Part Number:313482701

Shared Virtual Array

SVA Path

Version 3.2

for AIX

User's Guide

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This edition applies to Version 3.2 of the SVA Path for AIX product and to all subsequent modifications of that program until otherwise indicated in new editions or revision pages. If there are changes in the program or improvements in the information about the program, this document will be revised and reissued.

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Table of Contents

Who Should Read This Guide v
Shared Virtual Array Documentation v
How to Obtain Software Documentation v
SVA Administrator for AIX Library vi
Related SVA Software Publications vi
SVA Hardware Publications viii

Chapter 1. SVA Path Overview 1
Failover/Failback Data Paths 1
Load Balancing 2
Dynamic Allocation of Device Resources 2
How SVA Path Works 2
Supported SVA Path Configurations 3
System Requirements 3
Summary of SVA Path Benefits 4
Document Overview 4

Chapter 2. SVA Path Hardware Setup 5
Fibre Addressing Concepts 5
Host Bus Adapters/Initiators 5
Domains in Fibre Channel Connection 5
Domain Numbering 6
Domain Numbering with Fibre and SVA Path 7
Hardware Preparation 7

Chapter 3. SVA Path Installation 9
Installing SVA Path on IBM-AIX 9

Uninstalling SVA Path on IBM-AIX . . . 10
SVA Path Device Naming in AIX . . . 11
AIX Devices with Only One Path to the Host . . . 12

Chapter 4. SVA Path Operation . . . 15
The setsp Command . . . 15
The spmon Command . . . 18
Configuring Load Balancing . . . 18
Tuning Path Balancing . . . 21
How to Verify Load Balancing . . . 24
Adding FDEVs to an Existing Lun . . . 26
The sppath Command . . . 26
Display Options for sppath . . . 29
Ignoring and Reclaiming Devices with sppath . . . 29
Understanding the setsp -a Screen . . . 30
Changing the Configuration . . . 32
Specifying a Device for setsp . . . 32
Assigning a New Primary Path . . . 33
Turning the Exclusion Setting Off and On . . . 33
Redefining the Buffer Pointer Allocation . . . 34
Turning Load Balancing On and Off . . . 34
Changing the Retry Count and Retry Delay . . . 35
Turning Failback Off and On . . . 35
Dynamic Device Detection . . . 35
Device Deletion . . . 36

Chapter 5. Diagnosing Errors . . . 37
Troubleshooting AIX . . . 37
Before Installing SVA Path 3.2 . . . 37
Failover Error Reporting in AIX . . . 38
Recovering from an AIX Path Failure . . . 38

Preface

This guide describes how to use the SVA Path Intelligent Data Path Management software. SVA Path provides improved performance and data accessibility for the StorageTek Shared Virtual Array (SVA).

Who Should Read This Guide

This guide is for data administrators, capacity planners, performance specialists, and system administrators. This guide assumes that you are familiar with Shared Virtual Array operations and AIX system administration.

Shared Virtual Array Documentation

This section lists software and hardware documentation for the Shared Virtual Array products.

How to Obtain Software Documentation

All of the Shared Virtual Array software publications are available from the following sources:

- On the SVA Software Publications CD-ROM (part number 3112953*nn*). To order a copy, contact StorageTek Publication Sales and Service at 800-436-5554 or send a fax to 303-661-7367.

- Online (for viewing and printing), at the StorageTek Customer Resource Center (CRC) website at: www.support.storagetek.com. Click on Software and go to the Shared Virtual Array Software list.

☞ **Note:** Access to the CRC site requires a password. To obtain a password, call StorageTek Customer Support at 800-678-4430.

SVA Administrator for AIX Library

- *Shared Virtual Array Administrator for AIX Command Quick Reference*
- *Shared Virtual Array Administrator for AIX Installation Guide*
- *Shared Virtual Array Administrator for AIX Messages*
- *Shared Virtual Array Administrator for AIX Quick Start Guide*
- *Shared Virtual Array Administrator for AIX User's Guide*

Related SVA Software Publications

For SVA SnapShot for WindowsNT:

- *Shared Virtual Array SnapShot for WindowsNT User's Guide*
- *Shared Virtual Array SnapShot for WindowsNT Quick Start Guide*

For Shared Virtual Array Administrator for Solaris:

- *Shared Virtual Array Administrator for Solaris Command Quick Reference*
- *Shared Virtual Array Administrator for Solaris Installation Guide*
- *Shared Virtual Array Administrator for Solaris Messages*

- *Shared Virtual Array Administrator for Solaris Quick Start Guide*
- *Shared Virtual Array Administrator for Solaris User's Guide*

For SnapShot for Solaris:

- *SnapShot for Solaris User's Guide*
- *SnapShot for Solaris Quick Start Guide*

For SVA Administrator for OS/390:

- *Shared Virtual Array Administrator for OS/390 Configuration and Administration*
- *Shared Virtual Array Administrator for OS/390 Installation, Customization, and Maintenance*
- *Shared Virtual Array Administrator for OS/390 Messages and Codes*
- *Shared Virtual Array Administrator for OS/390 Reporting*

For SVA SnapShot for OS/390:

- *SVA SnapShot for OS/390 Installation, Customization, and Maintenance*
- *SVA SnapShot for OS/390 User's Guide*

For SVA Console for Windows NT (SVAC):

- *Shared Virtual Array Console for Windows NT Quick Start Guide*

For any StorageTek software:

- *Requesting Help from Software Support*

SVA Hardware Publications

Shared Virtual Array hardware publications are available from the following sources:

- On the SVA Hardware Publications CD-ROM (part number 3118447*nn*). To order a copy, contact StorageTek Publication Sales and Service at 800-436-5554 or send a fax to 303-661-7367.
- Online (for viewing and printing), at the StorageTek Customer Resource Center (CRC) website at: www.support.storagetek.com. Click on Disk Subsystems.

☞ **Note:** Access to the CRC site requires a password. To obtain a password, call StorageTek Customer Support at 800-678-4430.

The V960 Shared Virtual Array (SVA) library consists of:

- *V960 Shared Virtual Array Introduction*
- *V960 Shared Virtual Array Operation and Recovery*
- *V960 Shared Virtual Array Physical Planning*
- *V960 Shared Virtual Array Planning, Implementation, and Usage*
- *V960 Shared Virtual Array Reference*
- *V960 Shared Virtual Array System Assurance*
- *Peer to Peer Remote Copy Configuration Guide*

The 9500 SVA library consists of:

- *9500 Shared Virtual Array Introduction*

- *9500 Shared Virtual Array*
  Operation and Recovery
- *9500 Shared Virtual Array*
  Physical Planning
- *9500 Shared Virtual Array*
  Planning, Implementation, and Usage
- *9500 Shared Virtual Array*
  Reference
- *9500 Shared Virtual Array*
  System Assurance
- *Peer to Peer Remote Copy Configuration Guide*

Chapter 1. SVA Path Overview

This chapter provides an overview of SVA Path software and its features.

