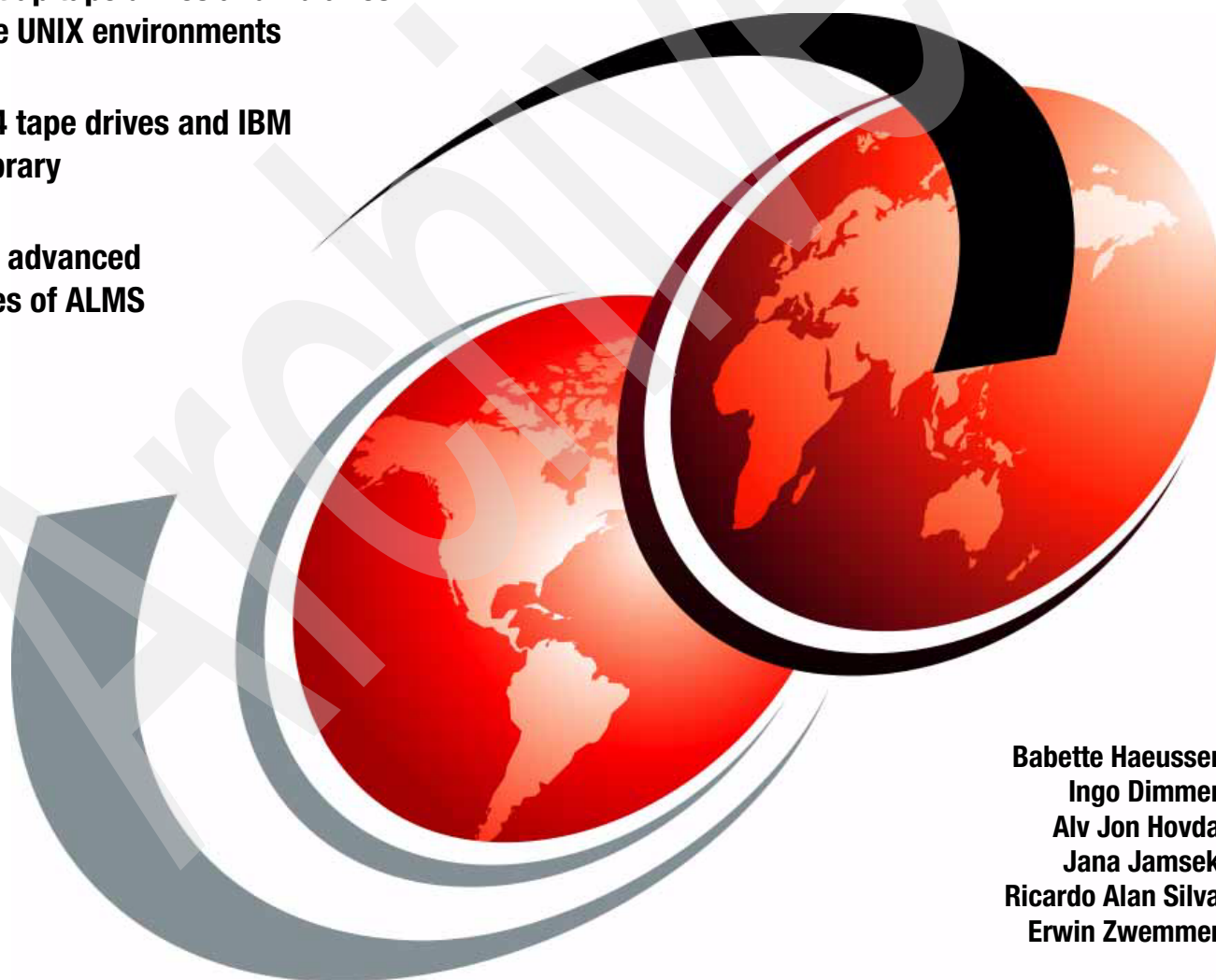


Implementing IBM Tape in UNIX Systems

How to set up tape drives and libraries
in multiple UNIX environments

New: LT04 tape drives and IBM
TS3400 library

Utilize the advanced
capabilities of ALMS



Babette Haeusser
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Redbooks



International Technical Support Organization

Implementing IBM Tape in UNIX Systems

October 2007

Archived

Note: Before using this information and the product it supports, read the information in “Notices” on page ix.

Fifth Edition (October 2007)

This edition applies to all IBM Tape Drives and Tape Libraries current at the time of publication.

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Preface

This IBM® Redbooks® publication follows *The IBM System Storage™ Tape Libraries Guide for Open Systems*, SG24-5946, and will help you plan, install, and configure IBM Ultrium LTO tape drives, as well as the TS1120 Tape Drive and libraries in UNIX® environments. The book focuses on the setup and customization of these drives and libraries in both direct-attached SCSI and SAN configurations for the AIX®, Solaris™, and HP-UX operating systems.

In the first part of the book, we describe how to attach and configure the drives and libraries, and covers basic installation and administration. We also describe the sharing and partitioning of libraries and explain the concept and usage of the Advanced Library Management System (ALMS).

In the second part, we document how to use these products with popular data backup applications such as IBM Tivoli® Storage Manager.

This book will help IBM personnel, Business Partners, and customers to better understand and implement the IBM Ultrium LTO product line, and also the TS1120 Tape Drive in UNIX environments. We assume that the reader is familiar with tape drives and libraries, and understands basic SAN concepts and technologies.

The team that wrote this IBM redbooks publication

This book was produced by a team of specialists from around the world working at the International Technical Support Organization, San Jose Center.

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Summary of changes

This section describes the technical changes made in this edition of the book and in previous editions. This edition may also include minor corrections and editorial changes that are not identified.

Summary of Changes
for SG24-6502-04
for Implementing IBM Tape in UNIX Systems
as created or updated on October 15, 2007.

October 2007, Fifth Edition

This revision reflects the addition, deletion, or modification of new and changed information described below.

New information

- ▶ Ultrium 4 drives
- ▶ TS3400 Tape Library
- ▶ TS1120 Tape Drive
- ▶ Tape Encryption

October 2005, Fourth Edition

This revision reflects the addition, deletion, or modification of new and changed information described below.

New information

- ▶ WORM media for Ultrium 3 drives
- ▶ Ultrium 3 drives and libraries
- ▶ Virtual I/O for IBM TotalStorage 3584 Tape Library

July 2004, Third Edition

This revision reflects the addition, deletion, or modification of new and changed information described below.

New information

- ▶ New models, IBM TotalStorage 3581 2U Tape Autoloader L28 and F28
- ▶ New frames and features for the IBM TotalStorage 3584 Tape Library, including support for IBM TotalStorage 3592 Tape Drive with WORM media
- ▶ Setup and implementation information for the IBM TotalStorage 3592 Tape Drive
- ▶ Advanced Library Management System (ALMS) for the IBM 3584

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Part 1

Setting up IBM Open Systems Tape in UNIX

In this part of the book, we introduce the IBM System Storage tape products (IBM LTO Ultrium products and TS1120 Enterprise Tape Drive) and describe how to set them up in various UNIX environments using SAN (Fibre Channel) attachments. We also show how to use the administration tools such as the IBM System Storage Tape Library Specialist.

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Introduction to IBM Open Systems Tape

In this chapter we provide an overview of the Linear Tape-Open (LTO) initiative and the corresponding IBM System Storage LTO Ultrium product line. This includes:

- ▶ An overview of the IBM System Storage Tape LTO models available:
 - IBM TS2230 Tape Drive
 - IBM TS2340 Tape Drive
 - IBM TS3100 Tape Library
 - IBM TS3200 Tape Library
 - IBM TS3310 Tape Library
 - IBM TS3500 Tape Library
- ▶ An overview of the other IBM System Storage Enterprise Tape models:
 - IBM TS1120 Tape Drive
 - IBM TS3400 Tape Library
- ▶ An overview of Tape Encryption
- ▶ Server and operating system platforms, and storage management software
- ▶ Connectivity examples, such as:
 - Direct SCSI attachment
 - SCSI bus performance
- ▶ Discussion of HBAs and drivers
- ▶ LVD and SAS
- ▶ Discussion of HD68 versus VHDCI

1.1 LTO overview

The Linear Tape-Open (LTO) program is a joint initiative of Hewlett-Packard, IBM, and Seagate Technology. In 1997, the three companies set out to enable the development of best-of-breed tape storage products by consolidating state-of-the-art technologies from numerous sources. The three companies also took steps to protect client investment by providing a four-generation road map and establishing an infrastructure to enable compatibility between competitive products.

The LTO technology objective was to establish new open-format specifications for high capacity, high performance tape storage products for use in the midrange and network server computing environments, and to enable superior tape product options.

LTO program cooperation goes beyond the initial three companies. LTO format specifications have been made available to all who want to participate through standard licensing provisions. LTO program technology has already attracted a number of other industry leaders, so that LTO-specified products (tape drives and tape storage cartridges) will reach the market from multiple manufacturers, not just the Technology Provider Companies. This is critical to meeting an open market objective, and is accomplished through open licensing of the technology.

Cooperation is also evident in the LTO program requirement that all products produced by licensees be technically certified annually. The primary objective of this certification is to help determine whether LTO format cartridges will be exchangeable across drives produced by different LTO Ultrium manufacturers. In other words, LTO compliant media from any vendor can be read and written in LTO compliant drives from any vendor.

All three consortium members (IBM, HP, and Certance LLC¹) are now shipping LTO Ultrium products, and numerous other licensees are shipping hardware and media.

The Linear Tape-Open organization home page is:

<http://www.lto.org>

For more information about LTO technology, see *IBM System Storage Tape Libraries Guide for Open Systems*, SG24-5946.

The IBM LTO home page is:

<http://www.ibm.com/storage/lto>

The LTO Ultrium road map (Figure 1-1) shows the evolution of LTO technology. At the time of writing, IBM Ultrium generation 3 and 4 products are offered. The information in the road map is given as an indication of future developments by the three consortium members, and is subject to change.

Important: Hewlett-Packard, IBM, and Certance reserve the right to change the information in this migration path without notice.

¹ Seagate RRS became Certance and is now owned by Quantum.

	Generation 1	Generation 2	Generation 3	Generation 4	Generation 5	Generation 6
Capacity (Native)	100GB	200GB	400GB	800GB	1.6 TB	3.2 TB
Transfer Rate (Native)	Up to 20MB/s	Up to 40MB/s	Up to 80MB/s	Up to 120MB/s	Up to 180MB/s	Up to 270MB/s
WORM	No	No	Yes	Yes	Yes	Yes
Encryption	No	No	No	Yes	Yes	Yes

Figure 1-1 LTO Ultrium road map

1.1.1 LTO Ultrium models

For the remainder of this book we will use the term LTO as a generic term for different generations of the LTO Ultrium tape drives.

As the specific reference to the IBM System Storage TS1040 LTO Ultrium 4 Tape Drive, we use the term LTO4.

The IBM System Storage LTO family consists of:

- ▶ IBM TS2230 Tape Drive
- ▶ IBM TS2340 Tape Drive
- ▶ IBM TS3100 Tape Library
- ▶ IBM TS3200 Tape Library
- ▶ IBM TS3310 Tape Library
- ▶ IBM TS3500 Tape Library

These models are shown in Figure 1-2.



