned with **SVOL_E** (execute SVOL-takeover and return **EX_VOLCUR**) on the (DC2) side.

→ state is No. 15.

As for other case:

If the DC2 takes over processing from the DC1 on processing paircreate operation, horctakeover command will be returned with **EX_ENQVOL(Unmatch volume status on the group)** due to the group's volume attribute is not the same on each volume ((DC2)SMPL & (DC2)SVOL) on the (DC2) side.

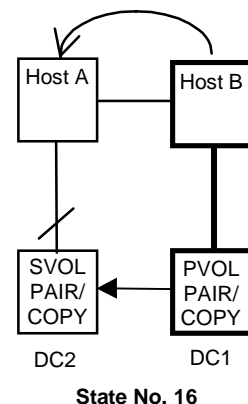
In this case, pairvolchk (-s) command will be returned with **EX_ENQVOL** on the (DC2) side.



As for other case in state No. 16:

If the DC2 takes over processing from the DC1 without pairevtwait (-s pair) operations, horctakeover command will be returned with **SVOL_E** (execute SVOL-takeover and return **EX_VOLCUR**) due to the group's volume attribute is not the same on each volume ((DC2)SVOL_PAIR & (DC2)SVOL_COPY) on the (DC2) side.

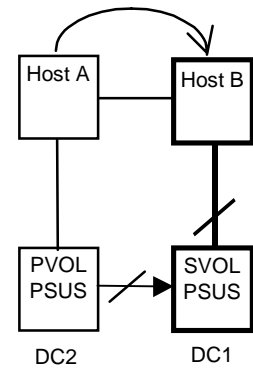
In this case, pairvolchk (-s) command will be returned with **SVOL_COPY** on the (DC2) side.



In case of state No. 17:

This case is pair suspend (using pairsplit command) by operator. The DC1 takes over processing from the DC2, when the DC2 has PSUS state DC1(SVOL-PSUS) & DC2(PVOL-PSUS) that will be needed that ask operator for decision, and/or pairresync on the DC1 side. If the DC1 takes over processing from the DC2 without their confirmation operations, horctakeover command will be returned with **SVOL_E** (execute SVOL-takeover and return **EX_VOLCUR**) on the (DC1) side.

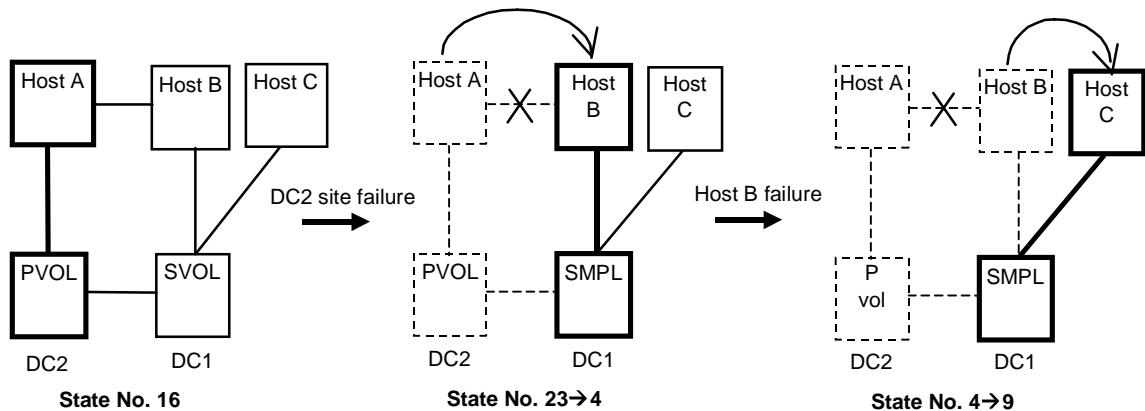
→ state is No. 17.



State No. 17

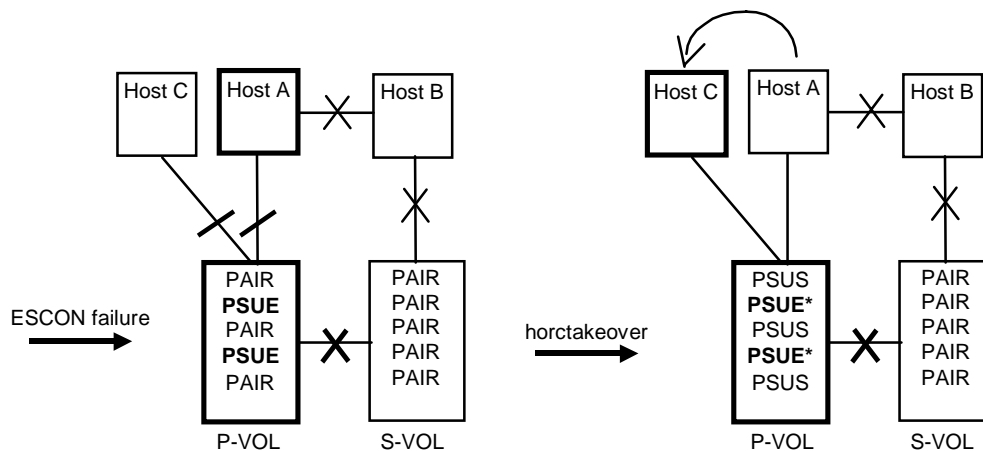
Consideration as for state No. 9

The horctakeover command will be failed with **EX_ENORMT** on the following nested failure case (state No. 4→9). Therefore, **HA Control Script** will be needed that ask operator for decision, and do nothing on the DC1 side.

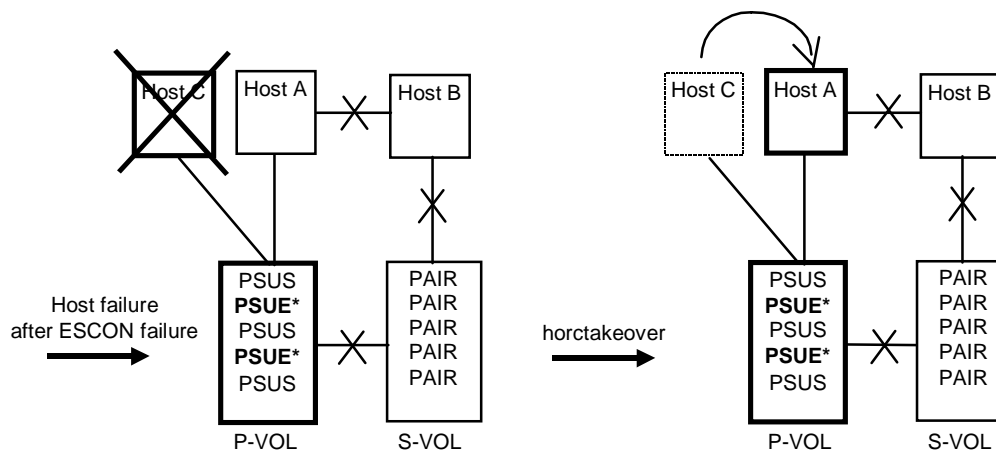


4.7.2 PVOL-PSUE-Takeover

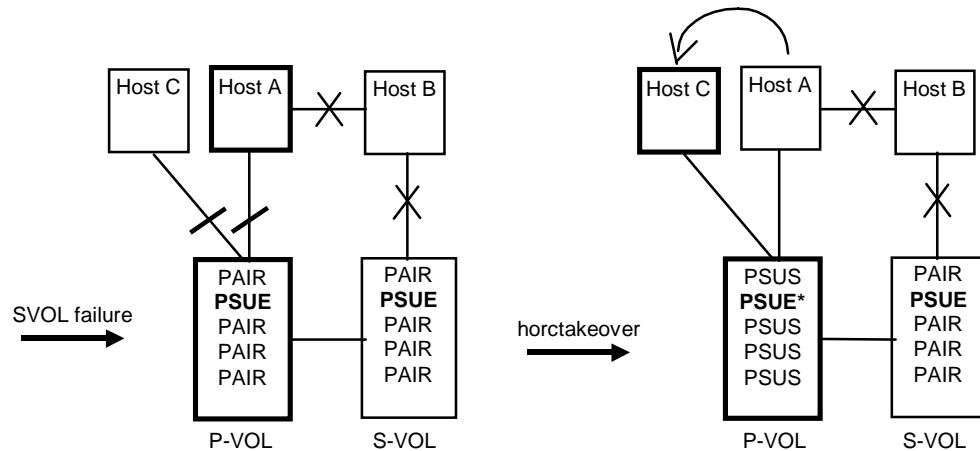
The horctakeover command executes PVOL-PSUE-takeover when the primary volume cannot be used (PSUE or PDUB volume is contained in the group), and will be returned with “PVOL-PSUE-takeover” as the return value. PVOL-PSUE-takeover changes the primary volume to the suspend state (PSUE or PDUB → **PSUE***, PAIR → PSUS) which permits WRITE to all primary volumes of the group.



The horctakeover command will be returned with PVOL-PSUE-takeover also on the following nested failure case.



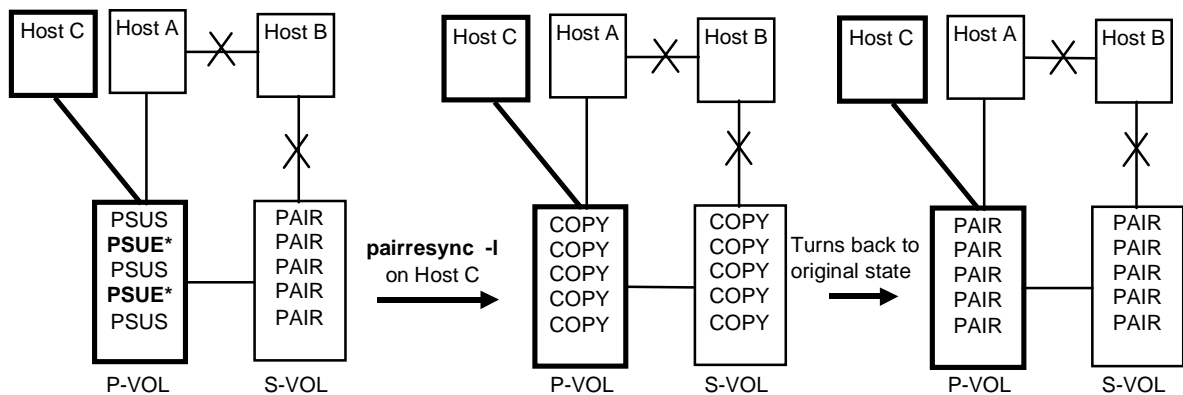
Even though ESCON® has been connected to S-VOL, PVOL-PSUE-takeover is changed to the suspend state with the primary volume only (**SVOL's state is not changed**), since that maintains consistence of the secondary volume at having accepted horctakeover command.



Group STATUS of the P-VOL. The PSUE and/or PSUS status is intermingled in the group through action of this PVOL-PSUE-takeover. This intermingled pair status is PSUE as the group status, therefore the pairvolchk command returned give priority PSUE(PDUB) instead of PSUS as the group status. Therefore, the group status of the PVOL is also continued after the PVOL-PSUE-takeover.

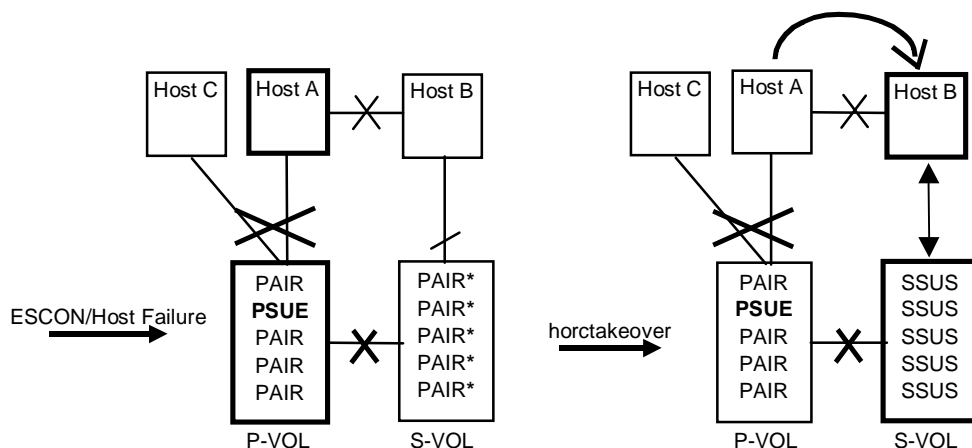
4.7.3 Recovery in Case of PVOL-PSUE-Takeover

This special state (**PSUE***) turns back to original state after the successful execution of the pairresync command (after the recovery of ESCON® link). If the pairresync command has been failed at the ESCON® link is not restored, then this special state (**PSUE***) is NOT changed.



4.7.4 SVOL-SSUS Takeover in Case of ESCON®/Host Failure

The SVOL-Takeover executes **SVOL-SSUS-takeover** to enable writing without changing the SVOL to SMPL. SVOL-SSUS-takeover changes the SVOL to the suspend state (PAIR, PSUE → SSUS) which permits write and maintains delta data (bitmap) for all SVOLs of the group.



PAIR* = PAIR for CA Sync., PAIR→PSUE for HORC Async.
SSUS = SVOL_PSUS

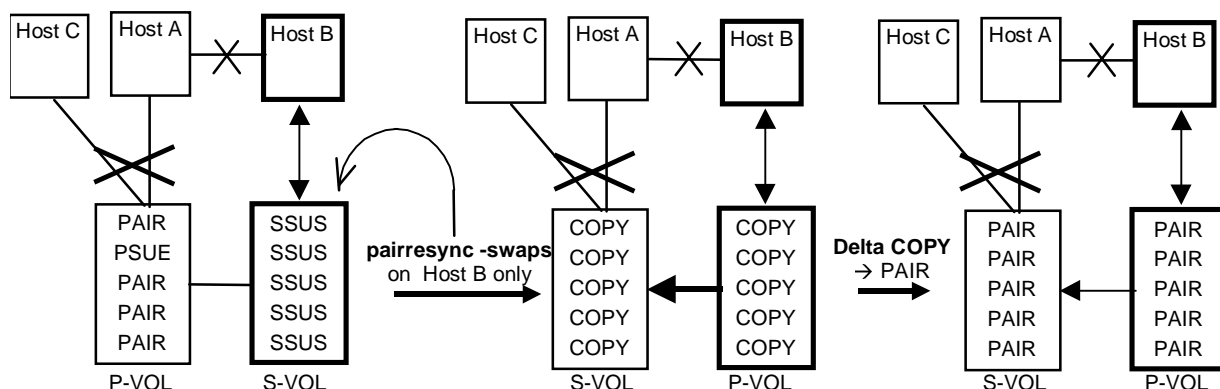
Group status of SVOL-SSUS-takeover: After SVOL-SSUS-takeover completes, the SVOL status is displayed as SSUS by pairdisplay command, and pairvolchk command will return SVOL status as SVOL_PSUS. Also this special state is displayed as SSWS using the **-fc** option of the pairdisplay command. This special state (PVOL_PSUE and SVOL_PSUS) between PVOL and SVOL may be needed that is handled by HA Control Script.

HORC Async: Before the SVOL is changed to SSUS, the SVOL-takeover will try to copy non-transmitted data (which remains in the FIFO queue (sidefile) of the PVOL) to the SVOL. In case of an ESCON® failure, this data synchronize operation may fail. Even so, the SVOL-takeover function will execute the force split to SSUS, enabling the SVOL to be used.

Note: Non-transmitted data (which remains in the FIFO queue (sidefile) of the PVOL) will be reflected to the bitmap to empty the FIFO queue, and the pair state will be set to PSUE. This non-transmitted data which is reflected to the bitmap **will be lost** (resynchronized as NEW_SVOL) by issuing of the pairresync-swaps command for recovery from SVOL-SSUS-takeover on takeover site (Host B) (see next section).

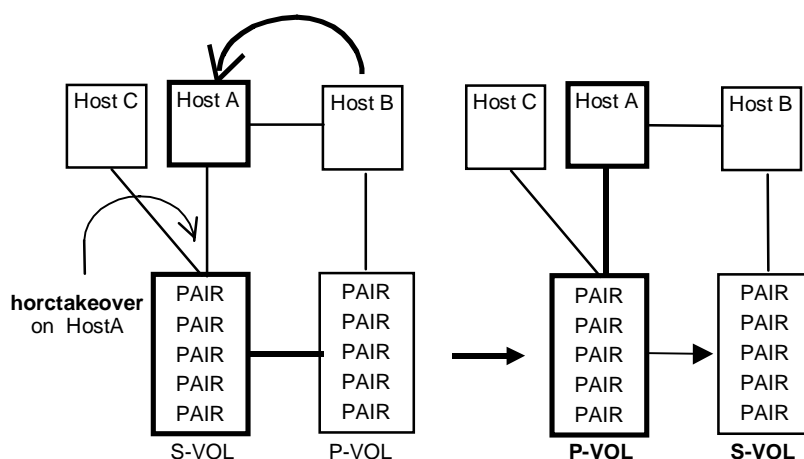
4.7.5 Recovery from SVOL-SSUS-Takeover

After recovery of the ESCON[®] link, this special state (PVOL_PSUE and SVOL_PSUS) will be changed to COPY state that original SVOL is swapped as the NEW_PVOL and resynchronizes (cast off original PVOL) the NEW_SVOL based on the NEW_PVOL by issuing of the **pairresync -swaps** command on takeover site (Host B).

