Sun StorEdge™ Fast Write Cache Installation and User's Guide

THE NETWORK IS THE COMPUTER™

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Shielded Cables: Connections between the workstation and peripherals must be made using shielded cables in order to maintain compliance with FCC radio frequency emission limits. Networking connections can be made using unshielded twisted pair (UTP) cables.

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Preface

The *Sun StorEdge Fast Write Cache Installation and User's Guide* describes how to install and operate the Sun StorEdge™ Fast Write Cache hardware and software available for Sun workstations and servers.

All of the information that you need to install and operate the NVRAM hardware and Fast Write Cache software is included in this guide, the online man pages, the Release Notes, and the Service Manual that came with your system. Have the *SunVTS User's Guide* ready for reference when running diagnostics at the end of this installation.

The procedures in this manual are for system or network administrators experienced in installing similar hardware and software in systems running the Solaris™ operating environment.

How This Book Is Organized

Chapter 1 describes the SBus NVRAM card, provides compliance and safety information, and describes how to enable the batteries and install the NVRAM card.

Chapter 2 contains an overview of the Fast Write Cache product and the installation instructions.

Chapter 3 describes how to use the `fwcadm` command.

Chapter 4 describes how to manage the Fast Write Cache under normal operating conditions.

Chapter 5 describes how to manage the Fast Write Cache under abnormal operating conditions.

Appendix A describes the operational theory of the Fast Write Cache.

Appendix B describes some of the error messages, notices, and solutions.

Appendix C provides an overview of the SunVTS™ diagnostic tool and describes how to use it with NVRAM cards.

Glossary defines terms used throughout this manual.

Using UNIX Commands

This document may not contain information on basic UNIX® commands and procedures such as shutting down the system, booting the system, and configuring devices.

Refer to one or more of the following for this information:

- *Solaris Handbook for Sun Peripherals*
- AnswerBook™ online documentation for the Solaris™ operating environment
- Other software documentation that you received with your system

Shell Prompts

TABLE P-1 Shell Prompts

Shell	Prompt
C shell	*machine_name%*
C shell superuser	*machine_name#*
Bourne shell and Korn shell	$
Bourne shell and Korn shell superuser	#

Documentation Conventions

TABLE P-2 Documentation Conventions

Typeface	Meaning	Examples
`AaBbCc123`	The names of commands, files, and directories; on-screen computer output	Edit your `.login` file. Use `ls -a` to list all files. `% You have mail.`
`AaBbCc123`	What you type, when contrasted with on-screen computer output	`% su` `Password:`
AaBbCc123	Book titles, new words or terms, words to be emphasized	Read Chapter 6 in the *User's Guide.* These are called *class* options. You *must* be superuser to do this.
	Command-line variable; replace with a real name or value	To delete a file, type `rm` *filename.*
{ *arg* | *arg*}	In syntax, braces and pipes indicate that one of the arguments must be specified.	In this example, one of the options must be specified with the `fwcadm cache command.` `fwcadm cache {-d|-e}`
`command(`*n*`)`	The form `command(`*number*`)`, where the number in parentheses ranges from 1 through 6 and is followed by letters, indicates the presence of an online reference man page.	`fwcadm(1FWC)`

Related Documentation

TABLE P-3 Related Documentation

Application	Title	Part Number
Release	*Sun StorEdge Fast Write Cache Release Notes*	806-0476
Reference	`fwcache` man page	N/A
Installation	*Solaris 2.6 Handbook for SMCC Peripherals*	802-7295
Installation	*Solaris Handbook for SMCC Peripherals*	805-7404
Installation	*Solaris 2.x Handbook for SMCC Peripherals*	801-5488
Options	*OpenBoot 3.x Command Reference Manual*	802-3242
Diagnostics (Solaris 2.6)	*SunVTS 2.1 User's Guide*	802-7299
Diagnostics (Solaris 2.6)	*SunVTS 2.1.3 Test Reference Manual*	805-4163
Diagnostics (Solaris 2.6)	*SunVTS 2.1 Quick Reference*	802-7301
Diagnostics (Solaris 7)	*SunVTS 3.0 User's Guide*	805-4442
Diagnostics (Solaris 7)	*SunVTS 3.0 Test Reference Manual*	805-4443
Diagnostics (Solaris 7)	*SunVTS 3.0 Quick Reference*	805-4444
Diagnostics (Solaris 7)	*SunVTS 3.1 User's Guide*	805-7406
Diagnostics (Solaris 7)	*SunVTS 3.1 Test Reference Manual*	805-7407
Diagnostics (Solaris 7)	*SunVTS 3.1 Quick Reference*	805-7408

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CHAPTER 1

Fast Write Cache Hardware

The Fast Write Cache software is implemented using a pair of SBus nonvolatile random access memory (NVRAM) cards. The SBus NVRAM is a single-wide SBus memory card with battery backed-up error detection and correction (EDC) static memory. Nonvolatile memory remains intact even if the system loses power. Therefore, no data captured by the NVRAM is lost if the system goes down unexpectedly (during a power outage, for example).

The data stored on one NVRAM card is mirrored on the second NVRAM card preventing the failure of one NVRAM card from causing the loss of data.

This chapter contains the following topics:

Features

Following is a list of the NVRAM card features:

- Draws 2.3 amps maximum from +5V
- Error detection and correction
- Battery backed-up NVRAM
- Battery redundancy for increased data integrity during power failure
- Data transfer rates of up to 108 Mbytes per second

EMC Compliance

The NVRAM card has been tested for electromagnetic compatibility (EMC) compliance (USA FCC, Canada DOC, Japan VCCI, and EU CE Mark). When installed and operated in accordance with this guide, the EMC class marked on your Sun™ server label remains the same.

Error Detection and Correction Capability

Data is stored in 64-bit double long words, with 8 check bits for each double long word. This gives the NVRAM card the capability to detect all double-bit errors and correct all single-bit errors in a single 64-bit double long word. The NVRAM card cannot detect errors of 3 or more bits within the same nibble.

Because the check bits are generated and checked for the entire 64-bit data word, all writes to memory that are less than 8 bytes wide require a read-modify-write cycle to memory. The following occurs in the read-modify-write cycle:

1. Existing 64 data bits and 8 check bits are read.
2. The bytes to be written are merged into the data.
3. New check bits are generated.
4. The resulting 64 data and 8 check bits are written back to memory.

Electrostatic Discharge Precautions

Circuit board components are vulnerable to damage by electrostatic discharge (ESD). An electrostatic charge can build up on the human body and discharge when you touch a board. Such discharge can be produced by walking across a carpet and touching a board, or by other similar causes. Touch a conductive surface of the chassis or other element connected to common earth ground to discharge the static electricity present in your body.

To minimize the risk of ESD damage:

- Handle the card by the edges only
- Store the card in the antistatic bag provided
- Use a grounding strap whenever you work on a circuit board

Enabling the NVRAM Card Batteries

The NVRAM card uses three permanently mounted lithium batteries that protect data when the system power is off. These batteries last at least ten years in a running system or in storage with the batteries disabled. The batteries last approximately 18 months in a powered down system or in storage with the batteries enabled.

The NVRAM card is shipped with the batteries *disabled* to prevent battery drainage during shipment.

Caution – There are Eagle Picher Model # LTC16M lithium batteries on the SBus NVRAM card. Batteries are not customer replaceable parts. They may explode if mishandled. Do not dispose of the battery in fire. Do not disassemble it or attempt to recharge it. If a battery fails, call your authorized Sun service provider.