Figure 1-2 The LTO product family

We describe these models in more detail in 1.1.2, “IBM System Storage TS2230 Tape Drive” on page 8.

Some existing models have two drive options and can have IBM LTO3 and LTO4 drives installed.

LTO1 was the first generation of the LTO technology with a tape capacity of 100 GB per cartridge in a native format, and capacity of 200 GB using 2:1 compression.

LTO2 is the second generation of the LTO technology with a tape capacity of 200 GB per cartridge in native format, and capacity of 400 GB using 2:1 compression.

LTO3 is the third generation of the LTO technology with a tape capacity of 400 GB per cartridge in native format, and capacity of 800 GB using 2:1 compression. A WORM (write-once, read-many) version of the LTO3 cartridge is also available.

LTO4 is the fourth generation of the LTO technology with a tape capacity of 800 GB per cartridge in native format, and capacity of 1600 GB using 2:1 compression. A WORM (write-once, read-many) version of the LTO4 cartridge is also available. Media compatibility

Figure 1-3 depicts the media compatibility characteristics for the last three generations of LTO tape.

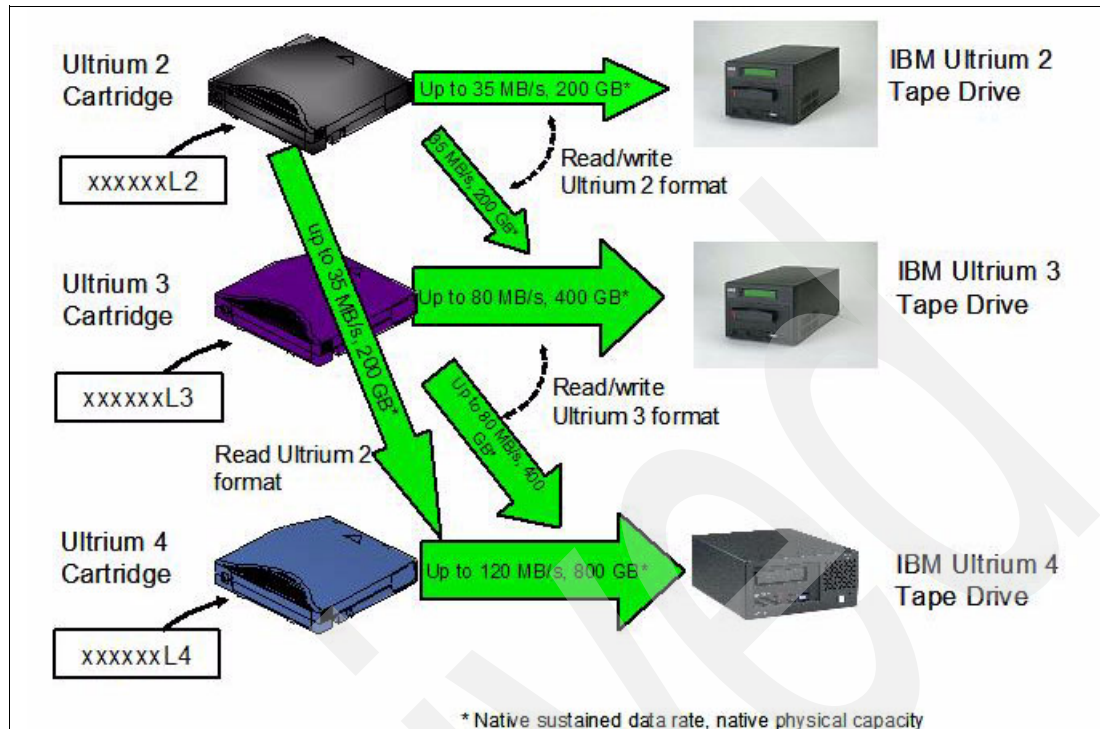


Figure 1-3 LTO Generation 1- 4 media compatibility

LTO2

The LTO2 Tape Drive is compatible with the cartridges of its predecessor, the LTO1 Tape Drive. Cartridge compatibility for the LTO2 Tape Drive is as follows:

- ▶ Reads and writes LTO2 format on LTO2 cartridges
- ▶ Reads and writes LTO1 format on LTO1 cartridges
- ▶ Does not write LTO2 format on LTO1 cartridges
- ▶ Does not write LTO1 format on LTO2 cartridges

LTO3

The LTO3 Tape Drive is compatible with the cartridges of its predecessors, the LTO2 and LTO1 Tape Drive. Cartridge compatibility for the LTO3 Tape Drive is as follows:

- ▶ Reads and writes LTO3 format on LTO3 cartridges
- ▶ Reads and writes LTO2 format on LTO2 cartridges
- ▶ Reads LTO1 format on LTO1 cartridges
- ▶ Does not write LTO3 format on LTO2 cartridges
- ▶ Does not write LTO2 format on LTO3 cartridges

LTO4

The LTO4 Tape Drive is compatible with the cartridges of its immediate predecessors, the LTO3 and LTO2 Tape Drives. Cartridge compatibility for the LTO4 Tape Drive is as follows:

- ▶ Reads and writes LTO4 format on LTO4 cartridges
- ▶ Reads and writes LTO3 format on LTO3 cartridges
- ▶ Reads LTO2 format on LTO2 cartridges
- ▶ Does not write LTO4 format on LTO3 cartridges
- ▶ Does not write LTO3 format on LTO4 cartridges
- ▶ Does not write or read on LTO1 cartridges

WORM tape format

Beginning with LTO3, Write Once Read Many (WORM) functionality provides for non-erasable, non-rewritable operation with tape media and is designed for long term tamper resistant record retention.

The IBM LTO3 specification for WORM includes the use of low level encoding in the Cartridge Memory (CM), which is also mastered into the servo pattern as part of the manufacturing process. This encoding is designed to prevent tampering.

Data can be appended at the end of a WORM cartridge to which data was previously written, allowing the full use of the high capacity tape media.

LTO3 WORM cartridges can be used with any LTO3 tape drive with the appropriate microcode and firmware. LTO3 non-WORM and WORM cartridges can coexist in the same library.

The same description holds for the LTO4 WORM cartridges. They can be used by any LTO4 tape drive, and can coexist with non-WORM cartridges. Additionally, the LTO4 drive can read and write WORM and non-WORM LTO3 cartridges.

1.1.2 IBM System Storage TS2230 Tape Drive

The IBM System Storage TS2230 Tape Drive (3580 Model H3L or H3S) is an external stand-alone or rack mountable unit and is the entry point to the family of IBM Linear Tape-Open (LTO) Tape products. The IBM System Storage TS2230 Tape Drive is designed for backup and restore of midrange Open Systems applications. The IBM System Storage TS2230 Tape Drive incorporates the IBM System Storage LTO3 half-high T880V Tape Drive, which has a native physical capacity of 400GB, or 800GB with 2:1 compression.

The TS2230 is the first member of the IBM LTO Tape Family that uses the new half-high LTO3 Tape Drive. It has the same characteristics of the full-high tape drive except the native transfer rate which is 60 MB/s compared to 80 MB/s for the full-high LTO3 drive. In addition to the standard LTO3 data cartridges, Write Once Read Many (WORM) cartridges are supported and recognized when loaded.

The IBM System Storage TS2230 Tape Drive Model H3L is available with a Low Voltage Differential (LVD) Small Computer System Interface (SCSI). The LVD SCSI interface has a native maximum data transfer rate of up to 60 MB/s. The IBM System Storage TS2230 Model H3S comes with a 3 Gbps Serial-Attached SCSI (SAS) interface.

The TS2230 can be attached to IBM System p™, IBM System i, IBM System p, IBM System x™, Microsoft® Windows®, HP-UX, Sun™ Solaris, UNIX, Linux®, and PC servers. To determine the latest update of supported servers, visit the Web at:

<http://www-03.ibm.com/servers/storage/tape/compatibility>

Figure 1-4 shows the front view of the TS2230.



Figure 1-4 Front view of IBM TS2230 Tape Drive

For more information about the IBM TS2230 Tape Drive, see *IBM System Storage Tape Libraries Guide for Open Systems*, SG24-5946.

1.1.3 IBM System Storage TS2340 Tape Drive

The TS2340 Tape Drive is an external stand-alone or rack-mountable unit and is the entry point for the family of IBM LTO tape products. The TS2340 Tape Drive provides an excellent migration path from digital linear tape (DLT or SDLT), 1/4-inch, 4mm, or 8mm tape drives.

IBM TS2340 is an LTO tape drive designed to increase maximum tape drive throughput native data rate performance up to 120 MB/sec. In addition, with the use of the LTO4 data cartridge, the LTO4 Tape Drive doubles the tape cartridge capacity up to 800 GB native physical capacity (1600 GB with 2:1 compression). IBM LTO4 Tape Drives can read and write LTO3 data cartridges and can read LTO2 data cartridges. In addition, the LTO4 SAS Tape Drive is encryption-capable and designed to support Application Managed encryption.

The TS2340 Tape Drive Model L43 uses a SCSI Ultra160 LVD attachment, and the Model S43 uses a 3 Gbps Serial-Attached SCSI (SAS) interface for connections to a wide spectrum of Open Systems servers. The new models attach to IBM System p, IBM System i, IBM System p, IBM System x, MicroSoft Windows, HP-UX, Sun Solaris, UNIX, and PC servers.

Figure 1-5 shows the IBM TS2340 Tape Drive.



Figure 1-5 IBM TS2340 Tape Drive

For more information about the IBM TS2340 Tape Drive, see *IBM System Storage Tape Libraries Guide for Open Systems*, SG24-5946.

1.1.4 IBM System Storage TS3100 Tape Library

The TS3100 Tape Library (Machine Type 3573, Model L2U), is a single drive or a dual drive entry level desktop or a rack mounted unit (requiring two rack units of a industry standard 19 inch rack). A total of 22 cartridges can be stored in two removable magazines. A single dedicated mail slot (I/O Station) is available for importing and exporting cartridges. The TS3100 Tape Library is available with a choice of two tape drive interfaces, either SCSI LVD or 4 Gbps Native Fibre Channel.

IBM TS3100 supports either one IBM LTO3 full-high tape drive with a native capacity of 400 GB, two IBM LTO3 half-high tape drives with a native capacity of 400 GB or one IBM LTO4 tape drive with a native capacity of 800 GB. With the IBM LTO4 tape drive, the IBM TS3100 also has 3 GB SAS (Serial Attached SCSI) attachment interface. Standard features are a barcode reader and a remote management unit (RMU).

The IBM TS3100 also supports Application Managed Encryption (AME) on SAS and Fibre Channel LTO4 drives using LTO4 media.

The TS3100 Tape Library can be attached to IBM System p, IBM System i, IBM System x, Microsoft Windows, HP-UX, Sun Solaris, UNIX, Linux, and PC servers.

It provides the ability to configure the number of logical libraries up to the number of tape drives. This provides a maximum capability of two logical libraries for the TS3100 with two half-high drives.