SVA Path offers a new level of data accessibility and improved performance for the SVA. It eliminates the point of failure represented by a single input/output (I/O) path between servers and storage systems and permits I/O devices to be distributed across multiple paths.

SVA Path suports up to 1024 FDEVs per LUN, and up to 1024 individual paths to up to 1024 LUNs. This means that you can have 512 LUNs with two paths each, or up to 32 LUNs with 32 paths each.

Failover/Failback Data Paths

By providing alternate I/O paths from the server to the SVA, SVA Path provides uninterrupted access to mission-critical data. This substantially insulates server applications from I/O path failures.

In the event of a failed host bus adapter (HBA), interface cable, or channel I/O card within the SVA, SVA Path automatically reroutes I/O traffic to an alternate data path. Failover is essentially transparent, ensuring continuous access to data stored on the SVA. When configured in the recommended failback mode, SVA Path automatically restores the primary data path and system redundancy once the defective component is replaced.

Load Balancing

SVA Path supports up to 32 data paths between a host and any SVA logical device. While only two data paths are required for path failover capability, multiple data paths can be used to improve performance in one of three ways:

1. by allowing SVA Path to uniformly distribute primary paths among all available I/O paths. This is the default behavior of SVA Path.

2. by manually assigning I/O traffic for a logical drive to a particular path. The administrator with an understanding of the I/O load patterns of his or her applications can optimize performance through an intelligent choice of paths.

3. by enabling automatic load balancing. In this mode of operation SVA Path monitors the load on each path and reassigns LUNs/FDEVs to balance the load across all available paths.

Dynamic Allocation of Device Resources

In SVA configurations with multiple servers attached to the same storage device, SVA Path allows the system administrator to assign a logical drive to one server and prevent the other servers in the SVA from accessing that same logical drive.

How SVA Path Works

SVA Path's filter driver resides between the file system drivers and the SCSI disk device driver. I/O requests are passed from the file system through SVA Path, then the SCSI disk driver and ultimately to the hardware.

SVA Path monitors the flow of I/O requests through the layered driver architecture. When it detects a failure along an I/O path, it automatically reroutes the request to an alternate path. Failover to the redundant I/O path is transparent to server applications and permits continuous access to the information stored on the disk array(s). To the operating system, there is only a slight delay in normal I/O operations during path failover; existing drive numbers and device access functions continue to work as expected.

If an I/O operation fails on all available paths, it is retried periodically on the primary path according to the retry delay and retry count parameters specified with `setsp`.

Supported SVA Path Configurations

SVA Path supports single server configurations.

System Requirements

Before proceeding to the next chapter, you should verify that your site meets the following minimum requirements (Table 1-1, "SVA Path Minimum System Requirements").

Table 1-1 SVA Path Minimum System Requirements

Host hardware:	All RS/6000 series computers
Host software:	AIX 4.3.3 32- and 64-bit
Host disk space:	10 MB in the `root` filesystem
SVA Subsystem Microcode:	E.02.01.14 or greater

Summary of SVA Path Benefits

- Increases potential subsystem throughput by directing I/O through multiple host adapters and SVA channels. Logical drives can be assigned to host bus adapters, manually balancing the I/O load across paths.
- Provides continuous access to mission-critical data by insulating server applications from I/O path failures.
- Installs easily and is transparent to server applications.
- Allows you to limit access to devices in a multiple server environment using LUN (logical unit number) exclusion.

Document Overview

This manual describes how to install and configure SVA Path on systems running the AIX operating system.

- Chapter 2 describes configuring your hardware in preparation for installing SVA Path.
- Chapter 3 contains instructions for installing SVA Path.
- Chapter 4 explains configuring and operating SVA Path.
- Chapter 5 offers assistance in diagnosing error messages.

Note that user documentation for products used with SVA Path, including AIX documentation, is referenced throughout this manual. Have your hardware and operating system manuals available for reference.

Chapter 2. SVA Path Hardware Setup

Fibre Addressing Concepts

Host Bus Adapters/Initiators

The terms “host bus adapter” and “initiator” mean essentially the same thing. Typically, the HBA is a card within the host that, in its role as initiator, issues commands on the Fibre channel.

Domains in Fibre Channel Connection

StorageTek uses the concept of “domains” to allow open systems hosts access to blocks of logical devices (the domains) within an SVA. A domain is an additional layer of device addressing, but one that is manually configured by the StorageTek Customer Service Engineer (CSE) in the SVA. This layer of addressing divides the SVA into “domains of access.” There can be up to 16 (0–15) domains per SVA, with each domain having one target with 255 LUNs. There is a limit of 1024 total devices available within an SVA.[1]

Each open systems host initiator is connected with Fibre cables to a controller card port, giving it access to the devices that have been configured within its domain. (An open systems host cannot see devices in domains other than the one to which it is attached.)

Full SVA Path functionality requires that redundant initiators can access the SVA over redundant data paths.

1. Using all allowed domains, targets, and LUNs, there are more than 1024 logical devices, but the SVA has a limit of 1024 logical devices.

Figure 2-1 shows two data paths connecting the open systems platform to the attached SVA using Fibre cables.

