High Availability FailOver/iX Manual

HP e3000 MPE/iX Computer Systems

Edition 2

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Preface

This manual documents the High Availability FailOver/iX (HAFO) utilities for the HP e3000 systems.

Each chapter of this manual is described briefly.

Chapter 1, "Introductions." Contains a brief description of the HAFO utility concept.

Chapter 2, "Product Description." Describes how a failover works, including the triggers and a generalized sequence of events after a failover. Each of the four major components is listed and described.

Chapter 3, "Installations." Explains how the installation of the HAFO utilities occurs.

Chapter 4, "Configuration." Provides some general information necessary to determine how best to implement the HAFO utilities and its hardware requirements. A configuration checklist is provided to help gather the necessary information needed for HAFO configuration. This chapter documents how to access the configuration commands. An overview of configuration steps is provided, along with detailed command descriptions and syntaxes.

Chapter 5, "Monitoring Status." Explains how to generate and interpret the failover status report. Each possible primary path status is listed and described. Sample reports are provided.

Chapter 6, "Recovering From a Failover." Describes the failover state, describes each failover status, and notes general repair recommendations. Instructions are provided to return the I/O data flow to the primary data path.

Chapter 7, "Quick Start Instructions." Presents short and concise steps for configuring HAFO.

Appendix A, "Sample Failover and Recovery." Presents a sample failover scenario, troubleshooting, and recovery.

Appendix B, " Error Messages." Lists HAFO error messages, their causes and suggested actions.

1   Introduction

This manual documents the High Availability FailOver/iX (or HAFO) utilities for HP e3000 systems running MPE/iX 7.0 and 7.5. HAFO provides protection from disk I/O path failures to the system and user volume sets by allowing a System Administrator to configure a "Primary Path" for normal I/O and an "Alternate Path" for temporary use during the recovery of a primary path failure. HAFO is also to be used only with multi-ported disk storage array products.

It is critical to understand that HAFO "protection" is available only on a device's primary path. When running on the alternate path a system is vulnerable to all the 'normal' I/O failure modes (see Chapter 2, Product Description). As offered, there is no "automatic" switching from the alternate path to a "repaired" primary path. However, Command Interpreter scripts can be written by a System Administrator to implement this functionality.

HAFO does not actively monitor the status of the alternate paths. It is possible to have a silent failure on an alternate path – this could result in the inability to complete a failover to the alternate path. Therefore, we strongly recommend that all HBAs participating in the HAFO configuration have at least one primary path assigned.

HAFO Analogy Some modern sports cars have "run flat" tires that allow one to loose air pressure in a tire and still drive your car, at limited speeds, for a limited distance. This allows you to drive to the tire store for a repair rather than crashing your car or requiring a long wait for a tow truck. However, you must decide how to repair the tire and when it is safe to drive again.

Similarly, HAFO/iX provides the alternate path as a "run flat" option for your disk Ldev's primary path. The "mileage" limit is subject to your anticipated I/O path failure rate, the longer you run on the alternate path the more likely you are to experience an actual system interruption. Your "speed" limit depends on your alternate path hardware configuration. The "switch" onto the alternate path is automatic. The decision to switch back to the repaired primary path is manual. Luckily, unlike the repair of a tire, the switch back to the primary path can, in many cases, be accomplished without stopping your system.

Prerequisites

The reader of this document must be familiar and knowledgeable with the following subject matters:

- Performing HP e3000 system administration tasks, such as configuring disk Ldevs using SYSGEN. See manual *Performing System Management Tasks* at http://www.docs.hp.com/mpeix/all/

- Creating and using HP e3000 User Volumes Sets. See manual *Volume Management Reference Manual* at http://www.docs.hp.com/mpeix/all/

- If a SCSI-FC fabric router is included as part of the connectivity solution then see manual *SCSI-Fibre Channel Router Installation and User Guide* at http://www.docs.hp.com/mpeix/all/ for details on configuring and troubleshooting the A5814-003 Fabric Router.

- Configuration of MPE/iX 7.5 Native Fibre Channel devices using the A6795A 2Gbit FC HBA is covered in *MPE/iX 7.5 Communicator*. See http://www.docs.hp.com/mpeix/all/

- Knowledge on how to configure LUNs on HP SureStore Arrays for access through dual ported arrays. *This work should be performed by a storage specialist.*

2   Product Description

Once installed and configured, the HAFO software is intended to provide continued data access to supported high availability storage arrays under a variety of conditions. There are typically five "points of failure" in any I/O subsystem. They are:

1. Disk drive mechanisms

2. Disk power supply

3. Disk array controller

4. I/O host adapter card

5. Cabling and FC switches.

High availability storage arrays protect against the first two points of failure by having:

*   RAID configured disk drives (1)

*   Redundant power supplies (2)

The HAFO software, working in conjunction with the proper hardware configuration and a disk storage array's ability to allow multiple interfaces to the same LUN, provides protection for the remaining three points of failure:

*   Disk array controller (3)

*   I/O host adapter card (4)

*   Cabling and FC switches. (5)

It is important to realize that HAFO Software cannot protect you from every type of I/O system failure. Among conditions that are not covered by HAFO are conditions that lead to most MPE/iX System Aborts and HP e3000 High/Low Priority Machine Checks (HPMC). These are handled outside the scope of the I/O system and thus are outside the scope of HAFO. Fortunately, these events should be rare as compared to the conditions HAFO does protect you from.

How Failover Works

Once installed and configured, the HAFO software continually monitors the configured "primary path" for I/O timeouts or errors caused by component failures. This adds minimal overhead to the I/O subsystem operation.

HAFO event information and data structures are memory resident. This eliminates the need for disk file access to perform high availability failover. This is an advantage especially if the path should fail to Ldev#1.

To configure and manage the HAFO functions there is a new section of the SYSGEN program for HAFO called "HA" (short for HAUTIL). The "ha" section is accessed through SYSGEN's "io" menu. That is, you run SYSGEN, type "io" at the SYSGEN prompt, then type "ha" at the "io" prompt. No failover action is taken until the Ldevs are configured for HAFO in the "ha" section of SYSGEN. Device data path and alternate data path information is entered and saved in SYSGEN's `HAFOCONF` configuration file. `HAFOCONF` configurations are read and validated during each subsequent system boot. Specific configuration information is provided in the Chapter 4, "Configuration."

Figure 2-1 illustrates a sample configuration. This figure can be compared against Figure 2-2, which illustrates a failover of the same system.

Figure 2- 1   **Normal System Layout**
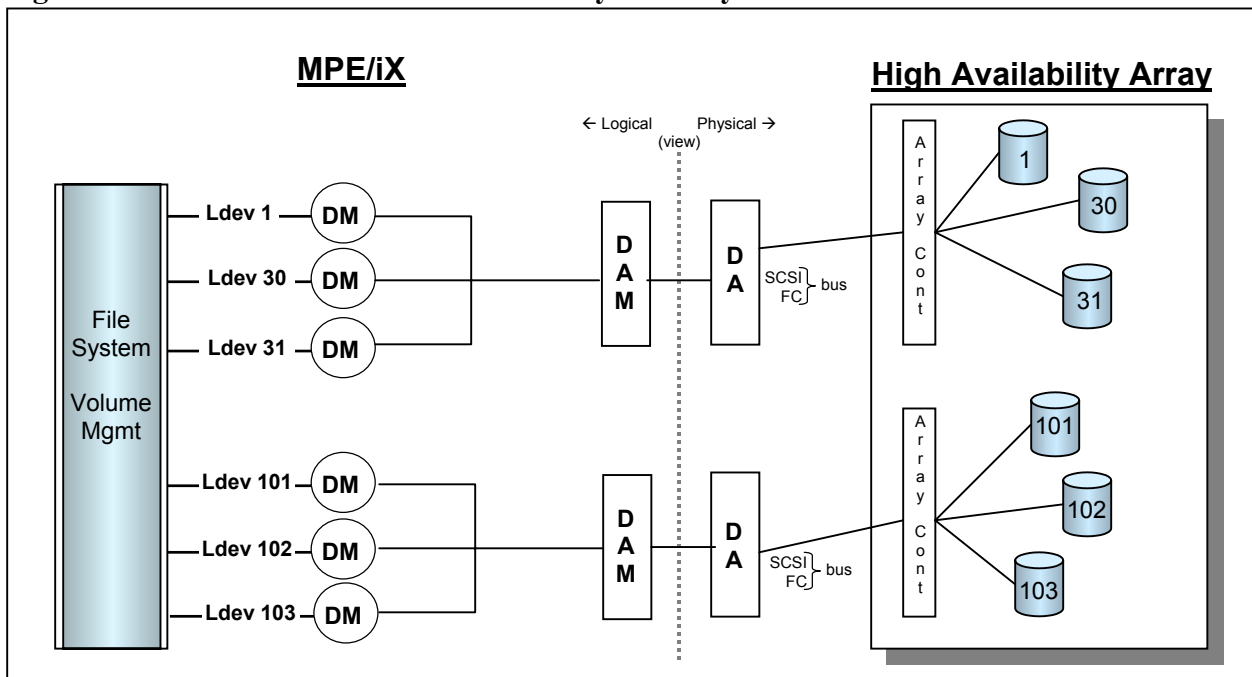
Triggering a Failover

HAFO acts on only specific error types that indicate a data path failure. Any of these three occurrences will generate a failover:

- Hung I/O

- Failed high availability array controller (communicated by a SCSI reply status)

- Failed host device adapter card

If any other error type occurs (such as a data transmission or device error), the I/O subsystem manages the error and perform corrective action. HAFO remains idle and not participate. In addition, HAFO remains idle when error types are received from non-high availability devices.

CAUTION   The difference between a Hung device and an extremely slow device can be very difficult to determine. It is possible that under extreme I/O loads a device may become so slow in responding that a HAFO event is triggered. Before adding HAFO to an existing system, Disk I/O subsystem performance should be analyzed for possible performance bottlenecks, especially around "peak" processing times. (Refer to Chapter 4, sections "Configuration Planning" and "ADDCONF" for more information.)