Available as a standard feature, a *Remote Management Unit (RMU)* provides an Ethernet port, so that the library can be configured as a TCP/IP device in the network. Library status can be sent to the network as Simple Network Management Protocol (SNMP) traps. The IBM System Storage Tape Library Specialist enables network access (via Web browser) to the library for more detailed status and for updating the firmware of the library. All library Operator panel functions can be accessed using the IBM System Storage Tape Library Specialist.

Figure 1-6 shows the IBM TS3100 Tape Library.



Figure 1-6 IBM TS3100 Tape Library

For more information about the IBM TS3100 Tape Library, see *IBM System Storage Tape Libraries Guide for Open Systems*, SG24-5946.

1.1.5 IBM System Storage TS3200 Tape Library

The TS3200 Tape Library (Machine Type 3573, Model L4U) is a midrange level desktop or a rack mounted unit (requiring four rack units of a industry standard 19 inch rack). A total of 44 cartridges can be stored in four removable magazines. A single dedicated mail slot (I/O Station) is available for importing and exporting cartridges. The TS3200 Tape Library is available with a choice of two tape drive interfaces, either SCSI LVD or 4 Gbps Native Fibre Channel.

IBM TS3200 supports either two IBM LTO3 full-high tape drives with a native capacity of 400 GB, four IBM LTO3 half-high tape drives with a native capacity of 400 GB, two IBM LTO4 tape drives with a native capacity of 800 GB or a mix of IBM LTO3 and LTO4 full-high tape drives. With the IBM LTO4 tape drive, the IBM TS3200 also has 3 GB SAS (Serial Attached SCSI) attachment interface. Standard features are a barcode reader and a remote management unit (RMU).

The IBM TS3200 also supports Application Managed Encryption (AME) on SAS and Fibre Channel LTO4 drives using LTO4 media. Designed for high system availability, the optional control path feature can assure continued host connectivity even if one path goes down.

The TS3200 Tape Library can be attached to IBM System p, IBM System i, IBM System x, Microsoft Windows, HP-UX, Sun Solaris, UNIX, Linux, and PC servers.

It provides the ability to configure the number of logical libraries up to the number of tape drives. This provides a maximum capability of four logical libraries for the TS3200 with four half-high drives.

Available as a standard feature, a *Remote Management Unit* (RMU) provides an Ethernet port, so that the library can be configured as a TCP/IP device in the network. Library status can be sent to the network as Simple Network Management Protocol (SNMP) traps. The IBM System Storage Tape Library Specialist enables network access (via Web browser) to the library for more detailed status and for updating the firmware of the library. All library Operator panel functions can be accessed using the IBM System Storage Tape Library Specialist.

Figure 1-7 shows the IBM TS3200 Tape Library.



Figure 1-7 IBM TS3200 Tape Library

For more information about the IBM TS3200 Tape Library, see *IBM System Storage Tape Libraries Guide for Open Systems*, SG24-5946.

1.1.6 IBM System Storage TS3310 Tape Library

The TS3310 Tape Library is a highly expandable IBM LTO library which allows you to start small with a 5U base unit available in desktop or rack mounted configurations. Over time, as your requirement for tape backup expands, you can add additional 9U expansion modules, each of which contains space for additional cartridges, tape drives, and a redundant power supply. The entire system grows vertically. Available configurations include the 5U base library module alone or with up to four 9U modules.

The TS3310 Tape Library offers a broad range of configuration possibilities. The smallest configuration includes a base unit with one or two tape drives, either IBM LTO3, LTO4, or a mix, 30 storage slots and 6 I/O slots. This will be upgradeable to a fully configured rack mounted library 41U high with up to 18 IBM LTO3 or LTO4 tape drives, tape storage (402 slots) and up to 54 I/O slots.

The IBM TS3310 also supports Application Managed Encryption (AME), System Managed Encryption (SME) and Library Managed Encryption (LME) on SAS and Fibre Channel LTO4 drives using LTO4 media. Designed for high system availability, the optional control path feature can assure continued host connectivity even if one path goes down.

The TS3310 Tape Library can be attached to IBM System p, IBM System i, IBM System x, Microsoft Windows, HP-UX, Sun Solaris, UNIX, Linux, and PC servers.

It provides the ability to configure the number of logical libraries up to the number of tape drives. This provides a maximum capability of 18 logical libraries for the IBM TS3310.

Available as a standard feature, a *Remote Management Unit* (RMU) provides an Ethernet port, so that the library can be configured as a TCP/IP device in the network. Library status can be sent to the network as Simple Network Management Protocol (SNMP) traps. The IBM System Storage Tape Library Specialist enables network access (via Web browser) to the library for more detailed status and for updating the firmware of the library. All library Operator panel functions can be accessed using the IBM System Storage Tape Library Specialist.

Figure 1-8 shows the IBM TS3310 Tape Library 5U base unit.



Figure 1-8 IBM TS3310 Tape Library 5U base unit

For more information about the IBM TS3310 Tape Library, see *IBM System Storage Tape Libraries Guide for Open Systems*, SG24-5946.

1.1.7 IBM System Storage TS3500 Tape Library

The IBM System Storage TS3500 Tape Library (Figure 1-9) leverages the LTO and Enterprise 3592 drive technologies within the same library. The TS3500 was previously known as the IBM TotalStorage 3584 Tape Library and still has the machine type 3584.

The IBM System Storage TS3500 Tape Library provides tape storage solutions for the large, unattended storage requirements from today's mid-range up to enterprise (z/OS® and Open Systems) environments. This chapter only covers information relating to the TS3500 Tape Library library attachment in an Open Systems environment. For information about TS3500 Tape Library attachment to a z/Series environment, refer to the Redbooks publication, *IBM TotalStorage 3584 Tape Library for zSeries Hosts: Planning and Implementation*, SG24-6789.

Combining reliable, automated tape handling and storage with reliable, high-performance IBM LTO tape and TS1120 drives, the TS3500 Tape Library offers outstanding retrieval performance with typical cartridge move times of less than three seconds.

The TS3500 Tape Library can be partitioned into multiple logical libraries. This makes it an excellent choice for consolidating tape workloads from multiple heterogeneous open-system servers and enables the support for z/Series attachment in the same library.

In addition, the TS3500 Tape Library provides outstanding reliability and redundancy, through the provision of redundant power supplies in each frame, an optional second cartridge accessor, control and data path failover, and dual grippers within each cartridge accessor. Both library and drive firmware can now be upgraded non-disruptively, that is without interrupting the normal operations of the library.

The TS3500 supports Tape Encryption on the following tape drives: IBM System Storage TS1040 Tape Drive, and the IBM System Storage TS1120 Tape Drive. The three different Encryption methods are supported: Application-Managed Encryption (AME), System-Managed Encryption (SME) and Library-Managed Encryption (LME) by the TS3500.



Figure 1-9 IBM System Storage TS3500 Tape Library

1.1.8 TS3500 frames L53 and D53 for IBM LTO Fibre Channel drives

The TS3500 Tape Library Models L53 and D53 integrate the TS1030 and TS1040 LTO 4 Gbps Fibre Channel Tape Drive. The Model L53 frame includes an enhanced Frame Controller Assembly (FCA) with two power supplies (for redundancy), an optimized dual-gripper cartridge accessor, on-demand storage slot capacity, and 16-slot I/O stations. The Model D53 frame can be attached to current or installed frame models.

TS3500 Tape Library Model L53

The L53 can be installed on its own as a complete library enclosure, or it can have up to 15 expansion frames attached to it. This frame provides the major library components for the whole library, whether it has single or multiple frames. It also provides cartridge storage capacity for LTO media and it can be equipped with IBM LTO 1, 2, 3, and 4 tape drives. The expansion frames must be added to the right of the L53 frame.

The number of LTO cartridge storage slots ranges from 64 to 287. With the minimum configuration, there are just 64 slots available for use, but the maximum of 287 slots are already physically installed. Additional slots can be added for use by simply enabling through a license key.

The Intermediate Capacity feature (FC1643) gives a total amount of usable cartridge slots of 129. This feature is required to add a Full Capacity feature (FC1644), which gives the capacity of 287 cartridge slots. The full capacity feature is in turn required to add an Additional I/O Slots feature (FC1658 for LTO or FC1659 for 3592) or to attach an optional expansion frame.

This gives a maximum data capacity for the L53 of 229 TB native (up to 458 TB with 2:1 data compression).

Up to 12 IBM LTO drives can be installed. LTO1, LTO2, LTO3, and LTO4 tape drives can be installed in the same frame. As you add more than four drives or install the additional I/O station, there is an incremental reduction in storage slots. It is also possible to install the LTO FC Drive Mounting Kit (FC1514) in advance, to simplify future tape drive installation, but it will also reduce the number of available slots.

Each TS3500 Model L53 has a standard 16-slot LTO cartridge input/output station for importing or exporting cartridges from the library without requiring re-inventory or interruption of library operations. Optional features can provide 16 additional input/output slots for LTO (FC1658) or 3592 media (FC1659). The lockable library door can be opened for bulk-loading IBM LTO tape cartridges. Re-inventory of the cartridges is done in fewer than 60 seconds per frame each time the library door is closed. A barcode reader mounted on the autochanger scans the cartridge labels at less than one minute per frame. A door lock is included to restrict physical access to cartridges in the library.

TS3500 Tape Library Model D53

The D53 frame has the same footprint as the model L53.

The D53 cannot be installed on its own. It must be connected to a library with a base frame and optionally multiple expansion frames. Up to 16 frames can be connected together.

If one or more tape drives are installed in the D53, then the Enhanced Frame Control Assembly Feature (FC1451) is required along with the LTO Fibre Drive Mounting Kit (FC1514). This feature provides the hardware and firmware required to support IBM LTO drives within the D53 and also provides a redundant AC line feed for the L frame accessor. The Frame Control Assembly Feature is also required if LTO Fibre Drive Mounting Kit (FC1504) is installed.

You can easily configure D53 frames according to future requirements. By installing the Enhanced Frame Control Assembly (FC1451), the D53 frame is ready to host LTO drives. The LTO Fibre Drive Mounting Kit (FC1514) prepares the drive slots for hosting an LTO drive. This enables you to install or move LTO drives without any additional hardware changes.

A fully configured IBM TS3500 Tape Library with one L53 frame and 15 D53 frames supports up to 192 drives. An L53 base frame and 15 D53 expansion frames with a minimal drive configuration provides a maximum capacity of 6887 storage slots with a total capacity of 5.5 PB without compression.

The base L23 or L53 is always on the left and as many as 15 additional D53 and/or D23 expansion frames can be added to the right side. During the installation of additional D53 frames, the x-rail of the L frame where the accessor resides will be extended, so that the accessor can move through the new installed frame.

If a D53 is being added to an installed L32 or D32 frame, feature FC1610 is required, since the D53 is a shorter frame. This feature includes a short rear side cover for the Model D32/L32 frame and the Model D23/D53 front and rear side covers.

An additional 16-slot input/output station for LTO media should be ordered via feature FC1658 if attaching a D53 expansion frame to an L23 base frame.

An additional 4 I/O station door can be installed in a D53 frame. This requires Feature Code 1451, and up to three D53 frames can be installed with this feature. Figure 1-10 shows the 4 I/O Station D-Frame. On the right upper corner there is a LED status panel located. The LEDs represents the amount of cartridges per I/O station and if the I/O station is locked. The I/O door has a total amount of 64 slots, 16 slots per I/O station.