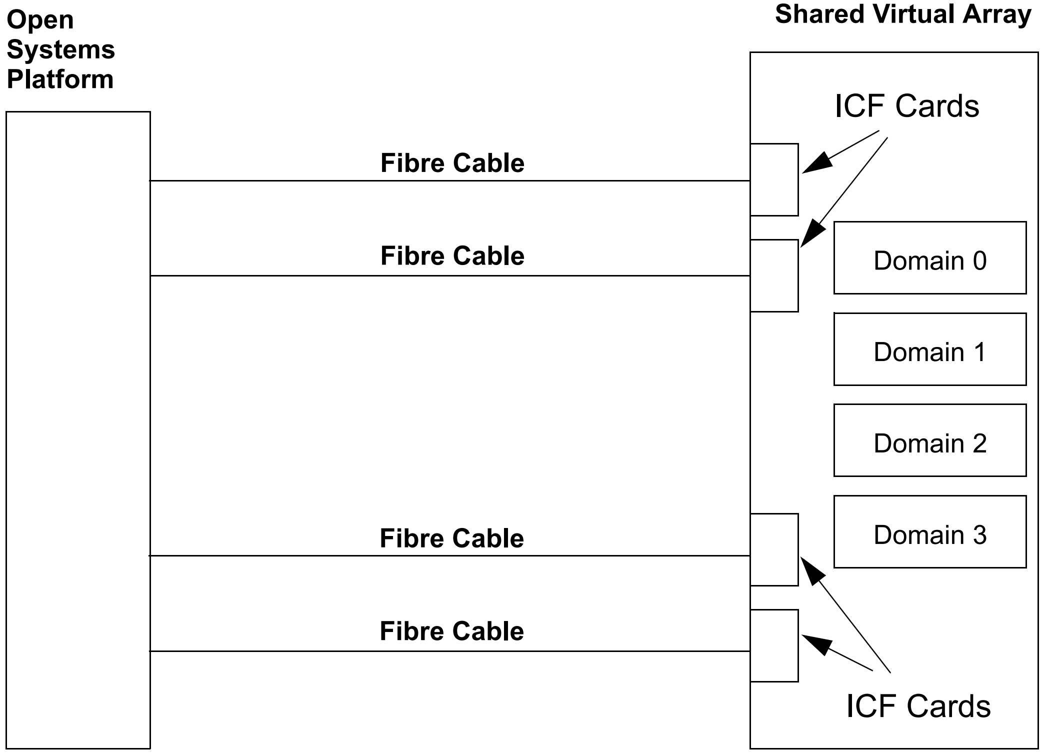

Figure 2-1 Fibre Paths from the Host to the SVA

Note: In the above figure, a domain can represent up to 255 logical devices (1 Target × 255 LUNs = 255 Logical Devices). There is a limit of 1024 logical devices with an SVA.

Domain Numbering

Using Fibre connection, the domain number is configured at the SVA operator panel by the StorageTek Customer Service Engineer.

The domain number is never seen by the open systems host; from its point of view, just a target and logical unit number are involved in an I/O operation.

Domain Numbering with Fibre and SVA Path

Without SVA Path, it is not advisable to have more than one path from a single host set to the same domain number on a given SVA. Two hosts accessing the same domain could attempt to share the same LUN and corrupt the data stored on it.

SVAPath addresses the problems of such a setup through its LUN exclusion feature, which allows association of each LUN of the domain to only one host.

With SVA Path installed, the system needs to be set up with two or more paths accessing the same domain for the failover/failback feature to be enabled.

> **Note:** With only one path, failover/failback cannot be enabled, but the system could still benefit from the LUN exclusion feature in a multi-host environment.

A single host without SVA Path installed, accessing the same domain through different paths, would see different devices representing the same LUN and could be confused by it.

Hardware Preparation

When adding SVA Path for AIX to an existing, configured SVA subsystem, no configuration changes are required.

Chapter 3. SVA Path Installation

SVA Path supports IBM AIX version 4.3.3.

If a previous version of SVA Path is installed on your system, remove it before continuing with this installation (See “Uninstalling SVA Path on IBM-AIX,” on page 10).

To determine if an older version of SVA Path is present on your system examine the output of the command:

lslpp –L |grep SVAPath

Installing SVA Path on IBM-AIX

Follow these steps to install the SVA Path driver and its supporting files.

1. Set your system hardware up according the instructions in their respective user manuals and in “SVA Path Hardware Setup,” on page 5.

2. Before installing SVA Path software, the host must be able to see and access all storage devices through all available paths. For example, if you have two HBAs and redundant paths to your storage system, each logical drive should be displayed twice when viewing your list of available devices.

   If you can't see all available storage devices through every path, verify that you have the latest fibre channel or SCSI HBA drivers loaded on your system.

3. To install the software, insert the CD-ROM distribution and log on as `root`.

4. Install SVA Path by becoming root and using the following commands:

   a. `# /usr/sbin/mount -v cdrfs -o ro /dev/cd0 /<mountpoint>`

      Note: Before proceeding, refer to the README file in the directory `<mountpoint>/dh_aix_3_2` for information on any changes to the software or installation procedure that may have occurred after this manual was printed.

      Note: Installation of SVA Path will rebuild your system kernel. You will have to reboot in order to use SVA Path devices.

   b. From the `/<mountpoint>/dh_aix_3_2` directory, issue `./install` command

      Follow the onscreen instructions to completion.

5. Reboot the system using: `shutdown -Fr`

Uninstalling SVA Path on IBM-AIX

To remove SVA Path, enter the following command line commands as root:

1. `setsp -T`

2. `/etc/svapath.rc stop`

3. `setsp -x -l all`

   To list all spd's, enter: `lsdev -C | grep spd`

   Note: The command `lsdev -Cc generic` can be used to return *all* generic devices, including the spd devices.

4. `rmdev -d -l spdctrl -R`

5. `installp -ug SVAPath`
   or
   `/opt/storagetek/SVAPath/svapath_install uninstall`

6. Reboot the system.

SVA Path Device Naming in AIX

Disk device filenames in IBM-AIX 4.3.x have names in the following format:

`/dev/hdiskX`

`/dev/rhdiskX`

where X = the controller instance number. A sample listing follows:

```
hdisk1 Available 30-60-00-0,0 Fibre Channel SCSI FCP Disk Drive

hdisk2 Available 30-60-00-1,0 Fibre Channel SCSI FCP Disk Drive

hdisk3 Available 30-78-00-0,0 Fibre Channel SCSI FCP Disk Drive

hdisk4 Available 30-78-00-1,0 Fibre Channel SCSI FCP Disk Drive
```

In a typical, single-path disk storage system, each physical disk is represented in the host's /dev directory by two special device files representing the character and block mode device instances. For simplicity, we reference the set of device files as a single device filename and disregard the first part of the pathnames that distinguish between raw and block modes.

As a layered device driver that runs on top of the standard IBM AIX disk driver (hdisk), SVA Path creates its own device files. The SVAPath created special files are only used for SVA Path internal processing. From an application view, the SVA Path created files are not used. The AIX logical volume manager and applications continue to use the hdisk and associated identifiers.

When we have multiple path, for each LUN, we have as many devices (and thus special files) on the host. If we consider that all these file that give access to the same LUN form a group, applications continue to use one special file of such groups : the smallest numbered one. This can be checked with the output of 'setsp -a'. Access to the other special files in the group is blocked by SVAPath.

Note: It is the virtual device file that will be used by applications to access that device. The original, redundant data paths should never be used to access the device, or the data it contains could be corrupted.