Executing a Failover

When a trigger status is received, HAFO immediately begins the failover sequence. This sequence activates the alternate data path and reroutes I/O to it. Failover occurs on a per Ldev basis. Each device manager (the piece of the I/O subsystem that manages a specific Ldev) detects a data path failure independently as a result of an I/O to its Ldev. If the I/O rate is low, it is possible that Ldevs on a failed path will not learn of a failure for a noticeable period of time however, as I/O failures occur, each Ldev will failover. For example, if three Ldevs on a fast-wide SCSI bus experience an array controller failure, the associated three device managers will perform a HAFO failover event independently. Figure 2-2 illustrates a failover event in a sample system.

Figure 2- 2   **Failover**
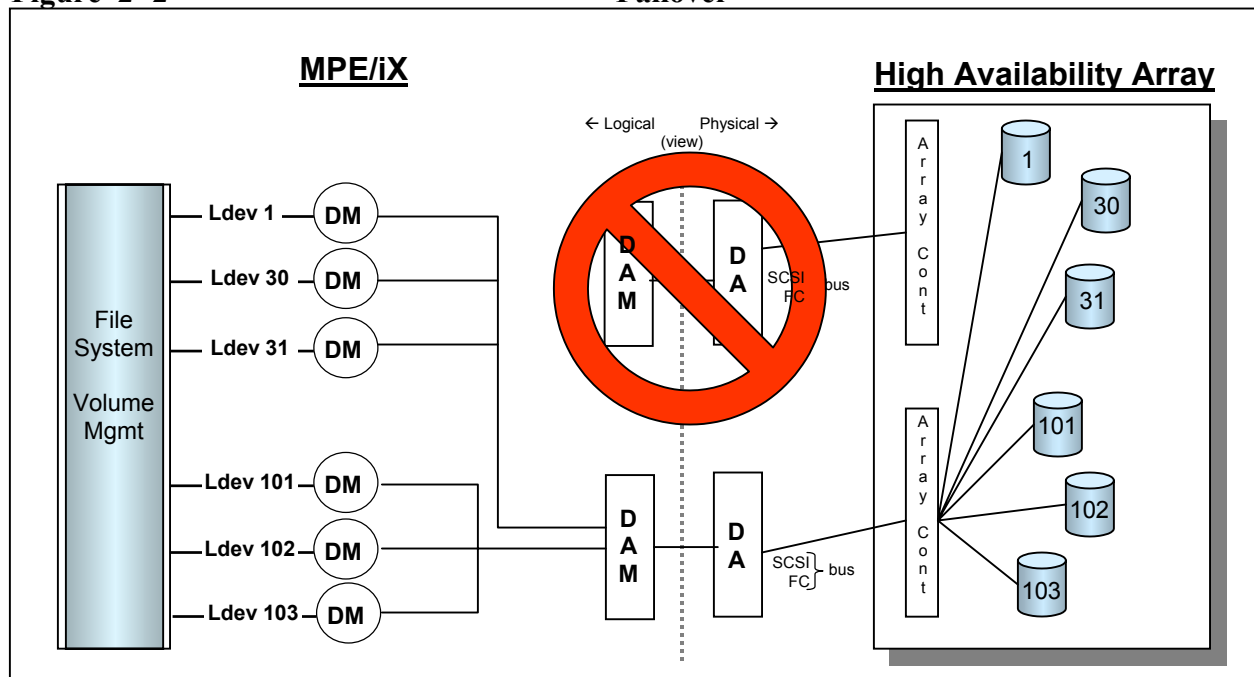
User Notification of Failover

The MPE System Logs will contain Type 111 log records (subsystem 900) to document the failover event. Log entries are also created as a result of HAFO activities including configuration, path verification and path switching. In addition, the following console error message will be displayed upon failover and every five minutes thereafter. The repeating message can be turned off with an MPE "reply" (**[CTRL] [A]** REPLY or :REPLY).

```
HIGH AVAILABILITY FAILOVER IS STARTED FOR Ldev# IN DISK ARRAY. NO DATA LOSS
OR CORRUPTION. SYSTEM OPERATION WILL CONTINUE.PLEASE PLACE SERVICE CALL SOON.

ACKNOWLEDGE HAFO FAILOVER IN DISK ARRAY FOR Ldev# (Y/N)?
```

Once a Failover Has Occurred

After a HAFO event, system I/O activity resumes via the alternate data path. There are no limits to the kinds of normal I/O that can be processed on the alternate data path. However, throughput may be affected since I/O is shared with bus activities from other Ldevs configured for that bus.

For additional information, see the Chapter 6, "Recovering From a Failover."

Components

The HAFO product has multiple components:

- System Boot Failover Initialization Utility

- SYSGEN HAFO commands

- HASTAT HAFO status report

- HAFOCONF configuration file

Each of these components are briefly described.

System Boot Failover Initialization Utility

During system boot, the HAFO configuration utility reads the `HAFOCONF` configuration file and arms HAFO. This configuration information is then frozen into memory and is accessible to the MPE/iX I/O subsystems when a HAFO event is detected.

High Availability Failover Commands

The following commands are used to configure and maintain the `HAFOCONF` configuration file

- **ADDCONF** (ad) — adds high availability device configuration

- **DELCONF** (de) — deletes high availability device configuration

- **LISTCONF** (li) — lists high availability device configurations

- **DOHA** — validates high availability device configurations, and activates the HAFO configuration

- **GONEXT** (go) — instructs device manager to switch to the inactive path. Typically used to switch back to the primary path to recover from a failure but can be used to switch temporarily to the alternate path during primary path maintenance.

- **STATUS** (st) — displays primary and alternate path status.

- **HELP** — get help on HAFO commands

- **EXIT** — exit the "ha" section and return to the "io" section of SYSGEN.

These commands, located in SYSGEN, are documented in Chapter 4, "Configuration." **GONEXT** is documented in more detail in Chapter 6, "Recovering From a Failover."

High Availability Failover Status

With the installation of HAFO, a new reporting program, HASTAT, is supplied. The report lists each configured Ldev, its primary and alternate paths, and their status. This feature is documented in detail in Chapter 5, "Monitoring Status.".

Additionally, SYSGEN "HA" contains a **STATUS**(st) command which produces the same output as the HASTAT program.

HAFOCONF Configuration File

Each configured HAFO Ldev will have a record entry in the `HAFOCONF` configuration file. This file will reside in SYSGEN's CONFIG groups. The HAFO information configured or modified using the HAFO commands resides in this file. `HASTAT` displays the HAFO Status information available from this file.

3   Installation

HAFO requires no subsystem product installation. It is an enhancement to MPE/iX FOS and is installed via operating system patches.

On MPE/iX 7.0 and MPE/iX 7.5 releases you must install MPEMXG9 and MPEMXH5 (or superceding patches). If you are updating from 6.5 with a current, active HAFO configuration you need to recreate your `HAFOCONF` file (see Chapter 4)

With correct installation, HAFO becomes available, requiring only HAFO configuration. The HAFO configuration commands are available in SYSGEN. The `HASTAT` command generates a HAFO status report for each configured HAFO Ldev.

Device configuration using the SYSGEN commands is documented in Chapter 4, "Configuration." The `HASTAT` HAFO status report is documented in Chapter 5, "Monitoring Status."

System Requirements

The following is a list of HAFO supported devices and connectivity restrictions:

- SureStore E Disk Array XP256 (SCSI Attached ONLY).

- SureStore E Disk Array XP512/XP48 with either native FC or Fabric Router attached.

- SureStore E Disk Array XP1024/XP128 with either native FC or Fabric Router attached.

- **Virtual Array 7100 is not supported because the VA7100 contains one active port and one passive port. HAFO requires two active ports.**

- Virtual Array 7110 with either native FC or Fabric Router attached.

- Virtual Array 7410 with either native FC or Fabric Router attached.

HAFO/iX Support for Disk Array Products vs. O.S. Releases.

Product	Release 6.5	Release 7.0 plus MPEMXG9 and MPEMXH5	Release 7.5 plus MPEMXG9 and MPEMXH5
XP 256 (SCSI Only)	Yes	Yes	Yes
XP48/512 via A5814A-003	Device Not Supported	Yes	Yes
XP48/512 via Native Fibre Channel	Device Not Supported	Device Not Supported	Yes
XP128/1024 via A5814A-003	Device Not Supported	Yes	Yes
XP128/1024 via Native Fibre Channel	Device Not Supported	Device Not Supported	Yes
VA7110 VA7410 via A5814A-003 Router	Device Not Supported	Yes	Yes
VA7110 VA7410 via Native Fibre Channel	Device Not Supported	Device Not Supported	Yes

4   Configuration

Once HAFO software is installed, the core components are active. This means HAFO is monitoring the I/Os for any HAFO (like) reply messages, as documented in Chapter 2, "Product Description." However, for failover protection, the Ldevs must be configured for HAFO and the configuration must be activated.

Configuring an Ldev creates an entry in the HAFO configuration file, `HAFOCONF`. The `HAFOCONF` file resides in the configuration group on Ldev1. It contains one record for each Ldev configured for FAILOVER. If you are updating from MPE/iX 6.5 with an existing, active HAFO configuration you will have some additional steps to recreate your `HAFOCONF` file. See the "Chapter 4 Configuration –"Special Considerations" section for details.

Configuration Planning

Detailed planning of the hardware configuration of the array itself and the actual HAFO configuration (in SYSGEN) is required. Before taking any action on the array or in SYSGEN, the user should have a complete map and plan for the setup. The path layout and primary and alternate paths for all the Ldevs to be covered by HAFO must be determined in advance. Both user and system volumes may be configured for high availability failover. All Ldevs covered by HAFO must be on supported high availability storage arrays (see chapter 3).

Before beginning HAFO configuration in SYSGEN, the array must already be cabled and the hardware configured to work with the HAFO utilities, as described earlier in this document.

It is possible that a poorly performing Disk Array could actually trigger false HAFO events. If a system is experiencing any problems with Disk Array response times or I/O throughput it is not a good candidate for HAFO. If you are planning to add HAFO to an existing system then it is recommended that performance data for the system be analyzed to ensure that there are no disk I/O bottlenecks. At a minimum, it is a good idea to check system logs for I/O Timeout errors.

HAFO Configuration Restrictions

1. **HAFO works with pairs of controllers.** That is, all Ldevs on a given primary path/controller, for example (path A) must be configured to failover to the same alternate path (path B). By the same token, any Ldevs that happen to have path B as their primary path, must be configured to have path A as their alternate path.