The 4 I/O station door reduces the frame storage slot capacity by 176 for a model D53. The I/O stations increase the maximum library I/O station slots from 32 to 224 due to a maximum of three D23 or D53 I/O frames in a sixteen frame library. The D23 and D53 models are compatible with existing models L22, L32, L52, D22, D32, and D52.

Figure 1-10 shows a graphical overview of the 4 I/O station door using the Web user interface. In our example there are five cartridges imported in the upper right I/O station and when you put your cursor on the data cartridge, it shows you the volume label.

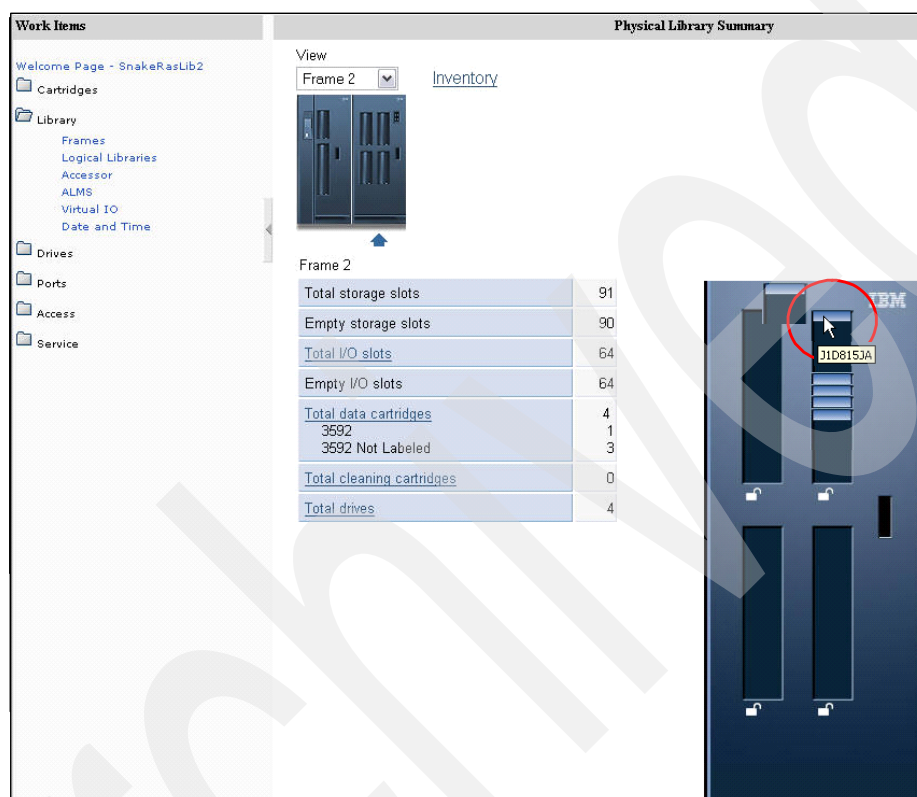


Figure 1-10 A graphical overview of the 4 I/O door using the Web user interface

1.1.9 IBM TS3500 Tape Library frames L23 and D23

The Model L23 and D23 frames integrate the IBM TotalStorage 3592 Tape Drive with 4 Gbps dual-ported switched fabric Fibre Channel attachment. The TS3500 Tape Library Model L23 and D23 frames can be attached to LTO Frames (L53 and D53), and, therefore, TS1120 and LTO tape drives can be intermixed within the same TS3500 Tape Library.

The TS1120 Tape Drive used in the IBM TS3500 Tape Library Models L23 and D23 is designed for automation and uses a tape cartridge with a form factor similar to the IBM 3590 tape cartridges. The TS1120 Tape Drive has a dual-ported 4 Gbps Fibre Channel interface and has a native data rate of up to 100 MB/s. The TS1120 Tape Drives are designed to provide high levels of performance, functionality, and cartridge capacity supporting the 3592 tape format, including Write Once Read Many (WORM) media support.

IBM System Storage TS3500 Model L23 Frame

The TS3500 Model L23 provides cartridge slots for 3592 media and support for up to twelve TS1120. This model has the same footprint as the model L53. Data capacity for the model L23 using 3592 data cartridges is 17 to 78 TB native. The L23 can be installed on its own as

a complete library enclosure, or up to 15 Model D23 or D53 can be attached to it. The library capacity and number of drives can be expanded to meet changing requirements.

The L23 frame provides the major library components for the whole library, whether it has single or multiple frames. The expansion frames must be added to the right of the L53 frame.

The number of 3592 cartridge storage slots ranges from 58 to 260. The minimum configuration provides 58 slots available for actual use, although all 260 slots are already physically installed. To enable the additional slots for use (up to the total of 260), obtain an additional license key by ordering one of the following Capacity On Demand features. The Intermediate Capacity feature (FC1643) gives a total amount of usable cartridge slots of 117. This feature is required to add a Full Capacity feature (FC1644), which gives the capacity of 260 cartridge slots. The Full Capacity feature is required to add an additional I/O Slots feature (FC1658 or FC1659) or to attach the optional expansion frame models D23 or D53.

Up to 12 IBM TS1120 Tape Drives can be installed. Adding more than four drives or drive mounting kits, or installing the additional I/O station, will reduce the number of storage slots available for use. You can also install the 3592 FC Drive Mounting Kit (FC1513) in advance, which will simplify future tape drive installation. This kit reduces the storage slots to the appropriate number and provides the power supply and necessary cables for installing a TS1120 drive.

Each L23 has a standard 16-slot 3592 cartridge input/output station for importing or exporting cartridges from the library without requiring re-inventory or interruption of library operations. Optional features can provide 16 additional input/output slots for LTO media. The lockable library door can be opened for bulk-loading cartridges. Re-inventory of the cartridges is done in fewer than 60 seconds per frame each time the library door is closed. A barcode reader mounted on the autochanger scans the cartridge labels at less than one minute per frame. A door lock is included to restrict physical access to cartridges in the library.

IBM System Storage TS3500 Model D23 frame

The D23 frame has the same footprint as the Model L23. The D53 cannot be installed on its own. It must be connected to a base frame and optionally other expansion frames. Up to 16 frames can be connected.

If one or more tape drives are installed in the D23, then the Enhanced Frame Control Assembly Feature is also required (FC1451). This feature provides the hardware and firmware required to support IBM 3592 drives within the D23 and provides a redundant line feed for the L23 or L53 accessor.

You can easily configure D23 frames according to future requirements. By installing the Enhanced Frame Control Assembly (FC1451), the D23 frame is ready to host TS1120 tape drives. The 3592 Fibre Drive Mounting Kit (FC1513) prepares the drive slots for hosting a TS1120 Tape Drive. This enables you to install or move 3592 drives without any additional hardware changes.

A fully configured IBM TS3500 Tape Library with one L23 frame and 15 D23 frames supports up to 192 drives. An L23 base frame and 15 D23 expansion frames with a minimal drive configuration provides a maximum capacity of 6260 storage slots with a total capacity of 1878 TB without compression using the IBM TotalStorage 3592 Tape Drive.

The base frame (mode Lxx) is always on the left and as many as 15 additional expansion frames (Dxx) can be added to the right side. During the installation of additional D23 frames, the x-rail of the L frame where the accessor resides is extended, so that the accessor can move through the new installed frame.

If a D23 is being added to an installed L32 or D32 frame, feature FC1610 is required, since the D23 is a shorter frame. This feature includes a short rear side cover for the Model D32/L32 frame and the Model D23/D53 front and rear side covers.

If attaching a D23 frame to an L53 frame, the First Expansion Frame Attachment Feature (FC9002) for the L53 must be specified. Subsequent expansion requires the Additional Expansion Frame Attachment feature (FC9003).

Additional 16-slot I/O stations for 3592 media should be ordered via feature FC1659 if attaching a D23 frame to a L53.

An additional 4 I/O station door can be installed in a D23 frame. This requires Feature Code 1451, and up to three D23 frames can be installed with this feature. Figure 1-10 on page 15 shows the 4 I/O Station D-Frame. On the right upper corner there is a LED status panel located. The LEDs represents the amount of cartridges per I/O station and if the I/O station is locked. The I/O door has a total amount of 64 slots, 16 slots per I/O station.

The 4 I/O station door reduces the frame storage slot capacity by 160 for a model D23. The I/O stations increase the maximum library I/O station slots from 32 to 224 due to a maximum of three D23 or three D53 I/O frames in a sixteen frame library. The D23 and D53 models are compatible with existing models L22, L32, L52, D22, D32, and D52.

1.1.10 IBM TS3500 High Availability Unit HA1

The IBM TS3500 High Availability Frame Model HA1 can be added to the IBM TS3500 Tape Library Base Frame Models. In conjunction with a service bay feature on the TS3500 Tape Library Model D23 or L23, the Model HA1 provides for the installation and operation of a second library accessor that is designed to operate simultaneously with the first accessor and service mount requests in the IBM TS3500 Tape Library. It is designed to non-disruptively fail over to a redundant accessor when any component of either accessor fails, which helps maintain availability and reliability. This design also includes the ability to add one or more Model D53 or D23 frames to an IBM TS3500 Tape Library that has an attached Model HA1 with minimal disruption.

Dual active accessor support is provided in a mixed media library. This includes any combination of 3592 and LTO media types. For example, a single library can have 3592, LTO1, LTO2, LTO3, and LTO4 media installed and configured. The Advanced Library Management Systems (ALMS) (see 1.1.15, "ALMS" on page 21) is required for support of dual accessors and two or more media types.

When dual accessors are installed and an attached host issues a command for cartridge movement, the library automatically determines which accessor can perform the mount in the most timely manner. If the library's primary accessor fails, the second accessor assumes control and eliminates system outage or the requirement for operator intervention.

A dual accessor library will have two garage areas called service bays (see Figure 1-11). Service Bay A (the TS3500 High Availability Frame Model HA1) is to the left of and adjacent to the L-frame, when facing the front door. Service Bay B (a modified TS3500 Tape Library Model D23 or D53) is to the right of the last active frame in the library.

The TS3500 Tape Library Model HA1 itself provides only a frame, which serves as Service Bay A for the original accessor for the TS3500 Tape Library Model Lxx. The second accessor is provided by ordering the Service Bay B Configuration and Dual Accessor feature (FC1440) on a TS3500 Tape Library Expansion Frame Model D23 or D53. When this feature is ordered on a Model D23 or D53, that expansion frame will be reserved and function as a Service Bay B for the second accessor. This feature should initially be installed on a new Model D23 or

D53 frame that is added to the IBM TS3500 Tape Library when ordering the Model HA1. If your library already contains the service bays and you decide to add one or more D23 or D53 expansion frames, Service Bay B will be converted to an expansion frame, the new frame or frames will be added to the right, and the last frame on the right will be converted to Service Bay B. The downtime for this process is designed to be less than hour.

The service bays will be regular library frames but they will not have drives, power supplies, or node cards. Storage slots within the service bays will only be used to test service actions. Figure 1-11 demonstrates how the Service Bays surround the other library frames.

