HP LTO Ultrium tape drives technical reference manual

Volume 5: UNIX, Linux and OpenVMS configuration guide

LTO 5 drives

Abstract

This is one of five volumes that document HP LTO Ultrium 5 tape drives (Fibre Channel and SAS). This volume provides basic information on configuring the drives with various operating systems. See Chapter 8 on page 35 for details of the other guides.

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Legal and notice information

Acknowledgements

Warranty

WARRANTY STATEMENT: To obtain a copy of the warranty for this product, see the warranty information website:

http://www.hp.com/go/storagewarranty

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1 Introduction

Purpose of this manual

This manual provides basic information on configuring the drives with various operating systems. See the top-level release notes that accompany the drive for expected functionality and features.

LTO Ultrium drives are supported on the following platforms:

- HP (HP-UX) servers and workstations, page 7
- HP (OpenVMS) servers and workstations, page 15
- IBM (AIX) servers and workstations, page 21
- Linux servers and workstations, page 17
- Sun servers and workstations, page 25

For versions of the operating systems supported, see http://www.hp.com/go/connect.

For platforms not mentioned here, contact HP because there may be new connectivity details available that arrived after the release notes were published.

See "Verifying the installation" on page 31 for details of how to verify the installation.

LTO Ultrium drives in a library

Although LTO Ultrium drives may also be used in a library, instructions about installing device drivers for automatic robotics are not included in this manual.

SAS drives

For supported UNIX, Linux and OVMS versions, go to http://www.hp.com/go/connect.

Backup applications

For optimum performance it is important to use a backup application that supports the drive's features within your system's configuration.

For details of which backup applications are supported with your tape drive and system, visit the HP Tape Compatibility website:

http://www.hp.com/products1/storage/compatibility/tapebackup/index.html.

Follow the "Software compatibility" link then click a tick in the appropriate matrix to drill down into detailed application support information.

See the *Getting Started Guide* for more information about usage models.

2 HP (HP-UX) servers and workstations

For supported versions of HP-UX, go to http://www.hp.com/go/connect.

Before you install your tape drive, visit the HP web site, www.hp.com, and search to locate IT Resource Center (you may be required to set up a new login). Download the latest hardware enablement (HWE) patch bundle for your operating system. This ensures that you will have the correct device driver for your tape drive.

System Administration Management (SAM) tools have evolved with ongoing HP-UX version releases. As a result, the procedures for setting up with different HP-UX versions differ. They are described separately in this chapter.

HP-UX11i v3 and agile addressing

HP-UX11i v3 introduces *agile addressing* of devices. Agile addressing uses a different format of the device special file (dsf) to represent the tape drive—known as a *persistent dsf*. However HP-UX11i v3 retains support for the legacy dsf format as used in 11i v2.

For more information about HP-UX releases including HP-UX 11i v3 please refer to www.docs.hp.com.

NOTE:

A block size no larger than 256 KB is strongly recommended when working with HP-UX. See "Using large block sizes" on page 14.

Identifying connected devices

Scan the system to list the existing devices attached. From a shell window (hpterm/xterm), execute `ioscan` as follows:

For HP-UX 11i v2 and 11i v3 (legacy format)

Enter the command:

```
% /sbin/ioscan -f
```

The output should look similar to the following (which shows an LTO 5 drive):

```
Class        I  H/W Path       Driver          S/W State   H/W Type     Description
=============================================================================
root         0                 root            CLAIMED     BUS_NEXUS
ioa          0  0              sba             CLAIMED     BUS_NEXUS    System Bus Adapter (4030)
ba           0  0/0            lba             CLAIMED     BUS_NEXUS    Local PCI-X Bus Adapter (122e)
tty          0  0/0/1/0         rmp3f01         CLAIMED     INTERFACE    PCI class(255,0) (103c1303)
tty          1  0/0/1/1         rmp3f01         CLAIMED     INTERFACE    PCI SimpleComm (103c1302)
tty          2  0/0/1/2         asio0           CLAIMED     INTERFACE    PCI Serial (103c1048)
OO           0  0/0/2/0         UsbOhci         CLAIMED     INTERFACE    USB OHCI Interface
OO           1  0/0/2/0.0       UsbMiniBus      CLAIMED     INTERFACE    USB Composite Device
OO           4  0/0/2/0.0.0     UsbBootKeyboard CLAIMED     DEVICE       Virtual Keyboard
unknown     -1  0/0/2/0.0.1                     UNCLAIMED   UNKNOWN      OO Device Driver
OO          11  0/0/2/1         UsbOhci         CLAIMED     INTERFACE    USB OHCI Interface
OO           5  0/0/2/1.0       UsbMiniBus      CLAIMED     INTERFACE    USB Composite Device
OO           9  0/0/2/1.0.0     UsbBulkOnlyMS   CLAIMED     DEVICE       USB Bulk Only
disk         1  0/0/2/1.0.16    UsbScsiAdaptor  CLAIMED     DEVICE       USB SCSI Stack Adaptor
OO          12  0/0/2/1.1       UsbMiniBus      CLAIMED     INTERFACE    USB Composite Device
OO          18  0/0/2/1.1.0     UsbBootKeyboard CLAIMED     DEVICE       EP1 Interrupt
OO          20  0/0/2/1.1.1     UsbBootMouse    CLAIMED     DEVICE       USB Boot Protocol Mouse
OO          16  0/0/2/2         UsbEhci         CLAIMED     INTERFACE    USB EHCI Interface
graphics     0  0/0/3/0         gvid_core       CLAIMED     INTERFACE    PCI Display (1002515e)
ba           1  0/1             lba             CLAIMED     BUS_NEXUS    LocalPCI-X Bus Adapter (122e)
escsi_ctlr   0  0/1/1/0         sasd            CLAIMED     INTERFACE    HP  PCI/PCI-X SAS MPT Adapter
lan          0  0/1/2/0         igelan          CLAIMED     INTERFACE    HP PCI-X 1000Base-T Dual-port Built-in
lan          1  0/1/2/1         igelan          CLAIMED     INTERFACE    HP PCI-X 1000Base-T Dual-port Built-in
ba           2  0/2             gh2p            CLAIMED     BUS_NEXUS    Local Bus Adapter
ba           3  0/2/0/0         PCItoPCI        CLAIMED     BUS_NEXUS    PCItoPCI Bridge
slot         0  0/2/0/0/0       pci_slot        CLAIMED     SLOT         PCI Slot
escsi_ctlr   1  0/2/0/0/0/0     sasd            CLAIMED     INTERFACE    HP  PCI-E SAS MPT Adapter
ext_bus      4  0/2/0/0/0/0.0.0      sasd_vbus  CLAIMED     INTERFACE    SAS Device Interface
target       3  0/2/0/0/0/0.0.0.9    tgt        CLAIMED     DEVICE
tape        29  0/2/0/0/0/0.0.0.9.0  stape      CLAIMED     DEVICE       HP      Ultrium 5-SCSI
ba           4  0/3             gh2p            CLAIMED     BUS_NEXUS    Local Bus Adapter
ba           5  0/3/0/0         PCItoPCI        CLAIMED     BUS_NEXUS    PCItoPCI Bridge
slot         1  0/3/0/0/0       pci_slot        CLAIMED     SLOT         PCI Slot
ext_bus      0  0/3/0/0/0/0     ciss            CLAIMED     INTERFACE    PCIe SAS SmartArray P400 RAID Controller
target       0  0/3/0/0/0/0.0   tgt             CLAIMED     DEVICE
disk         2  0/3/0/0/0/0.0.0      sdisk      CLAIMED     DEVICE HP    LOGICAL VOLUME
```