2. **All Ldevs on a given Host Bus Adaptor path must be configured in a similar manner.**. That is, if any Ldev on the HBA path is configured for failover, then all Ldevs on the path must be configured for failover to the same alternate path.

3. **The storage array's LUN must have the same LUN address for both the primary path and alternate path.** If a device is LUN 20 on the primary path it must be LUN 20 on the alternate path. This also means that each device LUN must be unique across both paths.

4. **The total number of devices assigned to a primary and alternate path pair should not exceed recommended maximums for the HBA you are using.** In the case of the NIO FW/SCSI card no more than 10 devices are supported. With PCI-HVD SCSI connections up to 14 devices are supported. Native Fibre Channel connections should generally not exceed 20 devices.

Configuring HAFO in Pairs

HP strongly recommends that ALL HAFO configurations evenly assign Ldev primary paths to each member of HBA path pairs. That is if, you have four Ldevs and two paths ("A" and "B") then two Ldevs should have "A" as their primary path (SYSGEN (io)) and two Ldevs should have "B" assigned as the primary path. This is critical to avoid "silent" failures of an alternate path. It is NOT recommended that all four Ldevs be assigned path "A" as the primary with no other Ldevs assigned to "B".

Figure 4-1 shows the Ldevs in the top path could be configured to failover to the bottom path. If any of the Ldevs 1, 30, or 31 are configured to failover to the bottom path, then all must be configured to failover to the bottom path. Further, since in this example, some Ldevs indeed exist on the bottom path, they must all (Ldevs 101, 102 and 103) be configured to failover to the top path.

Figure 4- 1   Configuring HAFO in Pairs
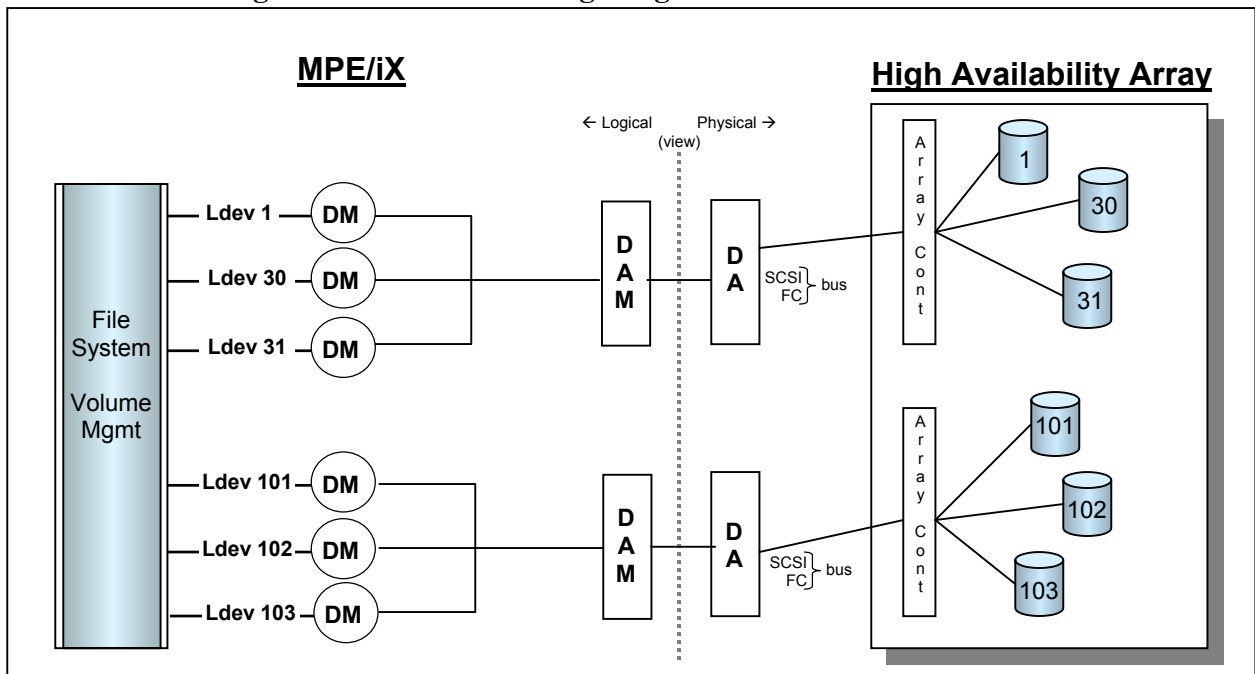
The SYSGEN (io) configured SCSI target & LUN that is being used on a primary path cannot be configured in the (io) section of SYSGEN on the alternate path. (Configuration restriction #3)

For example, if the path for Ldev 1 were 8.0.0, and the alternate path were 48, then one should not use 48.0.0 for any of the Ldevs on that path. None of the Ldevs 101-103 could be configured as 48.0.0. A correct configuration would be to make Ldevs 1, 30, and 31 be 8.0.0, 8.1.0, and 8.2.0. Then make Ldevs 101, 102, 103 be 48.3.0, 48.4.0, and 48.5.0. Now Ldevs 1, 30, and 31 can failover to path 48 and Ldevs 101–103 can failover to path 8 with no conflicts.

Again, HAFO does not address the hardware configuration of the array itself. In the example above, the array itself would have to be pre-configured to allow the top controller to talk to the Ldevs on the bottom and to allow the bottom controller to talk to the Ldevs on the top.

Each controller on the array that is to be used must be connected to a single host adapter card. All host adapters to be used in HAFO configuration must be configured in SYSGEN and present at the time you issue an `ISL>START` command to boot MPE/iX.

Configuration Map

Creation of a configuration map is crucial. Proper planning, mapping, and maintenance of the map are critical to the successful use of HAFO. Without a proper plan and up-to-date map, troubleshooting will be difficult and system availability will not be optimized.

The following is a checklist of the steps required to enable HAFO:

1. Select the array and volume-set(s) to be configured for HAFO. Ldev 1 and the system volume set can be configured for HAFO. HAFO depends on information stored in MPE/iX Disk Volume Labels. New Volumes or Volume Sets must be created using `VOLUTIL` before a disk Ldev is configured in HAFO.

2. Identify the logical data paths of the Host Bus Adaptors for each pair of controllers in the array. One path will be the primary path, fully qualified, and the other will be the alternate data path.

3. Ensure that all paths (I/O adapter cards and Ldevs) are configured and recognized when the system is booted..

4. Create a map of exactly how the layout will look, including the path pairs and each Ldev on each path. Include the addresses of each card and Ldev, and clearly show the failover scheme.

5. Ensure that the array itself is configured to allow each primary path controller to talk to the Ldevs on its corresponding alternate path.

6. When the entire plan and map are complete, configure the primary and alternate data paths in SYSGEN via the HAutil interface.

CAUTION   Mirrored Disk/iX or Cluster/iX cannot be configured as HAFO devices.

Mirrored disk, Cluster/iX and HAFO can be used on the same system with multiple volumes and multiple arrays. However, these products must be completely isolated from each other. That means no shared Ldevs on the bus and with completely separate cabling and ports.

HAFO Configuration Commands

HAFO configuration is a sub-menu of SYSGEN. The sub-menu, HAFO(ha), is found under the "io" sub-menu of SYSGEN.

```
:SYSGEN
>io
>ha
```

HAFO configuration commands:

1. **ADDCONF** (ad) to add each Ldev's configuration path to the HAFO configuration file.

2. **LISTCONF** (li) to display configurations.

3. **DOHA** (do) to verify and activate the configuration.

4. **delconf** (de) any mistakes or to delete the entry for an Ldev.

Each of these high availability configuration commands is documented in the following sections. **GONEXT** is used after a failover event and is documented in Chapter 6, "Recovering From a Failover."

NOTE HAFO configuration commands should only be executed when there are no broken paths or Ldevs that have failed over. All Ldevs must be operating on their primary path.

NOTE HAFO Configuration commands depend upon information stored in the MPE/iX Volume Label. HAFO configuration commands should only be performed if :DSTAT shows MASTER or MEMBER status for the volume. HAFO may not work properly on volumes in states such as "UNKNOWN", "SCRATCHED", "LOANER", etc.

ADDCONF (ad)

Once the configuration file is built for a specific SYSGEN base configuration, and the MPE/iX Volumes are initialized, the Ldevs must be configured for HAFO with their primary and alternate paths. Fully qualified paths are required. Research and obtain this information prior to configuration. The syntax is:

```
addconf (ad)      <Ldev>  <path>  <altpath> <timeout>
```

A "path" is a description of the MPE/iX I/O Path including host adapter plus cables and interconnection devices (like FC Routers or Switches) to connect to the high-availability array.

`<Ldev>` is the MPE/iX device id from the SYSGEN io>"add device" command.

`<path>` is the complete path value from SYSGEN io> "Add Device" command (for the primary path)

`<altpath>` is an abbreviated path describing the "alternate path" to the device.

This value is slightly different for SCSI HBA vs. FC HBAs (see examples below) For SCSI HBAs, the `altpath` is only the path of the alternate HBA (e.g. one does not specify SCSI target and LUN values). For FC HBAs the `altpath` must include the HBA and FC-Nport value (e.g. only the LUN is not specified).

`<timeout>` controls whether slow I/O will trigger a primary path failure; see discussion below for more details.

AD with an SCSI HBA (direct connect or SCSI-FC Router) :

```
ha>ad 450   0/6/2/1.3.3   0/6/2/0   True
```

AD with an FC-HBA (notice altpath has FC-Nport):

```
ha>ad 352  0/6/0/0.73289.25  0/4/0/0.70954  False
```

(continued next page)

Timeout Parameter

The Timeout parameter is used to allow or disallow failovers caused by slow or slightly unresponsive disk arrays. Timeout defaults to "true", which gives the best protection but may give "false" failovers under heavy I/O loads. If it has been determined that the observed failovers are "false" failovers and are caused by heavy I/O traffic, setting the timeout parameter to "false" may reduce the "false" failovers but it also reduces the protection offered by HAFO.

NOTE   Systems administrators who see many timeout conditions may need to consult with Disk Array "storage" specialists to determine the source of these performance limitations. As disk arrays are often shared by several systems the diagnosis of these problems can be very difficult. It is possible that the only solution to a performance issue is the purchase of additional hardware. This is why it is very important to understand the I/O "environment" of an MPE/iX system before adding HAFO.