AIX Devices with Only One Path to the Host

SVA Path creates virtual device files for all supported devices and blocks access to them through their original device filenames whether or not they are accessible via redundant paths. Virtual device files are created for devices that have only one physical path for two reasons:

- a device could actually have more than one path but only one was functional at the time that SVA Path was installed, and
- the device could be part of a SAN configuration where it is necessary to prohibit applications on the local host from accessing the device because the device was assigned to another host on the SAN.

Note: Boot devices do not qualify as supported devices, and virtual device files are never created for them. (For a complete description of qualifying devices, refer to "The sppath Command," on page 26.)

Table 3-1 Installed SVA Path Files (Partial List[a])

File	Description
`/usr/lib/drivers/spd`	SVA Path driver
`/etc/sppath.conf`	sppath configuration file (installed empty)

Table 3-1 Installed SVA Path Files (Partial List[a])

File	Description
`/etc/spmon.conf`	spmon configuration file
`/etc/spd.conf`	spd configuration file (installed empty)
`/etc/spd/bin/sppath`	qualifies and claims SVA storage devices for SVA Path control
`/etc/spd/bin/setsp`	configures SVA Path parameters
`/etc/spd/bin/spmon`	monitors device paths and implements load balancing

a. A full list of all files installed is provided during the installation sequence, or by running the `lslpp -f SVAPath` command.

Chapter 4. SVA Path Operation

This chapter describes SVA Path commands and configuration options.

There are three basic commands in SVA Path

- `setsp` is used to examine and configure the system's operating parameters, and as such is the command most often invoked by the user.
- `spmon` monitors path states and implements load balancing.
- `sppath` identifies devices to be placed under SVA Path's control.

The setsp Command

The `setsp` command is used for most configuration tasks.

Table 4-1, "`setsp` Command Options", on the next page gives a brief explanation of `setsp` command options. Those used to configure SVA Path device parameters are covered in some detail in "Changing the Configuration", beginning on page 32. In these cases, the pages containing more detailed explanations of command options are noted parenthetically.

The output of `setsp -a` is also used in conjunction with operating system events to determine the nature and physical location of failures. This is covered in "Diagnosing Errors", starting on page 37.

Command options that take arguments (shown in braces after the command) *require* an argument and should not be run without one.

Table 4-1 setsp Command Options

Option	Effect
`-a`	show current device configuration and state
`-b{0|1}`	set load balancing for a logical drive. (pages 31 and 34). Must be used with `-l` `-b0` disables load balancing for the device; `-b1` enables it
`-d<n>`	set a retry delay of *n* for a logical drive, where *n* is the interval between retries in milliseconds (page 32 and 35). Must be used with `-l`
`-e{0|1}`	set exclusion for a logical drive (pages 31 and 33). Must be used with `-l` `-e0` includes the device; `-e1` excludes it; excluded devices are not accessible by user applications; devices are excluded by default
`-f{0|1}`	set failback for a logical drive. Must be used with `-l` `-f0` disables failback for the device; `-f1` enables it (pages 32 and 35)
`-g`	generate configuration files after an `sppath` command (Page 28)
`-i`	show contents of driver configuration files

Table 4-1 setsp Command Options

Option	Effect
-L <parameter>	show current device configuration according to condition(s) defined by `setsp` command option parameter(s) (e.g., `setsp -L -e1` lists all excluded devices; `setsp -L -b0 -f1` lists all devices that have load balancing disabled and failback enabled); acceptable parameters are: `-l`, `-e`, `-p`, `-b`, `-r`, `-d`, and `-f`
`-l{<n>|all}`	specify a logical drive for the command, where; *n* is the drive's `spd` number ; `all` specifies all devices (page 32)
`-N`	runs a command to change the configuration files without affecting the running system (changes will take effect at the next boot)
`-n<n>`	allocate *n* buffer pointers for a logical drive, where *n* should be a number approximately equal to the device's maximum queue depth (pages 31 and 34). Must be used with `-l`.
`-p<n>`	select primary path n. Must be used with -l.
`-r<n>`	set a retry count of *n* for a logical drive, where *n* is the number of times a command will be retried (pages 32 and 35)
`-S`	start the `spd` driver
`-T`	terminate the `spd` driver
`-u{0|1|2}`	show devices by their configuration status: `-u0` shows all available devices; `-u1` shows configured disks; `-u2` shows unconfigured disks

Table 4-1 setsp Command Options

Option	Effect
`-v`	runs a command in verbose mode
`-x`	Remove an SPD device from the configuration file. The spd driver will no longer configure it after a reboot. (`setsp -g -l` reconfigures the spd, and returns it to SVA Path control.) The result is similar to ignoring a device (using `sppath -I`).

The spmon Command

The `spmon` command is primarily associated with load monitoring and balancing of SVA Path functional devices (FDEVs). FDEV is a logical disk as viewed by the host operating system, the applications and the users. An FDEV can emulate one of a variety of SCSI and count-key-data (CKD) disk devices.

Note: For optimum performance when striping data across multiple LUNs, disable load balancing on the devices being striped using the `setsp -b0` option. Also, the primary path of each LUN should be assigned to a different HBA in a way that will ensure static balance of the I/O.

Configuring Load Balancing

Load balancing is enabled or disabled using `setsp -l all -b0` (disable) or `setsp -l all -b1` (enable) commands, with the default setting being load balancing is enabled. Parameters for load balancing are stored in the configuration file `spmon.conf`. This file is read automatically after each modification at the end of the expiration of the last measurement interval.

Following is a listing of available parameters in `spmon.conf`:

- **`balance-threshold`** ***`percentage`***

  This parameter represents the maximum difference in load between the highest-loaded and lowest-loaded paths, as a percentage of the highest load, before the paths are considered balanced. At 100%, paths will never be considered unbalanced; at 50%, imbalance occurs when the load on the least-busy path is less than half of that of the busiest.

  A value of 10% specifies that any difference of more than 10% between the most and least busy paths triggers the path balancing algorithm.

- **`reassignment-threshold`** ***`percentage`***

  The reassignment-threshold parameter limits reassignments that do not reduce imbalance enough to be worthwhile. When considering a path reassignment, the load balancing algorithm computes a target value for the load it wants to transfer from the busiest path to the least busy path. The reassignment threshold is the percentage by which a less-than-optimal move may deviate from the target value and still be considered a candidate. For example, a value of 99% means that reassignments may be considered even if they result in only a very small reduction in the imbalance, while a value of 50% specifies that a device shall be reassigned only if such a reassignment will reduces the imbalance to less than 50% of what it was before the move. Lower percentage values discourage path reassignments.