Fibre Channel drives have a slightly different format in `ioscan` output, similar to the following segment:

```
Class     I  H/W Path                 Driver   S/W State H/W Type  Description
=============================================================================
ba        4  0/4                      lba      CLAIMED   BUS_NEXUS Local PCI-X Bus Adapter (783)
fc        2  0/4/1/0                  fcd      CLAIMED   INTERFACE HP AB378-60001 4Gb Single Port
    PCI/PCI-X Fibre Channel Adapter (FC Port 1)
fcp       1  0/4/1/0.84               fcd_fcp  CLAIMED   INTERFACE FCP Domain
ext_bus   6  0/4/1/0.84.3.255.0       fcd_vbus CLAIMED   INTERFACE FCP Device Interface
target    3  0/4/1/0.84.3.255.0.0     tgt      CLAIMED   DEVICE
tape      2  0/4/1/0.84.3.255.0.0.0   stape    CLAIMED   DEVICE    HP      Ultrium 5-SCSI
fcp       0  0/4/1/0.180              fcd_fcp  CLAIMED   INTERFACE FCP Domain
ext_bus  10  0/4/1/0.180.2.255.0      fcd_vbus CLAIMED   INTERFACE FCP Device Interface
target    7  0/4/1/0.180.2.255.0.0    tgt      CLAIMED   DEVICE
tape      9  0/4/1/0.180.2.255.0.0.0  stape    CLAIMED   DEVICE    HP      Ultrium 4-SCSI
```

For 11i v3 (Agile I/O tree view)

Enter the command:

```
% ioscan -m lun
```

The output should look similar to the following[1] which includes an LTO 5 SAS drive. Fibre Channel tape drives have a similar format in this type of `ioscan` output:

[1]Note that device files (such as `/dev/rtape/tape9_BEST`) may or may not be in place initially.

```
(blakey) DataProtector11.31.08.03 >ioscan -m lun
Class     I  Lun H/W Path        Driver   S/W State  H/W Type     Health  Description
=============================================================================================
ctl       0  64000/0xfa00/0x0    esctl    CLAIMED    DEVICE       online  HP  P400
             0/3/0/0/0/0.0x0.0x0
                      /dev/pt/pt0
disk      3  64000/0xfa00/0x1    esdisk   CLAIMED    DEVICE       online  HP  LOGICAL VOLUME
             0/3/0/0/0/0.0x0.0x4000000000000000
                      /dev/disk/disk3      /dev/rdisk/disk3
                      /dev/disk/disk3_p1   /dev/rdisk/disk3_p1
                      /dev/disk/disk3_p2   /dev/rdisk/disk3_p2
                      /dev/disk/disk3_p3   /dev/rdisk/disk3_p3
tape     28  64000/0xfa00/0x45   estape   CLAIMED    DEVICE       online  HP  Ultrium 3-SCSI
             64000/0x0/0x0.0x6.0x0
                      /dev/rtape/tape28_BEST    /dev/rtape/tape28_BESTn
                      /dev/rtape/tape28_BESTb   /dev/rtape/tape28_BESTnb
autoch    7  64000/0xfa00/0x46   eschgr   CLAIMED    DEVICE       online  HP  MSL G3 Series
             64000/0x0/0x0.0x7.0x0
                      /dev/rchgr/autoch7
tape     30  64000/0xfa00/0x4a   estape   CLAIMED    DEVICE       online  HP  Ultrium 5-SCSI
             0/2/0/0/0/0.0x500110a0013091b8.0x0
                      /dev/rtape/tape30_BEST    /dev/rtape/tape30_BESTn
                      /dev/rtape/tape30_BESTb   /dev/rtape/tape30_BESTnb
```

For a given SAS device the SAS address can be obtained from the Lun H/W Path. For example:

The `lunpath` hardware path for the above tape drive is "`0/2/0/0/0/0.0x500110a0013091b8.0x0`".

- The SAS bus ID is "`0/2/0/0/0/0`" (including all the numbers separated by "`/`").

From the remaining "`0x500110a0013091b8.0x0`" portion:

- Tape drive SAS address (hexadecimal) = `0x500110a0013091b8`
- Tape drive SCSI LUN = `0x0` (hexadecimal SCSI-3 64-bit LUN identifier)

Similarly, for a given FC device the FC bus ID, the World Wide Name (WWN) and the LUN ID can be decoded from the Lun H/W Path. For example:

If the `lunpath` hardware path for a giventape drive is "`0/4/1/0.0x50060b0000b7f3c8.0x0`".

- The FC bus ID is "`0/4/1/0`" (including all the numbers separated by "`/`").

From the remaining "`0x50060b0000b7f3c8.0x0`" portion:

- Tape drive WWN (hexadecimal) = `0x50060b0000b7f3c8`
- Tape drive SCSI LUN = `0x0` (hexadecimal SCSI-3 64-bit LUN identifier)

Adding stape/estape and eschgr/schgr (media changer driver) to the kernel

For HP-UX 11i v2

If your tape drive or media changer does not appear in `ioscan` listing or is listed with H/W Type "`UNKNOWN`" you may need to install the appropriate drivers.

Use the '`sam`' utility. Sam runs as a mouse driven GUI (Figure 1) on a system with full graphics capability, or as a console text-based interface (Figure 2). If you use the text-based interface, use the Tab and arrow keys to navigate, and the Return key to select.

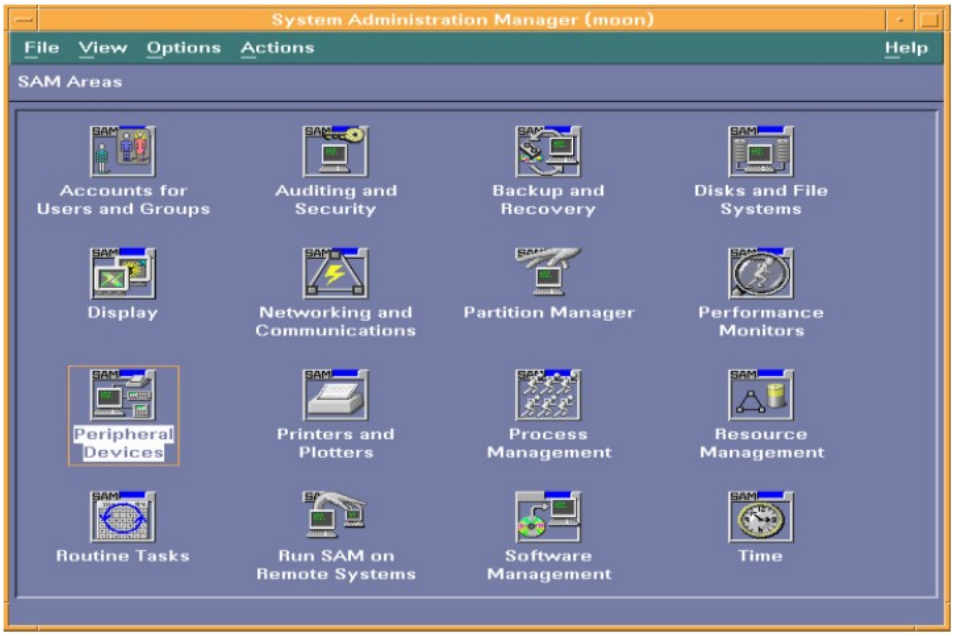


Figure 1 SAM GUI

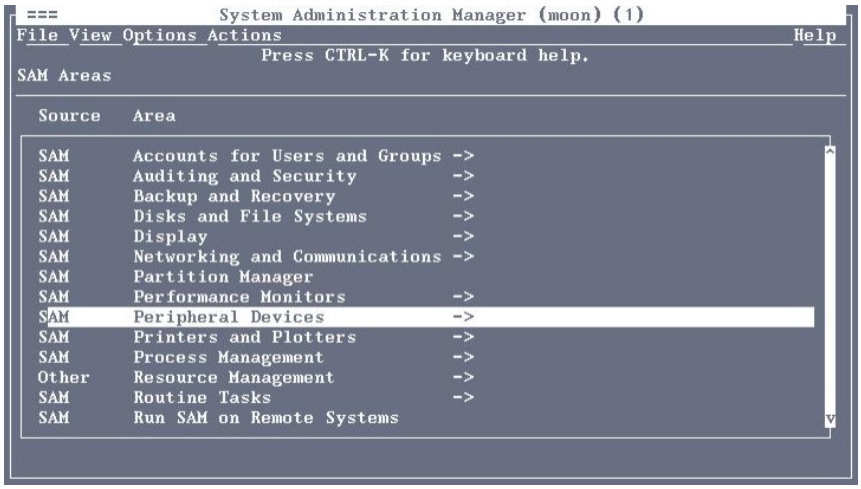


Figure 2 SAM text-based interface

1. Enter `sam` at the command line.

   ```
   % sam
   ```

2. Select the following:

   Kernel Configuration > Kernel Configuration (character mode) > Modules

3. Highlight the stape driver. If the driver has not been added to the kernel, both Current State and Planned State will read “unused”.
4. Type “`m` to modify the stape driver and “`s`” to set it to “`static`”. The Planned State will now read “static”.
5. The stape driver is now added to the kernel.
6. If you are going to attach a media changer, use a similar procedure to change `eschgr` or `schgr` to “static”.