ADDCONF limitations

The hardware must be in place, configured through SYSGEN, and initialized at system boot time before issuing this command. The Ldev specified must be mounted in the MEMBER or MASTER state. Once added using **ADDCONF**, the primary and alternate paths are checked for availability against internal system I/O tables. If the Ldev cannot be accessed through both paths specified, then an error will be issued and the Ldev will NOT be added to the configuration. Although this makes it much more difficult to make configuration mistakes, it also prohibits the creation of HAFO configurations for other systems that are different than the present system.

NOTE   Because HAFO works in pairs, the very first successful **ADDCONF** command that is entered (and applied, see the **DOHA** command) links the HBAs on those two paths. All Ldevs on the primary path specified must then be configured to failover to the alternate path specified. Further, all the Ldevs on the alternate path specified must be configured to failover to the primary path specified in the first **ADDCONF** command specifying these paths. See Figure 2-1.

LISTCONF (li)

LISTCONF displays the entire configuration in the HAFOCONF file or the configuration for a specific Ldev. The syntax is:

```
LI   <Ldev>
```

The <Ldev> is optional. For example:

```
ha> li
```

The LI command without any qualifier lists all Ldevs configured with their primary and alternate paths.

```
 Ldev   Primary Path            Alternate Path     Timeout
 =====  ==================      ==================  =======
   350 0/4/0/0.70954.23         0/6/0/0.73289        True
   351 0/4/0/0.70954.24         0/6/0/0.73289        True
   352 0/6/0/0.73289.25         0/4/0/0.70954        False
   353 0/6/0/0.73289.26         0/4/0/0.70954        False
   450 0/6/2/1.3.3              0/6/2/0              True
   451 0/6/2/1.3.4              0/6/2/0              True
   452 0/6/2/0.3.5              0/6/2/1              False
   453 0/6/2/0.3.6              0/6/2/1              False
```

The LI command with the Ldev number lists the Ldev and its configured primary and alternate paths. For example:

```
ha> li 350
```

```
Ldev   Primary Path            Alternate Path     Timeout
=====  ==================      ==================  =======
  350 0/4/0/0.70954.23         0/6/0/0.73289        True
```

Listing the configuration for an Ldev just added using **ADDCONF**:

• Confirms it is in the temporary HAFOCONF file

• Allows you to recheck the accuracy of the paths

NOTE   The **LISTCONF** command lists the contents of the *temporary* HAFOCONF file. The temporary file is an exact copy of the permanent file when you first enter the ha> section. Any adds or deletes of Ldevs will be shown by **LISTCONF**, but they will not be in the permanent file until you have done a hold and keep within SYSGEN.

DOHA

The HAFO configurations may be activated on-line.

In most cases, HAFO configurations can be activated on-line, with the **DOHA** command. The exception to this is when one has issued a **DELCONF** command. Deletes of Ldevs that have been previously activated, cannot be de-activated on-line, and a reboot is necessary.

The following sequence is mandatory for on-line activation:

```
do any ADDCONF commands needed

      ha> exit
      io> hold
      io> exit
sysgen> keep
sysgen> io
    io> ha
    ha> doha
```

The point is that you must do a "hold" and "keep" after the **ADDCONF** commands, and then return to the ha> section and execute the **DOHA** command. This is because **ADDCONF** adds records to the temporary HAFOCONF file, and then the permanent file is used to do the activation.

Using **ADDCONF**, you supply the Ldev number, Ldev (primary) path, and alternate device adapter manager (DAM) path. The **DOHA** command will then perform the following functions:

• Read each entry in the permanent HAFOCONF file

• Confirm the existence of the Ldev, primary, and alternate paths

• Verifies the paths by reading Ldev volume labels on both paths

The syntax is:

```
ha> doha
```

This command validates all configured Ldevs (even if they've already been validated). In the example, two Ldevs, Ldev 50 and 51, have been added, then a "hold" and "keep" were done. **DOHA** is performed:

```
ha> doha

Start of validation for all HAFO configured devices.
=====================================================


VALIDATING ** Ldev: 50  Pri path: 8.15.0  Alt path: 48
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

Ldev 50 configuration Validated Successfully


VALIDATING ** Ldev: 51  Pri path: 8.15.1  Alt path: 48
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

Ldev 51 configuration Validated Successfully


End of validation for all HAFO configured devices.
=====================================================
```

Using the **DOHA** command checks each HAFO configured Ldev in the following ways:

1. The configured Ldev and primary path are compared against internal system I/O tables. This confirms that the Ldev and paths exist.

2. The alternate path is confirmed against internal system I/O tables. This confirms that the path existed at boot time.

3. Using the primary path, the Ldev volume label is read. This confirms that the primary path is working and does, in fact, connect to the appropriate Ldev.

4. The device manager connects to the alternate path. This confirms it exists.

5. Using the alternate path, the Ldev volume label is read. This confirms that the alternate path is working and does connect to an Ldev.

6. Ldev volume labels are compared. This confirms that the two paths can access the same Ldev.

A full six-step validation is always performed in the following situations:

• On system boot

• Executing the **DOHA** command

• By each device manager during a failover event

Troubleshooting a Validation Error

If **DOHA** returns an error state, check Appendix B, "Error Messages". Double check for SYSGEN configuration errors or HAFO configuration errors.

If the Ldev, primary path, or alternate path needs to be changed, delete the configured Ldev using **DELCONF**, add the Ldev back in using **ADDCONF**, do a hold and keep, and then reboot the system.

Execute an **ADDCONF** command, hold and keep, and execute the **DOHA** command.

Validation Errors Displayed

Validation errors will be displayed after a HAFO event has occurred.

If a HAFO event has occurred, there will be errors displayed upon the issuance of the **DOHA** command. HAFO configuration commands should only be issued when there are no broken paths and all HAFO Ldevs are operating on their primary paths.

WARNING	As mentioned previously **DOHA** should not be attempted when you know you have "broken" primary or alternate paths.

DELCONF (de)

To remove a configuration that is incorrect or is no longer desired, use the **DELCONF** command. The syntax is:

```
DE  <Ldev>
```

For example:

```
ha> de 350


ha> li


Ldev   Primary Path          Alternate Path     Timeout
===== ==================== ================== =======
  351 0/4/0/0.70954.24      0/6/0/0.73289       True
  352 0/6/0/0.73289.25      0/4/0/0.70954       False
  353 0/6/0/0.73289.26      0/4/0/0.70954       False
  450 0/6/2/1.3.3           0/6/2/0             True
  451 0/6/2/1.3.4           0/6/2/0             True
  452 0/6/2/0.3.5           0/6/2/1             False
  453 0/6/2/0.3.6           0/6/2/1             False
```

NOTE A system Reboot is required after a **DELCONF** command to permanently removed an LDEV from the HAFOCONF file. A reboot is not required if you do a **delconf** followed immediately by an **addconf** to change the timeout parameter setting.

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GONEXT (go)

The **GONEXT** command causes the Ldev to switch from the current, "Ready", path to the "Validated" path according to the HAFOCONF file.

The most important use of this command is after the repair of a "failed" primary path. **GONEXT** switchs the Ldev from using the alternate path back to using the primary path. **GONEXT** can also be used during preventative maintenance activities to temporarily switch from the primary path to the alternate path. This command is fully documented in Chapter 6, "Recovering From a Failure."

WARNING HAFO protection is only available on the primary path! Use the **GONEXT** command to switch to the alternate path with caution. You should never intentionally run your system using the alternate path for extended periods of time.

WARNING **GONEXT** should NOT be used to "force" HAFO to use a known bad path for any reason. Attempts to force usage of a "broken" path may result in the need to do a full System Reboot to reinitialize the MPE/iX I/O configuration.

Miscellaneous HAFO Commands

REDO (re)

This is the standard MPE **REDO** command that re-displays the last command entered. This command may then be edited using the standard line editing commands.

HELP (he)

To get online help on one of the listed HAFO commands, type **HELP** and the command desired. For example, to get help for the **ADDCONF** command:

```
ha> he ad

        addconf (ad)        <Ldev>  <path>  <altpath> <timeout>

        Add Ldev Primary path alternate (DAM) paths to HAFO Configuration
```

For a full list of HAFO commands and help text:

```
ha> he all
```

EXIT (ex)

To exit the HAFO command menu:

```
ha> ex
```

STATUS (st)

Similar to HASTAT, the **STATUS** command gives detailed information regarding devices covered under HAFO and status of those devices.

```
    ha> st


 High Availability Failover Device Status

 Ldev   Primary Path         Alternate Path    Pri. Status      Alt. Status
 =====  ===================  =================  ===============  ===============

  350 0/4/0/0.70954.23     0/6/0/0.73289      Ready            Validated
  351 0/4/0/0.70954.24     0/6/0/0.73289      Timeout/No Reply Ready
  352 0/6/0/0.73289.25     0/4/0/0.70954      Ready            Validated
  353 0/6/0/0.73289.26     0/4/0/0.70954      Ready            Validated
  450 0/6/2/1.3.3          0/6/2/0            Ready            Validated
  451 0/6/2/1.3.4          0/6/2/0            Timeout/No Reply Ready
  452 0/6/2/0.3.5          0/6/2/1            Ready            Validated
  453 0/6/2/0.3.6          0/6/2/1            Ready            Validated
```

Special Considerations for Configuration

Rebooting After a HAFO Event

Rebooting the system after a HAFO event has occurred, but before the primary path is repaired is a special situation, especially if the event occurred on the path for Ldev 1.

HAFO is not active until very late in the MPE/iX system boot process. Non-MPE interfaces such as the system Boot Prompt (PDC) and ISL have no knowledge of HAFO. The system always attempts to mount Ldev 1 based on the PDC configured system primary path. If the system's primary boot path (Ldev #1) is not repaired or changed, the system will not boot.

All other disk volumes are accessed based on the configuration of the Ldevs done in the (io) section of SYSGEN. (i.e., NOT based on anything done in the ha> section of SYSGEN.) *If the primary path to any of the Ldevs is broken*, then those Ldevs will NOT mount at boot time and may NOT be available after the system is up.

For information on how to deal with these types of situations, please see the Special Considerations for Failed Paths section in Chapter 6, "Recovering From a Failure."

NOTE   All primary and alternate paths are validated near the end of the boot process. If any paths are broken, an error message will be issued.