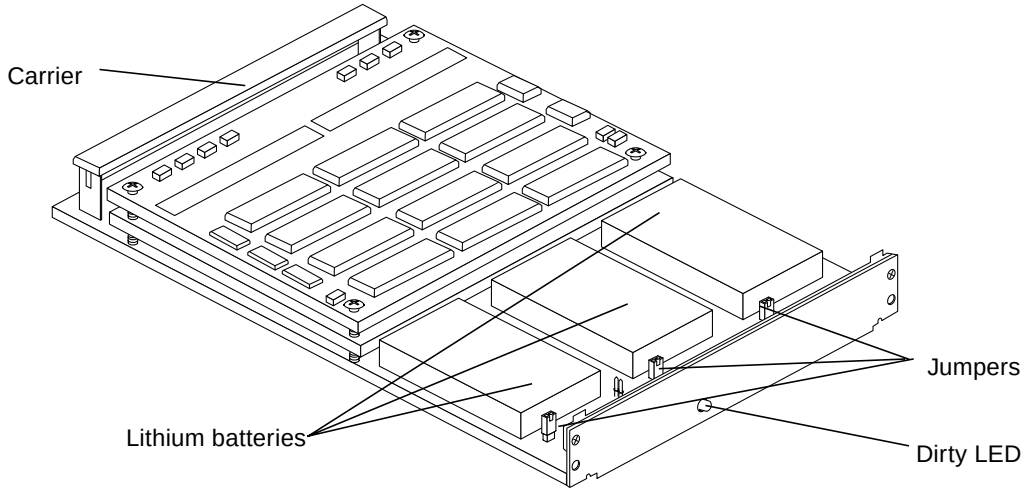

FIGURE 1-1 SBus NVRAM Card

Caution – Handle the NVRAM card with care to avoid damage. Wear an antistatic wrist strap when handling the card. Hold the card by its edges only, and do not touch any of the components on the card.

Do not place the NVRAM card on a metal surface, as it may discharge the batteries regardless of the battery jumper settings. If you must put the card down, place it in its antistatic bag.

Note – You must enable the batteries using the following procedure before you install the hardware.

▼ To Enable the NVRAM Card Batteries

1. **Attach the antistatic wrist strap's adhesive copper strip to the metal casing of the power supply. Wrap the other end twice around your wrist, with the adhesive side against your skin.**
2. **Remove the card from the antistatic bag. Hold the card by its edges and place it, component side up, on the bag.**

   Use antistatic bags as a protective cushion for the NVRAM card.
3. **Look for the battery jumpers.**

The NVRAM holds three batteries. Each has its own jumper, and all three batteries must be activated.

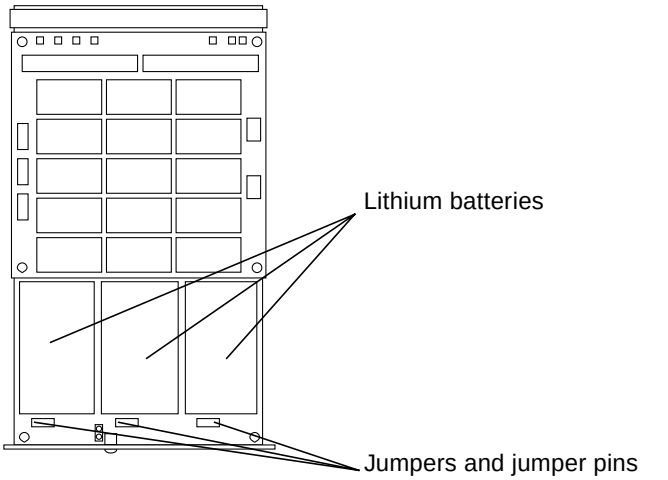

FIGURE 1-2 NVRAM Card Showing Location of Jumpers and Jumper Pins

4. Put the jumpers on the jumper pins.

When you unpack the card, the jumpers are inserted on only one pin of each pair, leaving the battery disabled.

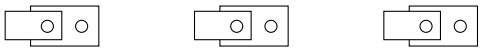

FIGURE 1-3 Detail of Jumpers and Jumper Pins With Batteries Disabled

a. Use tweezers or needle-nosed pliers to lift each jumper off the single pin and align it with both pins.

b. Press the jumper in place on top of the pair of jumper pins.

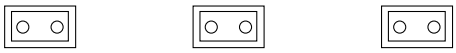

FIGURE 1-4 Detail of Jumpers and Jumper Pins With Batteries Enabled

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Note – Be sure to *disable* the batteries if you remove the NVRAM card from the system and store it. Failure to do so drains the batteries and severely reduces their backup time.

Installing the NVRAM Cards

You must enable the NVRAM card batteries before installing the cards. Make sure you have performed the procedure in the previous section before continuing.

Note – To use Fast Write Cache, a pair of SBus NVRAM cards must be installed on your system.

If your server contains more than one I/O card, install each NVRAM card on a different I/O card to prevent the failure of a single I/O card from rendering the cache unavailable during a system recovery.

▼ To Install the NVRAM Cards

Note – Refer to your system installation or service manual for detailed instructions for the following tasks.

---

1. **Power off your system.**
2. **Open the system unit.**
3. **Attach the antistatic wrist strap's adhesive copper strip to the metal casing of the power supply. Wrap the other end twice around your wrist, with the adhesive side against your skin.**
4. **Disconnect the power cord from its outlet before continuing.**
5. **Identify the slot in which you want to insert the NVRAM card.**
6. **Disconnect the SBus filler panel from the slot that you selected.**
7. **Position the NVRAM on the system board over the SBus socket.**
8. **Carefully insert the NVRAM into the SBus socket.**

   The carrier is keyed so the NVRAM can be installed only one way.
9. **Push the NVRAM into the socket until it is properly seated.**
10. **Detach the wrist strap, replace the unit cover, reinsert the power cord, and power on the system.**
11. **Install the Fast Write Cache software. Refer to Chapter 2 "Installing the Fast Write Cache Software" for installation instructions.**

▼ To Verify the Installation

Note – The Fast Write Cache software must be installed before verifying the installation of the NVRAM cards. See Chapter 2 “Installing the Fast Write Cache Software” for the Fast Write Cache installation instructions.

- **As superuser, type the following command to verify that the NVRAM cards are properly installed.**

```
# fwcadm nvram -s
Device      Size  Inst   Parent   Status  Dirty  Battery    UCE     CE   Mirror
-------------------------------------------------------------------------------
nvram0    32MB      #0  sbus #0  Active      0     Good      0      0   nvram1
nvram1    32MB      #1  sbus #0  Active      0     Good      0      0   nvram0
```

The system returns the status of all cards installed including the total amount of memory in Mbytes, the dirty bit status, the battery status, the ECC errors, and the mirror configuration.

Once the cards are installed it is transparent to you unless problems arise or the batteries become low.

See Chapter 3 “Using the `fwcadm` Command” for a detailed description of the `fwcadm nvram -s` display.

Configuration Data

The operating system keeps configuration data on the NVRAM card to keep track of information such as the host ID, mirror pairs (primary and secondary), and the number of NVRAM cards in the machine. During boot time, the operating system uses this information to verify the NVRAM configuration.

CHAPTER 2

Installing the Fast Write Cache Software

This chapter contains an overview of Fast Write Cache and instructions for installing the software using the `pkgadd` utility.

Overview

Fast Write Cache reduces the frequency of disk I/O access by caching the written data blocks in nonvolatile memory and then destaging the cached data to disk asynchronously.

Note – Fast Write Cache is implemented using a pair of SBus NVRAM cards installed on your system.