7. Reboot the system.

For HP-UX 11iv3 (11.31)

1. Start up the SMH web-based interface.

   ```
   % smh -w
   ```

   This will attempt to launch a web browser. Mozilla browser[2] is the default when HP-UX 11i v3 is installed.

2. From the SMH Tools page, select Modules from the Kernel Configuration section:

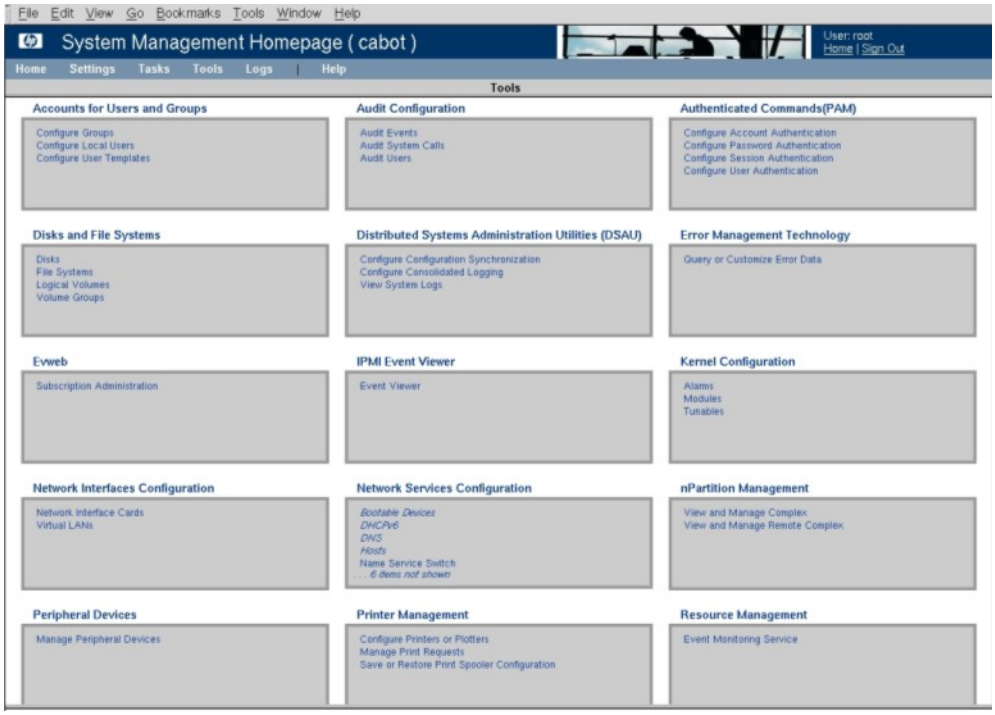


Figure 3 SMH web-based interface (HP-UX11i v3)

3. In the Search box on the Kernel Configuration page, type `stape` and execute the search. The search results list will include both `estape` and `stape` modules. If either of these modules is not installed both Current State and Next Boot State will be shown as “unused”. A state of “static” indicates that the module is installed.

4. Select the `estape` module[3] radio button. Its details will appear in a panel below the modules list. From the right hand panel on the web page, click the **Modify Module** link.

[2]If Mozilla is being invoked for the first time you may be asked to agree to license terms for the software.

[3]The `estape` and `stape` modules are linked, so it is sufficient to select the `estape` module alone for installation.

5. On the Modify Kernel Module: estape page, for **Next Boot State**, select the "static" radio button. Check the box entitled **Backup** to create a backup copy of the existing kernel:

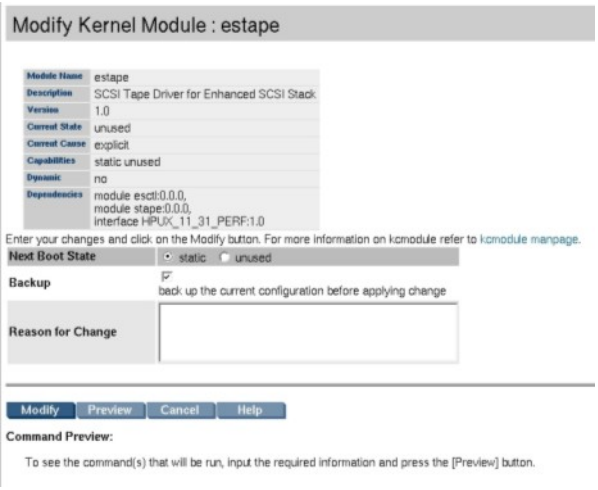


Figure 4 Adding estape driver to the kernel

6. If you wish, type in a Reason for Change, such as "`Initial estape installation May 1st 2007`" and then select the **Modify** tab.
7. Click the **OK** button at the Operation Successful page. Both `estape` and `stape` drivers will now be shown with **Next Boot State** as "static".
8. For media changers, use a similar procedure to prepare the `eschgr` (with `schgr`) module.
9. From the right-hand panel on the Kernel Configuration page, click **View Pending Changes and reboot** and proceed to reboot the system as directed.
10. Following the reboot ,re-run SMH and search again for the driver as in step 3 above. **Current State** and **Next Boot State** should both be listed as "static".

Add device files

For HP-UX 11i v2

Use the `sam` utility to create device files. `sam` runs as a mouse-driven GUI (see Figure 1 on page 10) on a system with full graphics capability, or as a console text-based interface (see Figure 2 on page 10). If you use the text-based interface, use the Tab and arrow keys to navigate, and the Return key to select.

1. Enter `sam` at the command line:

```
% sam
```

2. Select the following:

   Peripheral Devices > Tape Drives

   `sam` will then scan the system for any tape drives connected.

   For example, when an HP LTO Ultrium 5 drive is found, for example, it will be displayed as something like:

```
Hardware Path       Driver      Description
=======================================================
8/0/2/0.3.0         stape       HP Ultrium 5-SCSI
```

3. Highlight the drive and select the following from the tool bar:

   Actions > Create Device Files > Create Default Device Files

   This will create default device files for the drive. To view the device files that have been created, select:

   Actions > Create Device Files > Show Device Files

4. When you have exited `sam`, run `ioscan` to see the tape drive:

```
%/sbin/ioscan -fnC tape
```

   All default device files displayed have compression enabled.

NOTE:

HP recommends the 'Berkeley' device files of most applications:

`cXtYdZBESTnb` = Berkeley, no rewind, best available density

`cXtYdZBESTb` = Berkeley, with rewind, best available density

where:

`X` = card number

`Y` = target number

`Z` = LUN number

For HP-UX 11i v3 (HP-UX 11.31)

1. Start up the SMH web-based interface:

```
% smh -w
```

   This will attempt to launch a web browser. Mozilla browser[4] is the default when HP-UX 11i v3 is installed.

2. From the SMH Tools page (see Figure 3 on page 11), select Manage Peripheral Devices from the Peripheral Devices section.
3. Select tape from the **Class** drop-down box on the HP-UX Peripheral Device Tool page. Select the tape device (radio button) requiring device files from the resulting list. If device files are not already present this will be indicated under the Properties header (see Figure 5)[5] .

[4]If Mozilla is being invoked for the first time you may be asked to agree to license terms for the software.

[5]Depending on how SMH was last used the HP-UX Peripheral Device Tool page will display either the *Agile View* or the *Legacy View* as described at the beginning of this chapter. To switch between these views use the *Toggle Global Device View* link on the right hand side of the HP-UX Peripheral Device Tool page. In this chapter, the Agile View is assumed. The process is similar for the Legacy View.