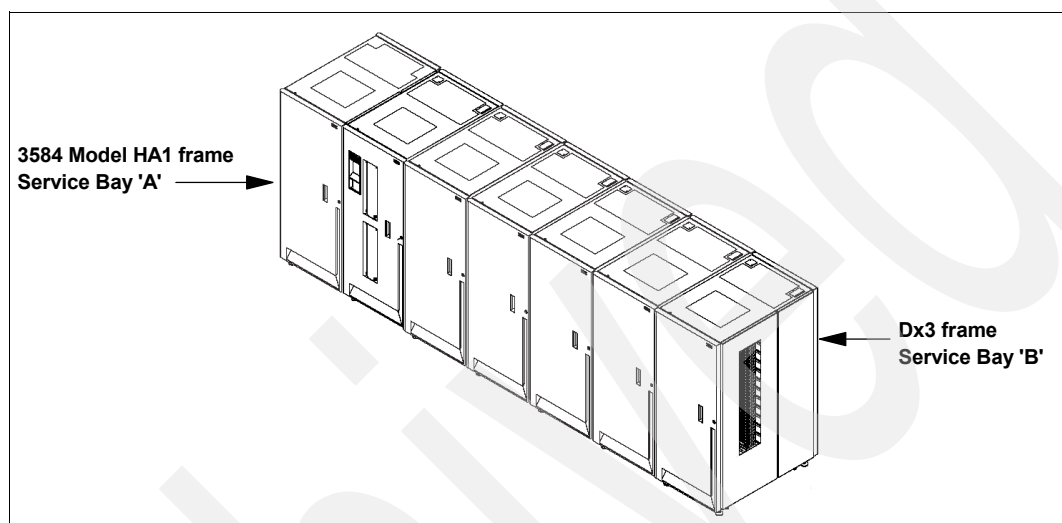


Figure 1-11 Location of service bays in the IBM TS3500 Tape Library

To summarize, to implement non-disruptive accessor failover, these features are required:

- ▶ A TS3500 Model HA1 frame to act as Service Bay A
- ▶ High Availability Library feature (FC9040) for the Lxx frame.
- ▶ Advanced Library Management System feature (FC1690)
- ▶ A D53 or D23 frame to operate as Service Bay B for the second accessor
- ▶ Additional expansion frame Attachment (FC9003)
- ▶ Service Bay B Configuration with Accessor (FC1440)

1.1.11 Control path failover

Control path failover, currently available for AIX, Linux, Solaris, HP-UX, and Windows hosts, configures multiple physical control paths to the same logical library within the device driver and provides automatic failover to an alternate control path when a permanent error occurs on one path. This process can be transparent to some applications while in operation.

For example, consider a simple multi-path architecture connection consisting of two HBAs in a host that are connected to a library with two or more drives. Two drives have the control ports enabled. The two HBAs are connected to the first and second control port drives, respectively. This simple configuration provides two physical control paths to the library for redundancy if one path from an HBA to the library fails. When the server boots, each HBA detects a control port to the library, and two medium changer devices (smc0 and smc1) are configured. Each logical device is a physical path to the same library; however, an application can open and use only one logical device at a time, either smc0 or smc1.

Without the device driver alternate pathing support, if an application opens smc0 and a permanent path error occurs (because of an HBA, cable, switch, or drive control port failure),

the current command to the library fails. It is possible to initiate manual failover by changing the device path to the alternate path (smc1), but this is a manual operation and the last failing command has to be resent.

When the alternate pathing support is enabled on both smc0 and smc1, the device driver configures them internally as a single device with multiple paths. The application can still open and use only one logical device at a time (either smc0 or smc1). If an application opens smc0 and a permanent path error occurs, the current operation continues on the alternate path without interrupting the application.

Activation of control path failover is done by entering a license key at the library Operator Panel. Control path failover is provided by an optional FC1680 for Lx2 frame models and requires the use of the IBM Atape device driver. For Lx3 models, control path failover and data path failover are available with the optional Path Failover feature (FC1682).

1.1.12 Data path failover

Data path failover and load balancing exclusively support native Fibre Channel LTO and IBM 3592 tape drives in the IBM TS3500 Tape Library using the IBM device driver. AIX, Linux, HP-UX, Solaris, and Windows hosts. Load balancing is supported for AIX, Linux, HP-UX, and Solaris. Refer to the *IBM Tape Device Drivers Installation and User's Guide*, GC27-2130, for current support and implementation details.

Data path failover provides a failover mechanism in the IBM device driver, so that you can configure multiple redundant paths in a SAN environment. If a path or component fails, the failover mechanism is designed to provide automatic error recovery to retry the current operation using an alternate, preconfigured path without stopping the current job in progress. This improves flexibility in SAN configuration, availability, and management. When accessing a tape drive device that has been configured with alternate pathing across multiple host ports, the IBM device driver automatically selects a path through the HBA that has the fewest open tape devices and assigns that path to the application. This autonomic self-optimizing capability is called *load balancing*.

The dynamic load balancing support is designed to optimize resources for devices that have physical connections to multiple HBAs in the same machine. The device driver is designed to dynamically track the usage on each HBA as applications open and close devices, and balance the number of applications using each HBA in the machine. This can help optimize HBA resources and improve overall performance. Further, data path failover provides autonomic self-healing capabilities similar to control path failover, with transparent failover to an alternate data path in the event of a failure in the primary host-side path.

Data path failover and load balancing for Linux and Solaris are provided by an optional feature (FC1681) for Lx2 models. Data path failover is included in the Path Failover feature (FC1682) for Lx3 models, which also includes control path failover.

Data path failover and load balancing support for AIX or for IBM 3592 tape drives do not require this feature.

1.1.13 SNMP

Occasionally, the IBM TS3500 Tape Library might encounter a situation that should be reported, such as an open door that causes the library to stop. Because many servers can attach to the IBM TS3500 Tape Library by differing attachment methods, the library provides a standard TCP/IP protocol called Simple Network Management Protocol (SNMP) to send alerts about conditions (such as an opened door) over a TCP/IP LAN network to an SNMP monitoring server. These alerts are called *SNMP traps*. Using the information supplied in

each SNMP trap, the monitoring server (together with customer-supplied software) can alert operations staff of possible problems or operator interventions that occur. Many monitoring servers (such as IBM Tivoli NetView®) can be used to send e-mail or pager notifications when they receive an SNMP alert.

For more details about SNMP, see Appendix A, “SNMP setup” on page 233.

1.1.14 SMI-S support

This section describes how the IBM TS3500 Tape Library uses the Storage Management Initiative - Specification (SMI-S) to communicate in a SAN environment.

To communicate with storage devices in a SAN, management software can use other software known as the Storage Management Initiative - Specification (SMI-S) Agent for Tape. The SMI-S Agent for Tape is available for Intel®-based SuSE LINUX Enterprise Server 9. The SMI-S Agent for Tape communicates by using the Web-Based Enterprise Management (WBEM) protocol, which allows management software to communicate with the IBM TS3500 Tape Library.

The SMI-S Agent for Tape is designed for compliance with the Storage Management Initiative - Specification. The SMI-S is a design specification of the Storage Management Initiative (SMI) that was launched by the Storage Networking Industry Association (SNIA). The SMI-S specifies a secure and reliable interface that allows storage management systems to identify, classify, monitor, and control physical and logical resources in a Storage Area Network (SAN). The interface is intended as a solution that integrates the various devices to be managed in a SAN and the tools used to manage them. The SMI-S was developed to address the problems that many vendors face in managing heterogeneous storage environments. It creates a management interface protocol for multivendor storage networking products. By enabling the integration of diverse multivendor storage networks, the initiative is able to expand the overall market for storage networking technology.

For detailed information about SMI-S, see the *IBM TotalStorage SMI-S Agent for Tape Installation Guide*, GC35-0512.

The SMI-S agent ran normally on a separate LINUX PC but from library firmware level 7050 SMI-S, in a limited form, is running on the MCP. The level of SMI-S is 1.1 and the following functions are supported within the Server Profile:

- ▶ Library code level:
 - Use IBMTSSML3584_SoftwareIdentity VersionString
- ▶ Library name:
 - Use IBMTSSML3584_TapeLibrary ElementName
- ▶ Administrator and contact information:
 - Use IBMTSSML3584_TapeLibrary PrimaryOwnerName and PrimaryOwnerContact

There is no support for Service Location Protocol (SLP) and Secure Socket Layer (SSL) at the time writing this publication.

The external LINUX PC supports the following protocols:

- ▶ Server Profile SMI-I Version 2
- ▶ Storage Media Library Version 2
 - Limited Access Port 1.1
 - Chassis 1.1
 - FC Port 1.1
 - Software 1.1
 - Physical Package 1.1

In the future, the imbedded SMI-S will have the same functions as the external LINUX PC.

Note: The imbedded SMI-S function requires a LX3 Frame and a library firmlevel that supports SMI-S.

1.1.15 ALMS

The Advanced Library Management System (ALMS), an optional extension to the IBM patented multi-path architecture (FC1690), provides enhanced flexibility and capabilities for partitioning the IBM TS3500 Tape Library. ALMS virtualizes the SCSI element addresses while maintaining the approach of the multi-path architecture and using SCSI3 Medium Changer commands. Without ALMS everything is based on the SCSI element address (location-centric) and partitioning is based on real cartridge slots and drive slots. With ALMS, there is no affinity between a real slot address and a SCSI Element address reported to the server and used by the server. Instead there is now an affinity with the VOLSER (volume serial numbers on the barcode label of the cartridge). For further information and examples of using ALMS, see 2.3, “ALMS” on page 73.

Note ALMS is available only for the IBM TS3500 Tape Library and requires FC1690 for enablement.

1.1.16 Virtual I/O

The IBM TS3500 Tape Library has I/O stations and I/O slots that enable you to import and export up to 32 cartridges at any given time. The I/O slots are also known as *import/export elements (IEEs)*. As a feature of ALMS, Virtual I/O (VIO) slots increase the quantity of available I/O slots by allowing storage slots to appear to the host as I/O slots. Storage slots that appear to the host as I/O slots are called *virtual import/export elements (VIEEs)*. The goal of virtual I/O slots is to reduce the dependencies between the system administrator and library operator so that each performs their import and export tasks without requiring the other to perform any actions. With virtual I/O slots, the library automatically moves cartridges from the I/O stations to physical storage slots and from physical storage slots to the I/O stations. For further description of Virtual I/O, refer to 2.3.2, “Virtual I/O” on page 77.

1.1.17 Element number

Element numbers identify the physical location within the library. This information is required mostly for storage applications, such as IBM Tivoli Storage Manager, which translate the device to a name that the robotic system understands.

In the IBM TS3500 Tape Library, each SCSI storage element is assigned a SCSI element address. A SCSI storage element is a physical location capable of holding a tape cartridge (such as an I/O slot, drive, or storage slot). The element numbering is grouped in:

- ▶ Tape drive sequence
- ▶ I/O station sequence
- ▶ Cartridge slot sequence

Note: The numbering is contiguous for the cartridge slot sequence. However, the addition, removal, or movement of one or more tape drives affects the element numbering of the cartridge slots.