- **`measurement-interval`** ***`time`***

  This parameter accepts an positive integer value with a suffix of "s" (seconds), "m" (minutes), or "h" (hours). A reasonable minimum value will be based on the CPU load presented to the system by the algorithm and the maximum value is based on the amount of time that can pass before the driver's internal counters overflow.

- **`reassignment-limit`** ***`number`***

  This parameter specifies the maximum number of devices that should be moved in one pass of the algorithm. The default value is equal to or one half of the FDEVs. If the path group includes one or more multi-FDEV LUNs, each FDEV is considered a separate device.

- **`read-overhead`** μ***`s-per-cmd`*** μ***`s-per-sector`***

  This parameter is used to specify how bus connect time overhead is estimated for read commands. The first value specifies the number of microseconds estimated for read command overhead, while the second is an estimate of connect time required for each 512 bytes of data requested. For each read operation, the sum of the command overhead and the product of the transfer length and the per-sector overhead is added to a counter that is used to estimate overall bus utilization on a per-FDEV and per-channel basis.

- **`write-overhead`** μ***`s-per-cmd`*** μ***`s-per-sector`***

  This parameter is analogous to the read-overhead statement. Sample values for these two statements are:

  ```
  read-overhead  1000 120
  write-overhead 1000 160
  ```

- **`log-data-directory`** ***`directory-name`***

  This parameter specifies that log files should be placed in the specified directory each time the load balancing algorithm runs. The data files in the directory are named using the "path group name," consisting of the names of the HBAs in each group concatenated with hyphens, followed by "-fdevs.csv" or "-paths.csv". These files contain the data used as input to the load balancing algorithm. The -fdevs file contains the following fields:

  SecondSinceProgramStarted,

  FdevName,

  CurLoadMilliSec,

oldPath,

NewPath

The -paths.csv file contains these fields:

SecondSinceProgramStarted,

PathNum,

PathName,

CurLoadMilliSec

If the directory name contains a space or ends in a backslash, enclose the entire directory name in double quotes.

Tuning Path Balancing

The path balancing algorithm captures details about the I/O load going to each device, then enters an algorithm which performs several tests to determine whether a device movement will improve the balance across all possible physical paths.

For the purpose of this section, moving a device means re-directing I/O from one physical interface to another. This creates a certain amount of work to be done by the SVA. While tuning using the parameters below, you should consider how to achieve a satisfactory balance while moving the least amount of devices:

> Parameters should be changed one at a time and then monitored for a period of time. An indication of an incorrect parameter value can either be no device movements or too many device movements. Try to always err on the side of no device movements and adjust slowly until device movement is seen.

Additionally, the `spmon` command can be a valuable asset to observe system load numbers either real-time, or over a period of time. The show option of `spmon` will display load information every time it is issued.

There is also a **log-data-directory** parameter in the `spmon.conf` file which identifies a file to place load information every time the algorithm runs, i.e., every measurement interval. This file can then be imported into a graphing utility, and load peaks and lows can be seen over time.

Read / Write µs-per-cmd & sector

The first 2 parameters which can be used to tune the algorithm are:

- Read-overhead µs-per-cmd µs-per-sector
- Write-overhead µs-per-cmd µs-per-sector

These parameters aid in determining the I/O load to the devices. Since writes require more subsystem resources than reads, these parameters set the skew. They must be altered to match the prevalent RFA blocksize being used by the operating system per the chart below:

Table 4-2 Blocksize

	512 Byte	2K Byte	4K Byte	8K Byte	16K Byte
Read µs-per-sector	110	45	25	25	24
Write µs-per-sector	180	68	44	33	32

Note: When tuning, leave the Read / Write µs-per-command at 1000. It is also recommended to only change one of these parameters since they have a co-relationship.

Measurement Interval

The next parameter to consider tuning is the measurement interval time. This parameter determines how long the I/O load will be measured before entering the algorithm itself.

Raising the value too high could overrun the program buffers and cause errors.

Setting the value too low renders the sample unique, to the extreme where it is not representative of the actual load.

The value of this parameter should remain in the range of 20 - 60 seconds.

Balance Threshold Percentage

Balance Threshold Percentage is the first actual Load Balancing Algorithm parameter. It determines how far apart, in load, the paths can be allowed to get before the algorithm progresses with further tests. The actual formula is:

```
High_Load_Path - Low_Load_Path > High_Load_Path * Balance_Threshold_Percent
```

If the result of this formula is true, the algorithm will continue to the Re-assignment Threshold test. (See below.)

The default value for Balance Threshold Percentage is 10%. Try setting it lower if the load is mostly small I/O 's and higher if there are mostly large I/O's. As with all parameters, an indication of an incorrect parameter is either no movement or too many movements. Bear in mind that with a smaller number, more movement is likely; larger numbers restrict movement.

Re-assignment Threshold Percentage

Re-assignment Threshold Percentage is the second Load Balancing Algorithm parameter, and determines whether a device is worth moving. It forces the software to locate the best device to move and therefore achieve the tolerable balance set in the Balance Threshold Percent parameter. It asks the question, "Will an X% improvement be made to the balance?"

The default value is 50%. Setting this parameter too high can cause too many movements and impact device performance. Too low, and no devices will ever qualify to be moved.

For example, if there were a theoretical load on path A of 100 and a load on path B of 50:

> If Balance Threshold Percent = 10%, the maximum tolerable out-of-balance condition is within 65 - 85, with the ideal at 75.
>
> If the Re-Assignment Threshold Percentage is set to 50%, only a device with a load of 12.5 to 25 would be a candidate to be moved.

12.5 would change path A to 87.5 and path B to 62.5: a 50% improvement.

Re-Assignment Limit Number

The final tuning parameter is Re-Assignment Limit Number. This parameter controls how many devices can be moved after each Measurement Interval.

Set this parameter to 1/2 the number of paths under SVA Path control on that host, for example:

- If there are 2 paths, set it to 1
- If there are 4 paths, set it to 2
- If there are 3 paths, experiment with both 1 and 2, starting with 1.