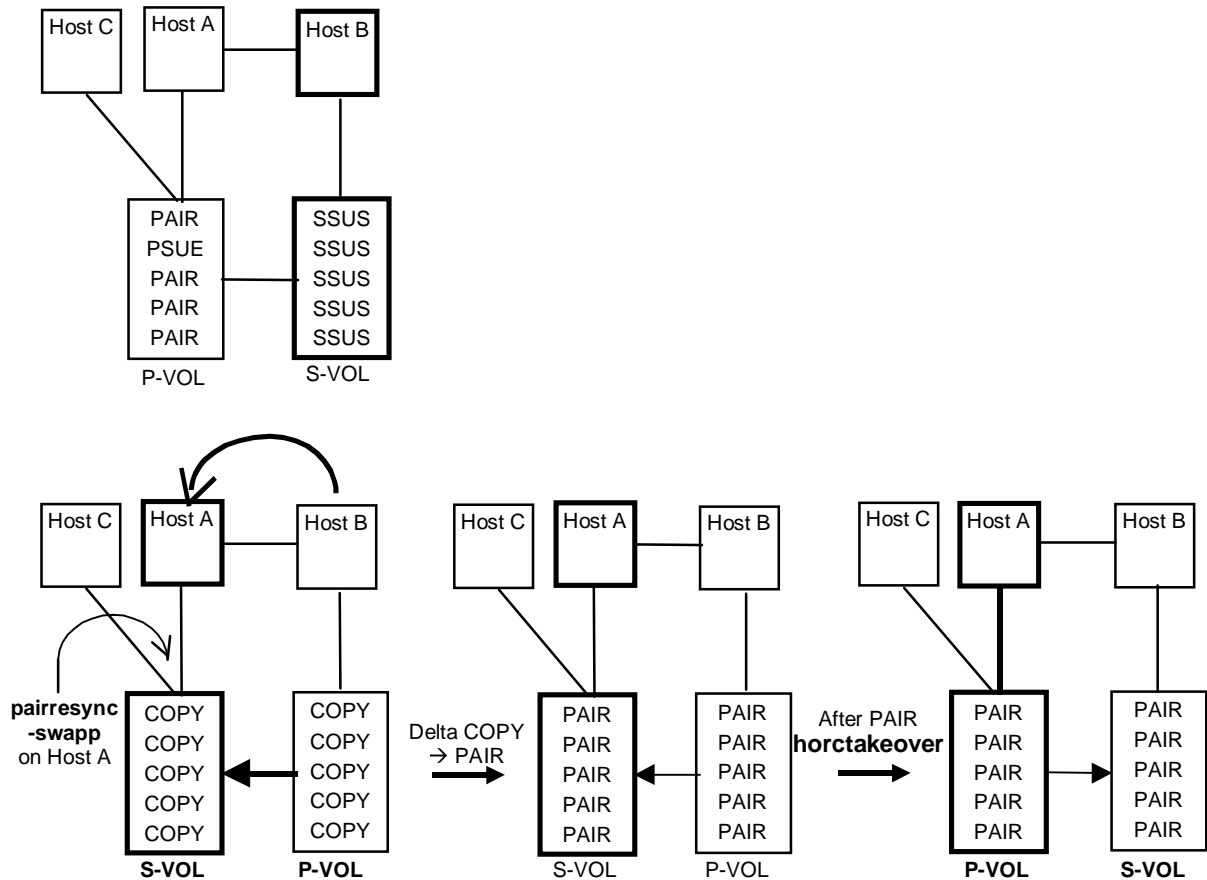


If the pairresync -swaps command has been failed at the ESCON[®] link is not restored, then this special state (PVOL_PSUE and SVOL_PSUS) is NOT changed.

Failback after recovery on Host B. After recovery with execution of the pairresync -swaps command on Host B, if you stop the applications on Host B and restart the applications on Host A, then horctakeover will execute Swap-Takeover, even though Host A cannot communicate with remote Host B.



Failback without recovery on Host B. After recovery of the ESCON® link and hosts, if you stopped the applications without executing the pairresync -swaps command on Host B and restarted the applications on Host A, you must use the following procedure for recovery. At this time, pairvolchk command on Host A will be returned **PVOL_PSUE & SVOL_PSUS** as state combination.

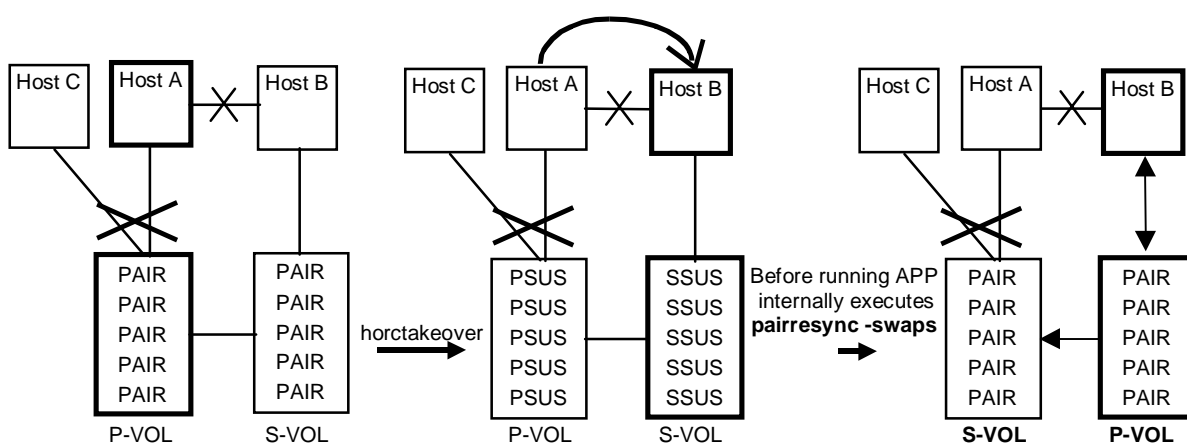


Note: The pairresync -swapp option is used to be swapped volume from the PVOL to SVOL at suspending state on the **PVOL side** and re-synchronizes (cast off original PVOL) the NEW_SVOL based on the NEW_PVOL. At the result of this operation, the volume attributes of own host (local host) becomes for the NEW_SVOL. **The target volume of the local host must have the P-VOL, and needs to the remote host for this operation.**

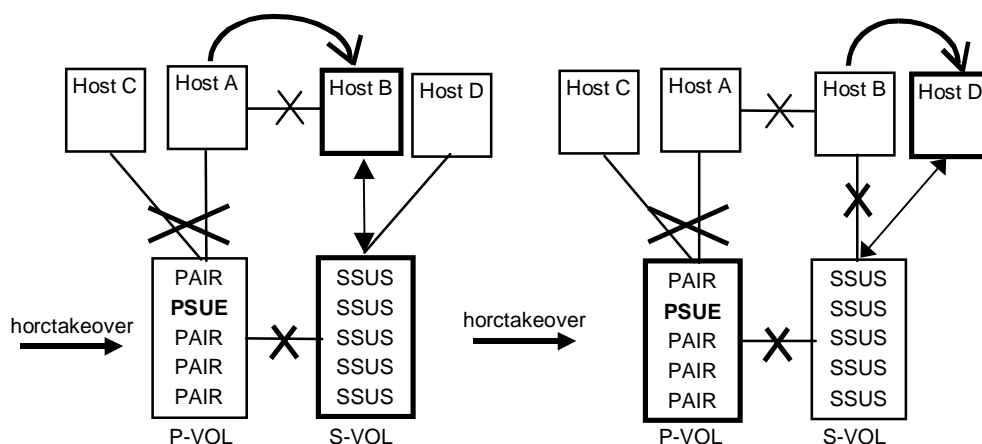
4.7.6 SVOL-Takeover in Case of Host Failure

After SVOL-takeover changed to the suspend (PAIR, PSUE → SSUS) state with the SVOL only, internal operation of SVOL-takeover will be executed **pairresync -swaps** command for maintaining mirror consistency between NEW_PVOL and NEW_SVOL, and then will be returned with Swap-takeover as the return value of horctakeover command.

HORC Async. Before the SVOL is changed to SSUS, the SVOL-takeover will copy non-transmitted data (which remains in the FIFO queue (sidefile) of the PVOL) to the SVOL side. The SVOL-takeover operation is waited to copy non-transmitted data of the PVOL before a timeout value (that is specified by `-t <timeout>` option). After the completion of a synchronous state between the PVOL and SVOL, the SVOL-takeover will be split and the state will be changed to SSUS, and the operation of after that is same.



Since the SVOL has been the **SSWS** already as state of the SVOL_SSUS takeover after, the horctakeover command will do nothing in this nested failure case.



4.8 Displaying Pair Status (Pairedisplay)

The pairedisplay command displays the pair status allowing you to verify completion of pair operations (e.g., paircreate, pairresync). The pairedisplay command is also used to confirm the configuration of the pair connection path (the physical link of paired volumes and servers). The pairedisplay command can be used for a paired volume or a group of paired volumes. Figure 4.17 and Figure 4.18 show examples of the pairedisplay command and its output. Table 4.12 lists and describes the pairedisplay command parameters and returned values.

# pairedisplay -g oradb -fcx										
Group	Pair Vol(L/R)	(P,T#,L#),	Seq#,	LDEV#..	P/S,	Status,	Fence,	Copy%,	P-LDEV#	M
oradb	oradb1(L)	(CL1-B, 1,0)	1234	64.....	P-VOL	PAIR	Never,	75	C8	-
oradb	oradb1(R)	(CL1-A, 1,0)	5678	C8.....	S-VOL	PAIR	Never,	---	64	-



Figure 4.17 HORC Pairedisplay Command Example

# pairedisplay -g oradb										
Group	Pair Vol(L/R)	(Port#,TID,LU-M),	Seq#,	LDEV#....	P/S,	Status,	Fence,	Seq#,	P-LDEV#	M
oradb	oradb1(L)	(CL1-A, 1,0)	30053	18.....	P-VOL	PAIR	Never,	30053	19	-
oradb	oradb1(R)	(CL1-D, 1,0)	30053	19.....	S-VOL	PAIR	Never,	----	18	-

Figure 4.18 HOMRCF Pairedisplay Command Example

The output of the pairedisplay command includes:

- Group = group name (dev_group) as described in the configuration definition file.
- Pair Vol(L/R) = paired volume name (dev_name) as described in the configuration definition file. (L) = local host; (R) = remote host.
- (P,T#,L#) (HORC) = port number, target ID, and LU number as described in the configuration definition file. For further information on fibre-to-SCSI address conversion, see Appendix D.
- (Port#,TID,LU-M) (HOMRCF) = port number, target ID, LU number, and MU number as described in the configuration definition file.
- Seq# = serial number of the 9900 subsystem.
- LDEV# = logical device number.
- P/S = volume attribute.
- Status = status of the paired volume.
- Fence (HORC only) = fence level.
- % (HORC only) = copy operation completion, or percent pair synchronization

State Vol.	HORC Async			HORC sync			HOMRCF		
	COPY	PAIR	OTHER	COPY	PAIR	OTHER	COPY	PAIR	OTHER
PVOL	CR	SF	BMP	CR	BMP	BMP	CR	CR	CR
SVOL		SF	BMP		BMP	BMP	CR	CR	CR

CR: Shows the copy operation rate (identical rate of a pair).

BMP: Shows the identical percentage of BITMAP both PVOL and SVOL.

SF: Shows sidefile percentage of each CT group as sidefile 100% on cache of both PVOL and SVOL. The following is an arithmetic expression of HWM as 100 % of a sidefile space: $HWM(\%) = 30 / \text{sidefile space (30 to 70)} * 100$

- P-LDEV# = LDEV number of the partner volume of the pair.
- M = W (PSUS only)
For P-VOLs, shows suspension with the S-VOL read/write enabled.
For S-VOLs, shows that write I/Os were accepted at the S-VOL.
M = N (COPY, RCPY, PAIR, PSUE). Shows that read access is disabled.

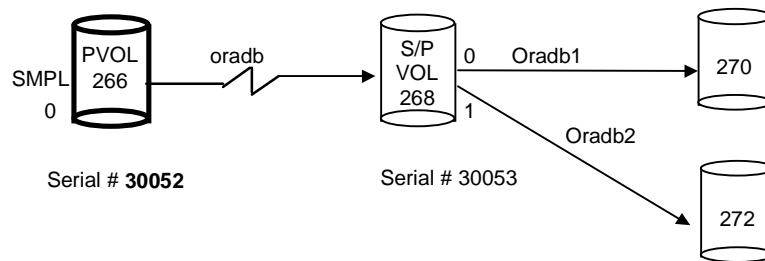
Table 4.12 Pairdisplay Command Parameters (continues on the next page)

Parameter	Value
Command Name	pairdisplay
Format	pairdisplay { -h -q -z -g <group> -d <pair Vol> -d[g] <raw_device> [MU#] -FHORC -FMRCF [MU#] -d[g] <seq#> <LDEV#> [MU#] -c -l -f[xc] -CLI -m <mode> }
Options	<p>-h: Displays Help/Usage and version information.</p> <p>-q: Terminates the interactive mode and exits the pair volume check command.</p> <p>-z or -zx: Makes the pairdisplay command enter the interactive mode. The -zx option guards performing of the HORCM in the interactive mode. When this option detects a HORCM shut down, interactive mode terminates.</p> <p>-g <group>: Specifies the group name defined in the configuration definition file. This option must always be specified. The command is executed for the specified group unless the -d <pair Vol> option is specified.</p> <p>-d <pair Vol>: This option is used to specify the paired logical volume name defined in the configuration definition file. When this option is specified, the command is executed for the specified paired logical volumes.</p> <p>-d[g] <raw_device> [MU#] (HP-UX®, Linux®, Windows® NT/2000, Solaris® only): Searches a group on the configuration definition file (local instance) for the specified raw_device, and if the specified raw_device is contained in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified the raw_device is contained in two or more groups, the command is executed on the first group.</p> <p>-FHORC or -FCA: Forcibly specifies a cascading HORC volume for specified pair logical volumes on HOMRCF environment. If the -l option is specified, this option displays status of a cascading HORC volume on a local host (near site). If no -l option is specified, this option displays status of a cascading HORC volume on a remote host (far site). This option cannot be specified with -m <mode> option on the same command line.</p> <p>-FMRCF [MU#] or -FBC [MU#]: Forcibly specifies a cascading HOMRCF volume for specified pair logical volumes on HORC environment. If the -l option is specified, this option displays status of a cascading HOMRCF volume on a local host (near site). If no -l option is specified, this option displays status of a cascading HOMRCF volume on a remote host (far site). This option cannot be specified with -m <mode> option on the same command line.</p> <p>-d[g] <seq#> <LDEV#> [MU#]: Searches a group on the configuration definition file (local instance) for the specified LDEV, and if the specified LDEV is contained in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified LDEV is contained in two or more groups, the command is executed on the first group. The <seq #> <LDEV #> values can be specified in hexadecimal (by addition of "0x ") or decimal notation.</p> <p>-c: Checks the configuration of the paired volume connection path (physical link of paired volume among the servers) and displays illegal pair configurations. If this option is not specified, the status of the specified paired volume is displayed without checking the path configuration.</p> <p>-l: Displays the paired volume status of the local host (which issues this command).</p> <p>-fc: Displays the copy operation progress, the sidefile percentage, or the bitmap percentage. Displays PFUL/PFUS for HORC Async. Used to confirm SSWS state as indication of SVOL_SSUS-takeover after.</p> <p>-fx: Displays the LDEV ID as a hexadecimal number.</p>

Table 4.12 Pairedisplay Command Parameters (continued)

Parameter	Value
Options (continued)	<p>-CLI: Used to specify display for command line interface (CLI). This option displays to the same position that defined number of columns, and displays one header. The delimiters between columns are displayed as spaces or hyphens (-). Display example:</p> <pre> Group PairVol L/R Port# TID LU-M Seq# LDEV# P/S Status Seq# P-LDEV# M homrcf1 deva0 L CL1-D 3 5 0 30053 271 P-VOL PAIR 30053 263 - homrcf1 deva1 L CL1-D 3 5 1 30053 271 SMPL - - - - homrcf1 deva2 L CL1-D 3 5 2 30053 271 SMPL - - - - </pre> <p>-m <mode>: Used to display a paired status of each mirror descriptors for the specified pair logical volume, and used for paired status indication of the cascading volume. <mode> option can be designated "cas" or "all " (see Figure 4.19):</p> <ul style="list-style-type: none"> "cas" option is used to display a paired status of specified group that is registered to the mirror descriptor (MU#) on the cascading configuration file. "all" option is used to display a paired status of all mirror descriptors (MU#). <p>This option (-m <mode>) is not affected with command execution environment (HORC and HOMRCF), and displays the paired status. This option cannot be specified with the -FHORC/-FMRCF option on the same command line.</p>
Returned values	<p>1: The volume attribute is SMPL.</p> <p>2: The volume attribute is P-Vol.</p> <p>3: The volume attribute is S-Vol. When displaying groups, 1/2/3 = normal termination for all pairs.</p> <p>Abnormal termination (other than 0 to 127): refer to the execution log files for error details.</p>

Figure 4.19 shows examples of the **-m** option of the pairdisplay command.



Display example for **-m cas**:

```
# pairdisplay -g oradb -m cas
```

Group	PairVol(L/R)	(Port#,TID,LU-M)	Seq#	LDEV#..P/S	Status	Seq#	P-LDEV#	M
oradb	oradev1(L)	(CL1-D , 3, 0-0)	30052	266....SMPL	----	-----	----	-
oradb	oradev1(L)	(CL1-D , 3, 0)	30052	266....P-VOL	COPY,	30053	268	-
oradb1	oradev11(R)	(CL1-D , 3, 2-0)	30053	268....P-VOL	COPY,	30053	270	-
oradb2	oradev21(R)	(CL1-D , 3, 2-1)	30053	268....P-VOL	PSUS,	30053	272	W
oradb	oradev1(R)	(CL1-D , 3, 2)	30053	268....S-VOL	COPY,	-----	266	-

Display examples for **-m all**:

```
# pairdisplay -g oradb -m all
```

Group	PairVol(L/R)	(Port#,TID,LU-M)	Seq#	LDEV#..P/S	Status	Seq#	P-LDEV#	M
oradb	oradev1(L)	(CL1-D , 3, 0-0)	30052	266....SMPL	----	-----	----	-
-----	----- (L)	(CL1-D , 3, 0-1)	30052	266....SMPL	----	-----	----	-
-----	----- (L)	(CL1-D , 3, 0-2)	30052	266....SMPL	----	-----	----	-
oradb	oradev1(L)	(CL1-D , 3, 0)	30052	266....P-VOL	PAIR,	30053	268	-
oradb1	oradev11(R)	(CL1-D , 3, 2-0)	30053	268....P-VOL	COPY,	30053	270	-
oradb2	oradev21(R)	(CL1-D , 3, 2-1)	30053	268....P-VOL	PSUS,	30053	272	W
-----	----- (R)	(CL1-D , 3, 2-1)	30053	268....SMPL	----	-----	----	-
oradb	oradev1(R)	(CL1-D , 3, 2)	30053	268....S-VOL	COPY,	-----	266	-

↖ No MU# indicates a HOCR volume.

```
# pairdisplay -d /dev/rdsd/c0t3d0 -l -m all
```

Group	PairVol(L/R)	(Port#,TID,LU-M)	Seq#	LDEV#..P/S	Status	Seq#	P-LDEV#	M
oradb	oradev1(L)	(CL1-D , 3, 0-0)	30052	266....SMPL	----	-----	----	-
-----	----- (L)	(CL1-D , 3, 0-1)	30052	266....SMPL	----	-----	----	-
-----	----- (L)	(CL1-D , 3, 0-2)	30052	266....SMPL	----	-----	----	-
oradb	oradev1(L)	(CL1-D , 3, 0)	30052	266....P-VOL	PAIR,	30053	268	-

Figure 4.19 Pairdisplay -m Example

4.9 Checking HORC Pair Currency (Paircurchk)

The HORC paircurchk command checks the currency of the HORC secondary volume(s) by evaluating the data consistency based on pair status and fence level. Table 4.13 specifies the data consistency for each possible state of a HORC volume. A paired volume or group can be specified as the target of the paircurchk command. The paircurchk command assumes that the target is an S-VOL. If the paircurchk command is specified for a group, the data consistency of each volume in the group is checked, and all inconsistent volumes are found in the execution log file and displayed. Paircurchk is also executed as part of the HORC takeover command (see next section).