Capabilities

Fast Write Cache provides the following capabilities:

- Accelerated NFS™ server performance
  - Faster selection of file systems
  - Synchronous write requests to disk are intercepted, and the data is stored in nonvolatile memory
  - Write cache for synchronous I/O operations
- Reliable, high-speed performance
  - Synchronous writes at memory speed
  - Reliable write caching
  - File definition block caching
  - Accelerated database logs
  - Write coalescing improves small sequential write performance and allows full stripe writes for RAID 5
- Caching is definable at the device level
  - File systems and raw volumes can be cached

Installation Requirements

The minimum requirements for installing Fast Write Cache are:

- Solaris 2.6 operating environment or a subsequent compatible version.
- CD-ROM drive connected to the host server where Fast Write Cache is to be installed.
- Approximately four Mbytes of disk drive space.
- Pair of SBus NVRAM cards.
- Sun-4u system architecture that supports OpenBoot™ firmware. These architectures include:
  - Sun Enterprise™ E3000
  - Sun Enterprise E3500
  - Sun Enterprise E4000
  - Sun Enterprise E4500
  - Sun Enterprise E5000
  - Sun Enterprise E5500
  - Sun Enterprise E6000
  - Sun Enterprise E6500

Installing or Upgrading Fast Write Cache

Fast Write Cache and its related packages include configuration files with a `.cf` suffix. For example, `sv.cf` is in the `/etc/opt/SUNWspsv` directory.

The Fast Write Cache CD contains sample configuration files that are installed in the `/etc/opt/`*SUNWpackage* directory; however, the packages do not overwrite existing configuration files in this directory.

Note – Install Fast Write Cache only on systems with clean NVRAM cards. If an unclean shutdown of the system occurred, recover or purge the data before installing Fast Write Cache.

▼ To Install Fast Write Cache

Do the following before installing Fast Write Cache:

- Install the NVRAM cards. See Chapter 1 “Fast Write Cache Hardware” for the NVRAM installation instructions.
- Install the `SUNWvts` diagnostic package. Refer to the appropriate SunVTS documentation.

1. **Read the** `pkgadd(1M)` **man page.**
2. **Insert the Fast Write Cache CD into the CD-ROM drive.**
3. **Mount the CD-ROM drive:**

```
# /etc/mount /cdrom/cdrom0/s0
```

4. **Start the Fast Write Cache package installation.**

Note – The products must be specified in the following order.

```
For Solaris 2.6:
# pkgadd -d /cdrom/cdrom/Product/Solaris_2.6 SUNWscm SUNWspsv SUNWnvm SUNWvtsnp

For Solaris 7:
# pkgadd -d /cdrom/cdrom/Product/Solaris_7 SUNWscm SUNWspsv SUNWnvm SUNWvtsnp
```

5. **Reply** `yes` **to all prompts by typing y.**
6. **Type the following command to enable the cache:**

```
# sh /etc/init.d/scm start
```

7. **Edit the** `/etc/opt/SUNWspsv/sv.cf` **file to add any volumes that must be cached. See “`sv.cf` Configuration File” on page 3-15 for an example of an** `sv.cf` **file.**
8. **Type the following command to enable the storage volumes:**

```
# sh /etc/init.d/sv start
```

▼ To Upgrade or Reinstall Fast Write Cache

1. **Read the** `pkgrm(1M)` **man page.**
2. **Copy the existing configuration files to another directory.**
3. **Insert the Fast Write Cache CD into the CD-ROM drive.**
4. **Mount the CD-ROM drive:**

```
# /etc/mount /cdrom/cdrom0/s0
```

5. **Remove the existing Fast Write Cache and related packages:**

```
# pkgrm SUNWvtsnp SUNWnvm SUNWspsv SUNWscm
```

6. **Reinstall the packages by following the procedures described in “Installing or Upgrading Fast Write Cache” on page 2-3.**

CHAPTER 3

Using the fwcadm Command

This chapter describes the fwcadm system administration command, the command parameters, and the /etc/sd.cf and /etc/opt/SUNWspsv/sv.cf configuration files.

fwcadm Parameter Summary

The fwcadm command is an administrative command for the cache, the nonvolatile random access memory (NVRAM) card, and the Storage Volume (SV) driver.

Note – fwcadm fails if there is insufficient contiguous host memory. The host memory requirement is based on the cache_mem parameter in the /etc/sd.cf file and the size of the NVRAM memory.

Syntax

```
fwcadm cache [purge diskname | sync diskname]
                        [-d] [-e] [-f file] [ -s ]
fwcadm nvram -s
fwcadm volume { -d | -e | -f file | -r | -s }
```

Command Parameters

Command Parameters		Definition
cache	-d	Disables the cache.
	-e	Enables the cache.
	-f *file*	Specifies a different configuration file.
	-s	Displays cache statistics.
	purge *diskname*	Clears the offline state of a failed device.
	sync *diskname*	Destages the failed blocks and clears the offline state of the failed device.
nvram	-s	Displays the status of the NVRAM cards.
volume	-d	Disables the SV driver.
	-e	Enables the SV driver.
	-f *file*	Specifies a different configuration file.
	-r	Dynamically reconfigures the system.
	-s	Displays the current state of the SV subsystem.

fwcadm cache Command

Use the fwcadm cache command to do the following:

- Enable or disable the cache
- View cache statistics
- Destage cache
- Clear the offline state of a failed device

Note – You must be superuser to run all of the fwcadm cache command options except -s.

Syntax

```
fwcadm cache [purge diskname | sync diskname]
                        [-d] [-e] [-f file] [ -s ]
```

Options

Parameter	Description
-d	fwcadm cache -d disables the cache.
-e	fwcadm cache -e reads the configuration file (the default is /etc/sd.cf) and enables the storage device cache with those parameters.
-f *file*	fwcadm cache -f *file* specifies an alternate configuration file. The default configuration file is/etc/sd.cf.
-s	fwcadm cache -s displays cache statistics. Press the t key to toggle between two screens. The first screen shows general statistics about the data cache, and the second screen displays total counts.
purge *diskname*	fwcadm cache purge *diskname* discards the failed blocks and clears the offline state of the failed device.
sync *diskname*	fwcadm cache sync *diskname* destages the failed blocks and clears the offline state of the device.

fwcadm cache -s Display

When `fwcadm cache -s` is running, you can change the display by selecting various keys.

TABLE 3-1 `fwcadm cache -s` Display Options

Key	Description
`+`	Increases the screen update delay an additional second.
`-`	Decreases the screen update delay by a second (minimum delay is 1 second).
`B`	Toggles between normal and bold types.
`b` or `CTRL-b`	Scrolls the display backwards to the previous set of devices currently not in view.
`C`	Clears the screen and displays the statistics again.
`f` or `CTRL-f`	Scrolls the display forward to the next set of devices currently not in view.
`M` or `m`	This key does not apply to Fast Write Cache but is designed for use with other Network Storage Data Services.
`R`	Toggles between normal and reverse video.
`T` or `t`	Toggles between regular (per second statistics) and cumulative screens.
`Z`	Clears the index cache statistics.

Example

In the following example, `fwcadm cache -s` displays the per second general statistics. Pressing the t key toggles to the second screen, which displays the cumulative counts.

```
# fwcadm cache -s

SAMPLE 1        ******     Storage Cache     ******          12:01:25
                        disk_io         cache          write_blocks
cd cached_partition  reads  writes  reads  writes  dirty  to disk  failed
-------------------------------------------------------------------------
----
0  ...dsk/c1t5d0s1     352     320      0       0      0        0       0
1  ...dsk/c1t5d0s3     320    1024      0     352      8      128       0
2  ...dsk/c1t5d0s4     320     960      0     320      4      120       0
3  ...dsk/c1t5d0s5     288       0     64     320    112        0       0
4  ...dsk/c1t5d0s6     320       0     32     352    112        0       0
5  ...dsk/c1t5d0s7      64       0    256     352     80        0       0
```

```
                     -----   -----  -----   -----  -----    -----   -----
     Kbytes/s total:  1664    2304    352    1696

accesses/s    read/s    write/s   %readh   %writeh
            (misses/s) (misses/s)
-------------------------------------------------
   126.12      11.01      53.05     17.5     84.1
            (  52.05 )  (10.01)
```