Corrupt or Problem HAFOCONF File

If the HAFOCONF file becomes corrupt, there are two ways to deal with it. One way to fix it is to purge the file and restore a good file from a backup. Another way is to purge it, then enter SYSGEN. If there is no HAFOCONF file when SYSGEN is entered, it will build a new (empty) one automatically. Use **ADDCONF** to configure Ldevs for HAFO.

Do not perform HAFO configuration when a path is broken. No HAFO configuration changes should be made unless all paths are functioning properly and all Ldevs are operating on their primary path.

Updating from MPE/iX 6.5 to MPE/iX 7.0 or 7.5.

The structure of the HAFOCONF file used by the 7.0 & 7.5 version (supporting Fibre Channel devices) has changed from that used by the 6.5 version (for use with XP256 only). BEFORE UPDATING to 7.0 or 7.5, you should dump the output of the SYSGEN ha> "**LISTCONF**" to an ASCII file.

Then, edit the file down to just the lines that list your Ldevs along with their primary and alternate paths. This list, with "AD" inserted, can then be used as the core of an input file for SYSGEN on 7.0/7.5 to create a new HAFOCONF:

For example, a file containing the following commands, passed to SYSGEN as input, would create a HAFOCONF file with Ldevs 450-453 using the HBA pair at 0/6/2/0 and 0/6/2/1. It also performs the necessary "hold" and "keep" commands to make this change permanent.

```
permyes on
io
ha
ad  450 0/6/2/1.3.3        0/6/2/0
ad  451 0/6/2/1.3.4        0/6/2/0
ad  452 0/6/2/0.3.5        0/6/2/1
ad  453 0/6/2/0.3.6        0/6/2/1
exit
hold
exit
keep
exit
```

5   Monitoring Status

Failover from the primary path to alternate path is automatic and allows applications to continue uninterrupted. In the event of failover, repeated warnings appear on the system console indicating a failover event has occurred. The warning specifies which high availability array Ldev has experienced a failover event.

```
HIGH AVAILABILITY FAILOVER IS STARTED FOR Ldev# IN DISK ARRAY. NO DATA LOSS
OR CORRUPTION. SYSTEM OPERATION WILL CONTINUE.PLEASE PLACE SERVICE CALL SOON.

ACKNOWLEDGE HAFO FAILOVER IN DISK ARRAY FOR Ldev# (Y/N)?
```

The warning message is displayed on the console every five minutes until the operator replies via the **:REPLY** or **=REPLY** commands. In addition to the console warning message, a failover generates entries in the I/O and system logs.

The HAFO console message allows you to monitor the failure event. There is also a new program `HASTAT.PUB.SYS`, that allows you to display status for all HAFO configured Ldevs at anytime. `HASTAT` displays the following information:

- Ldev # of arrays configured for failover

- Primary and alternate path information

- Status of primary and alternate data path for doing I/O (failover and possible cause of data path failure)

NOTE   The `HASTAT` command only reports on Ldevs that are in the `HAFOCONF` file in the group from which the system was booted.

Failover Status Report

A sample report is shown here.

```
:HASTAT


  High Availability Failover Device Status

 Ldev   Primary Path          Alternate Path    Pri. Status      Alt. Status
 =====  ====================  ================== ===============  ===============

   350 0/4/0/0.70954.23      0/6/0/0.73289      Ready            Validated
   351 0/4/0/0.70954.24      0/6/0/0.73289      Timeout/No Reply Ready
   352 0/6/0/0.73289.25      0/4/0/0.70954      Ready            Validated
   353 0/6/0/0.73289.26      0/4/0/0.70954      Ready            Validated
   450 0/6/2/1.3.3           0/6/2/0            Ready            Validated
   451 0/6/2/1.3.4           0/6/2/0            Timeout/No Reply Ready
   452 0/6/2/0.3.5           0/6/2/1            Ready            Validated
   453 0/6/2/0.3.6           0/6/2/1            Ready            Validated
```

All primary path statuses are explained in the following section. Appendix A, "Sample Failover and Recovery," provides a sample failover scenario and documents how to recover.

Failover Status Descriptions

The following is a complete list of the failover statuses that may appear in the HASTAT HAFO Status Report:

Status shown during normal operation:

- Ready

- Validated

Status associated with a failover event:

- Array Failure

- Timeout/No Reply

- Failover Failed

Other miscellaneous status values:

- **GONEXT** started

- Not HAFO dev

- Not Validated

- Unknown status

Each status is described in the sections below.

Status shown during normal operation

Ready

The Ready status indicates that this is the path that will be used for the next I/O for this Ldev and that the last I/O to this Ldev successfully completed on this path. After a system boot or successful **DOHA** command, your primary path should show Ready status. (shown for Ldev 350 primary path in the sample report (on page 33))

Validated

The Validated status indicates that this path was verified to be operational AND that both paths, primary and alternate, are able to access the MPE/iX Ldev. Validated status is set at the following times:

1. During System Boot the alternate path should be set to Validated status if the HAFOCONF file is read and validation is successful.

2. A **DOHA** command will perform the same checks as done during system boot. The alternate path should show Validated status as a result.

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3. A **GONEXT** command that is successful should leave the original path in Validated status and the new path in Ready status.

Since the Validated status is set ONLY at the above times, it is critical to understand that "Validated" status may be very out of date. The non-active path is NOT monitored by HAFO and may fail silently in some HAFO configurations.

Status Associated with a Failover Event

Array Failure

This status indicates an error was returned from the hardware (HBA or Disk Controller) indicating an inability to communicate with the Ldev via this path. When this status is generated, the device adapter reported its failure via a SCSI message that was monitored and acted upon by HAFO. Failover occurred and data requests to the high availability array have been rerouted to the alternate data path. Normal system I/O activity continues on the alternate path.

Timeout/No Reply

This state reflects the fact that I/O to the Ldev is not making progress due to a condition that could not be determined. Possible causes for this are:

• The host adapter is not responding

• Cabling is broken or not carrying data

• Array controller not responding

• Heavy I/O load on the device/channel/HBA (usually the device)

Failover Failed

This status means a failure has occurred on the primary path. When failover was attempted, the alternate path was unavailable.

The alternate path has failed due to a data path fault (either an actual failure or I/O timeout) or possibly an invalid configuration. Troubleshoot this instance by repairing the failure on the primary and alternate paths.

Other Miscellaneous Status Values

GONEXT Started

This message appears only after the **GONEXT** command has been executed. If **GONEXT** is still running when a HAFO device status report is run (highly unlikely), this message will appear.

Run the HAFO device status report again. The "**GONEXT** started" message should be replaced by the actual status.

Not HAFO dev

This status message indicates that the Ldev on the path is not a high availability array. The list of supported arrays is documented in the "System Requirements" section of this document.

Ldev Not Validated

The Not Validated status is shown when HAFO is unable to validate both hardware paths (at boot time or during `DOHA` command).

Unknown Status

HAFO/iX has been written to account for a large number of known errors. It is possible that new error conditions may arise that are, by definition, unknown. This should be a very rare condition. If this condition occurs, be sure to save your system log files from the time of this error and then contact your HP Support representative to report the problem.

6   Recovering From a Failover

Once high availability failover to the alternate data path has engaged, users continue to access data on that high availability array Ldev with no restrictions. I/Os outstanding during the failure and those after the failover will be processed on the alternate data path without interruption.

NOTE

HAFO does not protect against multiple failures or cascading failure types. It is imperative that the broken path be repaired as soon as possible.

Repairs

The repair of Hardware failures on disk array products, especially those connected to a Fibre Channel network, can be a complex activity. Normal Hardware troubleshooting techniques must be followed to determine the source of the failover event. This may include examination of system or device error logs. The methods and procedures for these troubleshooting activities are outside the scope of the HAFO product and this manual. If a failover event occurs for which you cannot determine the cause, you should place a call with your Support provider as if the I/O path failed.

Repairs to the failed component in the data path should be performed as soon as possible to avoid a double failure on the HA array. Remember that while you are running on the alternate path, you are NOT protected from further path failures.

It should also be noted that the greater the number of Ldevs routed through a single device adapter card, the greater the I/O workload and possible I/O performance degradation. In some cases degradation may be severe enough to trigger "timeout" failover events on paths that don't otherwise have a problem. HAFO does not in anyway change the replacement procedures for hardware components. That is, some devices, such as system Host Bus Adaptors, will still require a system shutdown and power cycle to replace. However, HAFO does have the effect of turning an unplanned failure of a component into a future system maintenance activity.

High availability arrays like the HP SureStore XP1024 have many redundant subsystems including dual controllers. If an array controller is the source problem for data path failure, the controller may be replaced "hot swapped" while the system and array are online. It is up to your System Support provider to determine which activities can be performed without a System Reboot.

Rerouting to the Primary Path After Failover

If a repair does not require re-booting, such as after a "hot swap" replacement of the array controller, the GONEXT command should be invoked. GONEXT reroutes I/O to the other path. GONEXT should only be performed if the other path shows "Validated" status.

If a repair requires the system be shut down and re-booted, I/O will default to all available configured primary paths. GONEXT does not need to be invoked in this scenario.

The six-step validation process documented in the DOHA section of Chapter 4, "Configuration," occurs when GONEXT is invoked or when the system is re-booted.

GONEXT (go)

To execute **GONEXT**:

1. Start SYSGEN.

2. At the `sysgen>` prompt, enter `io`.

3. At the `io>` prompt, enter `ha`.

4. Execute the **GONEXT** (go) command using the syntax.

```
go <Ldev>
```

For example,

```
ha> go 8
```

5. Then execute the **DOHA** command

In this example, all I/Os for Ldev 8 will be rerouted to the primary path configured. Should this attempt fail, you will be notified and the I/Os will continue on the alternate data path.

Appendix A, "Sample Failover and Recovery." provides a sample failover scenario and documents how to recover.

Special Considerations for Failed Paths

HAFO is not active until the late in the MPE/iX system boot sequence (`ISL> START`). When the system boots, it first configures devices on the Primary path (according to SYSGEN `io>`), Then it mounts all disk volumes using ONLY the primary path. After volumes are mounted MPE attempts to validate the HAFO configuration.

This means that if a primary path is broken, the Ldevs on that path WILL NOT MOUNT, and will not be available for access after the system is up. HAFO Validation errors will be printed on your system console in this case.