Table 4.13 Data Consistency Displayed by the Paircurchk Command

Object Volume			Currency	
Attribute	Status	Fence	Paircurchk	SVOL_takeover
SMPL	—	—	To be confirmed	—
P-VOL	—	—	To be confirmed	—
S-VOL	COPY	Data		
		Status	Inconsistent	Inconsistent
		Never		
		Async	Inconsistent	Inconsistent
	PAIR	Data	OK	OK
		Status	OK	OK
		Never	To be analyzed	To be analyzed
	PAIR	Async	To be analyzed	OK (assumption)
	PFUL		To be analyzed	OK (assumption)
	PSUS	Data	Suspected	Suspected
		Status	Suspected	Suspected
		Never	Suspected	Suspected
	PSUS	Async	Suspected	Suspected
	PFUS		Suspected	OK (assumption)
	PSUE PDUB	Data	OK	OK
		Status	Suspected	Suspected
		Never	Suspected	Suspected
		Async	Suspected	OK (assumption)
	SSWS	Data	Suspected	—
		Status	Suspected	
		Never	Suspected	
		Async	Suspected	

Notes:

1. To be confirmed = It is necessary to check the object volume, since it is not the secondary volume.
2. Inconsistent = Data in the volume is inconsistent because it was being copied.
3. OK (assumption) = Mirroring consistency is not assured, but as S-VOL of HORC Async the sequence of write data is ensured.

Figure 4.20 shows an example of the paircurchk command for a group and the resulting display of inconsistent volumes in the specified group. Table 4.14 lists and describes the paircurchk command parameters and returned values.

# paircurchk -g oradb									
Group	Pair vol	Port	targ#	lun#	LDEV#	Volstatus	Status	Fence	To be...
oradb	oradb1	CL1-A	1	5	145	S-VOL	PAIR	NEVER	Analyzed
oradb	oradb2	CL1-A	1	6	146	S-VOL	PSUS	STATUS	Suspected

Figure 4.20 Paircurchk Command Example

Table 4.14 Paircurchk Command Parameters

Parameter	Value
Command Name	paircurchk
Format	paircurchk { -h -q -z -g <group> -d <pair Vol> -d[g] <raw_device> [MU#] -d[g] <seq#> <LDEV#> [MU#] -nomsg }
Options	<p>-h: Displays Help/Usage and version information.</p> <p>-q: Terminates the interactive mode and exits the command.</p> <p>-z or -zx: Makes the paircurchk command enter the interactive mode. The -zx option guards performing of the HORCM in the interactive mode. When this option detects a HORCM shut down, interactive mode terminates.</p> <p>-g <group>: Specifies a group name defined in the configuration definition file. The command is executed for the specified group unless the -d <pair Vol> option is specified.</p> <p>-d <pair Vol>: Specifies paired logical volume name defined in the configuration definition file. When this option is specified, the command is executed for the specified paired logical volume.</p> <p>-d[g] <raw_device> [MU#] (HP-UX®, Linux®, Windows® NT/2000, Solaris® only): Searches a group on the configuration definition file (local instance) for the specified raw_device, and if the specified raw_device is contained in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified the raw_device is contained in two or more groups, the command is executed on the first group.</p> <p>-d[g] <seq#> <LDEV#> [MU#]: Searches a group on the configuration definition file (local instance) for the specified LDEV, and if the specified LDEV is contained in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified LDEV is contained in two or more groups, the command is executed on the first group. The <seq #> <LDEV #> values can be specified in hexadecimal (by addition of "0x ") or decimal notation.</p> <p>-nomsg: Suppresses messages to be displayed when this command is executed. This option must be specified at the beginning of a command argument. The command execution log is not affected by this option.</p>
Returned values	<p>Normal termination (data is consistent): 0</p> <p>Abnormal termination: other than 0, refer to the execution logs for error details.</p>

4.10 Performing HORC Takeover Operations

The `horctakeover` command is a scripted command for executing several HORC operations. The takeover command checks the specified volume's or group's attributes (`paircurchk`), decides the takeover function based on the attributes, executes the chosen takeover function, and returns the result. The four HORC takeover functions designed for HA software operation are (see section 4.2.1): `takeover-switch`, `swap-takeover`, `PVOL-takeover`, and `SVOL-takeover`. A paired volume or a group can be specified as the target of the HORC takeover command. If HORC SVOL-takeover is specified for a group, the data consistency check is executed for all volumes in the group, and all inconsistent volumes are found in the execution log file and displayed (same as `paircurchk` command).

The takeover command allows swapping of the primary and secondary volumes, so that if the primary or secondary volume is switched due to a server error or package transfer, duplex operations can be continued using the reversed volumes. When control is handed over to the current node, swapping the volumes again eliminates the need to copy them. The takeover command also allows the secondary volume to be separated for disaster recovery operations.

Table 4.15 lists and describes the HORC takeover command parameters and returned values.

Table 4.15 Horctakeover Command Parameters

Parameter	Value
Command Name	horctakeover
Format	horctakeover { -h -q -z -g <group> -d <pair Vol> -d[g] <raw_device> [MU#] -d[g] <seq#> <LDEV#> [MU#] -S -I -t <timeout> -nomsg }
Options	<p>-h: Displays Help/Usage and version information.</p> <p>-q: Terminates the interactive mode and exits the command.</p> <p>-z or -zx: Makes the horctakeover command enter the interactive mode. The -zx option guards performing of the HORCM in the interactive mode. When this option detects a HORCM shut down, interactive mode terminates.</p> <p>-g <group>: Specifies a group name defined in the configuration definition file. The command is executed for the specified group unless the -d <pair Vol> option is specified.</p> <p>-d <pair Vol>: Specifies paired logical volume name defined in the configuration definition file. When this option is specified, the command is executed for the specified paired logical volume.</p> <p>-d[g] <raw_device> [MU#] (HP-UX®, Linux®, Windows® NT/2000, Solaris® only): Searches a group on the configuration definition file (local instance) for the specified raw_device, and if the specified raw_device is contained in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified the raw_device is contained in two or more groups, the command is executed on the first group.</p> <p>-d[g] <seq#> <LDEV#> [MU#]: Searches a group on the configuration definition file (local instance) for the specified LDEV, and if the specified LDEV is contained in the group, the target volume is executed as the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified LDEV is contained in two or more groups, the command is executed on the first group. The <seq #> <LDEV #> values can be specified in hexadecimal (by addition of "0x ") or decimal notation.</p> <p>-S: Selects and executes SVOL-takeover. The target volume of the local host must be an S-VOL. If this option is specified, then the following "-I" option is invalid.</p> <p>-I: Enables read and write to the primary volume(s) by a local host only without a remote host, and executes PVOL-takeover when the primary volume cannot be used because it is fenced (fence = DATA or STATUS, state = PSUE or PDUB, or PSUE or PDUB volume is contained in the group). If the primary volume can be accessed, nop-takeover is executed. The target volume of the local host must be a P-VOL.</p> <p>-t <timeout>: Must be specified for async volumes only, ignored for sync. Specifies the maximum time to wait (in seconds) for swap-takeover and SVOL-takeover operation to synchronize the P-VOL and S-VOL. If this timeout occurs, the horctakeover command fails with EX_EWSTOT. To avoid timeout, set this value less than or equal to the start-up timeout value of the HA Control Script.</p> <p>-nomsg: Suppresses messages to be displayed when this command is executed. This option must be specified at the beginning of a command argument. The command execution log is not affected by this option.</p>
Returned values	<p>Normal termination:</p> <ul style="list-style-type: none"> 0: Nop-takeover (no operation). 1: Swap-takeover was successfully executed. 2: SVOL-takeover was successfully executed. 3: PVOL-SMPL-takeover was successfully executed. 4: PVOL-PSUE-takeover was successfully executed. (This value depends on the 9900 microcode level.) 5: SVOL-SSUS-takeover was successfully executed. (This value depends on the 9900 microcode level.) <p>Abnormal termination: other than 0-5, refer to the execution logs for error details.</p>

4.10.1 Horctakeover Command Functions

Takeover-Switch Function

The control scripts activated by the HA software are used the same way by all nodes of a cluster; they do not discriminate between primary and secondary volumes. The takeover command, when activated by a control script, checks the combination of attributes of the local and remote volumes and determines the proper takeover action. Table 4.16 lists the volume attributes and specifies the HORC takeover action for each combination of attributes.

Table 4.16 Volume Attributes and Takeover Actions

Local Node (Takeover Node)		Remote Node		Takeover Action
Volume Attribute	Fence Level and Status	Volume Attribute	P-VOL Status	
SMPL	-	SMPL	-	NG [1]
		P-VOL	-	Nop-Takeover [2]
		S-VOL	-	Volumes not conform [3]
		Unknown [4]	-	NG
P-VOL (primary)	Fence = Data or Status Status = PSUE or PDUB	SMPL	-	NG
		P-VOL	-	Volumes not conform
		S-VOL	-	PVOL-Takeover
		Unknown Status (e.g. LAN down)	-	PVOL-Takeover
	Fence = Never Status = others	SMPL	-	NG
		P-VOL	-	Volumes not conform
		S-VOL	-	Nop-Takeover
		Unknown Status (e.g. LAN down)	-	Nop-Takeover
S-VOL (secondary)	Status = SSWS [5] After SVOL_SSUS-takeover	Any	-	Nop-Takeover
	Others	SMPL	-	Volumes not conform
		P-VOL	PAIR or PFUL	Swap-Takeover
			Others	SVOL-Takeover
		S-VOL	-	Volumes not conform
		Unknown	-	SVOL-Takeover

Notes:

1. NG = The takeover command is rejected, and the operation terminates abnormally.
2. Nop-Takeover = The takeover command is accepted, but no operation is performed.
3. Volumes not conform = The volumes are not in sync, and the takeover command terminates abnormally.
4. Unknown = The remote node attribute is unknown and cannot be identified. The remote node system is down or cannot communicate.
5. SSWS = Suspend for Swapping with SVOL side only. The SSWS state is displayed as SSUS (SVOL_PSUS) by ALL commands except the "-fc" option of the pairdisplay command.

Swap-Takeover Function

When the P-VOL status of the remote node is PAIR and the S-VOL data is consistent, it is possible to swap the primary and secondary volumes. The swap-takeover function is used by the HA control script when a package is manually moved to an alternate data center while all hardware is operational. Swap-takeover can be specified for a paired volume or a group.

The swap-takeover function internally executes the following commands to swap the primary and secondary volumes:

1. Execute **Suspend for Swapping** for the local volume (S-VOL). If this step fails, swap-takeover is disabled and an error is returned.
2. Execute **Resync for Swapping** for switch to the primary volume that the local volume (S-VOL) is swapped as the NEW_PVOL and re-synchronizes the NEW_SVOL based on the NEW_PVOL. As for copy tracks, if the remote host is known, the command will use the value of PVOL specified at paircreate time. If the remote host is unknown, the command will use the default number of tracks (three). If this step fails, swap-takeover returns at **SVOL-SSUS-takeover**, and the local volume (S-VOL) is maintained in SSUS(PSUS) state which allows and keeps track of write I/Os using a bitmap for the S-VOL. This special state is displayed as **SSWS** using the **-fc** option of the pairdisplay command.

Note: The swap-takeover function does not use **SMPL** or **No Copy** mode for swapping to guarantee mirror consistence, and this is included as a function of SVOL-takeover.

Note for HORC Async: The CCI software on the S-VOL side will issue a **Suspend for Swapping** to the S-VOL side 9900/7700E. Non-transmitted data which remains in the FIFO queue (sidefile) of the P-VOL will be copied to the S-VOL, and a **Resync for Swapping** operation will be performed (after the copy process). The swap operation is required to copy non-transmitted P-VOL data within a given timeout value (specified by the **-t <timeout>** option).

SVOL-Takeover Function

The SVOL-takeover function allows the takeover node to use the secondary volume (except in COPY state) in SSUS(PSUS) state (i.e., reading and writing are enabled), on the assumption that the remote node (possessing the primary volume) cannot be used. The data consistency of the HORC SVOL is evaluated by its pair status and fence level (same as paircurchk, refer to Table 4.13). If the primary and secondary volumes are not consistent, the SVOL-takeover function fails. If primary and secondary volumes are consistent, the SVOL-takeover function attempts to switch to the primary volume using **Resync for Swapping**. If successful, the SVOL-takeover function returns **Swap-takeover** as the return value of the horctakeover command. If not successful, the SVOL-takeover function returns **SVOL-SSUS-takeover** as the return value of the horctakeover command. In case of a host failure, **Swap-takeover** is returned. In case of an ESCON® or P-VOL site failure, **SVOL-SSUS-takeover** is returned.

SVOL-takeover can be specified for a paired volume or a group. If the SVOL-takeover is specified for a group, a data consistency check is executed for all volumes in the group, and all inconsistent volumes are displayed (see example in Figure 4.21).

Group	Pair vol	Port	targ#	lun#	LDEV#	Volstatus	Status	Fence	To be...
oradb1	/dev/dsk/hd001	CL1-A	1	5	145	S-VOL	PAIR	NEVER	Analyzed
oradb1	/dev/dsk/hd002	CL1-A	1	6	146	S-VOL	PSUS	STATUS	Suspected

Figure 4.21 Display of Inconsistent Volumes for SVOL-Takeover of Group

Note for HORC Async: The CCI software on the S-VOL side will issue a **Suspend for Swapping** to the S-VOL side 9900/7700E. Non-transmitted data of the P-VOL will be copied to the S-VOL side, and a **Resync for Swapping** operation will be performed (after the copy process). In case of a host failure, this data synchronize operation will be accomplished and SVOL-takeover function will return **Swap-takeover** by attempting a **Resync for Swapping**. In case of an ESCON® or P-VOL site failure, this data synchronize operation may fail. Even so, the SVOL-takeover function will do **Suspend for Swapping**, and enable the S-VOL to be used. As result, this function will be returned as **SVOL-SSUS-takeover**. Through this behavior, you will be able to judge that the non-transmitted data of the P-VOL was not transmitted completely when SVOL-takeover returns **SVOL-SSUS-takeover**.

The SVOL-takeover operation is required to copy non-transmitted P-VOL data within a given timeout value (specified by the **-t <timeout>** option). If the timeout occurs (before SVOL takeover has completed all S-VOL changes to SSWS state), the horctakeover command will be failed with EX_EWSTOT. Therefore this timeout value should be a greater than (or equal to) the start-up timeout value for the HA Control Script.

If the horctakeover command failed due to timeout, then try to recover as follows:

1. Wait until SVOL state becomes SSWS (use **pairedisplay -g <group> -l -fc** command), and try to the start-up again for the HA Control Script.
2. Make an attempt at doing resynchronize original PVOL based on SVOL using **pairresync -g <group> -swaps -c <size>** for Fast Failback Performance. If this operation has been failed at [EX_CMDRJE] or [EX_CMDIOE], then the cause is ESCON® link down and/or site failure. After the recovery from failure, please try again this command.

PVOL-Takeover Function

The PVOL-takeover function releases the pair state as a group, since that maintains the consistency of the secondary volume at having accepted horctakeover command when the primary volume is fenced ("data or status" & "PSUE or PDUB" state, "PSUE or PDUB" volume are contained in the group). This function allows the takeover node to use the primary volume (i.e., reading and writing are enabled), on the assumption that the remote node (possessing the secondary volume) cannot be used. PVOL-takeover can be specified for a paired volume or a group.

The PVOL-takeover function executes the following two commands:

- PVOL-PSUE-takeover: Changes the primary volume to the suspend (PSUE , PSUS) state which enables write I/Os to all primary volumes of the group. The action of the PVOL-PSUE-Takeover causes PSUE and/or PSUS to be intermingled in the group. This intermingled pair status is PSUE as the group status, therefore pairvolchk command returned give priority PSUE(PDUB) than PSUS as the group status. This special state turns back to the original state when the pairresync command is issued.
- PVOL-SMPL-takeover: Changes the primary volume to the simplex (SMPL) state. First, PVOL-takeover executes PVOL-PSUE-takeover further than PVOL-SMPL-takeover. If the PVOL-PSUE-takeover function fails, the PVOL-SMPL-takeover function is executed.

Note for HORC Async: PVOL-Takeover will not be executed. It will be Nop-Takeover, since the fence level for HORCA is Async, which is the same as Never.

4.10.2 Applications of the Horctakeover Command

The basic HORC commands (takeover, pair creation, pair splitting, pair resynchronization, event waiting) can be combined to enable recovery from a disaster, backup of paired volumes, and many other operations (e.g., restoration of paired volumes based on the secondary volume, swapping of the paired volumes). Figure 4.22 illustrates the flow of starting operations on a UNIX[®] server at the secondary site using the HORC takeover command. Figure 4.23 illustrates the flow of starting operations on a Windows[®] NT/2000 server at the secondary site using the HORC takeover command.