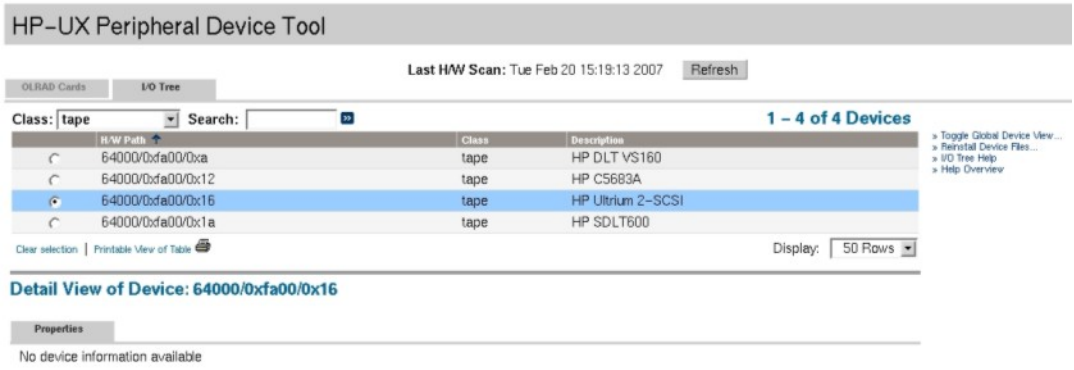


Figure 5 Selecting a tape device to create its device files (Agile View)

4. From the right-hand panel on the HP-UX Peripheral Device Tool page, click on **Reinstall Device Files**. At the next page, click the **Reinstall** button. When the browser returns to the HP-UX Peripheral Device Tool page, click the **Refresh** button one or more times until the list of device files appears under the Properties header.

Using large block sizes

A block size no larger than 256 KB (262144 bytes) is strongly recommended when working with HP-UX and tape or VTL devices. Backup applications should be configured to work with I/O block sizes that are no larger than 256 KB. Please check your application documentation to find out how to check or configure block sizes used for transfers to and from tape or VTL devices.

This is because, by default, the HP-UX stape driver processes a block size larger than 256 KB by subdividing it into 256 KB blocks for writing to tape (giving a net effect of 256 KB I/O transfers)[6] . For example a 1 MB block (1048576 bytes) is written to tape as four 256 KB blocks. During restore, stape attempts to reconstruct the original block size that was larger than 256 KB with the 256 KB blocks from tape. This subdivision and subsequent reconstruction process of block sizes larger than 256 KB adds unnecessary complexity and risk to tape positioning and restore operations and offers no net gain in terms of increased block size. It should therefore be avoided.

What next?

Once device files have been created, you should confirm that your new tape drive is working properly. "Verifying the installation" on page 31 provides instructions on backing up and restoring a sample file to test your installation.

[6]The maximum block size limit of 256 KB (262144 bytes) applies to all versions of HP-UX and is strongly recommended for broad backup/restore compatibility across all supported HP-UX versions. Different HP-UX kernel configurations or later versions of HP-UX may not use 256 KB 'chunks' as described; however all HP-UX versions and kernel configurations are compatible and interoperable with a block size limit of 256 KB.

3 HP (OpenVMS) servers and workstations

NOTE:

SAS drives are not supported on Alpha Server systems.

Determining attached devices

After connecting the tape drive to your system, boot OpenVMS and check for the presence of the new tape device. Execute the following commands.

For FC drives, first:

```
$mc sysman io find
$mc sysman io auto
```

Then, for all drives:

$mc sysman io find
$mc sysman io auto

$ sho dev mk

```
Device          Device          Error    Volume       Free  Trans Mnt
Name            Status          Count    Label        Blocks Count Cnt
MKA400:         Online              0
```

^*use this value in the next command line*

$ sho dev MKA400/full

```
Magtape SIT058$MKD300:, device type HP Ultrium 5-SCSI, is
online, file-oriented device, available to cluster, error
logging is enabled, controller supports compaction (compaction
disabled), device supports fastskip (per_io).

    Error count                0   Operations completed             0
    Owner process             ""   Owner UIC                 [SYSTEM]
    Owner process ID   00000000   Dev Prot       S:RWPL,O:RWPL,G:R,W
    Reference count            0   Default buffer size            2048
    Density              default   Format                   Normal-11

Volume status:  no-unload on dismount, beginning-of-tape, odd parity.
```

What next?

You are now ready to begin using your tape drive. Please consult your OpenVMS system documentation for details.

4 Linux servers and workstations

TIP:

Where convenient, do the original install of the Linux operating system with the tape drive attached to the SAS port, so that the st driver gets loaded with the kernel during boot up. Otherwise, see the guidelines below for cases where the operating system was already installed without the tape drive being available.

Ensure the correct HBA and driver are installed

Visit the HP Tape Compatibility website for details of supported Linux OS versions and SAS HBA controllers: http://www.hp.com/products1/storage/compatibility/tapebackup/index.html

Download and install the latest controller driver from the manufacturer's website – for example, for an HP branded HBA, visit www.hp.com to download the latest driver.

Check the driver modules are loaded in the kernel

In order to communicate with a tape device, the operating system needs to have drivers loaded for both the tape drive and the host bus adaptor. Ensure that both are available as either loadable modules (for example, usable with `insmod` and visible with `lsmod`) or are statically built into your kernel.

NOTE:

To add drivers to the statically-built kernel you need the Linux source code available on disk and knowledge of how to use the kernel building tools that ship with various Linux distributions. This should not be attempted by novice users.

The following guidelines assume the use of loadable driver modules.

Run the `lsmod` command to list all driver modules currently loaded in the kernel. Check whether the `st` driver for tape is listed and also whether the relevant HBA driver is listed.

```
lsmod
```

For example, the `st` driver for tape listing would resemble the entry shown below. Also shown below are two examples of HBA drivers—`cciss` driver (for HP SmartArray SAS HBAs) and `mptsas` driver (for LSI SAS HBA):

```
Module   Size   Used by
st    38749   0
.
.
cciss   68484  3
.
```

```
.
mptsas   37321  0
```

If a particular driver module is not listed as above use the `modprobe` utility to load it. For example if the `st` driver is missing, execute:

```
modprobe st
```

NOTE:

Loading of the `st` driver should happen naturally if your system is rebooted after attaching the drive.

Determining the attached devices

HBAs which use the `cciss` driver may require an explicit scan procedure to allow the attached tape drive to be discovered after each reboot; execute the following from the command line (or from a shell script):

```
for x in /proc/driver*/cciss/c*;do echo engage scsi > $x; done; dmesg
```

Check the contents of the file `/proc/scsi/scsi` to determine whether the system discovered the tape drive at module load time:

```
cat /proc/scsi/scsi
```

Examine the contents for something like:

```
Host: SCSI0 Channel: 00 Id:00 Lun:00
Vendor: HP    Model: Ultrium 5-SCSI Rev: ZxxD
Type: Sequential-Access ANSI SCSI Revision 06
```

Look through the output of `dmesg` to discover which tape drive instance is used (`st0` in the example below) and to review the SCSI HBA driver (`cciss` in the extract below).

NOTE:

The exact format and style of the listing may vary with different Linux distributions and versions.

TIP:

You may prefer to redirect a lengthy `dmesg` output to a file for browsing at your convenience:

```
dmseg > my_boot_messages.txt
```

or pipe the output of `dmesg` to a page scrolling utility

```
dmesg | more
```

Extract from `dmesg` output:

```
.
.
scsi3 : cciss
  Vendor: HP        Model: Ultrium 5-SCSI    Rev: ZxxD
  Type:   Sequential-Access                  ANSI SCSI revision: 06
scsi 3:0:0:0: Attached scsi generic sg0 type 1
```

```
st: Version 20050830, fixed bufsize 32768, s/g segs 256
st 3:0:0:0: Attached scsi tape st0
.
.
```

The tape drive instance identifies which device files are applicable to the tape drive. For example:

- `st0` indicates device files `/dev/st0` or `/dev/nst0`
- `st1` indicates device files `/dev/st1` or `/dev/nst1`

and so on...