<t key is pressed to toggle to the next screen>

```
SAMPLE 3   ******     Storage Cache (Cumulative)    ******     12:01:28

                            disk_io            cache
cd cached_partition    reads    writes    reads    writes
-----------------------------------------------------------
0  ...dsk/c1t5d0s1    170328   1403352      128    581312
1  ...dsk/c1t5d0s3     43464   2040406      992   2024694
2  ...dsk/c1t5d0s4     23616    183488      576    184160
3  ...dsk/c1t5d0s5     19680    186208     4512    186752
4  ...dsk/c1t5d0s6     20384    167552     3808    168096
5  ...dsk/c1t5d0s7      4128    164576    20000    164832
                      -------   -------  -------   -------
   Kbytes/s total:    281600   4145582    30016   3309846

accesses/s    read/s     write/s     %readh   %writeh
            (misses/s)  (misses/s)
-------------------------------------------------------
   90569        938       67892       10.8     82.9
            (  7747 )   ( 13992)

cachesize   blocksize
---------------------
   96128K       8192

Write blocks available:
-----------------------
Net 0:  3488  Net 1:      0   Net 2:     0    Net 3:    0

LRU stats:   Blocks       Requeued     Optimized
-----------------------------------------------
               8192           5321        551933
Total Cache Memory Usage:  2544 Kbytes
Total Stats Memory Usage:  0 Kbytes
```

Note – Fast Write Cache write activity proceeds from *cache writes* to *dirty* to *todisk* to *disk_io* writes.

cd

This field displays the CD number.

cached_partition

This field displays the partition name.

disk_io

These fields display the number of Kbytes read from disk and Kbytes written to disk.

cache

These fields display the number of Kbytes read from cache on a read hit and Kbytes written to cache on a write hit (that is, a fast write).

write_blocks

These fields display the following:

- **dirty** – number of 8Kbyte cache blocks having dirty sectors
- **todisk** – number of 8Kbyte cache blocks being processed to build I/O requests to the real driver
- **failed** – number of 8Kbyte cache blocks held in cache due to an I/O error

accesses

This field displays the total read hits, read misses, write hits, and write misses.

read / (misses)

The first number in this field (read) is the number of times that all data for a read request is in cache.

The second number in this field (misses) is the number of times that some data for read I/O is not in cache.

write / (misses)

The first number in this field (write) is incremented for each cache block allocated in fast write mode.

The second number in this field (misses) is the number of synchronous writes.

%readh

This percentage is obtained by dividing the read number by the total of the read hits and misses. That is, *read hits* / (*read hits + read misses*) = *%readh*.

%writeh

This percentage is obtained by dividing the write number by the total of the write hits and misses. That is, *write hits* / (*write hits + write misses*) = *%writeh*.

cachesize

This field displays the size of cache (host memory) plus the write cache (NVRAM).

blocksize

This field displays the cache blocksize.

Write blocks available

This field displays the number of free 8Kbyte blocks in NVRAM. NET is the NVRAM card.

LRU stats (Least Recently Used)

- **Blocks** – number of 8Kbyte cache blocks in host memory.
- **Requeued** – number of times the cache blocks were placed at the Most Recently Used (MRU) end of queue when released.
- **Optimized** – number of times blocks were *not* placed at the MRU end of queue when released. (The 25% most recently used blocks in the queue are not requeued.)

Total Cache Memory Usage

This field displays the total cache overhead used in Kbytes.

fwcadm nvram Command

The fwcadm nvram command displays the status of the NVRAM cards.

Note – You must be superuser to run the fwcadm nvram command.

Syntax

```
fwcadm nvram -s
```

Options

Parameter	Description
-s	fwcadm nvram -s displays the status of the NVRAM cards.

Example

```
# fwcadm nvram -s
Device    Size   Inst    Parent  Status  Dirty  Battery    UCE     CE   Mirror
-------------------------------------------------------------------------------
nvram0    32MB    #0   sbus #0  Active      1     Good      0      0   nvram1
nvram1    32MB    #1   sbus #1  Active      1     Good      0      0   nvram0
```

Device

This field displays the entry that is in the /dev directory.

Size

This field displays the total amount of memory in Mbytes detected by the NVRAM driver.

Inst

This field displays the instance number assigned by the system to the device during configuration. This is useful in matching a specified card to output (for example, `prtconf(1M)`).

Parent

This field displays the name and instance number of the I/O bus on which the NVRAM card resides. This is useful in matching a specified card and bus combination to output (for example, `prtconf(1M)`).

Status

This field displays the current state of the device.

TABLE 3-2 Device State Description

State	Description
Inactive	Card is not in use.
Active	Card is in use.
Disabled	Card has a problem.

Dirty

This field displays the status of the dirty bit, which also controls the state of the LED on the card. The dirty bit is set when the cache is enabled whether or not there is any dirty data on the card. It remains set if the cache was *not* shutdown cleanly (see "Unclean and Clean Shutdowns" in Chapter 5.). The dirty bit is not the best indicator of whether unwritten data is in the cache, as it keeps driver-specific information. Use `fwcadm cache -s` to display the cache statistics for dirty blocks.

This bit is useful for error recovery when the cache has an unclean shutdown. The state of this bit is maintained during a loss of power to the NVRAM card (that is, it is nonvolatile). During recovery, any dirty blocks on the NVRAM card are automatically destaged to disk. (See "Fast Write Cache Modes" in Appendix A.)

TABLE 3-3 Dirty Bit Description

Value	Description
0	No valuable data is on the card.
1	Valuable data is on the card.

Note – The system is the power source for the dirty LED and *not* the batteries on the card. For the dirty LED to light, the card must be installed in a system with power turned on. There is only one way to check for data on an NVRAM card that is not in a system: Plug the card into a system, power it on, and immediately press L1-A or Stop-A to halt the boot process. The LED lights if there is valid data from a previous unclean shutdown on the card.

TABLE 3-4 Dirty LED States

State	Reasons
ON	Cache is enabled (regardless of any dirty blocks in the cache). Unclean shutdown occurred while the cache was enabled.
OFF	Cache was disabled by a clean shutdown. NVRAM card is not installed. NVRAM card is installed, but the system power is off.

Caution – Do not attempt to alter the state of the dirty bit, as data may be lost.

Battery

This field displays the state of the three on-board lithium batteries.

TABLE 3-5 Battery Status Description

Status	Description
Good	All three batteries are good.
Bad	Low voltage in one or more batteries.
Disabled	At least one battery is disabled. More than one battery may be disabled. The battery is not connected to the array; either its fuse is open or the battery enable jumper is OFF. If all three batteries are installed, and the three battery enable jumpers are installed, the battery fuse is open.

If a card has a Bad or Disabled battery status, fwcadm nvram -s displays a WARNING message and specifies which battery on the card has the problem. For example:

```
Device      Size  Inst    Parent    Status  Dirty  Battery    UCE      CE    Mirror
-------------------------------------------------------------------------------
nvram0      32MB     #0  sbus #0 Disabled      0  Disabled      0       0    nvram1
WARNING: Battery 2 is disabled

nvram1      32MB     #1  sbus #0 Inactive      0       Good      0       0    nvram0
```

This message indicates that Battery 2 is disabled on nvram0. The possible causes and solutions are:

- Battery enable jumper is not installed (install the jumper)
- Battery is not installed (replace the card)
- Fuse is open (replace the card)

UCE (Uncorrectable Errors)

This field displays the number of uncorrectable ECC errors detected. These errors are considered fatal; if they occur, the card is unusable, and you must replace it. The data is not lost if this type of error is detected on one of the cards, as the NVRAM cards are mirrored.

CE (Correctable Errors)

This field displays the number of correctable ECC errors detected. This is not a fatal error condition. The NVRAM driver has a memory scrubber that scans for these errors and attempts to fix them. If the scrubber cannot fix the error, the error is uncorrectable; you must replace the card.