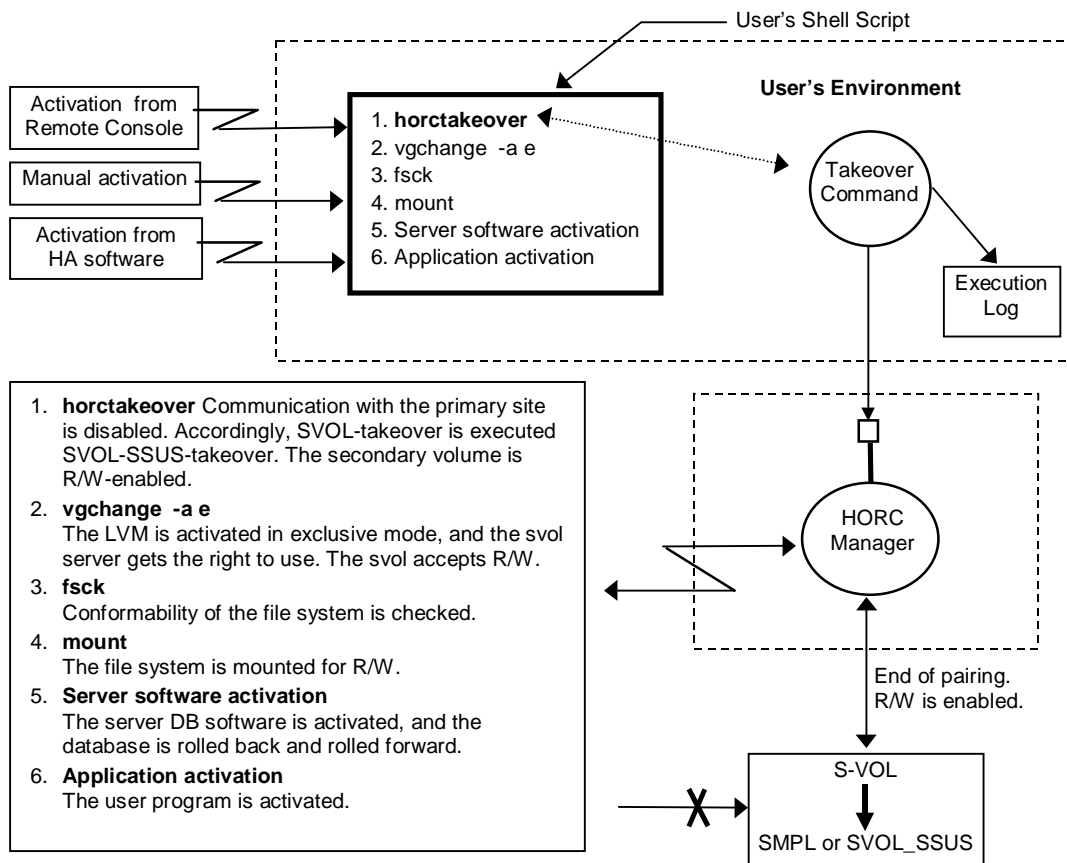


Figure 4.22 Application/Example of HORC Takeover (UNIX[®]-based System)

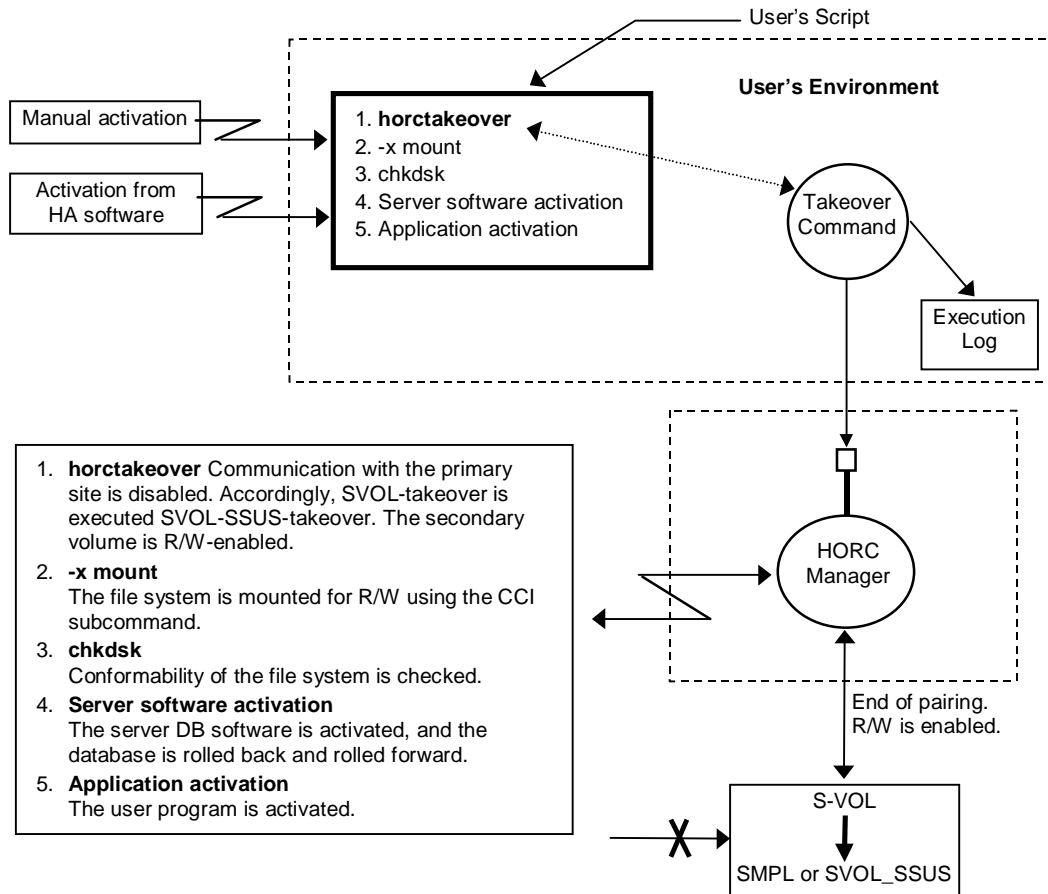


Figure 4.23 Application/Example of HORC Takeover (Windows®-based System)

4.11 Displaying Configuration Information

4.11.1 Raidscan Command

The raidscan command displays configuration and status information for the specified 9900 port/TID(s)/device(s). The information is acquired directly from the 9900 subsystem (not the configuration definition file). Table 4.17 lists and describes the raidscan command parameters. Figure 4.24 and Figure 4.25 provide examples of the raidscan command and its output.

Table 4.17 Raidscan Command Parameters

Parameter	Value																																												
Command Name	raidscan																																												
Format	raidscan { -h -q -z -p <port> -pd <raw_device> -s <Seq#> -t <target> -l <lun> [-f[xfg]] -CLI -find }																																												
Options	<p>-h: Displays Help/Usage and version information.</p> <p>-q: Terminates the interactive mode and exits the command.</p> <p>-z or -zx: Makes the raidscan command enter the interactive mode. The -zx option guards performing of the HORCM in the interactive mode. When this option detects a HORCM shut down, interactive mode terminates.</p> <p>-p <port>: Specifies the port ID of the 9900 port to be scanned. Valid ports are CL1-A to CL1-R (excluding CL1-I and CL1-O) and CL2-A to CL2-R (excluding CL2-I CL2-O). This option must always be specified.</p> <p>-pd <raw_device> (HP-UX®, Linux®, Windows® NT/2000, Solaris® only): Specifies the raw device name. This option finds Seq# and port_name of the 9900 that the specified device can be connected, and scans the port of the 9900 which corresponds with the unit ID that searches the unit ID from Seq#. This option must always be specified for HP-UX®, Linux®, Windows® NT/2000, and Solaris® platforms.</p> <p>-s <Seq#>: Used to specify the Seq# (serial#) of the 9900 when this option can't specify the unit ID which is contained for "-p <port>" option. This option scans the port specified by "-p <port>" option of the 9900 which corresponds with the unit ID that searches the unit ID from Seq#. If this option is specified, then the unit ID which is contained in "-p <port>" option is invalid.</p> <p>-t <target>: Specifies a target ID (0 to 15) of the specified port. If this option is not specified, the command applies to all target IDs.</p> <p>-l <lun>: Specifies a LUN (0 to 7) of the specified target ID. If this option is not specified, the command applies to all LUNs. If this option is specified, the TID must also be specified.</p> <p>-f or -ff: Specifies display of volume-type for a display column. If this option is specified, then the following -f[g] option is invalid.</p> <p>-fx: Displays the LDEV number in hexadecimal notation.</p> <p>-fg: Specifies display of group_name for a display column. This option searches a group on the configuration definition file (local CCI instance) from the scanned LDEV, and displays a group_name when the scanned LDEV is contained in the group. If this option is specified, the -f[f] option is excluded.</p> <p>-CLI: Specifies display for command line interface (CLI). This option displays to the same position that defined number of columns, and displays one header. The delimiters between columns are displayed as spaces or hyphens (-). Display example:</p> <table><tr><th>Port#</th><th>TargetID#</th><th>Lun#</th><th>Seq#</th><th>Num</th><th>LDEV#</th><th>P/S</th><th>Status</th><th>Fence</th><th>P-Seq#</th><th>P-LDEV#</th></tr><tr><td>CL1-C</td><td>1</td><td>0</td><td>30053</td><td>1</td><td>274</td><td>SMPL</td><td>-</td><td>-</td><td>-</td><td>-</td></tr><tr><td>CL1-C</td><td>2</td><td>2</td><td>30053</td><td>1</td><td>260</td><td>P-VOL</td><td>PAIR</td><td>NEVER</td><td>30053</td><td>268</td></tr><tr><td>CL1-C</td><td>2</td><td>3</td><td>30053</td><td>1</td><td>261</td><td>P-VOL</td><td>PAIR</td><td>NEVER</td><td>30053</td><td>269</td></tr></table>	Port#	TargetID#	Lun#	Seq#	Num	LDEV#	P/S	Status	Fence	P-Seq#	P-LDEV#	CL1-C	1	0	30053	1	274	SMPL	-	-	-	-	CL1-C	2	2	30053	1	260	P-VOL	PAIR	NEVER	30053	268	CL1-C	2	3	30053	1	261	P-VOL	PAIR	NEVER	30053	269
Port#	TargetID#	Lun#	Seq#	Num	LDEV#	P/S	Status	Fence	P-Seq#	P-LDEV#																																			
CL1-C	1	0	30053	1	274	SMPL	-	-	-	-																																			
CL1-C	2	2	30053	1	260	P-VOL	PAIR	NEVER	30053	268																																			
CL1-C	2	3	30053	1	261	P-VOL	PAIR	NEVER	30053	269																																			

Table 4.17 Raidscan Command Parameters (continued)

Parameter	Value
Options	<p>-find: Displays the port, target ID, and LUN (9900 notation) which was mapped for LDEV using a special file (raw device file) provided via STDIN (see Figure 4.26). If target ID and LUN are Unknown for the target device file, the user must start HORCM without a description for HORCM_DEV and HORCM_INST, and should describe the shown Port, target ID, and LUN for HORCM_DEV. This option also uses the -fx option to display the LDEV numbers in hexadecimal.</p> <p>Restriction: Special files via STDIN are specified in the following ways: HP-UX® and Solaris® systems: /dev/rdsk/... Linux® systems: /dev/sd... or /dev/rd...</p>

```
# raidscan -p cl1-r
Port#, TargetID#, Lun# Num(LDEV#...) P/S, Status, Fence, LDEV#, P-Seq# P-LDEV#
CL1-R, 15, 7 5(100,101...) P-VOL PAIR NEVER 100, 5678 200
CL1-R, 15, 6 5(200,201...) SMPL ---- ---- ---- ----

# raidscan -p cl1-r -f
Port#, TargetID#, Lun# Num(LDEV#...) P/S, Status, Fence, LDEV#, Vol.Type
CL1-R, 15, 7 5(100,101...) P-VOL PAIR NEVER 100, OPEN-3
CL1-R, 15, 6 5(200,201...) SMPL ---- ---- ---- OPEN-3

# raidscan -pd /dev/rdsk/c0t15/d7 -fg
Port#, TargetID#, Lun# Num(LDEV#...) P/S, Status, Fence, LDEV#, Group
CL1-R, 15, 7 5(100,101...) P-VOL PAIR NEVER 100, oradb
CL1-R, 15, 6 5(200,201...) SMPL ---- ---- ---- oradb1
Specified device is LDEV# 0100.
```

Figure 4.24 Raidscan Command Examples for SCSI Ports

```
# raidscan -p cl1-r
PORT#/ALPA/C, TID#, LU# Num(LDEV#...) P/S, Status, Fence, LDEV#, P-Seq# P-LDEV#
CL1-R/ ce/15, 15, 7 5(100,101...) P-VOL PAIR NEVER 100, 5678 200
CL1-R/ ce/15, 15, 6 5(200,201...) SMPL ---- ---- ---- ----

# raidscan -p cl1-r -f
PORT#/ALPA/C, TID#, LU# Num(LDEV#...) P/S, Status, Fence, LDEV#, Vol.Type
CL1-R/ ce/15, 15, 7 5(100,101...) P-VOL PAIR NEVER 100, OPEN-3
CL1-R/ ce/15, 15, 6 5(200,201...) SMPL ---- ---- ---- OPEN-3
```

Figure 4.25 Raidscan Command Examples for Fibre-Channel Ports

```
# ls /dev/rdsk/* | raidscan -find
DEVICE_FILE UID S/F PORT TARG LUN SERIAL LDEV PRODUCT_ID
/dev/rdsk/c0t0d4 0 S CL1-M 0 4 31168 216 OPEN-3-CVS-CM
/dev/rdsk/c0t0d1 0 S CL1-M 0 1 31168 117 OPEN-3-CVS
/dev/rdsk/c1t0d1 - - CL1-M - - 31170 121 OPEN-3-CVS
```

Figure 4.26 Example of -find Option for Raidscan

The output of the raidscan command includes:

- **SCSI: Port#, TargetID#, Lun#** = port ID, TID, and LU number (LUN).
- **Fibre: Port#, ALPA/C, TID#, LU#** = port ID, arbitrated loop phys. address, TID, LUN.
For further information on fibre-to-SCSI address conversion, see Appendix D.
Note: For HOMRCF, raidscan displays the MU# for each LUN (e.g., LUN 7-0, 7-1, 7-2).
- **Num(LDEV#...)** = number of LDEVs and LDEV ID for the LUSE volume.
- **P/S** = volume attribute.
- **Status** = status of the paired volume.
- **Fence** (HORC only) = fence level.
- **P-Seq#** = serial # of the subsystem which contains the partner volume of the pair.
- **P-LDEV#** = LDEV number of the partner volume of the pair.
- **Vol.Type** = logical unit (LU) type (e.g., OPEN-3, OPEN-9).
- **Group** = group name (dev_group) as described in the configuration definition file.
- **UID**: Displays the unit ID for multiple subsystem configuration. If UID is displayed as ‘-’, the command device for HORCM_CMD is not found.
- **S/F**: Displays whether a PORT is SCSI or fibre.
- **PORT**: Displays the 9900 (or 7700E) port number.
- **TARG**: Displays the target ID (**which was converted by the fibre conversion table**).
- **LUN**: Displays the LUN (**which was converted by the fibre conversion table**).
- **SERIAL**: Displays the production (serial#) number of the 9900 (or 7700E) subsystem.
- **LDEV**: Displays the LDEV# within the 9900 (or 7700E) subsystem.
- **PRODUCT_ID**: Displays product-id field in the STD inquiry page.

4.11.2 Raidar Command

The raidar command displays configuration, status, and I/O activity information for the specified 9900 port/TID(s)/device(s) at the specified time interval. The configuration information is acquired directly from the 9900 subsystem (not from the configuration definition file). Table 4.18 lists and describes the raidar command parameters. Figure 4.27 shows an example of the raidar command and its output.

Note: The I/O activity of a HORC S-VOL in the COPY or PAIR state includes HORC remote I/Os (update copy operations) in addition to host-requested I/Os. The I/O activity of an HOMRCF S-VOL in the COPY or PAIR state includes only host-requested I/Os (HOMRCF update copy operations are excluded). The I/O activity of a P-VOL or simplex volume includes only host-requested I/Os. If state changed into SMPL in S-VOL (COPY, PAIR) I/O actively, and then I/O activity of the between is reported in the SMPL state.

Table 4.18 Raidar Command Parameters

Parameter	Value
Command Name	raidar
Format	raidar { -h -q -z -p <port> <targ> <lun> -pd <raw_device> -s [interval] [count] }
Options	<p>-h: Displays Help/Usage and version information.</p> <p>-q: Terminates the interactive mode and exits the command.</p> <p>-z or -zx: Makes the raidar command enter the interactive mode. The -zx option guards performing of the HORCM in the interactive mode. When this option detects a HORCM shut down, interactive mode terminates.</p> <p>-p <port> <targ> <lun> [mun]....: Monitors one or more (up to 16) devices at a time.</p> <p> <port>: Specifies the port to be reported: CL1-A to CL1-R (excluding CL1-I and CL1-O) and CL2-A to CL2-R (excluding CL2-I and CL2-O). This option must be specified.</p> <p> <targ>: Specifies the SCSI target ID (0 to 15) of the specified port (see Appendix D for fibre-to-SCSI address conversion information).</p> <p> <lun>: Specifies the LUN (0 to 7) on the specified TID.</p> <p> [mun]: Specifies the MU number of the specified LUN (HOMRCF only).</p> <p>pd <raw_device> (HP-UX®, Linux®, Windows® NT/2000, Solaris® only): Allows designation of an LDEV by raw device file name.</p> <p>-s [interval] or -sm [interval]: Designates the time interval in seconds.</p> <p> -s: Interprets the time interval as seconds.</p> <p> -sm: Interprets the time interval as minutes.</p> <p> [interval]: Designates the time interval value (1 to 60). If the interval is not specified, the default interval (3) is used.</p> <p> [count]: Designates number of repeats. When omitted, this command repeats until CNTL-C.</p>

This line indicates no I/O activity for the specified port/TID(s)/LUN(s).									
#	raidar	-p	cl1-a	15	6	-p	cl1-b	14	5
TIME[03]		PORT	T	L	VOL	STATUS	IOPS	HIT (%)	W (%)
13:45:25		-	-	-	-	-	-	-	-
13:45:28		CL1-A	15	6	SMPL	---	200.0	80.0	40.0
		CL1-B	14	5	P-VOL	PAIR	133.3	35.0	13.4
		CL1-A	12	3	P-VOL	PSUS	200.0	35.0	40.6
									600
									400
									600

Figure 4.27 Raidar Command Example

The output of the raidar command includes:

- **IOPS** = number of I/Os (read/write) per second (total I/O rate).
- **HIT(%)** = Hit rate for read I/Os (read hit rate).
- **W(%)** = Ratio of write I/Os to total I/Os (percent writes).
- **IOCNT** = number of times of write and read.

4.11.3 Raidqry Command

The raidqry command (RAID query) displays the configuration of the connected host and 9900 subsystem. Figure 4.28 shows an example of the raidqry command and its output. Table 4.19 lists and describes the raidqry command parameters.

# raidqry -l							
No	Group	Hostname	HORCM_ver	Uid	Serial#	Micro_ver	Cache(MB)
1	---	HOSTA	01-00-03/03	0	30053	52-35-02/02	256
1	---	HOSTA	01-00-03/03	1	30054	52-35-02/02	256
# raidqry -r oradb							
No	Group	Hostname	HORCM_ver	Uid	Serial#	Micro_ver	Cache(MB)
1	oradb	HOSTA	01-00-03/03	0	30053	52-35-02/02	256
2	oradb	HOSTB	01-00-03/03	0	30053	52-35-02/02	256
1	oradb	HOSTA	01-00-03/03	1	30054	52-35-02/02	256
2	oradb	HOSTB	01-00-03/03	1	30054	52-35-02/02	256
# raidqry -l -f							
No	Group	Floatable Host	HORCM_ver	Uid	Serial#	Micro_ver	Cache(MB)
1	---	FH001	01-00-03/03	0	30053	52-35-02/02	256

Figure 4.28 Raidqry Command Examples

The output of the raidqry command includes:

- **No:** This column shows the order when the group name (dev_group) which is described in the configuration definition file has multiple remote hosts.
- **Group:** When the **-r** option is used, this column shows the group name (dev_group) which is described in the configuration definition file.
- **Floatable Host:** When the **-f** option is used, this column shows the host name (ip_address) which is described in the configuration definition file. Up to 30 host names can be displayed. The **-f** option interprets the host name as utilizing floatable IP for a host.
- **HORCM_ver:** This column shows the version of the HORC Manager on the local or remote host. The **-l** option specifies local host. The **-r** option specifies remote host.
- **Uid Serial# Micro_ver:** This column shows unitID, serial number, and (DKCMAIN) microcode version of the 9900 which is connected to the local or remote host. The **-l** option specifies local host. The **-r** option specifies remote host.
- **Cache(MB):** Shows the logical cache capacity (in MB) of the 9900 connected to the local or remote host. The **-l** option specifies local host. The **-r** option specifies remote host.

Table 4.19 Raidqry Command Parameters

Parameter	Value
Command Name	raidqry
Format	raidqry { -h -q -z -l -r <group> [-f] }
Options	<p>-h: Displays Help/Usage and version information.</p> <p>-q: Terminates the interactive mode and exits the command.</p> <p>-z or -zx: Makes the raidqry command enter the interactive mode. The -zx option guards performing of the HORCM in the interactive mode. When this option detects a HORCM shut down, interactive mode terminates.</p> <p>-l: Displays the configuration information for the local host and the local 9900.</p> <p>-r <group>: Displays the configuration information for the remote host and the remote 9900 which contains the specified group.</p> <p>-f: Displays the hostname (ip_address) as specified in the configuration definition file. Use this option if "floatable IP address" is used for the hostname (ip_address) in the configuration file.</p>

4.12 Controlling CCI Activity

4.12.1 Horcmstart Command

The horcmstart command is a shell script that starts the HORCM application (/etc/horcmgr). This shell script also sets the environment variables for HORCM as needed (e.g., HORCM_CONF, HORCM_LOG, HORCM_LOGS). Table 4.20 lists and describes the horcmstart command parameters.