Rebooting With a Failed Primary Path

In order to mount these Ldevs when their primary path is broken, the user must use the `io>` section of SYSGEN (NOT the `ha>` section) to specify the alternate path as the actual path for these Ldevs. The system must then be rebooted.

Consider the following sample output from the `HASTAT` command:

```
:HASTAT


 High Availability Failover Device Status

 Ldev    Primary Path          Alternate Path      Pri. Status        Alt. Status
 =====  ==================    ==================    ===============    ===============

  350 0/4/0/0.70954.23       0/6/0/0.73289         Ready              Validated
  351 0/4/0/0.70954.24       0/6/0/0.73289         Ready              Validated
  352 0/6/0/0.73289.25       0/4/0/0.70954         Ready              Validated
  353 0/6/0/0.73289.26       0/4/0/0.70954         Ready              Validated
  450 0/6/2/1.3.3            0/6/2/0               Ready              Validated
  451 0/6/2/1.3.4            0/6/2/0               Timeout/No Reply Ready
  452 0/6/2/0.3.5            0/6/2/1               Ready              Validated
  453 0/6/2/0.3.6            0/6/2/1               Ready              Validated
```

If there were an array failure on the path for Ldev 351, the output of the `HASTAT` command would be as follows:

```
 High Availability Failover Device Status

 Ldev    Primary Path          Alternate Path      Pri. Status        Alt. Status
 =====  ==================    ==================    ===============    ===============

  350 0/4/0/0.70954.23       0/6/0/0.73289         Ready              Validated
  351 0/4/0/0.70954.24       0/6/0/0.73289         Array Failure      Ready
  352 0/6/0/0.73289.25       0/4/0/0.70954         Ready              Validated
  353 0/6/0/0.73289.26       0/4/0/0.70954         Ready              Validated
```

```
  450 0/6/2/1.3.3          0/6/2/0              Ready            Validated

  451 0/6/2/1.3.4          0/6/2/0              Timeout/No Reply Ready
  452 0/6/2/0.3.5          0/6/2/1              Ready            Validated
  453 0/6/2/0.3.6          0/6/2/1              Ready            Validated



  High Availability Failover Device Status

  Ldev   Primary Path          Alternate Path     Pri. Status      Alt. Status
  =====  ====================  ==================  ===============  ===============

  350 0/4/0/0.70954.24       0/6/0/0.73289        Ready            Validated
  351 0/4/0/0.70954.24       0/6/0/0.73289        Array Failure    Ready
  352 0/6/0/0.73289.25       0/4/0/0.70954        Ready            Validated
  353 0/6/0/0.73289.26       0/4/0/0.70954        Ready            Validated
```

This indicates that Ldev 351 has failed over from path 0/**4**/0/0.70954 to path 0/**6**/0/0.73289. Because path 0/**4**/0/0 has suffered a hardware failure, Ldev 351 may NOT mount if the system is rebooted before the hardware is repaired. If the system must be rebooted before the hardware is repaired, then there must be some changes made in the "io" section of SYSGEN. Ldev 351 must be configured onto path 0/**6**/0/0. For example:

```
    io> mdev 361 path=0/6/0/0.73289.24
    io> hold
    io> e
sysgen> keep
```

Now when the system is rebooted, Ldev 351 will mount on path 0/**6**/0/0 and will be available for access.

NOTE   Near the end of the boot process, there will be an error message stating:

```
Invalid Primary Path for this Ldev. - (HAFOERR 500)
```

This is because Ldev 351 is still configured in the HAFOCONF file as having 0/**4**/0/0 as it's primary path. In this special case this error can be ignored. However, Ldev 351 is not covered by HAFO and path 0/**4**/0/0 should be repaired as soon as possible. (Note also that Ldev 350 is also not covered by HAFO since path 0/4/0/0 is physically broken.)

Rebooting With a Failed Primary Path for Ldev 1

Ldev 1 can be configured for HAFO just as any other Ldev. It is, however, a very special situation when the system needs to be rebooted while the primary path for Ldev 1 is broken.

The user will need to make adjustments at the system primary boot interface. before booting the system. If the primary path for Ldev 1 is broken, the system primary path needs to be adjusted to be alternate path for Ldev 1. The "System Startup, Configuration, and Shutdown Reference Manual" has procedures for most MPE/iX systems..

The following example illustrates how to handle Ldev 1.

Suppose that HASTAT shows the following on your system:

```
:HASTAT


  High Availability Failover Device Status


 Ldev   Primary Path        Alternate Path   Pri. Status     Alt. Status
 ===== =================== ================== =============== ===============

     1 8.0.0               15                 Ready           Validated
    90 15.0.1              8                  Ready           Validated
   100 15.0.2              8                  Ready           Validated
   110 15.0.3              8                  Ready           Validated
   120 15.0.4              8                  Ready           Validated
```

Now suppose that there is a hardware failure on path 8. The system would continue to function, and HASTAT would show something like:

```
:HASTAT


  High Availability Failover Device Status


Ldev   Primary Path        Alternate Path   Pri. Status     Alt. Status
===== =================== ================== =============== ===============

    1 8.0.0               15                 Array Failure   Ready
   90 15.0.1              8                  Ready           Validated
  100 15.0.2              8                  Ready           Validated
  110 15.0.3              8                  Ready           Validated
  120 15.0.4              8                  Ready           Validated
```

If for some reason the system must be rebooted before path 8 can be repaired, special action must be taken before entering the start command.

Each MPE system has what is known as the system primary path, which has nothing to do with the primary path concept in HAFO. Ldev 1 is always on the system primary path. Since, in this example, the system primary path is broken, Ldev1 will not be found and the system will not boot.

In order to remedy this, you must change the system primary path from 8 to 15. Please refer to the "System Startup, Configuration, and Shutdown Reference Manual" for information on changing the system primary path. After the system primary path is changed to 15.0.0, the system can find Ldev 1 and boot.

In the previous example, there was only one Ldev on the broken system *primary path*. If there had been other Ldevs on path 8, then in order to ensure that all the volumes mounted, the actions described in "Rebooting With a Failed Primary Path" would also have to be taken.

It is recommended that the user creates and maintains an alternate configuration group that has the alternate paths for the system volume Ldevs configured to be their primary path. That is in the io> section of SYSGEN and NOT in the ha> section. In the case where the system volume set's path goes bad and you need to reboot, you can use this alternate configuration group to ensure that the system volume set mounts properly. (This assumes that all the system volumes are on the same path. If they are not, then you may want to create multiple alternate configuration groups, one for each path that contains system volumes.)

Performance Considerations

It is recommended that the user understand the performance characteristics of the current system before making any non-HAFO configuration changes (i.e., changes in the io> section of SYSGEN) to accommodate HAFO. These changes may need to be carefully planned in order to maintain system performance.

Also be aware that a HAFO event can greatly increase the I/O load on a given path and can cause significant performance degradation. Actual performance is dependent on the capabilities of a host device adapter card and the load. We normally recommend no more then eight Ldevs on a host device adapter card for "best" performance. If the load on the host device adapter card is relatively low then the difference between eight Ldevs and fourteen Ldevs will not affect performance. If the load on a host device adapter is "high" then when other Ldevs have failed over to this host device adapter, performance degradation will most likely occur.

7   Quick Start List

The following are directions for creating a simple HAFO environment using an XP512.

1. Create a LUN in the storage array that is accessible from 2 different array ports. In this example we will configure this LUN as MPE/iX Ldev 90.

2. Connect the appropriate fiber cables between the storage array and server's HBAs.

    a. If the SCSI-FC Fabric Router is part of the connection solution, follow the connection procedures described in the SCSI-FC Router's User and Configuration Guide.

3. If an FC Switch is part of the connection solution, insert it between the storage array's FC port and the server's FC HBA (or to the router if it is in use).

    a. If you are using a Fabric Router configure a "Single Initiator Zone" for the port that the router is attached to. The "Single Initiator Zone" will eliminate "cross talk" between the routers in the event that Lun Security is active.

        (Cross talk between routers with Lun Security active will cause the routers to hang)

    b. If routers are used, clear the router maps and power up the routers and verify that they "see" the LUNs from the XP512 (See Router documentation). All the LUNs in the router should show ACTIVE. If INACTIVE, then investigate why.

4. Boot the HP e3000 to ISL> and verify with ODE that the LUNs are visible to the HP e3000 "Native FC" devices require use of the MPE/iX "FCSCAN" utility (see 6).

5. ISL>Start norecovery and logon to the system.

6. Run SYSGEN and, using the paths from MAPPER or FCSCAN –h, add Ldevs for the new LUNs. In this example, add the example device: io; ad 90 path=0/36.0.0 id=HPDARRAY. Hold; exit; Keep; exit. Then reboot the system. Alternately, you may use IOCONFIG to avoid the reboot.

7. Skip this step if the volume set is already created.
    Run Volutil and set up the volume set with NEWSET and volumes with NEWVOL. then VSCLOSE the volume set and then VSOPEN it. If you are adding to the system volume set, you must issue the NEWVOL command and then do a Shut Down and reboot of the system.

8. Run SYSGEN, type io then HAutil in SYSGEN and add the Ldev that will be protected by HAFO. We will again use Ldev 90 as the example. Add the device with AD command; HA> AD 90   0/36.0.0   0/28. The primary path is 0/36 and its alternate path is 0/28. Then Hold it; and then Keep it.

9. Return to the HAutil menu within SYSGEN and issue the `DOHA` command. This command will verify and validate the configuration. Then keep your work with the Hold command, `EXIT` command, Keep and `EXIT` commands.

10. Shutdown and reboot the HP e3000 so that HAFO can validate the newly created volume sets. *If volume sets ever need to be scratched and a new set created, then a reboot will be required to refresh HAFO's information that is used to validate that different paths point to a single unique volume set*.

11. Verify HAFO validation as system comes back up *(`DOHA` prints out to the system console during boot)* and validate that the HASTAT output agrees with the validation done at the reboot.

A Sample Failover and Recovery

The following scenario illustrates a possible HAFO situation.