Mirror

This field displays the mirror device that is configured with this device. If the device is not mirrored, it specifies none. The mirror contains the same data as this device. Mirroring prevents data loss if a UCE error occurs during recovery.

fwcadm volume Command

The fwcadm volume command is the Storage Volume (SV) driver administration utility. Use it to control the SV driver by providing facilities to enable and disable the SV driver for specified devices, and to dynamically reconfigure the system.

Note – You must be superuser to run the fwcadm volume command.

Syntax

```
fwcadm volume { -d | -e | -f file | -r | -s }
```

Options

Parameter	Description
-d	fwcadm volume -d disables the SV devices specified in the configuration file.
-e	fwcadm volume -e reads the configuration file (the default is /etc/opt/SUNWspsv/sv.cf) and enables the specified SV devices.
-f *file*	fwcadm volume -f specifies an alternate configuration file. The default configuration file is/etc/opt/SUNWspsv/sv.cf.
-r	fwcadm volume -r reconfigures the SV subsystem. It compares the contents of the configuration file to the state of the running system, and then enables and disables devices to reconfigure the running system as specified in the configuration file.
-s	fwcadm volume -s displays the current state of the SV subsystem.

sd.cf Configuration File

You can specify the following parameters in the /etc/sd.cf configuration file.

Parameter	Description
cache_mem *net size_in_mbytes*	Amount of cache memory to be allocated. Each configured network has a separate entry. This is tied closely to the write_cache_mem, as these two dictate how many I/Os can be outstanding. The *net* parameter is a reserved value and must be 0
threads *num*	Specifies the number of flush threads to create. One is needed for each cached volume.
write_cache_mem *megabytes*	Specifies the amount of memory reserved for write cache. Ignored for Fast Write Cache.

sv.cf Configuration File

The /etc/opt/SUNWspsv/sv.cf file specifies the SV devices to be enabled, disabled, or reconfigured by the fwcadm volume command. It contains the raw devices and access modes.

The following are examples of sv.cf entries:

```
# Example 1: Layer SV onto /dev/rdsk/c1t0d0s0, access through
# the SCM cache.
/dev/rdsk/c1t0d0s0     cache

# Example 2: Layer SV onto /dev/rdsk/c1t2d0s0, access the device
# directly.
/dev/rdsk/c1t2d0s0     raw

# Example 3: Layer SV onto /dev/rdsk/c1t4d0s0, use the default
# access mode.
/dev/rdsk/c1t4d0s0
```

Specifying a raw device enables both the raw and block devices. For example, specifying /dev/rdsk/c1t0d0s0 cache in Example 1 above also enables /dev/dsk/c1t0d0s0.

Note – A line containing a cache designator must be specified for Fast Write Cache. The raw designator is used by other data services to target I/O through the SV module and around the cache.

CHAPTER 4

Normal Operations

This chapter describes how to perform the following Fast Write Cache system administration procedures during normal operating conditions.

Removing Fast Write Cache Hardware

The NVRAM card is like a piece of your disk. If the system experiences a power outage, a system panic, or a machine abort, the Fast Write Cache driver cannot destage cached data to the disk. This type of *unclean* shutdown leaves valid data on the NVRAM card. In this state, removing the card is like removing a piece of the disk.

Caution – Removing an NVRAM card that contains valid data may result in loss of data. If you must move a card containing valid data, see Chapter 5 “Abnormal Operations.”

▼ To Remove an NVRAM Card

1. **Type the following commands to ensure that there is no valid data on the NVRAM card:**

```
# fwcadm volume -d
# fwcadm cache -d
```

2. **If any disk errors were noted, fix these prior to continuing, and then repeat step 1.**
3. **Shut down the system by following the instructions that came with your operating system.**
4. **Turn off the power to the machine.**
5. **Remove the NVRAM card by following the instructions that came with your system.**
6. **Put the NVRAM card in an antistatic bag.**

   You can safely move the card to a different system. If you must move a card containing valid data, see Chapter 5 “Abnormal Operations.”
7. **Reassemble the system.**
8. **Turn on the power on the system and reboot.**

Disabling the Batteries on the NVRAM Card

The NVRAM card has three permanently mounted lithium batteries that maintain the nonvolatile memory cache in case of power loss. These batteries last at least ten years in a running system or in storage with the batteries disabled. The batteries last approximately 18 months in a powered down system or in storage with the batteries enabled.

The Fast Write Cache driver monitors the state of the batteries, and a console message is displayed when the battery state changes. When the battery falls below nominal voltage levels, the Fast Write Cache driver disables its functions, and all subsequent disk requests are passed directly to the disks.

If a battery fails, call your authorized Sun service provider.

Caution – Do not attempt to replace the batteries yourself. The batteries are soldered to the card and are sensitive to heat. There is a danger of explosion if the batteries are incorrectly replaced.

If you disable the batteries on the NVRAM card, the memory is lost and its contents are cleared.

▼ To Disable the Batteries on the NVRAM Cards

1. Remove the NVRAM card according to the instructions in “Removing Fast Write Cache Hardware” on page 4-2.
2. Move each jumper so that only one jumper pin is inserted in each jumper.

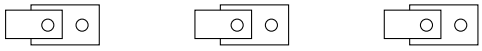

FIGURE 4-1 Jumpers and Jumper Pins With Batteries Disabled

Note – If you must completely clear the memory on the card, ensure that the batteries are disabled for at least 48 hours.

Selecting the File Systems and Volumes to Cache

When choosing file systems to cache, consider that good candidates for acceleration receive synchronous write requests (for example, a UNIX® File System (UFS) mounted with the force direction set).

Note – There is no benefit to accelerating file systems that perform asynchronous writes, as cache memory is wasted.

To recover disk data stored in an NVRAM card after a system crash, the data must be restored to disk before file systems are mounted or applications write to raw volumes. Because of this process, the following file systems must not be cached.

File System	Reason the File System Should Not be Cached
/	The driver is not loaded until after the root file system (/) is mounted. If the NVRAM card contains dirty data, the data cannot be recovered until after the driver is loaded. Recovering data after the root file system is mounted may corrupt the root file system.
/usr	The commands that start the recovery process reside on this partition. As above, caching this partition could result in data being recovered from the cache after the file system was mounted

---

Note – Because the cache is applied to volumes that sit above the cache, recovery occurs after the Volume Manager is started. As a result, caching Volume Manager subdisks is not allowed.

▼ To Enable Caching for a File System

1. **Add the raw disk entry representing the device on which the file system will be located.**

   For example, to cache the `/mnt1` file system, do the following:

   a. Determine the mount point for the file system. For example,

```
# grep mnt1 /etc/vstab
/dev/dsk/c1d0s2   /dev/rdsk/c1d0s2  /mnt1 ufs   1     yes    -
```

   b. Add the raw disk name to the `/etc/opt/SUNWspsv/sv.cf` file. For example, `vi` the `/etc/opt/SUNWspsv/sv.cf` file and add the following line:

```
/dev/rdsk/c1d0s2  cache
```

2. **Type the following reconfiguration command to enable the volume through the cache:**

```
# fwcadm volume -r
```

3. **If the cache is not enabled, type the following command to enable the cache:**

```
# fwcadm cache -e
```

▼ To Enable Caching for a Volume

1. **Add the volume name to the `/etc/opt/SUNWspsv/sv.cf` file. For example, `vi` the `/etc/opt/SUNWspsv/sv.cf` file and add the following line:**

```
/dev/vx/rdsk/vo101 cache
```

2. **Type the following reconfiguration command to enable the volume through the cache:**

```
# fwcadm volume -r
```

3. **If the cache is not enabled, type the following command to enable the cache:**

```
# fwcadm cache -e
```

▼ To Display Cache Statistics

- **Type the following command to display cache statistics:**

```
# fwcadm cache -s
```

Removable Disk Packs

Before removing a disk pack, perform the following procedure.