Table 4.20 Horcmstart Command Parameters

Parameter	Value
Command Name	horcmstart
Format	horcmstart.sh { inst ... } horcmstart.exe { inst ... }
Options	<p>Inst: Specifies the HORCM instance number (numerical value). When this option is specified, the horcmstart shell script sets the environment variables (HORCMINST, HORCM_CONF, HORCM_LOG, HORCM_LOGS) which correspond to the instance number, and starts the specified HORCM instance. (Environment variables set by the user become invalid.) When this option is not specified, the horcmstart shell script starts 1 HORCM and uses the environment variables set by the user. If you have designated full environment variables, you should use horcmstart.sh without any arguments. If you did not designate environment variables (HORCM_CONF, HORCM_LOG, HORCM_LOGS), then this shell script sets the environment variables as follows:</p> <p>For UNIX®-based platforms:</p> <p>If HORCMINST is specified:</p> <p>HORCM_CONF = /etc/horcm*.conf (* is instance number) HORCM_LOG = /HORCM/log*/curlog HORCM_LOGS = /HORCM/log*/tmplog</p> <p>If no HORCMINST is specified:</p> <p>HORCM_CONF = /etc/horcm.conf HORCM_LOG = /HORCM/log/curlog HORCM_LOGS = /HORCM/log/tmplog</p> <p>For Windows® NT/2000 platform:</p> <p>If HORCMINST is specified:</p> <p>HORCM_CONF = \WINNT\horcm*.conf (* is instance number) HORCM_LOG = \HORCM\log*\curlog HORCM_LOGS = \HORCM\log*\tmplog</p> <p>If no HORCMINST is specified:</p> <p>HORCM_CONF = \WINNT\horcm.conf HORCM_LOG = \HORCM\log\curlog HORCM_LOGS = \HORCM\log\tmplog</p> <p>Note: The HORCM_LOGS environment variable is used to specify the log file directory for automatic storing. When HORCM starts up, the log files created in the operation are stored automatically in the HORCM_LOGS directory. This log directory must give an equality class with HORCM_LOG.</p>

4.12.2 Horcmshutdown Command

The horcmshutdown command is a shell script for stopping the HORCM application (/etc/horcmgr). Table 4.21 describes the shutdown command parameters.

Table 4.21 HORCM Shutdown Command Parameters

Parameter	Value
Command Name	horcmshutdown
Format	horcmshutdown.sh {inst...} horcmshutdown.exe {inst...}
Option	<p>Inst: Specifies the HORCM (CCI) instance number (numerical value). When this option is specified, the command stops the specified HORCM instance. When this option is not specified, the command refers to the instance (environment variable HORCMINST) of the execution environment of this shell script and stops the following the HORCM instance.</p> <p>When HORCMINST is specified, this command stops the HORCM instance of the execution environment of this shell script.</p> <p>When HORCMINST is not specified, this command stops the HORCM having no instance setting.</p>

4.12.3 Horcctl Command

The HORCM and HORC software have logs that identify the cause of software and/or hardware errors as well as a tracing function for investigating such errors. The location of the log files depends on the user's command execution environment and the HORC Manager's execution environment. The command trace file and core file reside together under the directory specified in the HORC Manager's execution environment. See Appendix B for log file and log directory information.

The horcctl command (HORC control) can be used for both maintenance and troubleshooting. The horcctl command allows you to change and display the internal trace control parameters (e.g., level, type, buffer size) of the HORC Manager and/or HORC commands. If a new value for a parameter is not specified, the current trace control parameter is displayed. Table 4.22 lists and describes the horcctl command parameters.

Caution: Do not change the trace level unless directed to do so by a Hitachi Data Systems representative. Level 4 is the normal trace level setting. Levels 0-3 are for troubleshooting. Setting a trace level other than 4 may impact problem resolution. If you request a change of the trace level using the **horcctl -l <level>** command, a warning message is displayed, and this command enters interactive mode.

Table 4.22 HORC Control Command Parameters

Parameter	Value
Command Name	horcctl
Format	horcctl { -h -q -z -d -c -l <level> -d <y/n> -s <size(KB)> -t <type> -S -D -C [-u <-unitid> -ND -NC -g <group>] }
Options	<p>-h: Displays Help/Usage and version information.</p> <p>-q: Terminates the interactive mode and exits the command.</p> <p>-z or -zx: Makes the horcctl command enter the interactive mode. The -zx option guards performing of the HORCM in the interactive mode. When this option detects a HORCM shut down, interactive mode terminates.</p> <p>-d: Interprets the control options following this option (-l <level>, -b <y/n>, -s <size(KB)>, and -t <type>) as the parameters of the HORC commands.</p> <p>-c: Interprets the control options following this option (-l <level>, -b <y/n> and -t <type>) as the parameters of the HORC Manager (HORCM).</p> <p>-l <level>: Sets the trace level (range = 0 to 15). If a negative value is specified, the trace mode is canceled. A negative value "n" must be specified as "-n". Caution: Do not change the trace level unless directed to do so by a Hitachi Data Systems representative. Level 4 is the normal trace level setting. Levels 0-3 are for troubleshooting. Setting a trace level other than 4 may impact problem resolution. If you request a change of the trace level using the horcctl -l <level> command, a warning message is displayed, and this command enters interactive mode.</p> <p>-b <y/n>: Sets the trace writing mode: Y = buffer mode, N = synchronous mode.</p> <p>-t <type>: Sets the trace type (range = 0 to 511). When this option is used, only traces of the specified type are output. One or more values can be specified.</p> <p>-s <size(KB)>: Changes the default trace buffer size, which is 1 MB, in units of 1024 bytes.</p> <p>-S: Shuts down HORCM.</p> <p>-D: Displays the HORC command device name currently used by HORCM. If the command device is blocked due to online maintenance (microcode replacement) of the 9900/7700E, you can check the HORC command device name in advance using this option.</p> <p>-C: Changes the HORC command device name being used by HORCM and displays the new HORC command device name. If the command device is blocked due to online maintenance (microcode replacement) of the 9900/7700E, you can change the command device in advance using this option.</p> <p>-u <unitid>: Used to specify the unit ID of a command device as the target. This option is effective when the -D or -C option is specified. If this option is not specified, the unit ID is 0.</p> <p>-ND -g <group>: Displays the network address and port name being used by HORCM. The -g <group> option is used to specify the group name defined in the configuration definition file.</p> <p>-NC -g <group>: Changes the network address and port name being used by HORCM and displays the new network address name. The -g <group> option specifies the group name defined in the configuration definition file.</p>

4.13 Windows NT® and Windows® 2000 Subcommands

The CCI software provides subcommands for the Windows NT® and Windows® 2000 platforms which are executed as options (-x <command> <arg>) of another command. When you specify a subcommand as the only option of a command, you do not need to start HORCM. If another option of the command and the subcommand are specified on the same command line, place the other option after the subcommand.

4.13.1 Findcmddev Subcommand

The findcmddev subcommand (find command device) searches for command devices within the specified range of disk drive numbers. If it is found, the command device is displayed in the same format as in the configuration definition file. This subcommand is used when the command device name is not known. Figure 4.29 shows an example of the findcmddev subcommand used as an option of the raidscan command and its output. Table 4.23 lists and describes the findcmddev subcommand parameters.

```
raidscan -x findcmddev hdisk0, 20
cmddev of ser# 30014 = \\.\PhysicalDrive3
cmddev of ser# 30014 = \\.\PhysicalDrive4
```

Note: This example searches for command devices in the range of disk drive numbers 0 to 20.

Figure 4.29 Findcmddev Subcommand Example

Caution: The findcmddev subcommand must be used when HORCM is not running.

Note: The findcmddev subcommand searches for the physical and logical drives associated with the command device. If the command device is indicated as a logical drive, then you must delete the drive letter assigned to the command device to prevent utilization by general users.

Table 4.23 Findcmddev Subcommand Parameters

Parameter	Value
Command Name	findcmddev
Format	-x findcmddev drive#(0-N)
Argument	drive#(0-N): Specifies the range of disk drive numbers on the Windows® NT/2000 system.

4.13.2 Drivescan Subcommand

The drivescan subcommand displays the relationship between the disk numbers assigned by the Windows® NT/2000 system and the LDEVs on the 9900, and also displays attribute and status information for each LDEV. Table 4.24 lists and describes the drivescan subcommand parameters. Figure 4.30 shows an example of the drivescan subcommand used as an option of the raidscan command and its output.

Table 4.24 Drivescan Subcommand Parameters

Parameter	Value
Command Name	drivescan
Format	-x drivescan drive#(0-N)
Argument	drive#(0-N) : Specifies the range of disk drive numbers on the Windows® NT/2000 system.

```
raidscan -x drivescan harddisk0,20
Harddisk 0... Port[ 1] PhId[ 0] Tid[ 0] Lun[ 0] [HITACHI] [DK328H-43WS]
Harddisk 1... Port[ 2] PhId[ 4] Tid[ 29] Lun[ 0] [HITACHI] [OPEN-3]
                Port[CL1-J] Ser#[ 30053] LDEV#[ 9(0x009)]
                HORC = P-VOL HOMRCF[MU#0 = SMPL MU#1 = SMPL MU#2 = SMPL]
                RAID5[Group 2- 1] SSID = 0x0008 CTGID = 3
Harddisk 2... Port[ 2] PhId[ 4] Tid[ 29] Lun[ 1] [HITACHI] [OPEN-3]
                Port[CL1-J] Ser#[ 30053] LDEV#[ 10(0x00A)]
                HORC = S-VOL HOMRCF[MU#0 = SMPL MU#1 = SMPL MU#2 = SMPL]
                RAID5[Group 2- 1] SSID = 0x0004 CTGID = 3
Harddisk 3... Port[ 2] PhId[ 4] Tid[ 29] Lun[ 6] [HITACHI] [OPEN-3-CM]
                Port[CL1-J] Ser#[ 30053] LDEV#[ 15(0x00F)]
```

Note: This example displays the devices for the range of disk drive numbers from 0 to 20.

Figure 4.30 Drivescan Subcommand Example

The output of the drivescan subcommand includes:

- **Harddisk #:** Shows the hard disk recognized by the Windows® NT/2000 system.
- **Port:** Shows the port number on the device adapter recognized by the NT/2000 system.
- **Phid:** Shows the bus number on the device adapter port recognized by NT/2000 system.
- **Tid:** Shows the target ID of the hard disk(s) on the specified port and bus. For further information on fibre-to-SCSI address conversion, see Appendix D.
- **LUN:** Shows the LU number of the hard disk on the specified port, bus, and TID.
- **Port[CLX-Y]:** Shows the port number on the 9900 subsystem.
- **Ser#:** Shows the production number (serial number) of the 9900 subsystem.
- **LDEV#:** Shows the LDEV ID (hexadecimal) of the specified volume on the 9900.
- **HORC:** Shows the HORC attribute (P-VOL, S-VOL or SMPL) of the specified volume.
- **HOMRCF:** Shows the HOMRCF attribute (P-VOL, S-VOL, SMPL) and MU number (0-2) of the specified volume.
- **RAIDX[Group]:** Shows the physical location (frame number-parity group number) of the specified volume and the RAID level of this parity group.
- **SSID:** Shows the SSID of the specified volume.
- **CTGID (HORC Async only):** Shows the consistency group ID of the specified volume.

4.13.3 Portscan Subcommand

The portscan subcommand displays the devices on the specified port(s). Table 4.25 lists and describes the portscan subcommand parameters. Figure 4.31 shows an example of the portscan subcommand used as an option of the raidscan command and its output.

Table 4.25 Portscan Subcommand Parameters

Parameter	Value
Command Name	portscan
Format	-x portscan port#(0-N)
Argument	port#(0-N) : Specifies the range of port numbers on the Windows® NT/2000 system.

```
raidscan -x portscan port0,20
PORT[ 0] IID [ 7] SCSI Devices
        PhId[ 0] Tid[ 3] Lun[ 0] [MATSHIT] [CD-ROM CR-508 ] ...Claimed
        PhId[ 0] Tid[ 4] Lun[ 0] [HP      ] [C1537A      ] ...Claimed
PORT[ 1] IID [ 7] SCSI Devices
        PhId[ 0] Tid[ 0] Lun[ 0] [HITACHI ] [DK328H-43WS ] ...Claimed
PORT[ 2] IID [ 7] SCSI Devices
        PhId[ 0] Tid[ 5] Lun[ 0] [HITACHI ] [OPEN-3      ] ...Claimed
        PhId[ 0] Tid[ 5] Lun[ 1] [HITACHI ] [OPEN-3      ] ...Claimed
        PhId[ 0] Tid[ 5] Lun[ 2] [HITACHI ] [OPEN-3      ] ...Claimed
        PhId[ 0] Tid[ 6] Lun[ 0] [HITACHI ] [3390-3A     ] ...Claimed
```

Note: This example displays the devices for the range of ports from 0 to 20.

Figure 4.31 Portscan Subcommand Example

The output of the portscan subcommand includes:

- **Port:** Shows the port number on the device adapter recognized by the Windows® system.
- **IID:** Shows the initiator ID on the specified device adapter port.
- **Phid:** Shows the BUS number on the specified device adapter port.
- **Tid:** Shows the target ID of the hard disk(s) on the specified adapter port and bus. For further information on fibre-to-SCSI address conversion, see Appendix D.
- **LUN:** Shows the LU number of each hard disk on the specified device adapter port/bus. This item shows LDEV# of the partner who becomes a pair in or among the 9900.

4.13.4 Sync Subcommand

The sync (synchronization) subcommand sends unwritten data remaining on the Windows® NT/2000 server to the specified device(s) to synchronize the pair(s) before the CCI command is executed. Table 4.26 lists and describes the sync subcommand parameters.

Caution: The logical and physical devices to be synchronized must be offline to all other applications. The Sync does not propagate to a drive of the destination which is had a directory mount on the Windows® 2000 system.

Table 4.26 Sync Subcommand Parameters

Parameter	Value
Command Name	Sync
Format	-x sync A: B: C: ... -x sync all -x sync drive#(0-N)
Argument	A: B: C: Specifies the logical devices that you want to synchronize. all: Synchronizes all logical devices. The logical device on which the CCI software is installed and the logical device containing the Windows® NT/2000 directory are excluded. drive#(0-N): Specifies the range of devices on the Windows® NT/2000 system.

The following examples show the sync subcommand used as an option of the pairsplit command. For the example in Figure 4.32, the data remaining on logical devices C: and D: is written to disk, all pairs in the specified group are split (status = PSUS), and read/write access is enabled for all S-VOLs in the specified group.

```
pairsplit -x sync C: D: -g oradb -rw
```

Figure 4.32 Sync Subcommand Example – Pairsplit

For the example in Figure 4.33, the data remaining on physical devices harddisk2 and harddisk3 is written to disk, all pairs in the specified group are deleted (status = SMPL), which enables read/write access for all secondary volumes.

```
pairsplit -x sync hdisk2 hdisk3 -g oradb -S
```

Figure 4.33 Sync Subcommand Example – Pairsplit -S

4.13.5 Mount Subcommand

The mount subcommand mounts the specified drive to the specified partition on the specified hard disk drive. If the mount subcommand is executed without specifying an argument, all drives which are currently mounted are displayed. Table 4.27 lists and describes the mount subcommand parameters. Figure 4.34 shows an example of the mount subcommand used as an option of the pairsplit command and its output.

Caution: The partition on the specified disk drive (hard disk) must be recognized on the Windows® NT/2000 system. The volume which is had a directory mount is not displayed on the Windows® 2000 system.

Table 4.27 Mount Subcommand Parameters

Parameter	Value
Command Name	mount
Format	-x mount -x mount drive: hdisk# [partition#]
Argument	drive: Specifies the logical drive to be mounted. hdisk#: Specifies hard disk drive (number) to be mounted. partition #: Specifies the partition number to be mounted. If the partition# is not specified, the drive is mounted as HarddiskVolume# for Windows® 2000 systems. A mount way of HarddiskVolumeX does not specify a partition as the following: -x mount C: hdX

```
pairsplit -x mount F: hdisk2 p1 -x mount G: hdisk1 p1
pairsplit -x mount
```

Drive	FS_name	VOL_name	Device	Partition	...	Port	PathID	Targ	Lun
C:	FAT	Null	Harddisk0	Partition1	...	1	0	0	0
F:	FAT	Null	Harddisk2	Partition1	...	2	0	5	1
G:	NTFS	Null	Harddisk1	Partition1	...	2	0	5	0
Z:	CDFS	Null	CdRom0		...	Unknown			

This example mounts the F: drive to partition 1 on disk drive 2, and mounts the G: drive to partition 1 on disk drive 1.

Figure 4.34 Mount Subcommand Example for Windows® NT

```
pairsplit -x mount F: hdisk2
pairsplit -x mount
```

Drive	FS_name	VOL_name	Device	Partition	...	Port	PathID	Targ	Lun
C:	NTFS	Null	Harddiskvolume1		...	Unknown			
F:	NTFS	Null	Harddiskvolume2		...	Unknown			

This example executes mount from command option of the pairsplit, mounting the F: drive to the harddiskvolume2, after mounted devices are displayed.

Figure 4.35 Mount Subcommand Example for Windows® 2000

The output of the mount subcommand includes:

- **Drive:** Shows the logical drive recognized by the Windows[®] NT/2000 system.
- **FS_name:** Shows the name of the file system formatted on the specified drive.
- **VOL_name:** Shows the volume label name for the specified drive.
- **Device, Partition:** Shows the device name and partition for the specified drive.
- **Port,Phid,Tid,Lun:** Shows the port number, path ID (bus), target ID, and LUN for the specified drive. For further information on fibre-to-SCSI address conversion, see Appendix D.

4.13.6 Umount Subcommand

The unmount subcommand unmounts the specified logical drive and deletes the drive letter. Before deleting the drive letter, this subcommand executes sync internally for the specified logical drive and flashes unwritten data. Table 4.28 lists and describes the unmount subcommand parameters. Figure 4.36 shows an example of the umount subcommand used as an option of the pairsplit command.

Caution: The logical drive to be unmounted and the corresponding physical drive must be closed to all applications.

Table 4.28 Unmount Subcommand Parameters

Parameter	Value
Command Name	umount
Format	-x umount drive:
Argument	drive: Specifies the mounted logical device.

```
pairsplit -x umount F: -x umount G: -g oradb -rw
pairsplit -x mount
```

Drive	FS_name	VOL_name	Device	Partition	...	Port	PathID	Targ	Lun
C:	FAT	Null	Harddisk0	Partition1	...	1	0	0	0
Z:	Unknown	Unknown	CdRom0		...	Unknown			

This example unmounts the F: and G: drives, splits all pairs in the specified group (status = PSUS), enables read/write access to all secondary volumes in the specified group, and then displays all mounted drives.