How to Verify Load Balancing

In Figure 4-1, "Example setsp -a Output in Determining Load Balancing", there are three SVA Path devices; `spd0`, `spd1` and `spd2`.

```
setsp -a

===============================================================================
 spd   Path/disk          Status   Pri Exc Buf Balance RtrCnt  RtrDly FailBack
===============================================================================
   0   c6t1d0/9            Good     X       32    1       20     3000      1
       c7t1d0/11           Good
 spd0 = hdisk9                                   ID = "STK V960 0024000200000000"
===============================================================================
   1   c6t1d1/3            Good     X       32    1       20     3000      1
       c7t1d1/4            Good
 spd1 = hdisk3                                   ID = "STK V960 0024004800000000"
===============================================================================
   2   c6t1d2/10           Good     X       32    1       20     3000      1
       c7t1d2/12           Good
 spd2 = hdisk10                                  ID = "STK V960 0024004900000000"
```

Figure 4-1 Example setsp -a Output in Determining Load Balancing

- **`Status`** shows the current state of the path. `Good` paths are functioning normally. `Bad` paths have failed. `Excluded` paths are unavailable to applications on this host.

In our example (Figure 4-2), the command **spmon show** will show that each device in Figure 4-1 is accessible via two paths, using HBAs "fscsi1" and “fscsi2”:

```
Total I/O load across monitored HBAs = 0ms

    HBA   Device     I/O Load  %load
    --------------------------------
    fscsi1 fscsi1         3ms   100.0%
    fscsi2 fscsi2         0ms   00.0%

Device spd0 [STK V960 0024000200000000]
    FDev      Path                  I/O Load   HBA Load
    ----------------------------------------------------------
    spd0:0    0/hdisk11              1ms        3ms    33.3%

Device spd1 [STK V960 0024004800000000]
    FDev      Path                  I/O Load   HBA Load
    ----------------------------------------------------------
    spd1:0    0/hdisk3               1ms        3ms    33.3%

Device spd2 [STK V960 0024004900000000]
    FDev      Path                  I/O Load   HBA Load
    ----------------------------------------------------------
    spd2:0    0/hdisk10              1ms        3ms    33.3%
```

Figure 4-2   Example spmon show Output

The column headings describe the various fields on the screen:

- **FDEV** (Functional Device) identifies the SVA Path device and the zero-based index of the FDEV within the device, separated by a colon.
- **Path** identifies the current path assigned to the FDEV and the name of the host bus adapter used by that path.
- **I/O Load** estimates channel utilization time during the current measurement interval. The I/O Load may be expressed as one of the following formats:

  `milliseconds` (with an "ms" suffix) if it is less than one second.

  `seconds` (with an "s" suffix) if it is less than 300 seconds.

hours:minutes:seconds (hh:mm:ss) if it is more than 59 minutes.

- **HBA Load** identifies the I/O load contributed by traffic to/from this FDEV as a percentage of all I/O though the current HBA used to access this FDEV. The figure in the right-hand column is a ratio I/O Load / HBA Load, expressed as a percentage.

In this example, fscsi1 is carrying 100% of the load. At the next measurement interval, spmon will automatically calculate and redistribute the I/O load between the two paths, significantly reducing the maximum load on fscsi1.

Adding FDEVs to an Existing Lun

After adding new FDEVs to an existing LUN using the SVA operator panel, run the following command:

```
spmon update-fdevs
```

This enables spmon to load balance the new FDEVs separately from the rest of the FDEVs that make up the LUN. If this command is not run, the FDEVs will be treated as if they belonged to the last original FDEV and will be prevented from being assigned to different paths. For example, if a LUN was originally composed of two FDEVs spd0:0 and spd0:1 and the user adds three FDEVs using the SVA operator panel, the new FDEVs are assigned to spd0:1.

The sppath Command

The sppath command is run automatically at boot after SVA Path is installed. sppath's main function is to create the configuration file that identifies devices to be put under SVA Path's control. Its command options are used to display or modify this device set.

Note: Altering the physical connections to the SVA requires that the host be rebooted for SVA Path to recognize the new configuration.

sppath examines disk devices attached to the system to determine whether any physical devices are accessible via redundant paths and whether those devices should be put under the control of the SVA Path driver. Qualifying devices are written to the `sppath.conf` file. This file should not normally be modified directly by the user.

To qualify, devices must *not* be boot devices and must have the appropriate inquiry data.

The vendor ID must match one of:

- STK
- IBM
- RSBA

The product ID must match one of:

- 9200
- 9393
- 9500
- V960

`sppath`'s command options are used to display or modify this device set.

Table 4-3, "`sppath` Command Options" gives a synopsis of `sppath` options. They are explained in greater detail below.

Table 4-3 sppath Command Options

Option	**Effect**
`-d`	display debug information
`-D`	clear the list of ignored devices. Should be followed by `setsp -g` (see note below)
`-I{cX[tY[dZ]]}`	ignore the device or group of devices specified; devices are specified in the form `cX`, `cXtY`, or `cXtYdZ`. All devices that match will be ignored; Should be followed by `setsp -g` (see note below) Example: `sppath -I c5` will ignore all devices under controller 5; `sppath -I c5t0` will ignore all devices under target 0 of controller 5.
`-v`	display the contents of `/etc/sppath.conf` after writing the file

Note: After running `sppath` with options `-I` or `-D`, you must run `setsp -g` in order for the changes to be reflected in SVA Path's configuration file `spd.conf`. While most changes are immediate, *all* changes take effect at the next system reboot.

Display Options for sppath

The `-v` option causes `sppath` to display the contents of `sppath.conf` after updating it (Figure 4-3, “Using `sppath` in Verbose Mode”).

```
SPD=0  c6t1d0 dev=42,  7 type=2 SANID="STK V960 0024000200000000"
SPD=0  c6t1d0 dev=42,  6 type=2 SANID="STK V960 0024000200000000"
SPD=1  c6t1d1 dev=42,  1 type=2 SANID="STK V960 0024004800000000"
SPD=1  c6t1d1 dev=42,  2 type=2 SANID="STK V960 0024004800000000"
SPD=2  c6t1d2 dev=42,  8 type=2 SANID="STK V960 0024004900000000"
SPD=2  c6t1d2 dev=42,  9 type=2 SANID="STK V960 0024004900000000"
```

Figure 4-3   Using sppath in Verbose Mode

The `-d` option displays inquiry data in raw format and is generally used only for debugging.

Ignoring and Reclaiming Devices with sppath

The `-I` option accepts symbolic device names corresponding to controllers or specific disks and omits them from `sppath.conf`.

This prevents them from being put under SVA Path’s control.

If a device is to be ignored, all of its paths should be specified with `-I` options. Multiple devices can be specified in a single `sppath` command, but each device specified must be preceded by `-I`. Once specified, the ignored device is remembered in `sppath.conf` and will be ignored until the list of ignored devices is cleared with setsp using the `-D` option. Ignored devices will be displayed as `UNKNOWN` by `setsp -a`. The ignored devices will behave like standard disk drives not under the control of SVA Path.