▼ To Remove Disk Packs

1. **You must deconfigure devices from the Fast Write Cache before removing the disks by removing the entry for the device from the** `/etc/opt/SUNWspsv/sv.cf` **file.**
2. **Type the following command to reconfigure the system as specified in the** `sv.cf` **file:**

```
# fwcadm volume -r
```

3. **Use the** `umount` **command if there are file systems mounted on the disks.**
4. **Physically remove the disk pack.**

CHAPTER 5

Abnormal Operations

This chapter describes how to manage Fast Write Cache under abnormal operating conditions. Abnormal conditions include cases where the system did not shut down cleanly, or where a disk accelerated by Fast Write Cache encounters errors or failure.

Unclean and Clean Shutdowns

An *unclean* shutdown results if one of the following occurs before Fast Write Cache has been shut down with the `fwcadm cache -d` command:

- Power failure
- Hardware failure
- L1-A, BREAK, or Stop-A key sequences are pressed
- `reboot(1M)`, `halt(1M)`, or `vadmin(1M)` command is used
- Shutdown of any type when there is trapped data because of a disk failure

---

Note – After an unclean shutdown, Fast Write Cache may contain valuable data that has not been written to disk. Fast Write Cache attempts to destage the cache after you reboot the system or start the cache with the `fwcadm cache -e` command.

A *clean* shutdown results when the system is properly halted according to the instructions that come with the operating system (refer to the `shutdown(1M)` man page). You can also shut down the Fast Write Cache subsystem using the `fwcadm cache -d` command prior to shutting down the system.

Determining If an NVRAM Card Has Valid Data

The *dirty LED* on the faceplate of the NVRAM card indicates if the card has valid data. The LED is lit when the card contains valid data but may be on if there are no dirty data blocks in the cache (that is, the LED lights when the cache is enabled). The dirty LED is not the best indicator of whether data is dirty in the cache, as it keeps driver-specific information. Use the `fwcadm cache -s` to display cache statistics of dirty data blocks.

Note – The system is the power source for the dirty LED and *not* the batteries on the card. For the dirty LED to light, the card must be installed in a system with power turned on. There is only one way to check for data on an NVRAM card that is not in a system: Plug the card into a system, power it on, and immediately press L1-A or Stop-A to halt the boot process. The LED lights if there is valid data on the card from a previous unclean shutdown.

▼ To Check the LED for Data on a Card That is Not in a System

1. **Install the card into a system.**
2. **Power on the system.**
3. **Immediately press L1-A or Stop-A to halt the machine's bootup process.**
4. **Check the dirty LED on the card.**

Booting a Different Kernel

Fast Write Cache uses device path names to identify data blocks. If you reconfigure your machine after an unclean shutdown, you may have cached data blocks destaged to the wrong device. This could happen under the following conditions:

- A kernel is installed that has different disk device name mappings than the kernel last used with Fast Write Cache.
- A disk controller is added or removed.

Moving an NVRAM Card Containing Data

Caution – Moving cards containing valid data can result in loss of data. If you must move NVRAM cards from one system to another, shutdown both systems cleanly, and then remove the cards from the first system and install them in the second system.

Moving an NVRAM Card Without Losing Data

Data *should not* be lost when you do the following:

- Move NVRAM cards within the same machine and reboot.
  - Handle cards properly
  - Install all the original cards in the machine prior to bootup
- Add new NVRAM cards to a machine containing NVRAM cards with valid data.
- Change the system CPU or ID prom and all NVRAM cards remain in the system.

- Remove NVRAM cards from the machine and reboot when the remaining cards in the system form a valid mirror (complete primary or secondary), and an uncorrectable error does *not* occur on the mirror during data recovery.

Moving an NVRAM Card and Losing Data

Data *is* lost when you do the following:

- Remove NVRAM cards from the machine and reboot when the remaining cards in the system do not form a valid mirror (incomplete primary or secondary).
- Remove NVRAM cards from the machine and reboot when the remaining cards in the system form a valid mirror (complete primary or secondary) and an uncorrectable error occurs on the mirror during data recover.
- Move an NVRAM card to another machine. Data on that card is lost.
- Remove an NVRAM card from the machine and disable its batteries.

Note – If you must completely clear the memory on the card, ensure that the batteries are disabled for at least 48 hours.

Handling Disk Failures

When Fast Write Cache is caching disk blocks, data written by an application may not be written to disk immediately. If a disk on a cached volume fails, the system does not notice the failure until Fast Write Cache tries to destage the blocks. When this happens, Fast Write Cache marks the device as being offline. With the exception of read hits, Fast Write Cache does not accept I/O requests for the device until the successful disk synchronization operation has been performed on the failed device.

Temporary disk failures are those that can be fixed without major repairs, such as a disk being offline or write-protected.

Serious disk failures, such as a head crash, involve significant repair work and may result in data loss.

Note – Use the `fwcadm cache sync` and `fwcadm cache purge` commands only when the device is quiescent (that is, when all application I/O activity to the device has stopped and the cache has attempted to destage all pending writes).

Rebooting the system also causes Fast Write Cache to destage its cache.

Recovering Trapped Data After a Disk Failure

When a disk fails and data blocks are held in cache, correct the condition that caused the failure or repair or replace the disk. When the fault has been corrected, recover the trapped data by issuing the following command, which destages the failed blocks and clears the offline state of the device:

```
# fwcadm cache sync diskname
```

The offline state of a device is not persistent across system reboots or invocations of the cache. Thus, it may not be necessary to issue the `fwcadm cache sync` *diskname* command if the cache has been stopped and restarted since the disk has been repaired.

Clearing the Offline Device State

Use the following command to clear the offline state of the failed device. This command releases all failed blocks for a device.

Caution – Use this command with caution because data is lost.

```
# fwcadm cache purge diskname
```

APPENDIX **A**

Theory of Operation

This appendix provides the operational theory of the Sun Fast Write Cache product. This information is background material to increase your understanding of the system administration issues discussed in Chapter 4 “Normal Operations” and Chapter 5 “Abnormal Operations.”

Introduction

Fast Write Cache is implemented as a UNIX device driver, using nonvolatile memory to cache synchronous write requests. As the cache fills, older data is written asynchronously to the real disk. Fast Write Cache works as a layer between other disk drivers and the rest of the UNIX kernel. Stubs replace the original driver's entry points in the device switch tables. Whenever Fast Write Cache performs actual I/O (for example, when its cache must be destaged), it uses the real device driver routines.

Fast Write Cache requires minimal day-to-day administration. However, the system administrator must be familiar with how the `fwcadm` command works. This command is described in Chapter 3 "Using the `fwcadm` Command" and Chapter 4 "Normal Operations."

If you encounter error conditions, see Chapter 5 "Abnormal Operations" and Appendix B "Error Messages."

Buffer Management

Except for recovery procedures after an unclean shutdown and initial configuration at start up, data is never read from NVRAM. That is, all NVRAM accesses during normal I/O operation are writes only and the cache software maintains a consistent image of the data in host memory. This method avoids excessive bus traffic to and from the offboard NVRAM at the expense of host memory usage.

When an application does a write to a cached volume, a buffer is allocated from NVRAM and the data is copied into the NVRAM buffer from host memory. The buffer is marked *dirty* and the application receives notification of the write completion. Sometime later a flush thread, after possibly coalescing small individual writes into larger writes, calls the underlying device driver to write data blocks from host memory to disk. After the data has been successfully written to disk, the associated NVRAM data buffers are made available for re-use.

The host memory buffer of the data remains available to satisfy read hits, until it is re-used according to a least recently used allocation scheme.

Note – Because the amount of host memory that backs the NVRAM cache is determined by the assignment of the `cache_mem` parameter in the `sd.cf` file, it is possible to have a much larger pool of host buffers to satisfy read hits than write buffers in NVRAM.

Fast Write Cache Modes

The Fast Write Cache software is always in one of two modes:

- Write through – write completion is returned when the data has been written to disk.
- Fast write – write completion is returned when the data is on the NVRAM card.

Note – The terms fast write, write back, and write behind are synonymous.