Table 1-1 shows the element numbers for tape drives in each IBM TS3500 Tape Library frame up to six frames. For element numbers up to the maximum 16 frames, see the *IBM Total Storage UltraScalable Tape Library 3584 Operator Guide*, GA32-0468.

Table 1-1 IBM TS3500 Tape Library tape drive element numbers

Drive number	Frame 1 (Lx3)	Frame 2 (Dx3)	Frame 3 (Dx3)	Frame 4 (Dx3)	Frame 5 (Dx3)	Frame 6 (Dx3)
1	257	269	281	293	305	317
2	258	270	282	294	306	318
3	259	271	283	295	307	319
4	260	272	284	296	308	320
5	261	273	285	297	309	321
6	262	274	286	298	310	322
7	263	275	287	299	311	323
8	264	276	288	300	312	324
9	265	277	289	301	313	325
10	266	278	290	302	314	326
11	267	279	291	303	315	327
12	268	280	292	304	316	328

Each element in the IBM TS3500 Tape Library (the cartridge storage slots, I/O storage slots, and tape drives) has two addresses:

- ▶ Physical address
- ▶ SCSI element address

When initiating an operation such as moving a tape cartridge or performing manual cleaning, you can use the physical or logical address to specify a location in the library.

The physical address consists of frame, column, and row identifiers that define a unique physical location in the library. The address is represented as:

- ▶ Fx,Cyy,Rzz for a storage slot (where F equals the frame and x equals its number, C equals the column and yy equals its number, and R equals the row and zz equals its number).
- ▶ Fx,Rzz for a tape drive and I/O storage slot (where F equals the frame and x equals its number, and R equals the row and zz equals its number).

The SCSI element address consists of a bit and hex value that defines to the SCSI interface a logical location in the library. This logical address is represented as xxxx (X'yyy'), where xxxx is a bit value and yyy is a hex value. It is assigned and used by the host when the host processes SCSI commands. The SCSI element address is not unique to a storage slot, drive, or I/O slot; it varies, depending on the quantity of drives in the library.

For example, the storage slot address F2,C03,R22 means:

- ▶ F2: frame 2 (first expansion frame)
- ▶ C03: column 3 (second column from left on drive side)
- ▶ R22: row 22 (22nd position down from the top of the column)

Each drive has a unique address to indicate its physical location. The drive address consists of two values: a frame number and a row number:

- ▶ **Frame number:** Represented as Fx, where F equals the frame and x equals its number. Regardless of whether any drives are installed, the frame number for the base frame is 1 and increments by one for each adjacent expansion frame.
- ▶ **Row number:** Represented as Rzz, where R equals the row and zz equals its number. The row number is 1 for the top drive position in the frame, and increments by one for each row beneath the top drive. Regardless of whether drives are installed, the row numbering is the same for every frame.

A drive address of F2,R10 means frame 2 (that is, the first expansion frame), row 10 (tenth drive position from the top of the column).

Note: ALMS will virtualize a SCSI element address. Therefore, there is no relationship between physical location and SCSI element address if using ALMS.

1.2 Other IBM System Storage Tape Models

Here we describe the two models of IBM Open Systems Tape that belongs to the IBM System Storage Enterprise Tape Family. They are the IBM TS1120 Tape Drive and IBM TS3400 Tape Library.

1.2.1 IBM System Storage TS1120

The TS1120 Tape Drive is the follow-on to the IBM 3592 Tape Drive Model J1A and the highly successful 3590 Enterprise Tape Drive. The TS1120 Tape Drive can be installed in the IBM System Storage TS3500, the IBM TotalStorage 3494 Tape Library, the IBM System Storage TS3400 and in a StorageTek™ 9310 Powderhorn™.

The tape drive uses IBM 3592 Cartridges, which are available in limited capacity (100GB) for fast access to data, standard capacity (500GB) or extended capacity (700GB). All three cartridges are available in re-writable or Write Once Read Many (WORM) format.

The TS1120 Tape Drive is supported in a wide range of environments including selected IBM System i, System p, xSeries®, IBM mainframe Linux, Sun, and Hewlett Packard servers, as well as Intel-compatible servers running Linux, Microsoft Windows 2000, or Windows Server® 2003. A tape controller is required for attachment to ESCON® or FICON® channels on IBM mainframe servers. Sharing drives optimizes drive utilization and helps reduce infrastructure requirements.

The TS1120 tape drive supports a native data transfer rate of up to 104 MBps. In Open Systems environments where data typically compresses at 2:1, the TS1120 tape drive can transfer data up to 200 MBps. In a mainframe environment where data typically compresses at 3:1, a single tape drive can transfer data up to 260 MBps. This high transfer rate help reduce backup and recovery times.

Figure 1-12 shows the IBM System Storage TS1120 Tape Drive.



Figure 1-12 IBM System Storage TS1120 Tape Drive

For more information about the IBM TS1120 Tape Drive, see *IBM System Storage Tape Libraries Guide for Open Systems*, SG24-5946.

1.2.2 IBM System Storage TS3400 Tape Library

The IBM System Storage TS3400 Tape Library (Machine type 3577, Model 5LU) is designed to offer high performance drive technology and automation for the Open Systems environment. The IBM System Storage TS3400 Tape Library is a five units (5U) external desktop or rack-mountable tape library that incorporates one or two IBM System Storage TS1120 Tape Drives Model E05.

The IBM System Storage TS1120 Tape Drive has a native capacity of 700 GB, when using the IBM Extended Data Cartridge (JB) or 500 GB when using the IBM Data cartridge (JA). The only attachment to the host is a 4 GB/s switch fabric Fibre Channel connection. The tape drives must be ordered separately with the final order.

The IBM System Storage TS3400 Tape Library supports the IBM System Storage TS1120 Tape Drive built-in encryption capabilities. The encryption methods are Application-Managed-Encryption (AME), System-Managed-Encryption (SME), and Library Managed Encryption (LME).

The previous IBM System Storage 3592 J1A Tape Drive is not supported in the IBM System Storage TS3400 Tape Library.

Designed for tape automation, the IBM System Storage TS3400 Tape Library can be attached to IBM System p, IBM System i, IBM System x, Microsoft Windows, HP-UX, Sun Solaris, UNIX, Linux, and PC servers.

The IBM System Storage TS3400 Tape Library has two removable cartridge magazines providing 18 data cartridges slots including a 3 slot I/O station. The total native storage capacity is 12.6 TB when using the 700 GB data cartridges.

The IBM System Storage TS3400 Tape Library incorporates the IBM Multi-Path Architecture with one or two logical libraries. The TS1120 has two FC ports (dual ported) to make a connection to the host. The TS1120 provides a sustained native data transfer rate of 100MB/s.

Standard features for the IBM System Storage TS3400 Tape Library: Control path and data path fail over, barcode reader, dual power supplies, remote management and the possibility to use the IBM System Storage TS3400 Tape Library in sequential or random access mode.

Figure 1-13 shows the front view of the IBM TS3400 System Storage Tape Library.



Figure 1-13 Front view of the IBM TS3400 System Storage Tape Library.

For more information about the IBM TS3400 Tape Library, see *IBM System Storage Tape Libraries Guide for Open Systems*, SG24-5946.

1.3 Tape encryption overview

Data is one of the most highly valued resources in a competitive business environment. Protecting this data, controlling access to it, and verifying its authenticity while maintaining its availability are priorities in our security-conscious world. Tape encryption is a process that answers many of these requirements.

The IBM System Storage TS1120 (3592-E05) and TS1040 (LTO4) Tape Drives are capable of encrypting data as it is written to tape. The TS1120 tape drive supports any kind of IBM TotalStorage Enterprise Tape Cartridge, including WORM cartridges and the TS1040 tape drive supports IBM LTO4 Data Cartridges for data encryption. Encryption is performed at full line speed in the tape drive after compression. (Compression is more efficiently done before encryption). The encryption process takes less than one percent of the performance impact on the read/write throughput.

Encryption for the TS1120 Tape Drive is available at no charge. The TS1120 can be installed in the TS3400 and TS3500 Tape Libraries. For the TS1040 the Application-Managed Encryption method is available at no charge. However, a billable Feature Code must be installed, Feature Code 5900 or, for the TS3500, FC1604, to support Transparent LTO Encryption. Feature Code 9900 (Encryption Configuration) should also be ordered. Supported Tape Libraries for the TS1040 Tape Drive are: TS3100, TS3200, TS3310, and TS3500.

Encryption adds a strong measurement of security to stored data without the processing overhead and performance degradation associated with encryption performed on the server or the expense of a dedicated appliance.

Note: TS1120s produced before September 8, 2006 do not have the capability to encrypt data on the Data Cartridge. However there is a chargeable upgrade available (FC 5592) to upgrade the TS1120. This encryption capability includes drive hardware as well as microcode additions and changes.

Encryption keys are used to encrypt data when data is being written to, and decrypt the data when being read from data cartridge. The IBM Encryption Key Manager (EKM) is the component that assists the TS1120 and the TS1040 in generating, protecting, storing, and maintaining encryptions keys. EKM R2 must be used when TS1040s are installed in a tape library.

The EKM is installed on a server in the network and communicates through TCP/IP with the tape library or tape drive. The EKM operates on z/OS, i5/OS®, AIX, Linux, HP-UX, SUN Solaris, and Windows. The EKM is capable of serving numerous IBM encrypting tape drives, regardless of where those tape drives reside.

The EKM is part of the IBM Java™ environment and uses the IBM Java Security components for its cryptographic capabilities. The EKM has three main components that controls the encryption. These components are:

- ▶ Java security keystore:

The keystore is defined as part of the Java Cryptography Extension (JCE) and is an element of the Java Security components, which are, in turn, part of the Java runtime environment. A keystore holds the certificates and keys (or pointers to the certificates and keys) used by the EKM to perform cryptographic operations. The EKM supports several types of Java keystores offering different operational characteristics to meet your requirements.

- ▶ Configuration file:

The EKM configuration file allows you to tailor the behavior of the EKM to meet the requirements of your organization.

- ▶ Tape drive table:

The tape drive table is used by the EKM to keep track of the tape devices it supports. The tape drive table is a non-editable, binary file whose location is specified in the configuration file see Figure 1-14.

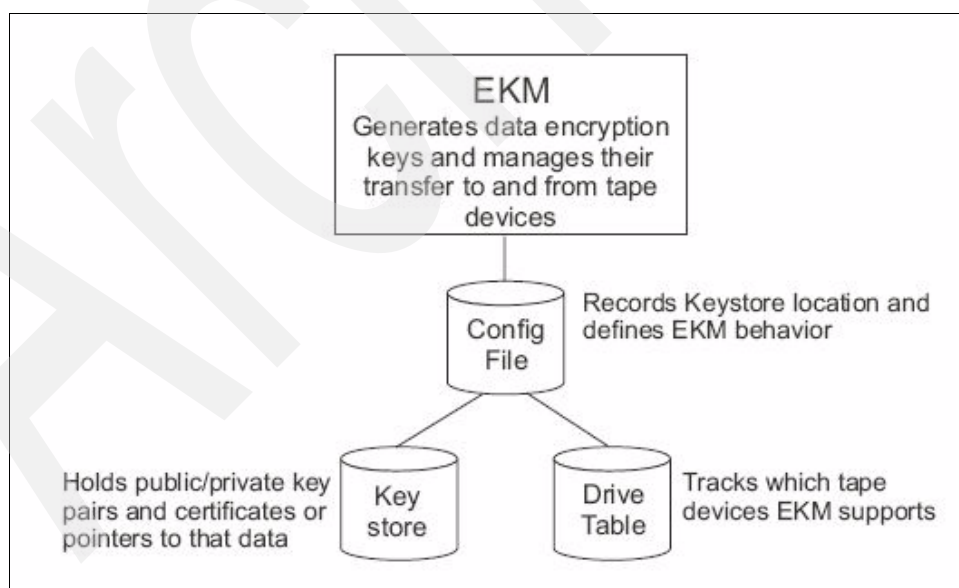


Figure 1-14 Three main components of the EKM

Important: Due to the critical nature of keys in your keystore, we highly recommend that you back up your keystore on a regular basis so that you can recover it as required and be able to read the data cartridges that were encrypted using the certificate with that drive or library. Do **not** encrypt your backups!