Run the following commands to ignore a device:

```
setsp -T -l<spdX>
sppath -I{cX[tY[dZ]]}
setsp -g
```

Alternately, you can also run `sppath -I`, followed by a reboot of the host, in order for the operating system to recognize the ignored device.

Note: The `sppath -I` (ignore) command should not be confused with the `setsp -e` (exclude) command. The former removes the device completely from SVA Path's control, treating it exactly as though it is incompatible with SVA Path and could not be recognized and claimed. The `setsp -e` command is intended chiefly for multiple host configurations and prevents particular logical devices from being accessed by a host.

The `-D` option clears the entire list of ignored devices, allowing any eligible device to be placed under SVA Path's control upon the next reconfiguration, either from a manually-entered `cfgmgr` command or a system reboot.

Understanding the setsp -a Screen

Use the `setsp -a` command to display the default path configurations.

```
setsp -a

================================================================================
 spd   Path/disk          Status   Pri Exc Buf Balance RtrCnt  RtrDly FailBack
================================================================================
   0   c6t1d0/9            Good     X       32    1       20     3000      1
       c7t1d0/11           Good
 spd0 = hdisk9                                ID = "STK V960 0024000200000000"
================================================================================
   1   c6t1d1/3            Good     X       32    1       20     3000      1
       c7t1d1/4            Good
 spd1 = hdisk3                                ID = "STK V960 0024004800000000"
================================================================================
   2   c6t1d2/10           Good     X       32    1       20     3000      1
       c7t1d2/12           Good
 spd2 = hdisk10                               ID = "STK V960 0024004900000000"
```

Figure 4-4 Sample Output of setsp -a Command

The column headings identify the various fields on this screen, the last seven of which are user-configurable parameters for the device. The `setsp -a` output fields (with their default values, when applicable) are described below. The commands used to change the default settings are described in the following section.

- **spd** is the SVA Path driver number, an ID assigned to the device by SVA Path and the name of the spd special device file created by SVA Path to access the storage. The disk number is given as `hdisk`*x*, where *x* is a number used by AIX ODM.

- **`Path/disk`** shows the device names and disk numbers for each of the redundant physical paths to the device. Their appearance in the `setsp -a` output facilitates interpreting these events in terms of the spd device names by which applications access devices. This field shows the disk number in the form `c`*X*`t`*Y*`d`*Z*.

- **`Status`** shows the current state of the path. `Good` paths are functioning normally. `Bad` paths have failed. `Excluded` paths are unavailable to applications on this host.

- **`Primary`** shows which of the physical I/O paths connecting the device to the host's host bus adapters (or controllers) is defined as primary (marked by an `X`). Initially, primary path assignments are distributed evenly among the available paths. Figure 4-4, "Sample Output of `setsp -a Command`" shows this as an alternating pattern in a dual-path configuration: `spd0` has a primary path to controller 7, `spd1` uses its path to controller 8 as primary, and `spd2` alternates back to controller 7. The device's duplicate path(s) are not used unless the primary path fails or the load balancing option is selected for that device.

- **`Exclude`** indicates the exclusion setting, which is used to keep particular servers from seeing particular logical drives. As a safety measure, SVA Path excludes all devices from host access by default, giving them an exclusion setting of `1`. Excluded devices are marked by an `X` in this column.

- **`Buf`** is the number of buffer pointers (or buffer structures) pre-allocated for each logical device. For peak performance, `Buf` should be approximately equal to the maximum useful queue depth of the logical unit. Values between 1 and 100 are permitted. The default value is `32`.

- **`Balance`** indicates whether dynamic load balancing is enabled for the device. When load balancing is enabled, SVA Path tracks the volume of I/O on each path and periodically reassigns the LUN's path as needed to keep the

I/O load balanced across all HBAs. `1` means load balancing enabled. `0` means load balancing not enabled. Load balancing is enabled by default for SVA devices.

- **`RtrCnt`** (retry count) is the number of times a failed I/O will be retried on the primary path after it has tried unsuccessfully to use its alternate path(s) and returned again to the primary. When the specified number of retries have failed, the I/O fails. The default value is `20`. The highest value allowed is 100.

- **`RtrDly`** (retry delay) is the time interval, in milliseconds, between the retry attempts described in the preceding parameter. The default value is `3000` ms. This value can not be set above 100,000 ms (100s).

- **`FailBack`** indicates whether failback is enabled for the logical device. When failback is enabled (the default setting of `1`), SVA Path will keep testing a path that has failed and return it to service (as the primary path or in sequential load balancing) as soon as the path has been restored.

If the default configuration is satisfactory, no reconfiguration of SVA Path is necessary.

In addition to the information defined by the setsp -a output's column headings, the last part of the last line for each device (ID=) shows the physical device's unique identifier, which is derived from the device's inquiry data.

Changing the Configuration

The information displayed by `setsp -a` is stored in the configuration file `spd.conf`, which should *never* be edited directly. User-configurable parameters must be changed exclusively through the `setsp` command options provided for that purpose and are described in more detail in the following sections.

Specifying a Device for setsp

To name a specific device in any setsp command, use the `-l` option (note that this is a lowercase letter L, and not the number 1) followed by the device's spd number, as expressed in the syntax illustrations used in the remainder of this chapter as `-l<x>`. To name all devices under SVA Path's control, use `-l all`. A device's spd number is listed in the first column of the `setsp -a` output (See setsp -a example on page 24).

Whether you are applying the configuration command to a single device or to all the devices, only one parameter can be changed per command.

Assigning a New Primary Path

The syntax for changing an SVA LUN's primary data path is

```
setsp -l<x> -p<n>
```

where *<x>* is the `spd` number (or `all`) and *<n>* is the number of the new path. The path number can be obtained by simply counting down `setsp`'s list of physical paths (in the `Path/disk` column), starting from zero.

The command to change the primary path shown in Figure 4-4, on page 30, for the SVA device with the `spd` ID of `0` from its default path through controller 7 to the path through controller 8, then, would be:

```
setsp -l0 -p1
```

If you run a `setsp` command with the verbose option (`-v`), the configuration change will be displayed on screen (below).

```
==============================================================================
 spd   Path/disk         Status   Pri Exc Buf Balance RtrCnt  RtrDly FailBack
==============================================================================
   0   c6t1d0/0                    X   X   32    1      20     3000      1
 spd0 = hdisk0                                 ID = "STK V960 0024000200000000"
==============================================================================
```

Figure 4-5 Using setsp -p in Verbose Mode

If an SVA LUN comprises multiple FDEVs, all FDEVs are assigned to the specified path.