During normal operation, the cache is in fast write mode. The cache goes into write through mode during recovery or when an error is detected on an NVRAM card.

The goal at bootup is to successfully destage any dirty Fast Write Cache buffers. If there are dirty buffers, I/O is blocked for all devices being recovered. The cache is in write through mode for all other devices until all dirty buffers have been queued for destaging, at which time the cache goes into fast write mode. It is not recommended that the cache be disabled if there are dirty buffers in NVRAM. However, to allow a graceful shutdown for hardware repair, the Fast Write Cache software permits a shutdown if there are dirty buffers that cannot be destaged to disk but are safely stored in NVRAM. If an error has been detected on an NVRAM card, and there are dirty buffers that cannot be destaged to disk, any attempt to shutdown the cache fails.

When an I/O failure occurs, the cache mode does not change but the device is marked offline and the dirty buffers are placed on the failed queue for the device. When the problem that caused the failure is corrected, the administrator can clear the offline state of the device and synchronize or purge the data by using the `fwcadm cache -s` command or the `fwcadm cache -p` command.

Recovery

At startup, the cache software reads a private header on the NVRAM card. If it finds that an unclean shutdown has occurred, it reads in all metadata (device names and dirty bits) from NVRAM, opens all previously cached devices, and searches the dirty bit maps for dirty blocks. If any dirty blocks are found, the data blocks are read into host memory and queued for destaging. At this point, normal I/O operation can proceed while the dirty blocks are destaged in the background.

Hints for Safe Operation

- In general, devices must be Storage Volume (SV) disabled using the `svadm -d` or `svadm -r` commands before doing any operations requiring a device to be quiescent. Some procedures (for example, an A5000 firmware download) will not complete successfully unless the appropriate devices are SV disabled.
- The volume manager must always be below the Fast Write Cache.
- Do not cache the root (`/`) and `/usr` file systems (or any file systems that come up before Fast Write Cache) because to recover disk data stored in an NVRAM card after a system crash, the data must be restored to disk before file systems are mounted or applications are written to raw volumes.
- Avoid multiple paths to data.
- If the NVRAM card contains dirty data, do not reconfigure your disks or move the card to another system until the dirty data is destaged to disk.

APPENDIX **B**

Error Messages

This appendix lists some of the error messages that may be displayed on your system when the NVRAM hardware and driver are installed. The appendix also describes causes and solutions for the errors.

TABLE B-1 Known Error Conditions

Message	Cause	Solution

`WARNING: nvmemX: can't map control registers`
`WARNING: nvmemX: can't find size`
`WARNING: nvmemX: can't map memory`
	NVRAM instance *X* or the system may have a problem. The card cannot be initialized and will not be used by the system.	Replace the NVRAM card or report the problem to Sun.

`WARNING: nvmemX: card did not initialize properly, base = W at Y = Z`	NVRAM instance *X* cannot initialize location *Y* with zeros. The card will not be used by the system. *W* is the base address of the card, *Y* is the location that failed, and *Z* are the contents of location *Y*.	Replace the NVRAM card.
`WARNING: nvmemX: card detects Y errors after writing/reading zeros`	NVRAM instance *X* is getting *Y* check bit errors after initializing the memory with zeros. The card will not be used by the system.	Replace the NVRAM card.
`WARNING: nvmemX: Batteries are disconnected`	The batteries for NVRAM instance *X* are disabled.	Refer to Chapter 1 "Enabling the NVRAM Card Batteries" for information on how to enable the batteries.

TABLE B-1 Known Error Conditions *(Continued)*

Message	Cause	Solution
`WARNING: nvmemX: Batteries are running low`	The batteries on NVRAM instance *X* are low. If Fast Write Cache is enabled, it destages all dirty blocks on the card and passes any new I/O directly to the disk.	Replace the NVRAM card.
`WARNING: nvmemX: Uncorrectable ECC error detected`	NVRAM instance *X* has an uncorrectable ECC error. If Fast Write Cache is enabled, it destages all dirty blocks on the card and passes any new I/O directly to the disk. If the uncorrectable ECC error occurs during recovery, the data is read from the mirror.	Replace the NVRAM card.
`NOTICE: nvmemX: memory scrubber detected an Uncorrectable ECC error Address range Y to Z`	The memory scrubber detected an Uncorrectable ECC error within the address range *Y* to *Z* on NVRAM instance *X*. The Uncorrectable ECC error WARNING will follow.	Replace the NVRAM card.
`WARNING: nvmemX: Correctable ECC error limit Y reached`	The number of Correctable ECC errors detected has reached the error limit *Y* (the default is 10000). NVRAM instance *X* may have a problem. If Fast Write Cache is enabled, it destages all dirty blocks on the card and passes any new I/O directly to the disk.	Replace the NVRAM card.
`WARNING: nvmem: not all mirrors enabled, expected X actual Y`	The number of mirrored pairs is less than expected.	Report the problem to Sun.
`WARNING: nvmemX: nvram_init, can't start scrubber thread`	A software or system resource problem was detected (possibly out of memory).	Report the problem to Sun.

TABLE B-1 Known Error Conditions *(Continued)*

Message	Cause	Solution
`WARNING: nvmemX: nvram_bcopy, write exceeds memory range`	A software failure was detected; trying to write past the end of NVRAM.	Report the problem to Sun.
`WARNING: nvmemX: nvram_bcopy, read exceeds memory range`	A software failure was detected; trying to read past the end of NVRAM.	Report the problem to Sun.
`WARNING: nvmem: nv_init, config changed, initializing memory`	The card configuration has changed since the last boot time. Any new cards are zeroed out and labeled internally, and old cards are handled accordingly.	This message is informational only and requires no action unless NVRAM configuration changes were not made to the system. In that case, report the problem to Sun.
`WARNING: nvmem: nv_init, primary X can't find secondary mirror card instance Y`	During initialization, the primary mirror instance *X* could not find its secondary mirror NVRAM card instance *Y*. The card may have been removed or it has a hardware problem. If the primary mirror is dirty, the driver uses it to recover data when Fast Write Cache is started. Since the primary does not have a secondary mirror, Fast Write Cache destages all dirty blocks on the card and passes any new I/O directly to the disk.	If NVRAM configuration changes were not made, and there were no previous error messages about NVRAM instance Y, report the problem to Sun.
`WARNING: nvmem: nv_init, primary X can't find secondary mirror instance Y`	During initialization, the primary mirror instance *X* could not find its secondary mirror instance *Y*. The secondary mirror card may have been replaced. The driver initializes the new card as a secondary mirror and resynchronizes it with primary *X*.	If NVRAM configuration changes were not made, report the problem to Sun.

TABLE B-1 Known Error Conditions *(Continued)*

Message	Cause	Solution
`WARNING: nvmem: nv_init, Inconsistent NVRAM mirror configuration, mirror disabled`	A configuration failure has been detected. Fast Write Cache will not be enabled.	Report the problem to Sun.
`WARNING: nvmem: nvram_init, mirror not configured`	The mirror is not configured because of inconsistencies found or insufficient number of working NVRAM cards detected. Fast Write Cache will not be enabled.	Replace the failed NVRAM card and ensure that a minimum of two cards is installed.
`WARNING: nvmem: nv_init, non-matching card sizes, mirror disabled`	The mirror is not configured because of mismatched NVRAM card sizes. Fast Write Cache will not be enabled.	If the cards are the same model, report the problem to Sun. Otherwise, install the same size NVRAM cards.

APPENDIX **C**

SunVTS Diagnostic Software

This appendix contains an overview of the SunVTS diagnostic tool and describes how to use SunVTS with NVRAM cards. This information is for experienced SunVTS users.

This appendix is organized as follows:

SunVTS Overview

The SunVTS software executes multiple diagnostic hardware tests from a single user interface and is used to verify the configuration and functionality of most hardware controllers and devices. SunVTS operates primarily from the OpenWindows™ and Common Desktop Environment (CDE) user interfaces, enabling test parameters to be set quickly and easily while a diagnostic test operation is being performed.