A list of tape device files gets created automatically when the `st` driver module and the correct HBA driver have been added. They reside in the `/dev/ directory` and have the syntax:

`/dev/stp` or `dev/nstp`

where:

- `p` is the instance number of the device file (if only one drive is connected to the system, this will be 0)
- *`n`* Indicates this is a no-rewind driver.

Using the seek and tell features of mt

To use the seek and tell features of `mt`, the `st` driver needs to be configured for logical block addressing with HP Ultrium drives.

With some Linux distributions it is possible to do this using the `stsetoptions` function with `mt` utility:

`mt -f <devicefile> stsetoptions scsi2logical`

where *`<devicefile>`* is `/dev/stp` or `/dev/nstp`.

Note however that this information is not preserved across reboots, so you need to execute this command each time the system comes up. Some Linux distributions include the `stinit` utility, which offers a convenient way of handling this using the `/etc/stinit.def` configuration file. Note that the file `/etc/stinit.def` may not exist in a new installation and so may need to be created. See the examples of `stinit.def` entries in `/usr/share/doc/mt-st-<version>/stinit.def.examples`. If you use this approach, set the manufacturer parameter to `HP` and the model to "`Ultrium 5-SCSI`".

Where `stinit` is available, you can also re-initialize the drive to new parameters as entered in `/etc/stinit.def` without reboot by running:

`stinit`

What next?

Once device files have been created, you should confirm that your new tape drive is working properly. "Verifying the installation" on page 31 provides instructions on backing up and restoring a sample file to test your installation.

5 IBM (AIX) servers and workstations

For supported versions of AIX, see http://www.hp.com/go/connect.

Identifying attached devices

For SAS, to list existing devices, use the following:

```
% lsdev -C |grep SAS
```

This produces output similar to:

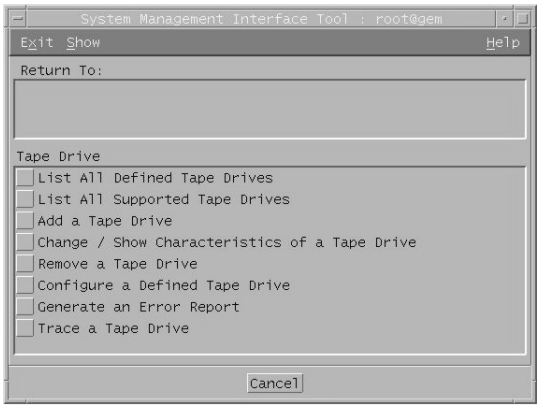
```
hdisk0     Available 00-08-00 SAS Disk Drive
hdisk1     Available 00-08-00 SAS Disk Drive
rmt0       Defined   03-08-00 Other SAS Tape Drive
sas0       Available 00-08-00 Controller SAS Protocol
sas1       Available 03-08-00 Controller SAS Protocol
ses0       Available 00-08-00 SAS Enclosure Services Device
ses1       Available 00-08-00 SAS Enclosure Services Device
ses2       Available 00-08-00 SAS Enclosure Services Device
sissas0    Available 00-08    PCI-X266 Planar 3Gb SAS Adapter
sissas1    Available 03-08    PCI-X266 Ext Dual-x4 3Gb SAS Adapter
```

Configuring the device files

Reboot the server/workstation with the tape drive attached and powered on.

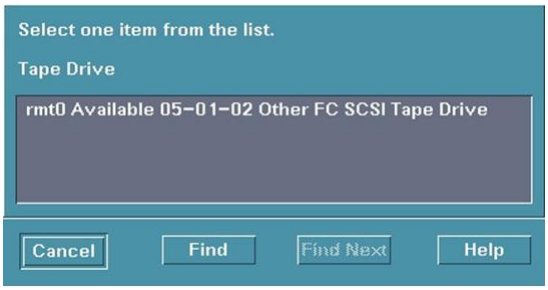
If you are using a graphics terminal running X-Windows

1. At a Windows terminal, type:
   ```
   smit tape
   ```
2. The following window is displayed:



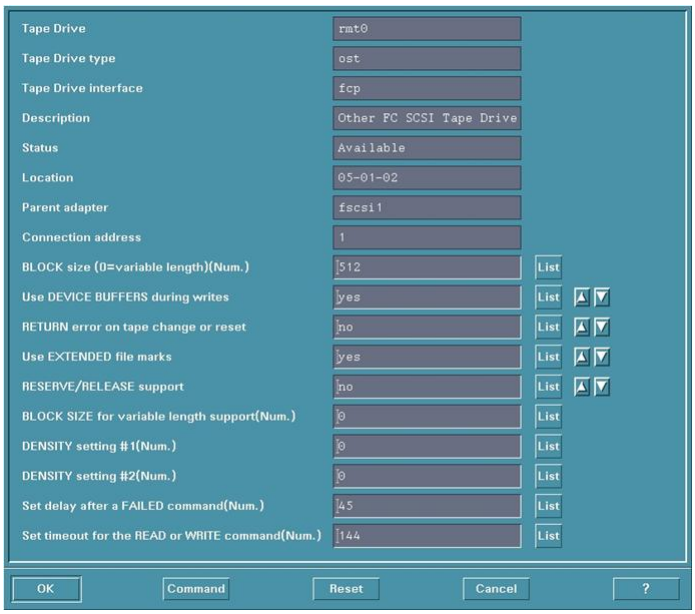
Select "`change/show characteristics of a tape drive`"

3. A pop-up window is displayed:



Select the tape drive you wish to change. The example above shows an LTO FC tape drive as available for selection.

4. The following details are displayed:



Check the following values and change them if necessary:

- BLOCK Size (0=variable length)= 0
- Use EXTENDED file marks = “no”
- RESERVE/RELEASE support = “yes”
- Set timeout for the READ or WRITE command = 1200

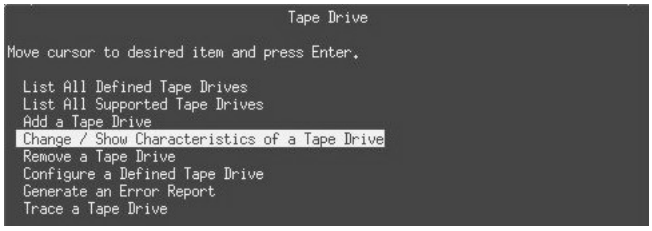
Click on the “OK” button to apply the changes.

If you are using a non-graphics terminal

1. At the command line type:

```
% smit -C tape
```

2. The following is displayed:

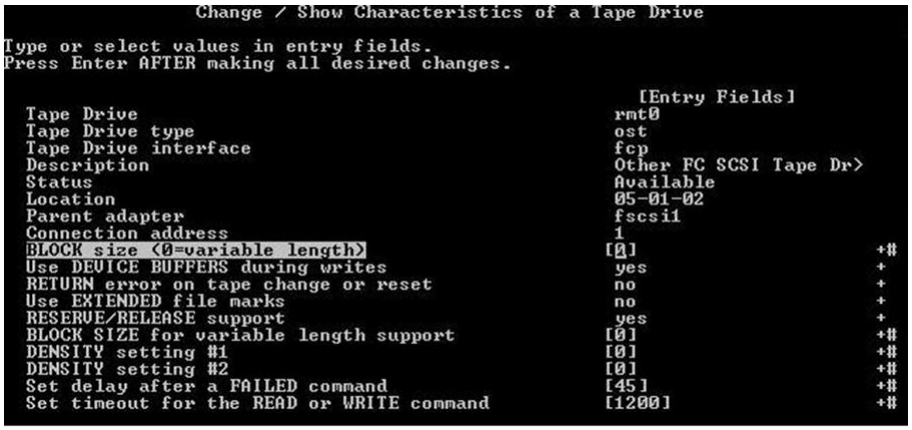


Select "`change/show characteristics of a tape drive`"

3. A pop-up window is displayed:

Select the tape drive you wish to change. The example above shows an LTO FC tape drive as available for selection.