Figure 4.36 Umount Subcommand Example

4.13.7 Environment Variable Subcommands

If no environment variables are set in the execution environment, the environment variable subcommand sets or cancels an environment variable within the CCI command. The `setenv` subcommand sets the specified environment variable(s). The `usetenv` subcommand deletes the specified environment variable(s). The `env` subcommand displays the environment variable(s). The `sleep` subcommand causes CCI to wait for the specified time. Table 4.29 lists and describes the environment variable subcommands and their parameters.

Caution: The environment variables must be set before connecting to HORCM, and must be specified during interactive mode (`-z` option). Changing an environment variable after a CCI command execution error is invalid.

Table 4.29 Environment Variable Subcommand Parameters

Parameter	Value
Command Name	<code>setenv</code> <code>usetenv</code> <code>env</code> <code>sleep</code>
Format	<code>-x setenv vname value</code> <code>-x usetenv vname</code> <code>-x env</code> <code>-x sleep time</code>
Argument	Vaname: Specifies the environment variable to be set or canceled. Value: Specifies the value or character string of the environment variable to be set. Time: Specifies the sleep time in seconds.

Figure 4.37 shows an example of the `setenv` and `usetenv` subcommands used as an option of the `raidscan` command. This example changes from “HORC” to “HOMRCF” an execution environment of the `raidscan` command which makes a dialog mode, because of establishing “HORCC_MRCF” as an environment variable.

```
raidscan[HORC]: -x setenv HORCC_MRCF 1
raidscan[MRCF]:

raidscan[MRCF]: -x usetenv HORCC_MRCF
raidscan[HORC]:
```

Figure 4.37 Environment Variable Subcommand Examples

4.14 Inqraid Command Tool

CCI provides the inqraid command tool for confirming the drive connection between the 9900 and host system (HP-UX®, Linux®, and Solaris® systems only). The inqraid command displays the relation between special file(s) on the HP-UX®/Linux® system and actual physical drive of 9900. Table 4.30 lists and describes the inqraid command and parameters. Figure 4.38 shows examples of using inqraid and system command to display the connection between special file of STDIN and actual physical drive of 9900.

Table 4.30 Inqraid Command Parameters

Parameter	Value
Command Name	/HORCM/usr/bin/inqraid
Format	/HORCM/usr/bin/inqraid [-h quit -inqdump -fx -find <special file>]
Options	<p>-h: This option displays Help/Usage.</p> <p>quit: This option terminates from waiting STDIN and exits this command.</p> <p>-inqdump: This option displays information for standard inquiry with Dump Image of hexadecimal.</p> <p>-fx: This option displays the LDEV number with hexadecimal.</p> <p>-find: This option searches a group on the configuration definition file (local instance) from <special file> of STDIN by using pairdisplay command, and uses the following options of the pairdisplay command to display its state. This option must be specified HORCMINST as command execution environment</p> <p>For HOMRCF(BC): pairdisplay -d <Seq#> <LDEV#> 0 1 2 -l [-fx] 2>/dev/null</p> <p>For HORC(CA): pairdisplay -d <Seq#> <LDEV#> -l [-fx] 2>/dev/null</p> <p>Note: <Seq#> and <LDEV#> are included using SCSI Inquiry command.</p> <p><special file>: This option is used to specify the special file name as argument of command.</p> <p>If no argument, this command makes mode that wait for STDIN without argument.</p>
Restriction	<p>The special file of STDIN or Argument must be specified following name:</p> <p>HP-UX® and Solaris®: /dev/rdisk/...</p> <p>Linux®: /dev/sd... or /dev/rd...</p>

HP-UX® System

```
# ioscan -fun | grep rdsk | ./inqraid
/dev/rdsk/c0t2d1 -> [HP] CL2-D Ser = 30053 LDEV = 9 [HP] [OPEN-3]
HARC = P-VOL HOMRCF[MU#0 = SMPL MU#1 = SMPL MU#2 = SMPL]
RAID5[Group 2- 1] SSID = 0x0008 CTGID = 3
/dev/rdsk/c0t4d0 -> [HP] CL2-D Ser = 30053 LDEV = 14 [HP] [OPEN-3-CM]
```

Linux® System

```
# ls /dev/sd* | ./inqraid
/dev/sdh -> CHNO = 0 TID = 1 LUN = 7
[HP] CL2-B Ser = 30053 LDEV = 23 [HP] [OPEN-3]
HARC = P-VOL HOMRCF[MU#0 = SMPL MU#1 = SMPL MU#2 = SMPL]
RAID5[Group 1- 2] SSID = 0x0004 CTGID = 2
/dev/sdi -> CHNO = 0 TID = 4 LUN = 0
[HP] CL2-B Ser = 30053 LDEV = 14 [HP] [OPEN-3-CM]
```

Solaris® System

```
# ls /dev/rdsk/* | ./inqraid
/dev/rdsk/c0t2d1 -> [HP] CL2-D Ser = 30053 LDEV = 9 [HP] [OPEN-3]
CA = P-VOL BC[MU#0 = SMPL MU#1 = SMPL MU#2 = SMPL]
RAID5[Group 2- 1] SSID = 0x0008 CTGID = 3
/dev/rdsk/c0t4d0 -> [HP] CL2-D Ser = 30053 LDEV = 14 [HP] [OPEN-3-CM]
```

Figure 4.38 Inqraid Command Tool Examples

```
ls /dev/sd* | inqraid -find
/dev/sdb -> No such on the group
Group PairVol(L/R) (Port#,TID,LU),Seq#,LDEV#.P/S,Status,Fence, Seq#,P-LDEV# M
oradb oradev2(L) (CL2-N , 3, 2) 8071 22..SMPL ---- -,----- -
->/dev/sdc
```

Figure 4.39 Inqraid: Example of -find Option for Linux

The output of the `inqraid` command includes:

- CLX-Y: Port number.
- Ser: Serial number.
- LDEV: LDEV ID.
- HORC: HORC attribute (PVOL, SVOL, or SMPL) of the volume.
- HOMRCF: HOMRCF attributes (PVOL/SVOL/SMPL) of the volume for MU#0-2.
- Group: Array (parity) group ID (physical position of the volume in the 9900/7700E).
- SSID: Subsystem ID of the volume.
- CTGID: HORC Async consistency group ID, displayed only for HORC Async volumes.
- CHNO: Channel number on the device adapter that recognizes the volume. Displayed only for Linux[®] systems.
- TID: Target ID of the volume. Displayed only for Linux[®] systems. For further information on fibre-to-SCSI address conversion, see Appendix D.
- LUN: Logical unit number of the volume. Displayed only for Linux[®] systems.

Note: The display of **Group**, **SSID**, and **CTGID** depends on the 9900/7700E microcode level.

4.15 Synchronizing Command for HORC Asynchronous

More robust systems need to confirm the data consistency between the HORC Async PVol and SVol. In DB operations (e.g., Oracle), the commit() of DB transaction (see Figure 4.40) is needed to confirm that a last writing for the commit() on a local site reached to remote site by using CCI-unique API command. The command is used for the confirmation that required writing was stored in DFW area of RCU, and it will be able to confirm whether or not a last writing of just before this command is reached to RCU DFW area.

When a client issued this command, this command is placed on the queue buffer for waiting in the HORCM daemon as a command request. HORCM get the latest sequence # from MCU sidefile and the sequence # whose block was transferred and stored in DFW area of RCU with data consistency, and will compare the latest sequence # of MCU sidefile with the sequence # of RCU DFW area within the term. HORCM replies return code to this command, when the write of MCU sidefile was stored in RCU DFW area. In use this function, a client will be able to confirm that a commit() has been reached to remote site, and also the backup utility on a remote site will be able to split the cascading HOMRCF volumes (HORCAsync → HORCAsync/HOMRCF) without splitting for HORC Async.

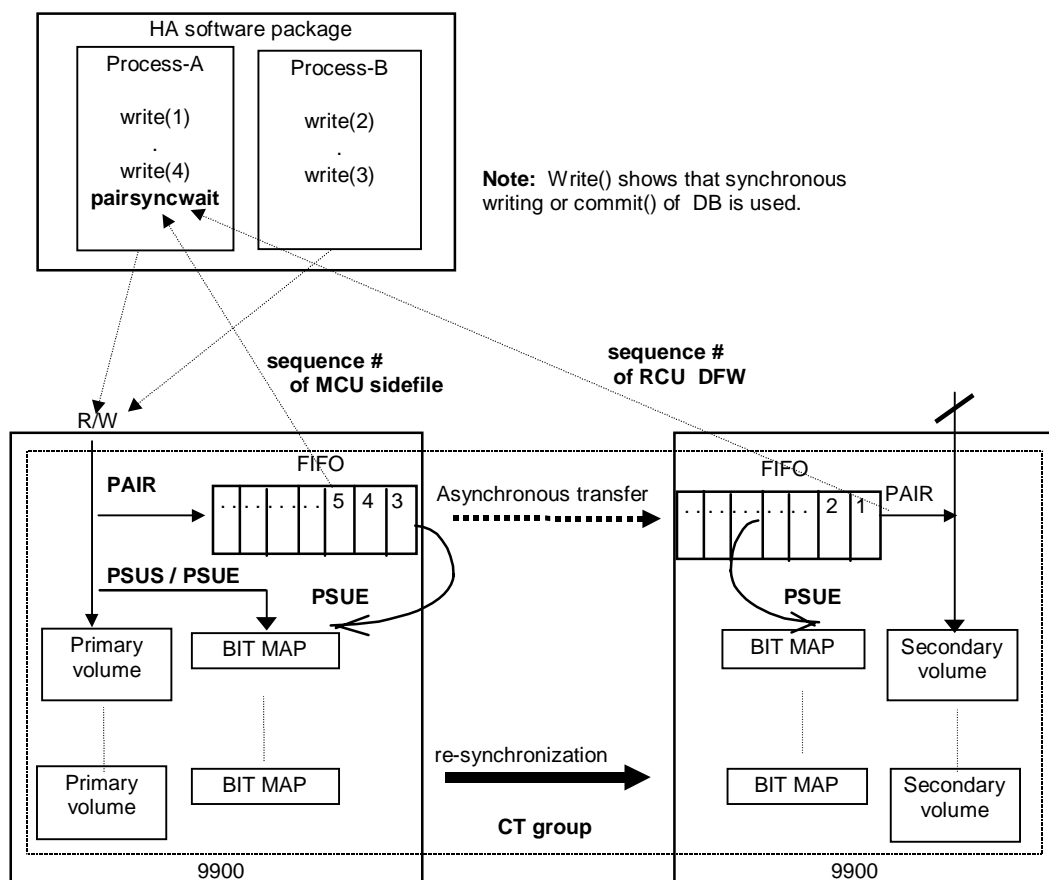


Figure 4.40 Synchronization for HORC Async

Table 4.31 lists and describes the pair synchronization waiting command parameters and returned values. The pairsyncwait command is used to confirm that required writing was stored in DFW area of RCU, and it will be able to confirm whether or not a last writing of just before this command is reached to RCU DFW area. This command gets the latest sequence # of MCU sidefile (PVOL latest sequence # within the CT group ID) and the sequence # of RCU DFW within the CT group ID which correspond to the <group> or <raw_device> that is specified by pairsyncwait, and compares MCU with RCU sequence # at that time and at regular interval. If RCU sequence # is over the value of MCU sequence # within the term that was specified by pairsyncwait, this command reports the return code 0 with the meaning of completion of synchronization. The -nowait option shows the latest sequence # (Q-marker) of MCU PVol and CTGID. The marker is shown in hexadecimal of ten characters.

Note: Specified <group> volume must be PVol with status PAIR. Other cases reply with error (EX_INVVOL). It is possible to issue pairsyncwait from SVOL side with **-m <marker>**.

Table 4.31 Pairsyncwait Command Parameters (continues on the next page)

Parameter	Value
Command Name	pairsyncwait
Format	pairsyncwait { -h -q -z -g <group> -d <pair Vol> -d[g] <raw_device> [MU#] -d[g] <seq#> <LDEV#> [MU#] -m <marker> -t <timeout> -nowait -nomsg }
Options	<p>-h: Displays Help/Usage and version information.</p> <p>-q: Terminates the interactive mode and exits the command.</p> <p>-z or -zx: Makes the raidar command enter the interactive mode. The -zx option guards performing of the HORCM in the interactive mode. When this option detects a HORCM shut down, interactive mode terminates.</p> <p>-g <group>: Specifies a group name defined in the configuration definition file. The command is executed for the specified group unless the -d <pair Vol> option is specified.</p> <p>-d <pair Vol>: Specifies paired logical volume name defined in the configuration definition file. When this option is specified, the command is executed for the specified paired logical volume.</p> <p>-d[g] <raw_device> [MU#] (HP-UX®, Linux®, Windows® NT/2000, Solaris® only): Searches a group on the configuration definition file (local instance) for the specified raw_device. If the specified raw_device is found, the command is executed on the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified raw_device is contained in two or more groups, the command is executed on the first group.</p> <p>-d[g] <seq#> <LDEV#> [MU#]: Searches a group on the configuration definition file (local instance) for the specified LDEV, and if the specified LDEV is contained in the group, the command is executed on the paired logical volume (-d) or group (-dg). This option is effective without specification of "-g <group>" option. If the specified LDEV is contained in two or more groups, the command is executed on the first group. The <seq #> <LDEV #> values can be specified in hexadecimal (by addition of "0x ") or decimal.</p> <p>-m <marker>: Specifies the sequence # of MCU PVOL, called the Q-marker. If the application gets Q-marker as the result of execution of pairsyncwait because of timeout or "-nowait", the application can reconfirm the completion of Async transfer by using pairsyncwait with Q-marker. If the application does not specify Q-marker, CCI uses the latest sequence # when CCI receives pairsyncwait. It is also possible to wait for the completion from SVol side with this option.</p> <p>Q-Marker format: = iisssssss, where ii = incarnation # of pair volume, and sssssss = PVOL serial #.</p> <p>-t <timeout>: Specifies the timeout value to wait for the completion of RCU DFW area. The unit is 100 ms. MCU gets the latest sequence # from RCU at regular interval.</p> <p>-nowait: Gets the latest sequence # of MCU PVol and CTGID without waiting. When this option is specified, the latest sequence # of MCU PVol is reported immediately, and -t <timeout> option is ignored.</p> <p>-nomsg: Suppresses messages to be displayed when this command is executed from a user program. This option must be specified at the beginning of the command arguments.</p>

Table 4.31 Pairsyncwait Command Parameters (continued)

Parameter	Value
Returned values	<p>When the -nowait option is specified:</p> <p>Normal termination: 0: The status is NOWAIT.</p> <p>Abnormal termination: other than 0 to 127, refer to the execution logs for error details.</p> <p>When the -nowait option is not specified:</p> <p>Normal termination: 0: The status is DONE (completion of synchronization).</p> <p>1: The status is TIMEOUT (timeout).</p> <p>2: The status is BROKEN (Q-marker synchronized process is rejected).</p> <p>3: The status is CHANGED (Q-marker is invalid due to resynchronize).</p> <p>Abnormal termination: other than 0 to 127, refer to the execution logs for error details.</p>

Figure 4.41 shows examples of the pairsyncwait command with and without the **-nowait** option. The output of the pairsyncwait command is:

- **UnitID**: Unit ID in case of multiple subsystem connection.
- **CTGID**: CTGID within Unit ID.
- **Q-Marker**: The latest sequence # of MCU PVol (Marker) when the command is received.
- **Status**: The status after the execution of command.
- **Q-Num**: The number of process queue to wait for synchronization within the CTGID.

```
# pairsyncwait -g oradb -nowait                               ← -nowait is specified.
UnitID  CTGID      Q-Marker  Status    Q-Num
   0      3    01003408ef  NOWAIT      2

# pairsyncwait -g oradb -t 100                                ← -nowait is not specified.
UnitID  CTGID      Q-Marker  Status    Q-Num
   0      3    01003408ef  DONE      2

# pairsyncwait -g oradb -t 1
UnitID  CTGID      Q-Marker  Status    Q-Num
   0      3    01003408ef  TIMEOUT   3

# pairsyncwait -g oradb -t 100 -m 01003408ef
UnitID  CTGID      Q-Marker  Status    Q-Num
   0      3    01003408ef  DONE      0

# pairsyncwait -g oradb -t 100
UnitID  CTGID      Q-Marker  Status    Q-Num
   0      3    01003408ef  BROKEN    0

# pairsyncwait -g oradb -t 100 -m 01003408ef
UnitID  CTGID      Q-Marker  Status    Q-Num
   0      3    01003408ef  CHANGED   0
                                ↖ Q Marker(01003408ef) is invalid when PVOL was
                                re-synchronized while this command is executed.
```

Figure 4.41 Pairsyncwait Command Examples

Chapter 5 Troubleshooting

5.1 General Troubleshooting

If you have a problem with the CCI software, first make sure that the problem is not being caused by the UNIX[®]/PC server hardware or software, and try restarting the server. Table 5.1 provides operational notes and restrictions for CCI operations.

For maintenance of HORC/HOMRCF volumes, if a failure occurs, it is important to find the failure in the paired volumes, recover the volumes, and continue operation in the original system. When a HORCM, HORC, or HOMRCF failure is detected, the system administrator should collect the data in the HORC error log file and trace data (all files in the HORCM_LOG directory), and report the failure to your Hitachi Data Systems representative.