Sample Scenario

The following is a sample HAFO status report extracted from a HASTAT display. The report shows several failover statuses which are explained in succeeding sections of this appendix. Troubleshooting advice for this sample scenario is also provided.

```
High Availability Failover Device Status


Ldev    Primary Path           Alternate Path     Pri. Status       Alt. Status
=====  ===================  ==================  ===============  ===============

  350  0/4/0/0.70954.23     0/6/0/0.73289       Array Failure    Ready
  351  0/4/0/0.70954.24     0/6/0/0.73289       Array Failure    Ready
  352  0/6/0/0.73289.25     0/4/0/0.70954       Ready            Validated
  353  0/6/0/0.73289.26     0/4/0/0.70954       Ready            Validated
  450  0/6/2/1.3.3          0/6/2/0             Ready            Validated
  451  0/6/2/1.3.4          0/6/2/0             Timeout/No Reply Ready
  452  0/6/2/0.3.5          0/6/2/1             Ready            Validated
  453  0/6/2/0.3.6          0/6/2/1             Ready            Validated
```

Incidents Summary

Bus path "0/4/0/0" has failed and all configured HAFO Ldevs (Ldev 350 and 351) have detected the path failure and have successfully failed over to their alternate path "0/6/0/0".

Ldev 352 and 353 are still operating using their primary paths and require no action.

Ldev 451 has detected a timeout due to very slow array response time probably caused by too many I/Os generated by the application for the array to handle.

Corrective Action: Failure on System Path "0/4/0/0..."

The system needs to be shutdown;use the diagnostics to isolate the failing component in bus path "0/4/0/0.70954". Failing candidates are: host device adapter card, cable, array controller or router. Each component needs to be verified. (As per 7.5 Communicator, "FSCAN –h" and "TDUTIL" may be helpful for FC devices.)

Corrective Action: Failure on Ldev 350 and 351

As indicated by the primary path status for Ldev 350, it is possible that the array controller has failed. This should be verified by your official support representative and the system diagnosed to verify the actual broken component. If it is the array controller, then in many cases, array controllers can be replaced on-line with the host powered-up and array powered-up. (Note also that IF the controller for path 0/4/0/0 is broken, then the Ldevs352 and 353 have no "fail over" path.)

After the array controller has been replaced, the primary path should be re-enabled for optimal system I/O performance and protection. Use `SYSGEN > IO > HA > GO 350` and `GO 351` command to force Ldev 350 and 351's device manager to try the primary path after online repairs.

Corrective Action: Timeout/No Reply for Ldev 451

As indicated by the primary path status for Ldev 451, a timeout value has been exceeded for an I/O to this Ldev. It possible that a hardware error occurred OR that too many I/Os are being generated for the array to handle within the time frame that HAFO expects.

In the example, you can see that Ldev 450 and Ldev 451 share the same primary I/O path. If there are I/Os being done to both devices and only one shows an error, it is unlikely that there is a "hard" failure in any component of the primary path.

This situation requires further troubleshooting. If it has been determined that I/Os are timing out and the status is not generated because of some other hardware problem, then one corrective action may be to disable the HAFO timeout detection feature. You may disable timeouts by deleting the device from the `HAFOCONF` file, then re-adding the device with the timeout flag set to "false".

As documented in the "**ADDCONF**" command a system administrator should be cautious when disabling HAFO timeout checks. In this example, IF the disk array is "slow" for Ldev 451, then likely it will cause HAFO timeouts for other Ldevs (450, 452, 453) on this array in the future. As disk arrays may be shared by several systems, it may be a complex issue to determine why the array is "slow".

B Error Messages

Command Input Errors (HAFOERR — 1…27)

1 **MESSAGE: Invalid Hautil Command — (HAFOERR 1)**

CAUSE: Command entered is not a valid command.

ACTION: See Help. Enter valid command.

3 **MESSAGE: Missing Ldev parameter — (HAFOERR 3)**

CAUSE: Parameter 1 for command is missing.

ACTION: Input Parameter 1 value with command.

4 **MESSAGE: Missing Primary Path parameter — (HAFOERR 4)**

CAUSE: Parameter 2 for command is missing.

ACTION: Input Parameter 2 value with command.

5 **MESSAGE: Missing Alternate Path parameter — (HAFOERR 5)**

CAUSE: Parameter 3 for command is missing.

ACTION: Input Parameter 3 value with command.

6 **MESSAGE: Not a valid Primary path format — (HAFOERR 6)**

CAUSE: Parameter 2 has an invalid value.

ACTION: Input correct Parameter 2 value with command.

7 **MESSAGE: Not a validate Alternate path format — (HAFOERR 7)**

CAUSE: Parameter 3 has an invalid value.

ACTION: Input correct Parameter 3 value with command.

8 **MESSAGE: Invalid character in Ldev parameter — (HAFOERR 8)**

CAUSE: Parameter 1 has an invalid value.

ACTION: Input correct Parameter 1 value with command.

9 **MESSAGE: Invalid character in Primary path parameter — (HAFOERR 9)**

CAUSE: Parameter 2 has an invalid value.

ACTION: Input correct Parameter 2 value with command.

10   **MESSAGE: Invalid character in Alternate path parameter — (HAFOERR 10)**

CAUSE: Parameter 3 has an invalid value.

ACTION: Input correct Parameter 3 value with command.

11   **MESSAGE: Ldev parameter too long — (HAFOERR 11)**

CAUSE: Parameter 1 has an invalid value.

ACTION: Input correct Parameter 1 value with command.

12   **MESSAGE: Primary Path parameter too long — (HAFOERR 12)**

CAUSE: Parameter 2 has an invalid value.

ACTION: Input correct Parameter 2 value with command.

13   **MESSAGE: Alternate Path parameter too long — (HAFOERR 13)**

CAUSE: Parameter 3 has an invalid value.

ACTION: Input correct Parameter 3 value with command.

14   **MESSAGE: Invalid Primary path for this Ldev — (HAFOERR 14)**

CAUSE: Parameter 2 has an invalid value.

ACTION: Input correct Parameter 2 value with command.

15   **MESSAGE: Primary DAM and Alternate DAM paths are same — (HAFOERR 15)**

CAUSE: Parameters 2 and 3 have the same value.

ACTION: Input correct Parameters 2 and 3 values with command.

16   **MESSAGE: Invalid Alternate path for this Ldev — (HAFOERR 16)**

CAUSE: Parameter 3 has an invalid value.

ACTION: Input correct Parameter 3 value with command.

17   **MESSAGE: Not a valid Ldev — (HAFOERR 17)**

CAUSE: Ldev input was not valid.

ACTION: Input correct Ldev with command.

18   **MESSAGE: Ldev not mounted as MASTER or MEMBER — (HAFOERR 18)**

CAUSE: The volume associated with specified Ldev has not mounted as a master or member.

ACTION: Check the state of the volume set using "DSTAT". The volume must be mounted as a master or member. If not, use the "VOLUTIL" utility to change to the appropriate state or remove Ldev from HAFO configuration.

19   **MESSAGE: Ldev does not exist — (HAFOERR 19)**

CAUSE: Ldev input was not valid.

ACTION: Input correct Ldev with command.

20   **MESSAGE: Gonext failed — Ldev <Ldev #> has not Failed over — (HAFOERR 20)**

CAUSE: GONEXT was attempted on an Ldev that has not failed over or GONEXT was attempted on a primary path that is broken.

ACTION: Run HASTAT utility and check status of Ldev's paths.

21   **MESSAGE: No devices to list — (HAFOERR 21)**

CAUSE: No devices have been configured for HAFO.

ACTION: None.

22   **MESSAGE: Device not configured — (HAFOERR 22)**

CAUSE: The device specified to be displayed has not been configured for HAFO.

ACTION: None.

23   **MESSAGE: Ldev does not exist in HAFO configuration file — (HAFOERR 23)**

CAUSE: HAFOCONF file record associated with specified Ldev was not found.

ACTION: None.

24   **MESSAGE: Ldev already configured for HAFO — (HAFOERR 24)**

CAUSE: Ldev specified has previously been configured for HAFO.

ACTION: None.

25	**MESSAGE: The path format for this Ldev is not correct — (HAFOERR 25)**
	CAUSE: The path format for this Ldev is not correct.
	ACTION: Check for too many periods or missing periods in path specification.
26	**MESSAGE: No devices are configured for HAFO — (HAFOERR 26)**
	CAUSE: No devices have been configured for HAFO.
	ACTION: Verify changes made to HAFO configuration have been made permanent then try again.
27	**MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 27)**
	CAUSE: Primary path is already configured.
	ACTION: None.

Configuration File Access Errors (HAFOERR — 200…207)

200	**MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 200)**
	CAUSE: The HAFOCONF file in the specified configuration group exists but cannot be opened because of insufficient capabilities or improper access privileges.
	ACTION: Make sure the group you're executing from has PM capability and the user has SM capability.
201	**MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 201)**
	CAUSE: Either the user is not logged on to the SYS account, or the HAFOCONF file does not exist.
	ACTION: Make sure you are logged onto the SYS account, or restore the HAFOCONF file from a backup. (A new (empty) HAFOCONF file can be generated by exiting SYSGEN and then running SYSGEN again.))
202	**MESSAGE: File close error on < file name > — (HAFOERR 202)**
	CAUSE: The file system was unable to close the specified file.
	ACTION: Call your HP Support Representative for assistance.

203	**MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 203)**
	CAUSE: An End Of File condition was encountered while reading the HAFOCONF file. The HAFOCONF file is a pre-formatted file and an End Of File in this context is not a normal Condition and may indicate corruption.
	ACTION: Call your HP Support Representative for assistance.
204	**MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 204)**
	CAUSE: An error occurred while executing an FREAD intrinsic call.
	ACTION: Call your HP Support Representative for assistance.
205	**MESSAGE: Maximum number of HAFO devices configured. Cannot add to HAFO configuration — (HAFOERR 205)**
	CAUSE: All entries in the HAFOCONF configuration file have been allocated.
	ACTION: List the entries in the HAFOCONF file and delete any entries not needed.
206	**MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 206)**
	CAUSE: An End Of File condition was encountered during the execution of an FUPDATE intrinsic call.
	ACTION: Call our HP support representative for assistance.
207	**MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 207)**
	CAUSE: An error occurred during the execution of an FUPDATE intrinsic call.
	ACTION: Call your HP support representative for assistance.