The NVRAM SunVTS (`SUNWvtsnp`) tests the memory and error detection and correction (EDC) functionality of the NVRAM card. This test runs in 32-bit and 64-bit operating environments.

Because `SUNWvtsnp` is not a stand-alone package, the appropriate SunVTS must be installed.

Solaris Version	SunVTS version
Solaris 2.6	SUNWvts 2.1.3
Solaris 7	SUNWvts 3.0
Solaris 7	SUNWvts 3.1

The Solaris 2.6 version of the `SUNWvtsnp` package contains a 32-bit nvtest.

The Solaris 7 versions of the `SUNWvtsnp` package contains both 32-bit and 64-bit nvtest binaries. Package dependency is checked during installation, and the nvtest binaries are installed in the appropriate directories. The 64-bit nvtest is not installed unless the `SUNWvtsx` (64-bit SunVTS) package is already installed.

The SunVTS documents are listed in TABLE C-1.

TABLE C-1 SunVTS Documentation

Title	Part Number	Description
SunVTS 2.1 User's Guide (Solaris 2.6)	802-7299	Describes the SunVTS environment, including starting and controlling various user interfaces.
SunVTS 2.1.3 Test Reference Manual (Solaris 2.6)	805-4163	Describes each SunVTS test; provides various test options and command-line arguments.
SunVTS 2.1 Quick Reference (Solaris 2.6)	802-7301	Quick reference for starting and using SunVTS.

TABLE C-1 SunVTS Documentation

Title	Part Number	Description
SunVTS 3.0 User's Guide (Solaris 7)	805-4442	Describes the SunVTS environment, including starting and controlling various user interfaces.
SunVTS 3.0 Test Reference Manual (Solaris 7)	805-4443	Describes each SunVTS test; provides various test options and command-line arguments.
SunVTS 3.0 Programmer's Guide (Solaris 7)	805-7338	Describes how to create, integrate, and package diagnostic tests for the SunVTS environment.
SunVTS 3.0 Quick Reference (Solaris 7)	805-4444	Quick-reference for starting and using SunVTS.
SunVTS 3.1 Test Reference Manual (Solaris 7)	805-7407	Describes each SunVTS test; provides various test options and command-line arguments.
SunVTS 3.1 Programmer's Guide (Solaris 7)	806-0452	Describes how to create, integrate, and package diagnostic tests for the SunVTS environment.
SunVTS 3.1 Quick Reference (Solaris 7)	805-7408	Quick-reference for starting and using SunVTS.

Preparing to Run SunVTS

The SunVTS test for NVRAM cards is a destructive test. It destroys any data currently on the cards. There are several other SunVTS tests that are also destructive. Therefore, run the NVRAM test only after disabling the Sun StorEdge™ Fast Write Cache driver.

To prevent data corruption, the whole system should be inactive and preferably not used at all during the test, as these procedures greatly reduce the speed of all data file systems on the system.

▼ To Prepare to Run SunVTS

The Fast Write Cache driver must be disabled before testing the NVRAM devices.

- **Disable the Fast Write Cache driver by typing the following command as superuser:**

```
# fwcadm cache -d
```

Running SunVTS

The following procedures describe how to invoke SunVTS locally and remotely.

▼ To Invoke SunVTS Locally (OpenWindows™)

1. **To invoke SunVTS locally on a machine running the OpenWindows environment, type the following as superuser:**

```
# cd /opt/SUNWvts/bin
# ./vtsk
# ./vtsui.ol
```

2. **Make the following selections from the SunVTS menus:**

   a. **Select** `Select Tests...`

   b. **Select Test Mode** `Functional Test`**.**

   c. **Select Test Set** `None`**.**

   d. **Select Test Intervention** `Enabled`**.**

   e. **Scroll down to** `Other Devices` **and select the** `nvramX` **devices, for the NVRAM devices you have. (Use the** `fwcadm nvram -s` **command to display your devices.)**

   f. **Select** `Start` **to start the test.**

3. **After the test finishes, enable Fast Write Cache by typing the following command as superuser:**

```
# fwcadm cache -e
```

▼ To Invoke SunVTS Locally (CDE)

1. **To invoke SunVTS locally on a machine running CDE, type the following as superuser:**

```
# cd /opt/SUNWvts/bin
# ./sunvts
```

2. **Make the following selections from the SunVTS menus:**

   a. **Select** `None` **from Select Devices.**

   b. **Enable intervention from Select Devices.**

   c. **Select** `Functional Test` **from Select Mode.**

   d. **Scroll down to** `Other Devices` **and select the** `nvramX` **devices, for the NVRAM devices you have. (Use the** `fwcadm nvram -s` **command to display your devices.)**

   e. **Select** `Start` **to start the test.**

3. **After the test finishes, enable Fast Write Cache by typing the following command as superuser:**

```
# fwcadm cache -e
```

▼ To Invoke SunVTS Remotely

1. **To invoke SunVTS remotely on a machine running either the CDE or OpenWindows environment, type the following on the machine that runs SunVTS:**

```
% /usr/openwin/bin/xhost nfs_machine
```

2. **On the machine to be tested, type the following as superuser:**

   For CDE:

```
# cd /opt/SUNWvts/bin
# ./sunvts -display display_machine:0.0
```

   For OpenWindows:

```
# cd /opt/SUNWvts/bin
# ./vtsk
# ./vtsui.ol -display display_machine:0.0
```

3. **Make the following selections from the SunVTS menus:**

   a. **Select** `Select Tests.`

   b. **Select** `Functional Test` **from Test Mode.**

   c. **Select** `None` **from Test Set.**

   d. **Select** `Enabled` **from Test Intervention.**

   e. **Scroll down to the** `Other Devices` **and select the** `nvramX` **devices, for the NVRAM devices you have. (Use the** `fwcadm nvram -s` **command to display your devices.)**

   f. **Select** `Start` **to start the test.**

Note – If any tests show errors in the card, have Sun Enterprise Services replace the card.

---

4. **After the test finishes, enable Fast Write Cache by typing the following command as superuser:**

```
# fwcadm cache -e
```

Glossary

alert	Message sent to identify a problem or impending problem.
cache	Buffer storage that is faster than main storage.
clean buffer	Buffer containing a valid disk block image that has been destaged to disk.
clean shutdown	System is halted according to the instructions that come with the operating system.
destage	To move data from the cache to the disk.
dirty buffer	Buffer containing a disk block image that has not been destaged to disk.
disk	Host view of the logical storage device. Disks are also referred to as volumes.
invalid buffer	Buffer that does not contain a disk block image.
nonvolatile memory	Memory that remains intact even if the system loses power.
NVRAM card	Single-wide SBus memory card with battery back-up error detection and correction (EDC) static memory.
mirroring	Process of maintaining two or more identical images of a designated disk volume.
node	See *subsystem*.
RAID	Redundant Array of Independent Disks.
SCM	Storage Cache Management.
Storage Cache Management	Provides quick access to recently used data or data that is physically close to recently accessed data.
Storage Volume driver	Enables standard system call access to a disk device to be redirected into the storage software, allowing standard applications to use the storage features.

stub New pointer and the function to which it points. Stubs are used to redirect or intercept the function calls away from the original driver over to the new driver (new layer). This can be done by saving the original driver entry pointers and replacing them with the new driver pointers. When the new driver goes away, it restores the original pointers. This enables the new driver to add and remove itself without affecting the driver above or below it.

subsystem A combination of storage hardware (channel adapters, device adapters, CPUs, cache memory) and software that is independently powered and configured. Subsystems are sometimes referred to as nodes.

SV Storage Volume driver.

unclean shutdown A shutdown that may leave data in the Fast Write Cache.

volume See *disk*.

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