Table 5.1 Operational Notes for CCI Operations (continues on the next page)

Condition	Recommended Action
Startup/shutdown restrictions	<p>When the server starts up, the secondary volume may be updated by the primary volume's server. The secondary volume must not be mounted automatically in the startup sequence. If the secondary volume is used by the LVM, the volume group of the LVM must be deactivated. The secondary volume must be mounted in the split state or in the simplex mode.</p> <p>When the server starts up, the secondary volume can be activated without confirming, when can be guaranteed that the secondary volume has been PSUS (R/W enable) or in the SMPL state by server shutdown sequence.</p>
Hot standby operations	<p>HORC commands cannot execute hot standby operations between the primary and secondary volumes. Use the takeover command intended for the HA configuration to execute the hot standby operation. In hot standby operation, two servers are used, and the active (primary) and standby (secondary) server programs are run alternately in each server in case of failure in one server. Follow these precautions:</p> <p>Operation across volumes. Since each HORC command causes the server software to handle the volume by volume, a single volume should not be partitioned to prevent it from being used by some servers.</p> <p>Using LVM and HORC together. When constructing the LVM on the paired volume in the mutual hot standby configuration, the LVM logical volumes must be constructed in units of volume to prevent the volumes from being mounted by the LVM.</p>
Coexistence of LVM mirror and HORC	<p>When the LVM mirror and HORC volumes are used together, the LVM mirror handles write errors and changes the volumes. Thus, the fence level of the volumes used by the LVM mirror must be set to data.</p>
Using paired volume in a single host	<p>When constructing paired volume in a single host, it is necessary to activate two or more CCI instances. To activate two or more CCI instances, instance numbers must be assigned using the environmental variable HORCMINST. The HORCM and HORC/HOMRCF commands must possess this environmental variable. A configuration definition file and a log directory must be set for each instance. The command device described in the configuration definition file must be established in a way to be following either every instance. If using a command device between different instances on the same SCSI port, the maximum number of instances per command device is 16. If this number is exceeded, the use a different SCSI path for each instance.</p>

Table 5.1 Operational Notes for CCI Operations (continued)

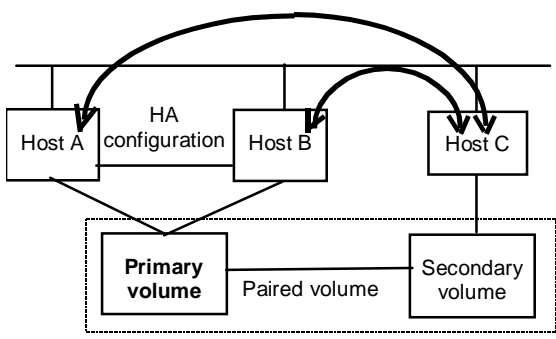
Condition	Recommended Action
Sharing volumes in a hot standby configuration	<p>When paired volume is used for the disk shared by the hosts in hot standby configuration using HA software, use the primary volume as the shared disk and describe the corresponding hosts using the paired volume in the configuration definition file as shown below. In the HA configuration, if a HORC command issued by host C fails in host B (because host B has gone down and/or IO_ERROR of the command device), host A is connected and the command execution is retried.</p> 
Linkage with HA software	<p>The HORC Manager must not be an object of the process monitoring by the HA software (cluster manager), because HORCM should run in the same level as the cluster manager. Cooperation with HA software is done by activating the takeover command from the shell script activated by the cluster manager in units of the package software.</p> <p>Note: Cannot use a pair volume for the cluster lock disk which HA software uses for election.</p>
Maintenance	<p>Restart of HORCM is required if the 9900 configuration is changed (e.g., microcode exchange, cache memory install/de-install).</p> <p>HORC only: In case of an error (e.g., single error in cache memory) which made the pair volume is accompanied by maintenance work, the pairresync command or paircreate command cannot execute copy rejection.</p>
Command device	<p>Each HORC/HOMRCF command is executed by issuing a command to the command device. The HORC/HOMRCF command is read or written from/into the specific block area of the command device. Therefore, the command device cannot be used by the user. In addition, this device must not belong to an LVM volume group. For Windows® systems, do not assign a drive letter to the command device to prevent utilization by general users.</p>
SCSI alternate path restrictions	<p>If the P-VOL and S-VOL are on the same server, alternate path from P-VOL to S-VOL cannot be used. Use of SCSI alternate path to a volume pair is limited to among primary (secondary) volumes. Alternate path using Hitachi Path Manager (Safe Path) is limited to primary volumes.</p>
Horctakeover (Swap-Takeover)	<p>When executing horctakeover on a standby server manually, I/O on the active server must be stopped. When the package software goes for a standby server a failover by HA software, the HA software must guarantee an I/O insulation of the active server.</p>
HORCM failure to activate	<p>After a new system has been constructed, a failure to activate HORCM may occur due to improper environmental setting and/or configuration definition by the user. Refer to the HORCM activation log, and correct the setting(s).</p>

Table 5.1 Operational Notes for CCI Operations (continued)

Condition	Recommended Action
Abnormal termination of command	<p>Refer to the command log file and HORCM log file to identify the cause of the error. If a command terminates abnormally because of a remote server failure, recover the server from the failure, then re-execute the command. If HORCM has shut down, restart HORCM. If an unrecoverable error occurs, obtain the log files and contact the Hitachi Data Systems Support Center.</p>
Error in paired volume operation	<p>HORC only: If an error occurs in duplicated writing in paired volumes (i.e., pair suspension), the server software using the volumes may detect the error by means of the fence level of the paired volume. In such a case, check the error notification command or syslog file to identify a failed paired volume.</p> <p>The system administrator can confirm that duplicated writing in a paired volume is suspended due to a failure and the system runs in regressed state using the error notification command of the HORC. HORCM monitors failures in paired volumes at regular intervals. When it detects a failure, it outputs it to the host's syslog file. Thus, the system administrator can detect the failure by checking the syslog file.</p> <p>Concerning the operation of the 9900, the failure can also be found on the Remote Console PC (or SVP) provided.</p> <p>Issue the HORC commands manually to the identified failed paired volume to try to recover it. If the secondary volume is proved to be the failed volume, issue the pair resynchronization command to recover it. If the primary volume fails, delete the paired volume (pair splitting simplex) and use the secondary volume as the substitute volume.</p>

5.2 Error Reporting

Table 5.2 lists and describes the HORCM system log messages and provides guidelines for resolving the error conditions. Table 5.3 lists and describes the command error messages and their return values and also provides guidelines for resolving the error conditions.

Table 5.2 System Log Messages

Message ID	Condition	Cause	Recommended Action
HORCM_001	The HORCM log file cannot be opened.	The file cannot be created in the HORCM directory.	Create space on the disk on which the root directory resides.
HORCM_002	The HORCM trace file cannot be opened.	The file cannot be created in the HORCM directory.	Create space on the disk on which the root directory resides.
HORCM_003	The HORCM daemon process cannot create a child process due to an error.	HORCM daemon attempted to create more processes than the maximum allowable number.	Terminate unnecessary programs or daemon processes running simultaneously.
HORCM_004	HORCM assertion failed, resulting in a fatal internal error in the HORCM.	An internal error which could not be identified by the HORCM occurred.	Restart the system, and call the Hitachi Data Systems support center.
HORCM_005	The CCI software failed to create the end point for remote communication.	HORCM failed to create a socket, or an error exists in the HORCM configuration file (\$HORCM_CONF).	Refer to the HORCM startup log to identify the cause of the error.
HORCM_006	HORCM memory allocation failed.	HORCM memory could not be secured.	Increase the system virtual memory, or close any unnecessary programs.
HORCM_007	An error exists in the HORCM setup file.	An error exists in the HORCM setup file.	Refer to the startup log and reset the parameters.
HORCM_008	HORCM configuration file parameters could not be read.	An error exists in the format or parameters of the HORCM configuration file (\$HORCM_CONF).	Refer to the HORCM startup log to identify the cause of the error.
HORCM_009	HORC/HOMRCF connection to the CCI software failed.	System devices are improperly connected, or an error exists in the HORCM configuration file.	Refer to the HORCM startup log to identify the cause of the error.
HORCM_101	HORC/HOMRCF and the CCI software communication fails.	A system I/O error occurred or an error exists in the HORCM configuration file (\$HORCM_CONF).	Refer to the HORCM startup log to identify the cause of the error.
HORCM_102	The volume is suspended.	The pair status was suspended due to code XXXX.	Call the Hitachi Data Systems support center.

Table 5.3 Command Error Messages

Message ID	Error Message	Condition	Recommended Action	Return Value
EX_COMERR	Can't Communicated with HORC Manager	This command failed to communicate with the CCI software.	Verify that HORCM is running by using UNIX® commands [ps - ef grep horcm].	255
EX_REQARG	Required Arg list	An option or arguments of an option are not sufficient.	Please designate the correct option using the -h option.	254

Table 5.3 Command Error Messages (continued)

Message ID	Error Message	Condition	Recommended Action	Return Value
EX_INVARG	Invalid argument	An option or arguments of an option are incorrect.	Please designate the correct option using the -h option.	253
EX_UNWOPT	Unknown option	Designated an unknown option.	Please designate the correct option using the -h option.	252
EX_ATTTHOR	Can't attached to HORC Manager	Could not connect with HORCM.	Please verify that HORCM is running and/or that HORCMINST is set correctly.	251
EX_ATTDBG	Can't attached to a Debug layer	Failed to communicate with HORCM, or cannot make a log directory file.	Verify that HORCM is running by using UNIX® commands [ps -ef grep horcm].	250
EX_INVNAM	Invalid name of option	The name specified in an argument of an option is not appropriate.	Please designate the correct option using the -h option.	249
EX_OPTINV	A specified option is invalid	Detected contradiction in information which RAID reported.	Call the Hitachi Data Systems Support Center.	248
EX_ENOENT	No such device or group	The designated device or group name does not exist in the configuration file.	Verify the device or group name and add it to the configuration file of the remote and local hosts.	247
EX_ENODEV	No such device	The designated device name does not exist in the configuration file.	Verify the device name and add it to the configuration file of the remote and local hosts.	246
EX_ENOUNT	No such RAID unit	The designated RAID unit ID does not exist in the configuration file.	Verify the RAID unit ID and add it to the configuration file of the remote and local hosts.	219
EX_ENQSER	Unmatched Serial# vs RAID unitID	The group designated by HOMRCF paircreate does not have the same RAID unit, or the unitID is not identical to the unit ID in the same RAID serial# (Seq#).	Please confirm serial# (Seq#) using the pairdisplay command, or confirm serial# (Seq#) of the RAID using the raidqry -r command	218
EX_ENOMEM	Not enough core	Insufficient memory exists.	Increase the virtual memory capacity of the system, or close any unnecessary programs and/or daemon processes.	245
EX_ERANGE	Result too large	Tried to use arguments for an option beyond the maximum allowed, or a result beyond the maximum was created.	Please refer to the error message, and designate an appropriate value.	244
EX_ENAMLG	File name too long	Undefined error.	Call the Hitachi Data Systems Support Center.	243
EX_ENORMT	No remote host alive for remote commands or remote HORCM might be blocked (sleeping) on an existing I/O	A timeout occurred on remote communication, and HORC Manager failed to re-execute.	Please confirm that the HORC Manager in the remote host is running, and then increase the value of the timeout in the configuration file.	242
EX_INVMOD	Invalid RAID command mode	Detected a contradiction for a command.	Call the Hitachi Data Systems Support Center.	241
EX_INVCMD	Invalid RAID command	Detected a contradiction for a command.	Call the Hitachi Data Systems Support Center.	240
EX_ENOGRP	No such group	The designated device or group name does not exist in the configuration file, or the network address for remote communication does not exist.	Verify the device or group name and add it to the configuration file of the remote and local hosts.	239

Table 5.3 Command Error Messages (continued)

Message ID	Error Message	Condition	Recommended Action	Return Value
EX_UNWCOD	Unknown function code	Detected a contradiction for a command.	Call the Hitachi Data Systems Support Center.	238
EX_CMDIOE	Control command I/O error	A read/write to the command device failed with an I/O error.	Refer to the host syslog file, and investigate the cause of the error. If the problem persists, call the Hitachi Data Systems Support Center.	237
EX_CMDRJE	An order to the control/command device was rejected	The request to the command device failed or was rejected. Note: This error code is sometimes caused by the operating system and reported as EX_CMDIOE instead of EX_CMDRJE (see next row).	Verify HORC/HOMRCF functions are installed. Verify RCP and LCP ports are set on the RAID. Verify CU paths have been established. Verify that the target volume is available.	221
EX_CMDIOE	Control command I/O error or rejected	A read/write to the command device failed with an I/O error or was rejected.	Refer to the host syslog file, and investigate the cause of the error. If the cause is "Illegal Request(0x05)" Sense Key, please confirm the following items. If the problem persists, call the Hitachi Data Systems Support Center. Verify HORC/HOMRCF functions are installed. Verify RCP and LCP ports are set on the RAID. Verify CU paths have been established. Verify that the target volume is available.	237
EX_ENQVOL	Unmatched volume status within the group	The volume attribute or the fence level within a group is not identical.	Confirm status using the pairdisplay command. Make sure all volumes in the group have the same fence level and volume attributes.	236
EX_EVOLCE	Pair Volume combination error	Combination of a volume is unsuitable between the remote and local host.	Confirm volume status using the pairdisplay command, and change the combination of volumes properly.	235
EX_EWSUSE	Pair suspended at WAIT state	Detected a suspended status (PSUE) for the paired volume, before it made it to the designated status.	Please issue the pairresync command manually to the identified failed paired volume to try to recover it. If the trouble persists, call the Hitachi Data Systems Support Center.	234
EX_EWSTOT	Timeout waiting for specified status	Detected a time out, before it made it to the designated status.	Please increase the value of the timeout using the -t option.	233
EX_EWSLTO	Timeout waiting for specified status on the local host	Timeout error because the remote did not notify about expected status in time.	Please confirm that HORC Manager on the remote host is running.	232
EX_ESTMON	HORCM Monitor stopped	HORC Manager monitoring was refused.	Please confirm the value of "poll" in the configuration file.	231
EX_UNWCMD	Unknown command	An unknown command was attempted.	Please confirm the command name.	230
EX_INCSTG	Inconsistent status in group	The pair status of a volume within a group is not identical to the status of the other volumes in the group.	Please confirm the pair status using the pairdisplay command.	229
EX_INVSTP	Invalid pair status	The pair status of the target volume is not appropriate.	Please confirm the pair status using the pairdisplay command.	228
EX_INVVOL	Invalid volume status	The volume status of the target volume is not appropriate.	Please confirm the pair status using the pairdisplay -l command.	222

Table 5.3 Command Error Messages (continued)

Message ID	Error Message	Condition	Recommended Action	Return Value
EX_INVMUN	Invalid mu# with HORC or HOMRCF	The MU# of the volume to be operated is not appropriate.	Please confirm the MU# for the specified group using the pairdisplay command. MU #1/2 cannot be used for HORC, and MU #1/2 must be P-Vol for HOMRCF.	220
EX_ENLDEV	No such LDEV within the RAID	A device defined in the configuration file does not have a mapping to a real LUN and Target ID within the RAID.	Please confirm that the Port, Target ID, LUN are defined correctly under HORCM_DEV in the configuration file.	227
EX_INVRCD	Invalid return code	Wrong return code.	Call the Hitachi Data Systems Support Center.	226
EX_VOLCUR	S-Vol currency error	Currency check error for S-VOL. Cannot guarantee identical data on S-VOL.	Check the volume list to see if an operation was directed to the wrong S-VOL.	225
EX_VOLCUE	Local volume currency error	The volume specified with the SVOL-takeover command is not the same as the P-VOL.	Please confirm the pair status of the local volume.	224
EX_VOLCRE	Local and remote vol. currency error	The combination of the volumes specified with Swap-takeover is unsuitable.	Please confirm the pair status of remote and local volumes using the pairdisplay command.	223
EX_UNWERR	Unknown error code.	Wrong error code.	Call the Hitachi Data Systems Support Center.	--
EX_ENOCTG	Not enough CT groups in the RAID	CTGID could not be registered due to being beyond the maximum number of CT groups (63[15]) when making a HORC Async volume.	Choose an existing CTGID (use pairvolchk to display CTGIDs). Use the '-f async <CTGID>' option of the paircreate command to force the pair into a pre-existing CTGID.	217
EX_EXTCTG	Extended CT group across RAIDs	A HORC Async volume is defined in the configuration file (HORCM_CONF) as a group that extends across RAIDs.	Please confirm the serial # of the volumes by using the pairdisplay command to verify that the CT group is contained completely within one RAID.	216
EX_ENXCTG	No CT groups left for OPEN Vol use.	An available CT group for OPEN Volume does not exist for HORC Async.	Please confirm whether all CT groups are already used by mainframe HRC volumes.	215
EX_ENQCTG	Unmatched CTGID within the group	The CT group references within a group do not have an identical CTGID.	Please confirm the CTGID using the pairvolchk command and/or confirm that group references within the configuration file (HORCM_CONF) refer to the same CT group.	214

5.3 Calling the Hitachi Data Systems Support Center

If you need to call the Hitachi Data Systems Support Center, make sure to provide as much information about the problem as possible, including the circumstances surrounding the error or failure and the exact content of any error messages and/or codes displayed on the Remote Console PC and/or logged at the host.

The worldwide Hitachi Data Systems Support Centers are:

- Hitachi Data Systems North America/Latin America
San Diego, California, USA
1-800-348-4357
- Hitachi Data Systems Europe
Contact Hitachi Data Systems Local Support
- Hitachi Data Systems Asia Pacific
North Ryde, Australia
011-61-2-9325-3300

Appendix A Acronyms and Abbreviations

CM	Cluster Manager
CU	control unit
CVS	Custom Volume Size (also called Virtual LUN)
DCR	Dynamic Cache Residency (also called FlashAccess)
ESCON®	Enterprise System Connection (IBM trademark for optical channels)
fd	floppy disk
HA	high availability
HACMP	High Availability Cluster Multiprocessing
hdisk	hard disk
HMDE	Hitachi Multiplatform Data Exchange
HMRCF	Hitachi Multiple RAID Coupling Feature (ShadowImage for S/390® data)
HOMRCF	Hitachi Open Multiple RAID Coupling Feature (Open ShadowImage)
HORC	Hitachi Open Remote Copy
HORCM	HORC Manager
HRC	Hitachi Remote Copy
INST	instance number
I/O	input / output
LDEV	logical device
LU	logical unit
LUN	logical unit number
LVM	logical volume manager
MCU	main control unit (HORC only)
MU	mirrored unit
PC	personal computer system
P-VOL	primary volume
RCU	remote control unit (HORC only)
SCSI	small computer system interface
S-VOL	secondary volume
SVP	service processor
TID	target ID

Appendix B Maintenance Logs and Tracing Functions

B.1 Log Files

The CCI software (HORCM) and HORC/HOMRCF commands maintain internal logs and traces which can be used to identify the causes of errors and keep records of the status transition history of paired volumes. Figure B.1 shows the CCI logs and traces.

HORCM logs are classified into start-up logs and execution logs. The start-up logs contain data on errors which occur before the HORCM becomes ready to provide services. Thus, if the HORCM fails to start up due to improper environment setting, users should refer to the start-up logs to resolve the problem. The HORCM execution logs (error log, trace, and core files) contain data on errors which are caused by software or hardware problems. These logs contain internal error data which does not apply to any user settings, and so users do not need to refer to the HORCM execution logs. When an error occurs in execution of a command, data on the error is collected in the command log file. Users may refer to the command log file if a command execution error occurs.