PPT ACCESS ERRORS (HAFOERR — 500…503)

500	**MESSAGE: Invalid Primary Path for this Ldev. — (HAFOERR 500)**
	CAUSE: The primary path specified for this Ldev is not correct.
	ACTION: Check the path specified for validity and try again.
501	**MESSAGE: Invalid Alternate Path for this Ldev. — (HAFOERR 501)**
	CAUSE: The alternate path specified for this Ldev is not correct.
	ACTION: Check the path specified for validity and try again.
502	**MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 502)**
	CAUSE: The Physical Path Table entry for this device was not found.
	ACTION: Call your HP Support Representative for assistance.

503 **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 503)**

CAUSE: The Physical Path Table entries are not linked.

ACTION: Call your HP Support Representative for assistance.

PORT ACCESS ERRORS (HAFOERR — 1000…1017)

1000 **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1000)**

CAUSE: An error occurred while attempting to create HAFO Utilities/Device Manager communications Port.

ACTION: Call your HP Support Representative for assistance.

1001 **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1001)**

CAUSE: An error occurred while attempting to create internal HAFO Utilities buffer object.

ACTION: Call your HP Support Representative for assistance.

1002 **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1002)**

CAUSE: An error occurred while attempting to return HAFO Utilities buffer to the operating system.

ACTION: Call your HP Support Representative for assistance.

1003 **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1003)**

CAUSE: An error occurred while attempting to freeze HAFO Utilities buffer in memory.

ACTION: Call your HP Support Representative for assistance.

1004 **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1004)**

CAUSE: An error occurred while attempting to unfreeze HAFO Utilities buffer.

ACTION: Call your HP Support Representative for assistance.

1005 **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1005)**

CAUSE: An error occurred while attempting to allocate a message frame for HAFO Utilities.

ACTION: Call your HP Support Representative for assistance.

1006   **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1006)**

CAUSE: An error occurred while attempting to release a message frame allocated for HAFO Utilities.

ACTION: Call your HP Support Representative for assistance.

1007   **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1007)**

CAUSE: An error occurred while attempting to send an I/O Request to the Device Manager.

ACTION: Check to make sure that there are no mismatches between the SYSGEN (io) section) configuration and the HAFO (ha) section configuration.

All HAFO (ha) configured primary paths must match the SYSGEN (io) path configuration for all HAFO Ldevs.

Check that there are no hardware problems and make sure no failover events have occurred. If a failover event has occurred, fix the primary path and make sure all HAFO Ldevs are operating on their primary path.

If the HAFO primary and SYSGEN (io) paths are in sync and all HAFO Ldevs are operating on their primary paths, then call your HP Support Representative for assistance.

1008   **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1008)**

CAUSE: An error occurred while waiting for an I/O request to the Device Manager to complete.

ACTION: Check to make sure that there are no mismatches between the SYSGEN (io) section configuration and the HAFO (ha) section configuration.

All HAFO (ha) configured primary paths must match the SYSGEN (io) path configuration for all HAFO Ldevs.

Check that there are no hardware problems and make sure no failover events have occurred. If a failover event has occurred, fix the primary path and make sure all HAFO Ldevs are operating on their primary path.

If the HAFO primary and SYSGEN (io) paths are in sync and all HAFO Ldevs are operating on their primary paths, then call your HP Support Representative for assistance.

1009   **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1009)**

CAUSE: An error occurred while attempting to send a message to Device Manager.

ACTION: Check to make sure that there are no mismatches between the SYSGEN (io) section configuration and the HAFO (ha) section configuration.

All HAFO (ha) configured primary paths must match the SYSGEN (io) path configuration for all HAFO Ldevs.

Check that there are no hardware problems and make sure no failover events have occurred. If a failover event has occurred, fix the primary path and make sure all HAFO Ldevs are operating on their primary path.

If the HAFO primary and SYSGEN (io) paths are in sync and all HAFO Ldevs are operating on their primary paths, then call your HP Support Representative for assistance.

1010   **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1010)**

CAUSE: An I/O request sent to the Device Manager caused a message to be sent to the wrong port.

ACTION: Check to make sure that there are no mismatches between the SYSGEN (io section) configuration and the HAFO (ha section) configuration.

All HAFO (ha) configured primary paths must match the SYSGEN (io) path configuration for all HAFO Ldevs.

Check that there are no hardware problems and make sure no failover events have occurred. If a failover event has occurred, fix the primary path and make sure all HAFO Ldevs are operating on their primary path.

If the HAFO primary and SYSGEN (io) paths are in sync and all HAFO Ldevs are operating on their primary paths, then call your HP Support Representative for assistance.

1011   **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1011)**

CAUSE: Failover to Alternate path during Volume Label Verification failed.

ACTION: Check to make sure that there are no mismatches between the SYSGEN (io section) configuration and the HAFO (ha section) configuration.

All HAFO (ha) configured primary paths must match the SYSGEN (io) path configuration for all HAFO Ldevs.

Check that there are no hardware problems and make sure no failover events have occurred. If a failover event has occurred, fix the primary path and make sure all HAFO Ldevs are operating on their primary path.

If the HAFO primary and SYSGEN (io) paths are in sync and all HAFO Ldevs are operating on their primary paths, then call your HP Support Representative for assistance.

1012   **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1012)**

CAUSE: Failover failed — Volume label verification failed.

ACTION: Check to make sure that there are no mismatches between the SYSGEN (io) section configuration and the HAFO (ha) section configuration

All HAFO (ha) configured primary paths must match the SYSGEN (io) path configuration for all HAFO Ldevs.

Check that there are no hardware problems and make sure no failover events have occurred. If a failover event has occurred, fix the primary path and make sure all HAFO Ldevs are operating on their primary path.

If the HAFO primary and SYSGEN (io) paths are in sync and all HAFO Ldevs are operating on their primary paths, then call your HP Support Representative for assistance.

1013   **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1013)**

CAUSE: Failover failed — Mounted Volume Table inconsistent.

ACTION: Check to make sure that there are no mismatches between the SYSGEN (io) section configuration and the HAFO (ha) section configuration.

All HAFO (ha) configured primary paths must match the SYSGEN (io) path configuration for all HAFO Ldevs.

Check that there are no hardware problems and make sure no failover events have occurred. If a failover event has occurred, fix the primary path and make sure all HAFO Ldevs are operating on their primary path.

If the HAFO primary and SYSGEN (io) paths are in sync and all HAFO Ldevs are operating on their primary paths, then call your HP Support Representative for assistance.

1014   **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1014)**

CAUSE: The Device Manager is in the wrong state for the command being executed.

ACTION: Check to make sure that there are no mismatches between the SYSGEN (io) section configuration and the HAFO (ha) section configuration.

All HAFO (ha) configured primary paths must match the SYSGEN (io) path configuration for all HAFO Ldevs.

Check that there are no hardware problems and make sure no failover events have occurred. If a failover event has occurred, fix the primary path and make sure all HAFO Ldevs are operating on their primary path.

If the HAFO primary and SYSGEN (io) paths are in sync and all HAFO Ldevs are operating on their primary paths, then call your HP Support Representative for assistance.

1015   **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1015)**

CAUSE: A message was sent to the Device Manager with an invalid function.

ACTION: Check to make sure that there are no mismatches between the SYSGEN (io) section configuration and the HAFO (ha) section configuration.

All HAFO (ha) configured primary paths must match the SYSGEN (io) path configuration for all HAFO Ldevs.

Check that there are no hardware problems and make sure no failover events have occurred. If a failover event has occurred, fix the primary path and make sure all HAFO Ldevs are operating on their primary path.

If the HAFO primary and SYSGEN (io) paths are in sync and all HAFO Ldevs are operating on their primary paths, then call your HP Support Representative for assistance.

1016   **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1016)**

CAUSE: A message was received from the Device Manager with an invalid function.

ACTION: Check to make sure that there are no mismatches between the SYSGEN (io) section configuration and the HAFO (ha) section configuration.

All HAFO (ha) configured primary paths must match the SYSGEN (io) path configuration for all HAFO Ldevs.

Check that there are no hardware problems and make sure no failover events have occurred. If a failover event has occurred, fix the primary path and make sure all HAFO Ldevs are operating on their primary path.

If the HAFO primary and SYSGEN (io) paths are in sync and all HAFO Ldevs are operating on their primary paths, then call your HP Support Representative for assistance.

1017   **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1017)**

CAUSE: A message was received from the Device Manager with an invalid class.

ACTION: Check to make sure that there are no mismatches between the SYSGEN (io) section configuration and the HAFO (ha) section configuration.

All HAFO (ha) configured primary paths must match the SYSGEN (io) path configuration for all HAFO Ldevs.

Check that there are no hardware problems and make sure no failover events have occurred. If a failover event has occurred, fix the primary path and make sure all HAFO Ldevs are operating on their primary path.

If the HAFO primary and SYSGEN (io) paths are in sync and all HAFO Ldevs are operating on their primary paths, then call your HP Support Representative for assistance.

GENERAL USER STATUS MESSAGES (HAFOERR — 1500...1505)

1500   **MESSAGE: HAFO configuration file does not exist — (HAFOERR 1500)**

CAUSE: The HAFO configuration file `HAFOCONF` cannot be opened.

ACTION: Run SYSGEN and the `HAFOCONF` should be built.

1501   **MESSAGE: HAFO configuration file is corrupt — (HAFOERR 1501)**

CAUSE: The HAFO configuration has an incorrect record size or has been incorrectly formatted or does not have a correct checksum.

ACTION: Purge the file and run SYSGEN again.

1502   **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1502)**

CAUSE: An unknown error has occurred in the HAFO utility.

ACTION: Call your HP support representative for assistance.

1503   **MESSAGE: HAFO INTERNAL ERROR — (HAFOERR 1503)**

CAUSE: An unknown error has occurred in the `HASTAT` Utility.

ACTION: Call your HP support representative for assistance.

1504   **MESSAGE: **warning** Information display mode only — (HAFOERR 1504);**

CAUSE: User does not have "save" capability. You may continue but only with display capability.

ACTION: User must have System Manager capability to make any configuration changes.

1505   **MESSAGE: Need System Manager capability to make configuration changes — (HAFOERR 1505)**

CAUSE: The user attempted to make changes to the HAFOCONF configuration file without having the proper capabilities.

ACTION: The user must System Manager capabilities to be able make changes to the HAFOCONF configuration file.