4. The following details are displayed:



Check the following values and change them if necessary:

- BLOCK Size (0=variable length) = 0
- Use EXTENDED file marks = "no"
- RESERVE/RELEASE support = "yes"
- Set timeout for the READ or WRITE command = 1200

Press the Enter key ("`Do`") to apply the changes.

Refer to http://www.hp.com/go/connect for up-to-date information on supported applications

Once device files have been configured, you should confirm that your new tape drive is working properly. "Verifying the installation" on page 31 provides instructions on backing up and restoring a sample file to test your installation.

Device filenames under AIX

Use device filenames as listed below for the combination of Rewind on Close, Retension on Open, and Compression that you want:

Filename	Rewind on Close	Retension on Open	Compression
/dev/rmt*n*	Yes	No	enabled
/dev/rmt*n*.1	No	No	enabled
/dev/rmt*n*.2	Yes	Yes	enabled
/dev/rmt*n*.3	No	Yes	enabled
/dev/rmt*n*.4	Yes	No	disabled
/dev/rmt*n*.5	No	No	disabled
/dev/rmt*n*.6	Yes	Yes	disabled
/dev/rmt*n*.7	No	Yes	disabled

The *n* in the filename is the instance number assigned to the drive by the operating system, where 0 is the first device, 1 is the second and so on.

Rewind on Close — Normally, the drive repositions the tape to BOT (Beginning of Tape) when the device file is closed. Using the no rewind option is useful when creating and reading tapes that contain multiple files.

Retension on Open — Retensioning consists of winding to EOT (End of Tape) and then rewinding to BOT, in order to reduce errors. If this option is selected, the tape is positioned at BOT as part of the open process.

Compression — Compression can be disabled or enabled.

6 Sun (Solaris) servers and workstations

For supported versions of Solaris, see http://www/hp.com/go/connect.

Fibre Channel drives

Before configuring your system to support an HP LTO Ultrium drive, ensure that the drive is visible to the Sun system HBA by correctly zoning the fabric switch (if one is being used).

Configuring the device files

Before configuring FC-attached drives, ensure the operating system is updated with the latest recommended patches. On Solaris 9 you also need to install the Sun/StorageTek StorEdge SAN Foundation software from www.sun.com/download (select the Storage Management link, then `StorageTek SAN x.x`).

When SAN configuration is complete, verify that the drive is visible to the HBA by typing:

```
% cfgadm -al
```

This should produce an output similar to:

```
...
c3::50060b000xxxxxxx      tape      connected    configured   unknown
...
```

This indicates that the drive is configured and the device files built. In this example `c3::50060b000`*`xxxxxxx`* is the attachment point identifier with `50060b000`*`xxxxxxx`* being the WWN of the drive port attached to the SAN and visible to the HBA.

If you do not see anything similar to the example above, recheck the SAN connections and the zoning configuration to ensure that the HBA and drive ports are visible to each other.

If the tape device shows as `unconfigured`, type the following:

```
% cfgadm -c configure c3::50060b000xxxxxxx
```

This will build the necessary device file in the `/dev/rmt` directory.

To verify the particular devices associated with a specific WWN then use the following command:

```
% ls -al /dev/rmt | grep 50060b000xxxxxxx
```

Replace `50060b000`*`xxxxxxx`* with the appropriate WWN for the drive.

SAS drives

Identifying attached devices

Use the `cfgadm` command to list attached tape devices:

```
% cfgadm -al |grep tape
```

This produces output lines with a format similar to the following:

```
c9::rmt/0                tape         connected    configured   unknown
```

The `rmt/K` entry indicates the tape device file, where `K` is the instance number. In the above example, `rmt/0` indicates a set of device file options for one tape drive, such as `/dev/rmt/0cb`, `/dev/rmt/0cbn`, and so on.[7]

The `cfgadm` command may also be used with the –v (verbose) option to list a full path including the SAS controller:

```
% cfgadm -val |grep tape
```

An output containing, for example, "`/devices/pci@0/pci@0/pci@8/pci@0/pci@1/LSILogic,sas@0:scsi::rmt/1`" indicates an SAS tape drive connected via an LSI SAS HBA.

Kernel patch levels

For optimal performance, ensure that you have the following minimum patch number:

	Minimum patch*
Solaris 9	The latest version of the st, sd and ssd drivers patch (currently 122300-48, though this version may be superceded)
Solaris 10	The latest version of the kernel patch (05/09 release (update 5) or later)

Upgrading to the minimum patch level will ensure that the necessary support for officially supported drives is included in the driver. You can view your existing patch level using the command "`uname -a`". To access Solaris patch upgrades, you need to set up an Online Account with Sun to use http://www.sunsolve/sun/com/.

NOTE:

Patch levels are liable to change every 6 months or so, so these "minimum" levels may quickly become out-of-date.

To obtain the lastest levels, enter the patch names into the search utility "Search the SunSolve Knowledgebase" found on http://www.sunsolve/sun/com/.

If for some reason you cannot upgrade to the minimum patch level, you can make the following file modifications to enhance performance:

[7]Device file variants for a given tape device are listed in `/dev/rmt` with various suffixes—`l`, `m`, `h`, `u`, `c` specifying the 'density' (low, medium, high, ultra, compressed), plus additional options `b`, 'Berkeley' behavior, and `n`, no rewind behaviour. HP recommends the 'Berkeley' device file option for most applications with compressed density `c`: `/dev/rmt/0cb` or `/dev/rmt/0cbn`

1. In the file `/kernel/drv/st.conf`, after these lines:

```
########
#
# Copyright 2004 Sun Microsystems, Inc.  All rights reserved.
#  Use is subject to license terms.
#
#
#pragma ident   "@(#)st.conf    1.34    04/06/24 SMI"
#
```

   add the following (there are 6 significant spaces between the first occurrences of HP and Ultrium in line 2):

```
tape-config-list =
 "HP      Ultrium 5","HP Ultrium LTO 5","HP_LTO_GEN_5";
HP_LTO_GEN_5 = 2,0x3B,0,0x18659,4,0x00,0x44,0x46,0x58,3,60,
1200,600,1200,600,600,18000
name="st" class="scsi" target=X lun=0;
```

   where `X` is the SCSI target address[8] of the device you have attached.

   See "HP-data values" on page 28 for the values of the parameters in these lines.

2. Instead of rebooting the device, follow these steps.

   a. Find the kernel module ID:

```
# modinfo | grep "st ("
96 60dcc000 cdb0 33 1 st (SCSI Sequential Access Driver)
```

   In this example the ID is 96.

   b. Unload the kernel module:

```
# modunload -i 96
```

   c. Load the kernel module back in:

```
# modload -p drv/st
```

   d. Rebuild the device paths:

```
devfsadm -C
devfsadm -i st
```

   For further details, see *How do you load st.conf changes without rebooting*, SunSolve document 18010, on http://sunsolve.sun.com/search/document.do?assetkey=1-9-18010-1&searchclause=18010

   This link is valid for registered SunSolve users with a valid Sun Service Plan.

[8]Typically `st.conf` already contains a range of target address entries by default, listed after the comments section (`#` prefixes) in the above format: `name="st" class="scsi" target=X lun=0;` While SAS drives contain a unique 64-bit SAS address, they are also allocated a target address value in the operating system. To obtain a particular tape drive's target address, run the following command to identify it:

`% ls -l <tape device file>`

This produces a line of output which includes a path which in turn contains an `st@X` element, where `X` is the target address.

For example: `% ls -l /dev/rmt/0cbn` would produce output containing something like the following path:

`/dev/rmt/0cbn -> ../../devices/pci@0/pci@0/pci@8/pci@0/pci@8/pci@0/pci1077,14f@1,1/st@3,0:cbn`

The element `st@3` here indicates target address = 3.

3. You should now be able to use the drive.
   - Use `/dev/rmt/Kcb` if you require a compression rewind device file, where *K* is the relevant device file instance.
   - Use `/dev/rmt/Kcbn` when you require a compression non-rewind device.

   Once the device files have been created, you should confirm that your new tape drive is working properly. "Verifying the installation" on page 31 provides instructions on backing up and restoring a sample file to test your installation.