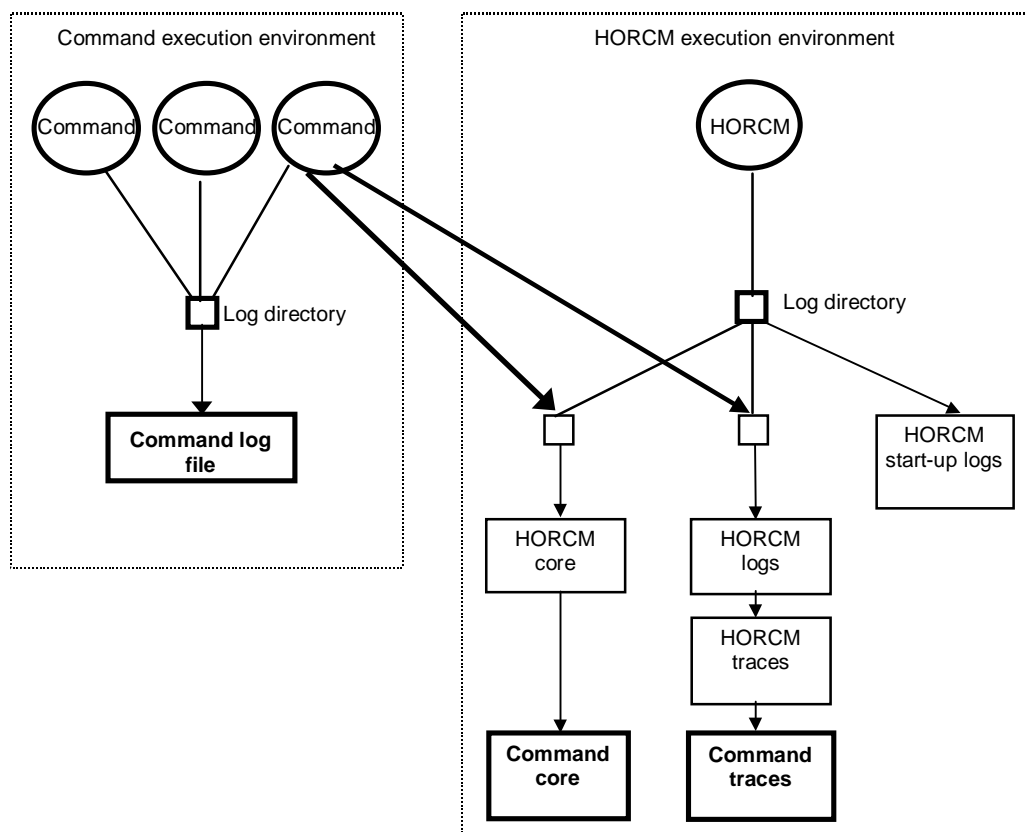


Figure B.1 Logs and Traces

The start-up log, error log, trace, and core files are stored as shown in Table B.1. The user should specify the directories for the HORCM and command log files using the HORCM_LOG and HORCC_LOG environmental variables as shown in Table B.2. If it is not possible to create the log files, or if an error occurs before the log files are created, the error logs are output in the system log file. If the HORCM activation fails, the system administrator should check the system log file, identify the error cause, and take the proper action. Chapter 5 lists and describes the messages output to the system log file and provides recommended actions for resolving the error conditions. The system log file for UNIX[®]-based systems is the syslog file. The system log file for Windows[®]-based systems is the event log file.

Table B.1 Log Files

File	UNIX [®] -based Systems	Windows [®] -based Systems
Start-up log	HORCM start-up log: \$HORCM_LOG/horcm_HOST.log Command log: \$HORCC_LOG/horcc_HOST.log	HORCM start-up log: \$HORCM_LOG\horcm_HOST_log.txt Command log: \$HORCC_LOG\horcc_HOST_log.txt
Error log	HORCM error log: \$HORCM_LOG/horcmlog_HOST/horcm.log	HORCM error log: \$HORCM_LOG\horcmlog_HOST\horcm_log.txt
Trace	HORCM trace: \$HORCM_LOG/horcmlog_HOST/horcm_PID.trc Command trace: \$HORCM_LOG/horcmlog_HOST/horcc_PID.trc	HORCM trace: \$HORCM_LOG\horcmlog_HOST\horcm_PID_trc.txt Command trace: \$HORCM_LOG\horcmlog_HOST\horcc_PID_trc.txt
Core	HORCM core: \$HORCM_LOG/core_HOST_PID/core Command core: \$HORCM_LOG/core_HOST_PID/core	HORCM core: \$HORCM_LOG\core_HOST_PID\core Command core: \$HORCM_LOG\core_HOST_PID\core

Note: HOST denotes the host name of the corresponding machine. PID denotes the process ID of that machine.

The location of the directory which contains the log file depends on the user's command execution environment and the HORCM execution environment. The command trace file and core file reside together under the directory specified in the HORCM execution environment. A directory specified using the environmental variable HORCM_LOG is used as the log directory in the HORCM execution environment. If no directory is specified, the directory **/tmp** is used. A directory specified using the environmental variable HORCC_LOG is used as the log directory in the command execution environment. If no directory is specified, the directory **/HORCM/log*** is used (* = instance number). A nonexistent directory may be specified as a log directory using the environmental variable.

Table B.2 Log Directories

Directory Name	Definition
\$HORCM LOG	A directory specified using the environmental variable HORCM_LOG. The HORCM log file, trace file, and core file as well as the command trace file and core file are stored in this directory. If no environmental variable is specified, "/HORCM/log/curlog" is used.
\$HORCC LOG	A directory specified using the environmental variable HORCC_LOG. The command log file is stored in this directory. If no environmental variable is specified, the directory "/HORCM/log*" is used (* is the instance number). While the HORCM is running, the log files are stored in the \$HORCM_LOG directory shown in (a). When the HORCM starts up, the log files created in the operation are stored automatically in the \$HORCM_LOGS directory shown in (b). <ul style="list-style-type: none">a. HORCM log file directory in operation \$HORCM_LOG = /HORCM/log*/curlog (* is instance number)b. HORCM log file directory for automatic storing \$HORCM_LOGS = /HORCM/log*/tmplog (* is instance number)

B.2 Trace Files

The command trace file is used for maintenance aiming at troubleshooting. It is not created normally. If a cause of an error cannot be identified by means of the log file, the environmental variables or trace control commands with trace control parameters are issued to start tracing and the trace file is created. The trace control parameters consist of the trace level, file size, mode, etc. More detailed tracing is enabled by increasing the trace level. Tracing is made in wraparound within the range of the file size. The HORCM makes the trace file according to the trace level specified in the HORCM start-up shell script set to activate the HORCM.

B.3 Trace Control Command

The trace control command (one of the HORCM control commands) sets or changes the trace control parameters. This command is used for troubleshooting and maintenance. If no trace control parameters can be specified using the environmental variables in the user's command execution environment, it is possible to change the trace control parameters into the global parameters using this command. Table B.3 lists and describes the parameters of the trace control command.

Table B.3 Trace Command Parameters

Parameter	Function
Trace level parameter	Specifies the trace level, range = 0 to 15.
Trace size parameter	Specifies the trace file size in kB.
Trace mode parameter	Specifies the buffer mode or non-buffer mode for writing data in the trace file.
Trace type parameter	Specifies the trace type defined internally.
Trace change instruction	Specifies either the command or the HORCM (CCI instance) for which the trace control parameters are changed.

Appendix C Updating and De-Installing CCI

C.1 UNIX® De-Installation

After verifying that the CCI software is not running, you can de-install the CCI software. If the CCI software is still running when you want to de-install, shut down the CCI software using the horcmshutdown.sh command to ensure a normal end to all HORC/HOMRCF functions.

Caution: Before de-installing the CCI software, make sure that all device pairs are in simplex status.

To deinstall the CCI software from a root directory (see Figure C.1): issue the uninstall command, go to the root directory, and delete the HORCM directory.

To deinstall the CCI software from a non-root directory (see Figure C.2): issue the uninstall command, go to the root directory, delete the HORCM link, and delete the HORCM directory.

# /HORCM/horcmuninstall.sh	← <i>Issue the de-install command.</i>
# cd /	← <i>Change directories.</i>
# rm -rf /HORCM	← <i>Delete the CCI directory.</i>

Figure C.1 Deinstalling the CCI Software from a Root Directory

# /HORCM/horcmuninstall.sh	← <i>Issue the de-install command.</i>
# cd /	← <i>Change directories.</i>
# rm /HORCM	← <i>Delete the CCI link.</i>
# rm -rf /non-root_directory_name/HORCM	← <i>Delete the CCI directory.</i>

Figure C.2 Deinstalling the CCI Software from a Non-Root Directory

C.2 Upgrading UNIX® CCI Software

After verifying that CCI is not running, you can upgrade the CCI software. If CCI is still running when you want to upgrade software versions, shut down the CCI software using the horcmshutdown.sh command to ensure a normal end to all HORC/HOMRCF functions. To upgrade the CCI software in a UNIX® environment follow the installation instructions provided in Chapter 3.

C.3 Windows® NT/2000 De-Installation

After verifying that the CCI software is not running, you can de-install the CCI software. If the CCI software is still running when you want to de-install, shut down the CCI software using the `horcmshutdown` command to ensure a normal end to all HORC/HOMRCF functions.

Caution: Before de-installing the CCI software, make sure that all device pairs are in simplex mode.

To de-install the CCI software :

1. On the **Control** panel select the **Add/Remove** programs option.
2. When the Add/Remove Program Properties panel opens, choose the **Install/Uninstall** tab and select **CCI/HORC** from the program products list.
3. Click **Add/Remove** to remove the CCI software.

C.4 Upgrading Windows® NT/2000 CCI Software

After verifying that the CCI software is not running, you can upgrade the CCI software. If the CCI software is still running when you want to upgrade software versions, shut down the CCI software using the `horcmshutdown` command to ensure a normal end to all HORC/HOMRCF functions. To upgrade the CCI software:

1. On the **Control** panel select the **Add/Remove** programs option.
2. When the Add/Remove Program Properties panel opens, choose the **Install/Uninstall** tab and select **CCI/HORC** from the program products list.
3. Click **Add/Remove** to remove the CCI software.
4. Insert the program product cd or floppy disk into the server and on the **Start** menu choose the **Run** command.
5. The Run window opens, enter **A:\Setup.exe** (where A: is floppy or CD drive) in the **Open** pull down list box.
6. An InstallShield will open. Follow the on screen instructions to install the CCI software.
7. Reboot the Windows® NT/2000 server and verify that the correct version of the CCI software is running on your system by executing the `raidqry -h` command.

Appendix D Fibre-to-SCSI Address Conversion

Fibre-channel physical addresses are converted to SCSI target IDs (TIDs) using a conversion table. Table D.1 shows the current limits for SCSI TIDs on various operating systems.

Table D.1 Limits for Target IDs

Port	HP-UX® and other Systems		Solaris® Systems		Windows® Systems	
	TID	LUN	TID	LUN	TID	LUN
Fibre	0 to 15	0 to 255	0 to 125	0 to 255	0 to 31	0 to 255
SCSI	0 to 15	0 to 7	0 to 15	0 to 7	0 to 15	0 to 7

Figure D.1 shows an example of using the raidscan command to display the TID and LUN of Harddisk6 (HP® system). **Note:** You must start HORCM without the descriptions of HORCM_DEV or HORCM_INST in the configuration definition file because of the unknown target IDs and LUNs.

```
C:\>raidscan -pd hd6 -x drivescan hd6
Harddisk 6... Port[ 2] PhId[ 4] Tid[ 3] Lun[ 5] [HITACHI      ] [OPEN-3      ]
Port[CL1-J] Ser#[ 30053] LDEV#[ 14(0x00E)]
HORC = SMPL HOMRCF[MU#0 = SMPL MU#1 = SMPL MU#2 = SMPL]
RAID5[Group 1- 2] SSID = 0x0004
PORT# /ALPA/C,TID#,LU#.Num(LDEV#....)P/S, Status,Fence,LDEV#,P-Seq#,P-LDEV#
CL1-J / e2/4, 29, 0.1(9).....SMPL ---- - - - - - , - - - - -
CL1-J / e2/4, 29, 1.1(10).....SMPL ---- - - - - - , - - - - -
CL1-J / e2/4, 29, 2.1(11).....SMPL ---- - - - - - , - - - - -
CL1-J / e2/4, 29, 3.1(12).....SMPL ---- - - - - - , - - - - -
CL1-J / e2/4, 29, 4.1(13).....SMPL ---- - - - - - , - - - - -
CL1-J / e2/4, 29, 5.1(14).....SMPL ---- - - - - - , - - - - -
CL1-J / e2/4, 29, 6.1(15).....SMPL ---- - - - - - , - - - - -
Specified device is LDEV# 0014
```

Figure D.1 Using Raidscan to Display TID and LUN for Fibre-Channel Devices

In this case, the target ID indicated by the raidscan command must be used in the configuration definition file. This can be accomplished using either of the following two methods:

- **Using default conversion table.** The TID# and LU# indicated by the raidscan command are used in the HORCM configuration definition file.
- **Changing default conversion table.** The HORCMFCTBL environmental variable enables you to change the default conversion table as shown in Figure D.2.


```

C:\> set HORCMFCTBL=X                                     'X' is fibre conversion table number.
C:\> horcmstart ...                                       Start of HORCM.
:
:
Result of "set HORCMFCTBL=X" command:
C:\>raidscan -pd hd6 -x drivescan hd6
Harddisk 6... Port[ 2] PhId[ 4] Tid[ 3] Lun[ 5] [HITACHI      ] [OPEN-3      ]
              Port[CL1-J] Ser#[ 30053] LDEV#[ 14(0x00E)]
              HORC = SMPL HOMRCF[MU#0 = SMPL MU#1 = SMPL MU#2 = SMPL]
              RAID5[Group 1- 2] SSID = 0x0004
PORT# /ALPA/C,TID#,LU#.Num(LDEV#....)...P/S,Status,Fence,LDEV#,P-Seq#,P-LDEV#
CL1-J / e2/0, 3, 0.1(9).....SMPL ---- -, ---- -, ---- -
CL1-J / e2/0, 3, 1.1(10).....SMPL ---- -, ---- -, ---- -
CL1-J / e2/0, 3, 2.1(11).....SMPL ---- -, ---- -, ---- -
CL1-J / e2/0, 3, 3.1(12).....SMPL ---- -, ---- -, ---- -
CL1-J / e2/0, 3, 4.1(13).....SMPL ---- -, ---- -, ---- -
CL1-J / e2/0, 3, 5.1(14).....SMPL ---- -, ---- -, ---- -
CL1-J / e2/0, 3, 6.1(15).....SMPL ---- -, ---- -, ---- -
Specified device is LDEV# 0014

```

Figure D.2 Using HORCMFCTBL to Change the Default Fibre Conversion Table

Tables D.2, D.3, and D.4 show the fibre address conversion tables:

Table number 0 = HP-UX[®] systems

Table number 1 = Solaris[®] systems

Table number 2 = Windows[®] NT/2000 systems

Note: If the TID displayed on the system is different than the TID indicated in the fibre address conversion table, you must use the TID (and LU#) returned by the **raidscan** command to specify the device(s).

Note: The conversion table for Windows[®] NT/2000 is based on the Emulex driver. If a different fibre-channel adapter is used, the target ID indicated by the **raidscan** command may be different than the target ID indicated by the Windows[®] NT/2000 system.

Table D.2 Fibre Address Conversion Table for HP-UX® Systems (Table 0)

C0		C1		C2		C3		C4		C5		C6		C7	
AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID
EF	0	CD	0	B2	0	98	0	72	0	55	0	3A	0	25	0
E8	1	CC	1	B1	1	97	1	71	1	54	1	39	1	23	1
E4	2	CB	2	AE	2	90	2	6E	2	53	2	36	2	1F	2
E2	3	CA	3	AD	3	8F	3	6D	3	52	3	35	3	1E	3
E1	4	C9	4	AC	4	88	4	6C	4	51	4	34	4	1D	4
E0	5	C7	5	AB	5	84	5	6B	5	4E	5	33	5	1B	5
DC	6	C6	6	AA	6	82	6	6A	6	4D	6	32	6	18	6
DA	7	C5	7	A9	7	81	7	69	7	4C	7	31	7	17	7
D9	8	C3	8	A7	8	80	8	67	8	4B	8	2E	8	10	8
D6	9	BC	9	A6	9	7C	9	66	9	4A	9	2D	9	0F	9
D5	10	BA	10	A5	10	7A	10	65	10	49	10	2C	10	08	10
D4	11	B9	11	A3	11	79	11	63	11	47	11	2B	11	04	11
D3	12	B6	12	9F	12	76	12	5C	12	46	12	2A	12	02	12
D2	13	B5	13	9E	13	75	13	5A	13	45	13	29	13	01	13
D1	14	B4	14	9D	14	74	14	59	14	43	14	27	14		
CE	15	B3	15	9B	15	73	15	56	15	3C	15	26	15		

Table D.3 Fibre Address Conversion Table for Solaris® Systems (Table 1)

C0		C1		C2		C3		C4		C5		C6		C7	
AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID
EF	0	CD	16	B2	32	98	48	72	64	55	80	3A	96	25	112
E8	1	CC	17	B1	33	97	49	71	65	54	81	39	97	23	113
E4	2	CB	18	AE	34	90	50	6E	66	53	82	36	98	1F	114
E2	3	CA	19	AD	35	8F	51	6D	67	52	83	35	99	1E	115
E1	4	C9	20	AC	36	88	52	6C	68	51	84	34	100	1D	116
E0	5	C7	21	AB	37	84	53	6B	69	4E	85	33	101	1B	117
DC	6	C6	22	AA	38	82	54	6A	70	4D	86	32	101	18	118
DA	7	C5	23	A9	39	81	55	69	71	4C	87	31	103	17	119
D9	8	C3	24	A7	40	80	56	67	72	4B	88	2E	104	10	120
D6	9	BC	25	A6	41	7C	57	66	73	4A	89	2D	105	0F	121
D5	10	BA	26	A5	42	7A	58	65	74	49	90	2C	106	08	122
D4	11	B9	27	A3	43	79	59	63	75	47	91	2B	107	04	123
D3	12	B6	28	9F	44	76	60	5C	76	46	92	2A	108	02	124
D2	13	B5	29	9E	45	75	61	5A	77	45	93	29	109	01	125
D1	14	B4	30	9D	46	74	62	59	78	43	94	27	110		
CE	15	B3	31	9B	47	73	63	56	79	3C	95	26	111		

Table D.4 Fibre Address Conversion Table for Windows® NT/2000 Systems (Table 2)

C5(PhId5)				C4(PhId4)				C3(PhId3)				C2(PhId2)				C1(PhId1)			
AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID	AL-PA	TID
						CC	15			98	15			56	15			27	15
				E4	30	CB	14	B1	30	97	14	72	30	55	14	3C	30	26	14
				E2	29	CA	13	AE	29	90	13	71	29	54	13	3A	29	25	13
				E1	28	C9	12	AD	28	8F	12	6E	28	53	12	39	28	23	12
				E0	27	C7	11	AC	27	88	11	6D	27	52	11	36	27	1F	11
				DC	26	C6	10	AB	26	84	10	6C	26	51	10	35	26	1E	10
				DA	25	C5	9	AA	25	82	9	6B	25	4E	9	34	25	1D	9
				D9	24	C3	8	A9	24	81	8	6A	24	4D	8	33	24	1B	8
				D6	23	BC	7	A7	23	80	7	69	23	4C	7	32	23	18	7
				D5	22	BA	6	A6	22	7C	6	67	22	4B	6	31	22	17	6
				D4	21	B9	5	A5	21	7A	5	66	21	4A	5	2E	21	10	5
				D3	20	B6	4	A3	20	79	4	65	20	49	4	2D	20	0F	4
				D2	19	B5	3	9F	19	76	3	63	19	47	3	2C	19	08	3
				D1	18	B4	2	9E	18	75	2	5C	18	46	2	2B	18	04	2
		EF	1	CE	17	B3	1	9D	17	74	1	5A	17	45	1	2A	17	02	1
		E8	0	CD	16	B2	0	9B	16	73	0	59	16	43	0	29	16	01	1