The EKM acts as a process waiting for a key generation of a key retrieval request that a tape drive or library sends over a TCP/IP communication path between the EKM and the tape library or tape drive. When a tape drive writes encrypted data, it first requests an encryption key from the EKM. Upon receipt of the request, the EKM generates an Advanced Encryption Standard (AES) key and sends it to the tape drive. AES uses a 256 bit encryption as stated in the Institute of Electrical and Electronics Engineers (IEEE P1619.1).

An AES encryption key is typically a random string of bits generated specifically to scramble and unscramble data. Encryption keys are created using algorithms designed to ensure that each key is unique and unpredictable. The longer the key string, the harder it is to break the encryption code. TS1120 and TS1040 Tape Drives encryption uses 256-bit AES algorithm keys to encrypt data.

1.3.1 Encryption methods

Symmetric and asymmetric key encryption are the two most important encryption methods. The encryption method for the TS1120 and the TS1040 Tape Drive are slightly different. In the following sections we explain those differences.

Symmetric key encryption

Encryption of data using a symmetric key and algorithm is sometimes called private key encryption or secret key, which is not to be confused with the private key in an asymmetric key system. In a symmetric key system, the cipher key that is used for encrypting data is closely related to the cipher key used for decryption.

The encryption and decryption ciphers can be related by a simple transform on the key, or the encryption key and the decryption key can be identical. In the IBM Tape Encryption solution, the same encryption key is used for both encryption of data and decryption of data, this key is protected by an asymmetric key algorithm and never available in the clear.

Symmetric key encryption is several orders of magnitude faster than asymmetric key encryption; in addition, the comparable key sizes for symmetric key as opposed to asymmetric key are an order of magnitude different. A 128-bit secret key is considered safe, while Rivest-Shamir-Adleman (RSA) suggests a 1024-bit key length. The IBM Tape Encryption solution utilizes an Advanced Encryption Standard (AES) algorithm with a key length of 256 bits. The AES algorithm is based off the Rijndael algorithm. AES is an accepted standard that supports a subset of the key sizes and block sizes that the Rijndael algorithms supports.

Secret key algorithms can be architected to support encryption one bit at a time, or by specified blocks of bits. The AES standard supports 128-bit block sizes and key sizes of 128, 192, and 256. The IBM Tape Encryption solution uses an AES-256 bit key. Other well known symmetric key examples include Twofish, Blowfish, Serpent, Cast5, DES, TDES, and IDEA.

Figure 1-15 shows the process of symmetric data flow.

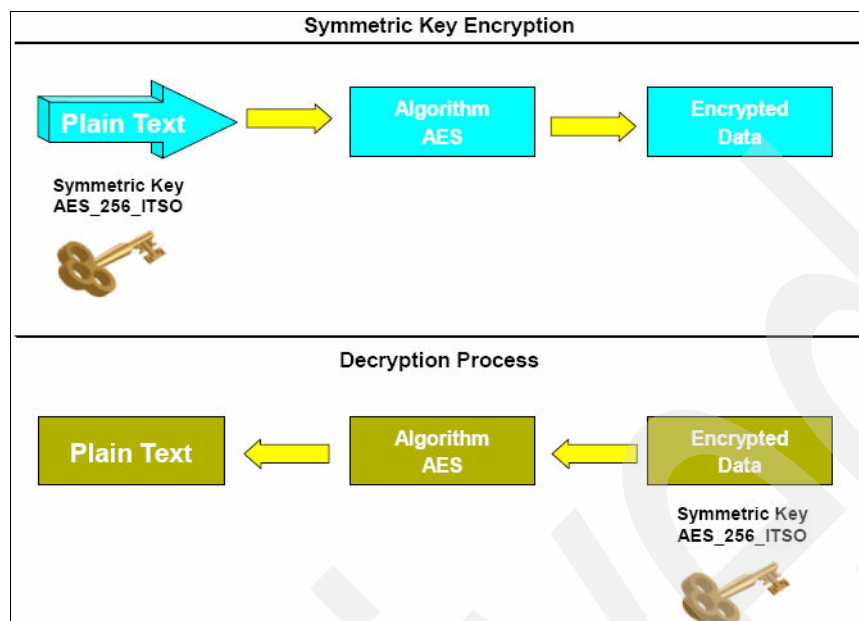


Figure 1-15 Symmetric key encryption data flow

Asymmetric key encryption

Another important method of encryption that is widely used today is referred to as public/private key encryption or asymmetric encryption. Using this encryption methodology, ciphers are generated in pairs. The first key is used to encrypt the data, and the second key is used to decrypt the data.

This technique was pioneered in the 1970s and represented a significant breakthrough in cryptography. Rivest-Shamir-Adleman (RSA) algorithm is the most widely used public key technique. The power of this approach is a public key, which is used to encrypt the data. This public key can be widely shared, and anyone who wishes to send secure data to an organization can use its public key. The receiving organization then uses its private key to decrypt the data; this makes public/private key very useful for sharing information between organizations. This methodology is widely used on the Internet today to secure transactions, including SSL.

Asymmetric key encryption is much slower and more computationally intensive than symmetric key encryption. The advantage of asymmetric key encryption is the ability to share secret data without sharing the same encryption key. Figure 1-16 shows an encryption and decryption data path when using public key encryption algorithms. In the diagram, the plain text is enciphered using the public key and an RSA encryption algorithm, which yields the encrypted data. Starting with the enciphered text, a private key is used, with the RSA algorithm to decrypt the data back to plain text.

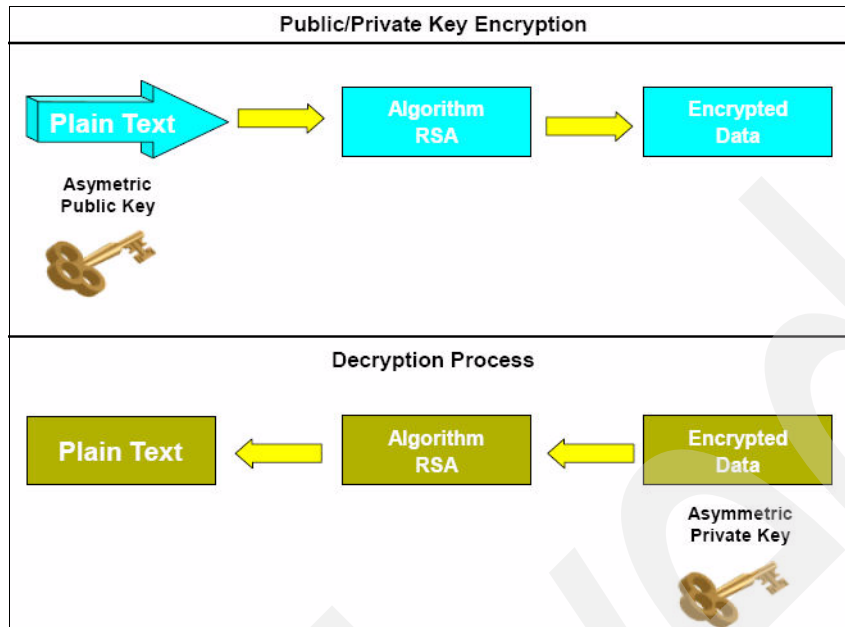


Figure 1-16 Asymmetric key encryption data flow

Managing encryption

There are three methods of encryption management to choose from. These methods differ in where you choose to locate your EKM application. Your operating environment determines which is the best for you, with the result that key management and the encryption policy engine can be located in any one of the following environmental layers.

Application-managed tape encryption

This method is best where operating environments are running an application already capable of generating and managing encryption policies and keys, such as Tivoli Storage Manager (TSM). Policies specifying when encryption is to be used are defined through the application interface. The policies and keys pass through the data path between the application layer and the TS1120 and TS1040 Tape Drives. Encryption is the result of interaction between the application and the encryption-enabled tape drive, and is transparent to the system and library layers. Since the application manages the encryption keys, volumes written and encrypted using the application method can only be read using the application-managed encryption method.

System-managed tape encryption

This method is best for Open Systems operating environments where no application capable of key management runs. Encryption policies specifying when to use encryption are set up through each instance of the IBM device driver. Key generation and management is performed by the Encryption Key Manager (EKM), a Java application running on the host or externally on another host. Policy controls and keys pass through the data path between the system layer and the TS1120 and TS1040 Tape Drives. Encryption is transparent to the applications. System-managed tape encryption and library-managed tape encryption are transparent to one another. In other words, a tape encrypted using system-managed encryption can be decrypted using library-managed encryption, and vice versa, provided they both have access to the same EKM keystore.

Library-managed tape encryption

This method is supported on the following IBM Tape Libraries:

- ▶ TS3100 with TS1040 Tape Drive
- ▶ TS3200 with TS1040 Tape Drive
- ▶ TS3400 with TS1120 Tape Drive
- ▶ TS3500 with TS1040 and TS1120 Tape Drives. Both tape drives can be installed in the TS3500, but they cannot be intermixed within the same logical library.

Key generation and management is performed by the EKM, a Java application running on a library-attached host. The keys pass through the library-to-drive interface, therefore encryption is transparent to the applications. Library-managed encryption, when used with certain applications such as Symantec Netbackup, includes support for an internal label option. When the internal label option is configured, the TS1120 and TS1040 tape drives automatically derives the encryption policy and key information from the metadata written on the tape volume by the application.

System-managed tape encryption and library-managed tape encryption are transparent to one another. In other words, a tape encrypted using system-managed encryption can be decrypted using library-managed encryption, and vice versa, provided they both have access to the same EKM keystore and both use AIX and the AIX atape driver. Otherwise, this might not be feasible.

1.3.2 TS1120 Tape Encryption

The TS1120 Tape Drive uses an AES encryption key that is typically a random string of bits generated specifically to scramble and unscramble data. Encryption keys are created using algorithms designed to ensure that each key is unique and unpredictable. The longer the key string, the harder it is to break the encryption code. TS1120 Tape Drive encryption uses 256-bit AES algorithm keys to encrypt data.