HP-data values

The values for `HP_LTO_GEN_n` and *name*, which provide normal LTO mode, have the following meanings:

The syntax for `HP_LTO_GEN_n` is:

```
<drive type> = <version>, <type>, <bsize>, <options>,  <no. of densities>,
  <density 0>, <density 1>,  <density 2>,<density 3>, <default density>,
  <non-motion timeout>, <read/write timeout>,  <rewind timeout>, <space timeout>,
  <load timeout>,  <unload timeout>, <erase timeout>
```

where:

Parameter	Value	Meaning	
`<version>`	`1` or `2`	Indicates the format of the following parameters.	
`<type>`	`0x3B`	The value for an LTO drive in `/usr/include/sys/mtio.h`. The value `0x3B` indicates a type of `MT_LTO`.	
`<bsize>`	`0`	Indicates variable block size.	
`<options>`	`0xd639` or `0x18659`	This value is derived from constants provided in `/usr/include/sys/scsi/targets/stdef.h`. The value determines which operations the driver can perform with the attached device by using a unique value for each feature and then adding them together to form the options value. Supported features will vary with OS revision, and may include the following:	
		`0x001`	Device supports variable length records.
		`0x008`	Device can backspace over files (as in the '`mt bsf`' option).
		`0x010`	Device supports backspace record (as in '`mt bsr`').
		`0x020`	Device requires a long time-out period for erase functions.
		`0x040`	Device will automatically determine the tape density.
		`0x0200`	Device knows when end of data has been reached.
		`0x0400`	Device driver is unloadable.
		`0x1000`	Time-outs five times longer than normal.
		`0x4000`	Driver buffers write requests and pre-acknowledges success to application.

Parameter	Value	Meaning	
		0x8000	Variable record size not limited to 64 KB.
		0x10000	Device determines which of the two mode pages the device supports for selecting or deselecting compression.
		So 0xd639 indicates variable record length, bsf and bsr enabled, long timeouts for erase, EOD recognition, Unloadable device driver, 5 x longer timeouts, buffer writes and pre-acknowledge success, variable records not limited to 64 KB, auto-density over-ride and MODE SELECT compression. Similarly, 0x018659 indicates variable record length, bsf and bsr enabled, automatic density determination, EOD recognition, unloadable device driver, variable records not limited to 64 KB, and device selection of mode pages for controlling compression.	
<no. of densities>	4	There are four densities following in the parameter list.	
<density 0>	0x00	Creates a device file with compression disabled.	
<density 1>	0x44	The Ultrium 3 density code for data compression with Ultrium 3 media	
<density 2>	0x46	The Ultrium 4 density code for data compression with Ultrium 4 media	
<density 3>	0x58	The density code for data compression enabled by default.	
<default density>	3	Density 3 (0x58) is the default for Generation 5 drives.	
<X timeout>		All timeouts are in seconds	

Values for the parameters for *name* are as follows:

Parameter	Value	Meaning
target	*X*	*X* specifies the target address[8] of the device.
lun	0	Specifies the LUN for the device.

7 Verifying the installation

Verifying the installation of the drive (UNIX)

As part of the installation process, you will have installed the appropriate device driver for your UNIX system, and created device files to communicate with the tape drive.

This section describes how you can verify the installation has been performed correctly.

In outline, the procedure is as follows:

1. Check the tape drive responds to a rewind command.
2. Write test data to a tape.
3. Read the test data from the tape.
4. Compare the data read from the tape with the original data on disk.

To verify the installation:

1. Test the SCSI connection to the tape drive by performing a rewind:
   a. If there is a tape cartridge already in the drive, remove it.
   b. Insert a tape cartridge.
   c. Rewind the tape using the command line:
      ```
      % mt -f device file rewind
      ```
      For example, on HP-UX 11i v2:
      ```
      % mt -f /dev/rmt/c4t3d0BESTnb
      ```
      For example, on HP-UX 11i v3 (using a persistent device file):
      ```
      % mt -f /dev/rtape/tape0_BESTnb rewind
      ```
      If the command completes successfully, there will be no feedback. If it fails, you will see an error message on the console. There may be a reservation by another host, or a zone change, or the hardware installation may be faulty. Check the troubleshooting section of the *User's Guide* for help in identifying the problem.

2. Write a sample file to tape, using 'tar':

   ```
   % cd /% tar cvf <device_file> <file>
   ```

   The options to tar have the following meanings:

c	Create a new archive (backup file) on the device.
v	Operate in verbose mode.
f	Specify the device file explicitly.

   The arguments follow the cvf options in the command line. Their values depend on the operating system; suggested values are given the appropriate operating system chapter. The arguments are as follows:

<device file>	The name of the device file for the drive. *Example:*/dev/rmt/c4t3d0BESTnb
<file>	The name of the file to archive, prefixed with './'. *Example:*./stand/vmunix

   NOTE:

   Make sure you prefix the file name with '.' when you back it up to tape. If you do not, the restore operation in step 3 will overwrite the original copy on disk.

3. Read the file back from tape:

   ```
   % cd /tmp % tar xvf <device file>
   ```

   The 'x' option to tar here means "extract from the archive".

   Use the same value for the *<device file>* argument as in step 2.

4. Compare the original with this retrieved file:

   ```
   % cmp <original file> /tmp/<retrieved file>
   ```

   This compares the files byte by byte. If they are the same, there should be no output, and this verifies that the installation is correct. The arguments are:

<original file>	The name of the original file, prefixed with '/'. *Example:*/stand/vmunix
<retrieved file>	The name of the file retrieved from the archive. *Example:*stand/vmunix

Example

Suppose you are verifying the installation of an HP LTO Ultrium tape drive on an HP-UX 11.X system. The procedure would be as follows:

1. Use `ioscan` to obtain the tape drive device file options:

   ```
   %/sbin/ioscan -fnC tape
   ```

   Identify the Berkeley 'no-rewind' option, for example: `/dev/rmt/c4t3d0BESTnb`

2. Change directory to root:

   ```
   % cd /
   ```

3. Back up `/stand/vmunix` to tape:

   ```
   % tar cvf /dev/rmt/c4t3d0BESTnb ./stand/vmunix
   ```

   Note the prefix of '`.`' to the filename.

4. Change to the temporary directory:

   ```
   % cd /tmp
   ```

5. Extract the file from the tape:

   ```
   % tar xvf /dev/rmt/c4t3d0BESTnb
   ```

6. Compare the original with the restored version:

   ```
   % cmp /stand/vmunix /tmp/stand/vmunix
   ```

   Note that the original filename is *not* prefixed with '`.`'.

8 Support and other resources

Related documents

The following documents provide additional information:

Documents specific to HP LTO Ultrium drives

- *Hardware Integration Guide*, volume 1 of the HP LTO Ultrium Technical Reference Manual
- *Software Integration Guide*, volume 2 of the HP LTO Ultrium Technical Reference Manual
- *Host Interface Guide*, volume 3 of the HP LTO Ultrium Technical Reference Manual
- *Specifications*, volume 4 of the HP LTO Ultrium Technical Reference Manual

Please contact your HP supplier for copies.

- The features and benefits of HP LTO Ultrium drives are discussed in the *HP LTO Ultrium Technology White Paper*.
- For a general background to LTO technology and licensing, go to http://www.lto-technology.com.

Documentation map

The following will help you locate information in the Technical Reference Manual. A reference like "1 HW Integration: *ch. 7*" means Volume 1, Hardware Integration Guide, of the HP LTO Ultrium Technical Reference Manual, chapter 7.