Turning the Exclusion Setting Off and On

The syntax for changing the exclusion setting for a device is

```
setsp -l<x> -e{0|1}
```

where <x> is the spd number (or `all`) and the -e option takes one of two arguments:

- -e0 turns exclusion off (makes the device visible to the host);
- -e1 turns exclusion on (excludes the device).

In a single-host configuration all devices should be visible to the host. Devices can be included (or unexcluded) by using the command.

```
setsp -l all -e0
```

All devices may be included, because no other host can access them at the same time. However, in a multiple-host environment, where all spds are visible to SVA Path on all hosts, spds must be either excluded or included so that a host shares no spds. Use the ID number under the `spd` column on the `setsp -a` output to identify devices. Do not use the `spdX` number.

Note: When including a device you must run the following command:

```
cfgmgr
```

Redefining the Buffer Pointer Allocation

The syntax for changing the number of buffer pointers pre-allocated for a given device is

```
setsp -l<x> -n<n>
```

where *<x>* is the `spd` number (see “Specifying a Device for setsp” on page 32) and *<n>* is the new value. The system must be rebooted for this change to take effect. The number of buffer pointers recommended for a given device is approximately equal to the logical unit’s maximum useful queue depth; the default value of `32` should suit most SVA devices.

Turning Load Balancing On and Off

The syntax for changing a device's load balancing mode is

```
setsp -l<x> -b{0|1}
```

where *<x>* is the spd number (or `all`) and the `-b` option takes one of two arguments:

- `-b0` turns load balancing off;
- `-b1` turns load balancing on.

Changing the Retry Count and Retry Delay

The syntax for changing the retry count for a device is

```
setsp -l<x> -r<n>
```

where *<x>* is the numerical element of the `spd` number (see “Specifying a Device for setsp” on page 32) and *<n>* is the number of times a failed I/O will be retried on the primary path (after its alternate paths have been tried unsuccessfully) before the path is marked as failed (with a `Status` of `Bad`).

The syntax for changing the retry delay for a device is

```
setsp -l<x> -d<n>
```

where *<x>* is the numerical element of the `spd` number and *<n>* is the interval between the retries specified by the retry count parameter.

Turning Failback Off and On

The syntax for changing the a device’s failback mode is

```
setsp -l<x> -f{0|1}
```

where *<x>* is the `spd` number and the `-f` option takes one of two arguments:

- `-f0` turns failback off;
- `-f1` turns failback on.

Dynamic Device Detection

You may be able to add new storage devices and place them under SVA Path's control without requiring a reboot of the host. This is also known as dynamic LUN allocation.

To add a fibre channel device to an existing path, perform the following steps after the devices are physically connected:

1. Run **cfgmgr**

Note: When you run **cfgmgr**, the following commands are automatically run:

sppath to cause SVA Path to detect the new devices.

setsp -g to create an updated configuration file.

setsp -S -l *<new_spd_number>* to start SVA Path on the new device.

2. To obtain the new spd number, run:

   setsp -a

3. Unexclude the device:

   setsp -e0 -l *<new_spd_number>*

Device Deletion

1. From the command prompt, run this command to instruct SVA Path to ignore these paths/disks:

   sppath -I cxtydz

2. From the command prompt, run this command to instruct SVA Path to terminate the spd driver:

   setsp -T -l(n)

3. From the command prompt, run this command to make the update permanent:

   setsp -g

4. Delete the device from SVAA CLI or SVAC.

Note: To remove one specific device from the ignored devices list, run the `sppath -D` command to first remove *all* devices from the list, then run the `sppath -I cxtydz` command for each device you wish to return to the list.

Chapter 5. Diagnosing Errors

Troubleshooting AIX

Before Installing SVA Path 3.2

Before installing SVA Path software, the host must be able to see and access all storage devices through all available paths. For example, if you have two HBAs and redundant paths to your storage system, each logical drive should be displayed twice when viewing your list of available devices.

- **If you can't see all available storage devices** through every path, verify that you have the latest fibre channel or SCSI HBA drivers loaded on your system.
- **To load HBA drivers in IBM-AIX**, run the "installp" or by using the SMIT utility.

  Once the proper driver is loaded, the system will be able to communicate with your HBA. All devices on the bus will be listed under the HBA within the Devices menu. If the host is unable to see the HBA and/or its devices, please upgrade to the latest driver. Most drivers can be obtained from the HBA manufacturer's web site.

  If the latest driver is installed, please review the hardware configuration attached to the host. See “Hardware Preparation,” on page 7 for examples.

Failover Error Reporting in AIX

The output from `setsp -a` (Figure 5-1) now shows that every device's path 0 (those corresponding to device filenames beginning c5) have a Status designation of Bad.

```
==============================================================================
 spd   Path/disk          Status   Pri Exc Buf Balance RtrCnt  RtrDly FailBack
==============================================================================
   0   c5t1d0/17           Bad      X       32    1      20     3000      1
       c6t1d0/12           Good
 spd0 = hdisk12                                 ID = "STK V960 0024000200000000"
==============================================================================
   1   c5t1d1/13           Bad              32    1      20     3000      1
       c6t1d1/22           Good     X
 spd1 = hdisk13                                 ID = "STK V960 0024004800000000"
==============================================================================
   2   c5t1d2/19           Bad      X       32    1      20     3000      1
       c6t1d2/14           Good
 spd2 = hdisk14                                 ID = "STK V960 0024004900000000"
==============================================================================
```

Figure 5-1   setsp -a Output after the Failed Path Is Detected

Recovering from an AIX Path Failure

Path failures generate a lot of output, resulting primarily from the disk driver's attempts at error recovery.

The output of `setsp -a` will return to normal (Figure 5-2).

```
==============================================================================
 spd   Path/disk          Status   Pri Exc Buf Balance RtrCnt  RtrDly FailBack
==============================================================================
   0   c5t1d0/17           Good     X       32    1      20     3000      1
       c6t1d0/12           Good
 spd0 = hdisk12                                 ID = "STK V960 0024000200000000"
==============================================================================
   1   c5t1d1/13           Good             32    1      20     3000      1
       c6t1d1/22           Good     X
 spd1 = hdisk13                                 ID = "STK V960 0024004800000000"
==============================================================================
   2   c5t1d2/19           Good     X       32    1      20     3000      1
       c6t1d2/14           Good
 spd2 = hdisk14                                 ID = "STK V960 0024004900000000"
==============================================================================
```

Figure 5-2   setsp -a Output after the Failed Path Is Back Online

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