Drives—general

	FC Drives	SAS Drives
Connectors	1 HW Integration: *ch. 4*	1 HW Integration: *ch. 7*
Front panel LEDs	1 HW Integration: *ch. 3*	1 HW Integration: *ch. 6*
Specifications	4 Specifications	

Installation and configuration

	FC Drives	SAS Drives
Connectors	1 HW Integration: *ch. 4*	1 HW Integration: *ch. 7*
Determining the configuration	2 SW Integration: *ch. 2*	
External drives	n/a	1 HW Integration: *ch. 5*

	FC Drives	SAS Drives
In libraries	1 HW Integration: *ch. 1*	
In servers	n/a	1 HW Integration: *ch. 4*
In tape arrays	n/a	1 HW Integration: *ch. 3*
Linux configuration	5 UNIX, Linux, OpenVMS Configuration	
Modes of usage	n/a	1 HW Integration: *ch. 8*
OpenVMS configuration	5 UNIX, Linux, OpenVMS Configuration	
Optimizing performance	n/a	1 HW Integration: *ch. 8*
	2 SW Integration: *ch. 4*	
UNIX configuration	5 UNIX, Linux, OpenVMS Configuration	

Operation

	FC Drives	SAS Drives
External drives	n/a	1 HW Integration: *ch. 5*
In libraries	1 HW Integration: *ch. 1*	
In servers	n/a	1 HW Integration: *ch. 4*
In tape arrays	n/a	1 HW Integration: *ch. 3*

Cartridges

	FC Drives	SAS Drives
Cartridge Memory (LTO-CM)	2 SW Integration: *ch. 5*	
Cartridges	1 HW Integration: *ch. 5*	1 HW Integration: *ch. 9*
Managing the use of cartridges	2 SW Integration: *ch. 1*	
Use of cartridges	2 SW Integration: *ch. 3*	

Interface

	FC Drives	SAS Drives
FC, SCSI and SAS host interface guide	3 Host Interface	
Commands	3 Host Interface: *ch. 5*	

	FC Drives	SAS Drives
Error codes	1 HW Integration: *ch. 6*	1 HW Integration: *ch. 10*
Implementation	3 Host Interface: *ch. 1*	
Interpreting sense data	2 SW Integration: *ch. 3*	
Messages	3 Host Interface: *ch. 2*	
Mode pages —see the MODE SENSE command	3 Host Interface: *ch. 5*	
Pre-execution checks	3 Host Interface: *ch. 4*	
Responding to sense keys and ASC/Q	2 SW Integration: *ch. 6*	
Sense keys and ASC/Q —see REQUEST SENSE command	3 Host Interface: *ch. 5*	
Task management functions	n/a	3 Host Interface: *ch. 3*

Maintenance and troubleshooting

	FC Drives	SAS Drives
Cleaning	2 SW Integration: *ch. 5* 2 SW Integration: *ch. 7*	
External drives	n/a	1 HW Integration: *ch. 5*
In libraries	1 HW Integration: *ch. 1*	
In servers	n/a	1 HW Integration: *ch. 4*
In tape arrays	n/a	1 HW Integration: *ch. 3*
Monitoring drive and tape condition	2 SW Integration: *ch. 7*	
Software troubleshooting techniques	2 SW Integration: *ch. 1*	

Dealing with errors

	FC Drives	SAS Drives
Error codes	1 HW Integration: *ch. 6*	1 HW Integration: *ch. 10*
Handling errors	2 SW Integration: *ch. 5*	
Logs—see the LOG SENSE command	3 Host Interface: *ch. 4*	
Recovering from write and read errors	2 SW Integration: *ch. 7*	
Software response to error correction	2 SW Integration: *ch. 3*	

	FC Drives	SAS Drives
Software response to logs	2 SW Integration: *ch. 3*	
TapeAlert log	2 SW Integration: *ch. 7*	

LTO Ultrium features

	FC Drives	SAS Drives
Autoload	1 HW Integration: *ch. 2*	
Automation Control Interface (ACI)	1 HW Integration: *ch. 2*	
Cartridge Memory (LTO-CM)	1 HW Integration: *ch. 2* 2 SW Integration: *ch. 5*	
Data compression, managing	2 SW Integration: *ch. 5*	
OBDR and CD-ROM emulation	2 SW Integration: *ch. 7*	
Performance optimization	n/a	1 HW Integration: *ch. 8*
	2 SW Integration: *ch. 1*	
Performance, factors affecting	2 SW Integration: *ch. 4*	
Software design	2 SW Integration: *ch. 1*	
Supporting LTO Ultrium features	2 SW Integration: *ch. 5*	

General documents and standardization

See http://www.t10.org/t10_main.htm for INCITS SCSI Primary Commands—3 (SPC-3), SCSI Streaming Commands (SSC-3) and other specifications

Copies of documents of other standards bodies can be obtained from:

INCITS	11 West 42nd Street New York, NY 10036-8002 USA	
ISO	CP 56 CH-1211 Geneva 20 Switzerland	
ECMA	114 Rue du Rhône CH-1204 Geneva Switzerland	Tel: +41 22 849 6000 Web URL: http://www.ecma.ch
Global Engineering Documents	2805 McGaw Irvine, CA 92714 USA	Tel: 800 854 7179 or 714 261 1455

Glossary

AT&T mode Berkeley and AT&T functional modes differ in “read-only” close functionality. In AT&T mode, a device close operation will cause the tape to be repositioned just after next filemark on the tape (the start of the next file).

Berkeley mode Berkeley and AT&T functional modes differ in “read-only” close functionality. In Berkeley mode the tape position will remain unchanged by a device close operation.

BOT *Beginning Of Tape*. The first point on the tape that can be accessed by the drive.

buffered mode A mode of data transfer in write operations that facilitates tape streaming. It is selected by setting the Buffered Mode Field to 1 in the SCSI MODE SELECT Parameter List header.

compression A procedure in which data is transformed by the removal of redundant information in order to reduce the number of bits required to represent the data. This is basically done by representing strings of bytes with codewords.
In LTO drives, the data is compressed using the LTO-DC compression format which is based on ALDC (licensed from Stac/IBM) with two enhancements. One limits the increase in size of data that cannot be compressed that ALDC produces. The other is the use of embedded codewords.

Fibre Channel Fibre Channel provides an inexpensive yet expendable means of quickly transferring data between workstations, mainframes, supercomputers, desktop computers, storage devices, displays and other peripherals. Although it is called Fibre Channel, its architecture represents neither a channel nor a real network topology. It allows for an active intelligent interconnection scheme, called a fabric, to connect devices. All a Fibre Channel port has to do is to manage a simple point-to-point connection between itself and the fabric.
Several common ULPs (Upper Level Protocols) including IP and SCSI can run on Fibre Channel, merging high-speed I/O and network functionality in a single connectivity technology.

filemark A mark written by the host to the tape that can be searched for, often using the drive’s fast-search capability. It does not necessarily separate files. It is up to the host to assign a meaning to the mark.

immediate mode A mode of responding to SCSI commands where the drive or other peripheral does not wait until the command has finished before returning status information back to the host. For writing filemarks, Immediate mode can significantly improve the performance of systems that do not set the Immediate bit when sending a SCSI WRITE FILEMARKS command. On the other hand, data is not flushed to tape in response to a filemark command.

infinite flush By default, the buffer in the drive is flushed every 5 seconds. Infinite flush avoids frequent starting and stopping of the mechanism when using a very slow application. It also avoids losing capacity through the flushing of partly written

groups. On the other hand, infinite flush means that data can remain in the buffer for very long periods of time, and could be lost in the event of a power failure.

LUN *Logical Unit Number*, by which different logical units within a particular device can be addressed individually. Each logical unit contains a device server. The drive provides a SSC device server, typically at LUN 0, and an ADC device server, typically at LUN 7. Both may be reassigned, for example the ADI automation controller may reassign the ADC LUN by using the ADC Device Server configuration mode sub-page. Finally, the drive also provides optional SMC LUN(s), which may be assigned by an ADI automation controller at the time of enablement, typically at LUN 1.

SAN *Storage Area Network*. A dedicated, high-speed network that establishes a direct connection between storage elements and servers. The hardware that connects workstations and servers to storage devices in a SAN is referred to as a fabric. The SAN fabric enables any-server-to-any-storage device connectivity through the use of Fibre Channel switching technology.

sequential access Sequential access devices store data sequentially in the order in which it is received. Tape devices are the most common sequential access devices. Devices such as disk drives are *direct access* devices, where data is stored in blocks, not necessarily sequentially. Direct access allows speedy retrieval, but is significantly more costly.

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