Two types of encryption algorithms are used by the EKM for encryption on the TS1120 Tape Drive:

- ▶ **Symmetric algorithms.** Symmetric, or secret key encryption, uses a single key for both encryption and decryption. Symmetric key encryption is generally used for encrypting large amounts of data in an efficient manner.
- ▶ **Asymmetric algorithms.** Asymmetric encryption uses a pair of keys. Data encrypted using one key can only be decrypted using the other key in the asymmetric key pair.

When an asymmetric, or public/private key pair is generated, the public key is typically used to encrypt, and the private key is typically used to decrypt. TS1120 Tape Drive encryption uses both types; symmetric encryption for high-speed encryption of user or host data, and asymmetric encryption (which is necessarily slower) for protecting the symmetric key used to encrypt the data (key wrapping). See Figure 1-17.

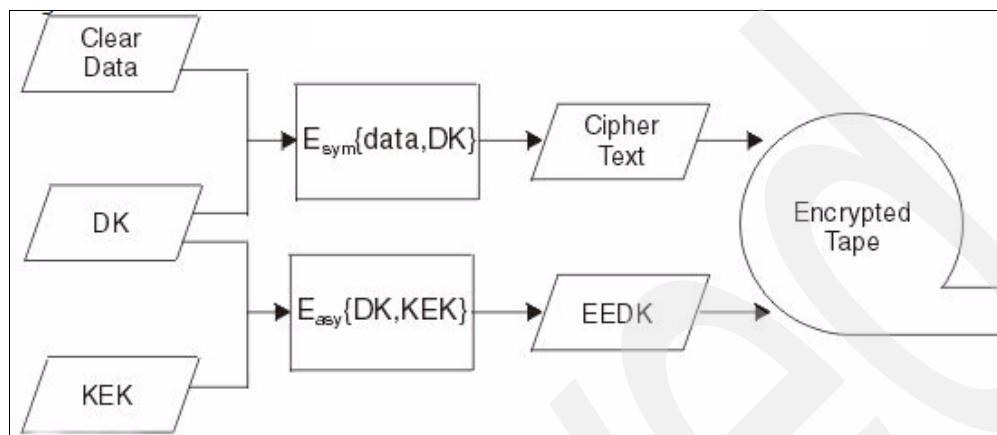


Figure 1-17 Tape Encryption process flow of the TS1120 Tape Drive

When unencrypted data (clear text) is sent to the TS1120 Tape Drive for encryption, it is converted to ciphertext (encrypted data) through AES encryption, a symmetric (or secret) key type of encryption requiring a symmetric Data Key (DK), and is then written to tape. The 256-bit AES Data Key is also encrypted, or wrapped, using the public key from an asymmetric Key Encrypted Key (KEK) pair to create an Externally Encrypted Data Key (EEDK).

This EEDK is written to the cartridge memory and to three additional places on the 3592 Tape Cartridge. The tape cartridge now has both the encrypted data and the means to decrypt it for anyone who holds the private KEK. The DK can also be wrapped a second time, using the public key of another party, to create an additional EEDK. Both EEDKs can be stored on the tape cartridge. In this way, the tape cartridge can be shipped to a business partner holding the corresponding private key that would allow the DK to be unwrapped and the tape decrypted on a different TS1120 Tape Drive.

In the following two diagrams we are explaining in more detailed way the Tape Encryption and Decryption process. We start first with the Encryption process.

Figure 1-18 describes the flow of encrypted data to tape, and how keys are communicated to the tape drive and then stored on the data cartridge. In our example we assume that an EKM is running on one server and that the tape library and tape drives are connected to another server.

We assume that a certificate, a certificate is a way to bind public key information with an identity, from a Business Partner had been imported into this keystore. It has only a public key associated with it; the Business Partner has the corresponding private key.

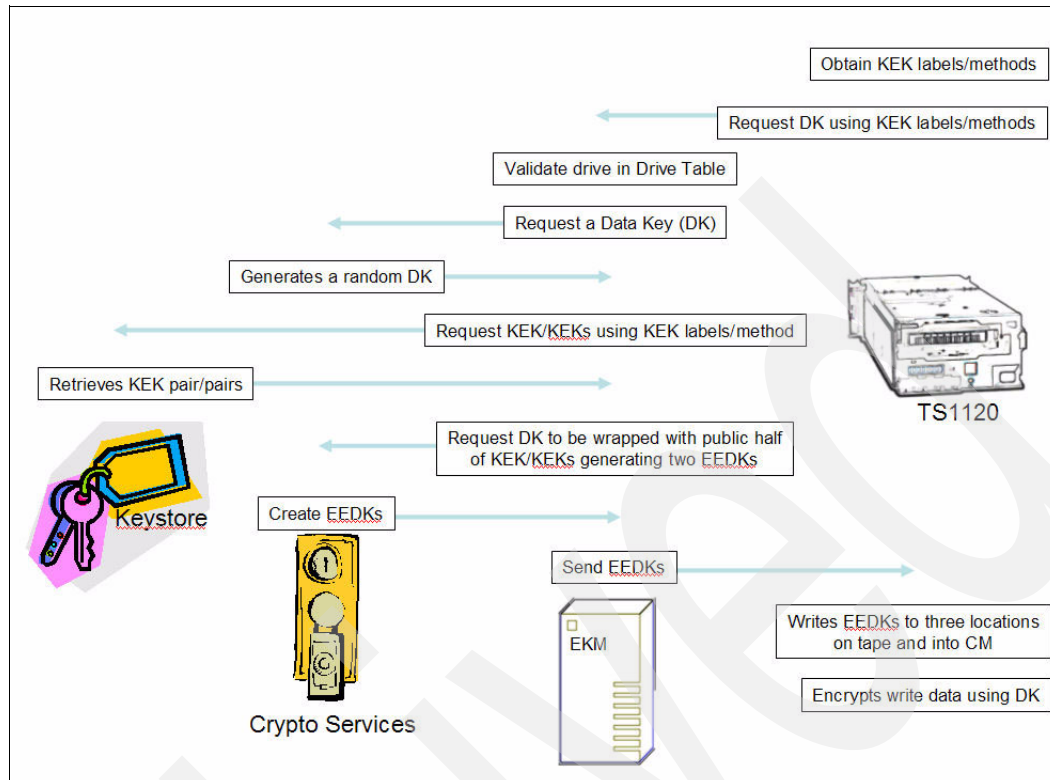


Figure 1-18 Encryption process TS1120

Now, our abstract server sends a write request to the drive. Our drive is encryption-capable, and the host has requested encryption. As part of this initial write, the drive obtains two Key Encrypting Keys (KEK) labels from the host or a proxy, which are aliases for two Rivest-Shamir-Adleman (RSA) algorithm KEKs. The drive requests that the EKM send it a data key (DK) and to encrypt the DK using the public KEKs aliased by the two KEK labels.

The EKM validates that the drive is in its list of valid drives. After validation, the EKM obtains a random DK from cryptographic services. The EKM then retrieves the public halves of the KEKs aliased by the two KEK labels. The EKM then requests that cryptographic services create two encrypted instances of the DK using the public halves of the KEKs, therefore, creating two Externally Encrypted Data Keys (EEDKs).

The EKM sends both EEDKs to the tape drive. The drive stores the EEDKs to several locations on the tape and in the cartridge memory. The EKM also sends the DK to the drive in a secure manner. The drive uses the separately secured DK to encrypt the data.

Figure 1-19 shows the decryption data path. In this example, we decrypt data that was encrypted at another site, as outlined in this diagram. For the decryption process, the tape has two EEDKs stored in its cartridge memory. We call these EEDK1 and EEDK2.

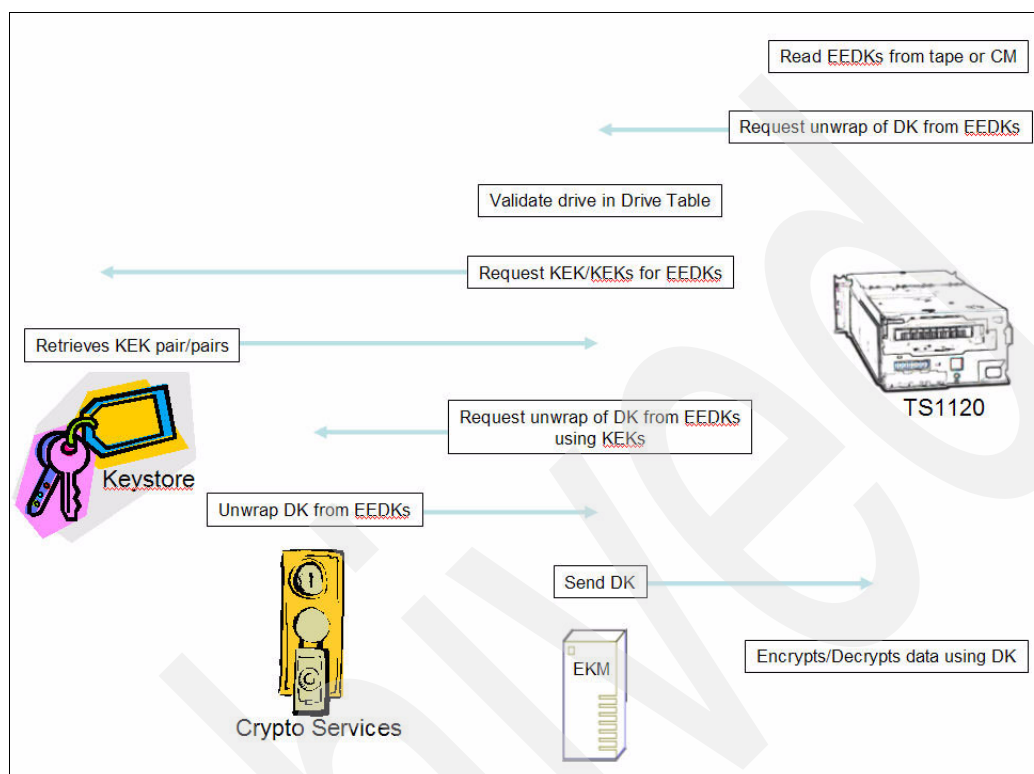


Figure 1-19 Decryption process TS1120

An encrypted tape is mounted for a read or a write append. The two EEDKs are read from the tape. The drive asks the EKM to decrypt the DK from the EEDKs. The EKM validates that the drive is in its list of valid drives. After validation, the EKM requests the keystore to provide the private halves of each KEK used to create the EEDKs. The KEK label associated with EEDK1 cannot be found in the keystore, but the HASH of the public key for EEDK2 is found in the keystore.

The EKM asks cryptographic services to decrypt the DK from EEDK2 using the private half of the KEK associated with EEDK2. The EKM then sends the DK to the drive in a secure manner. The drive either decrypts the data for a read operation or uses the DK to encrypt data for a write-append.

1.3.3 TS1040 Tape Encryption

The TS1040 Tape Encryption differs from the TS1120 Tape Encryption. The TS1040 cannot store a wrapped form of the symmetric encryption key on the tape cartridge like the TS1120. The symmetric encryption key is stored in the keystore attached to the EKM. An associated Key Identifier or alias maps to the Data Key in the key store. This alias is stored with each block of data on the tape. AES 256-bit encryption is used, like the TS1120, to encrypt/decrypt the data on the data cartridge.

Encrypted or non-encrypted records can co-exist on the same medium. The tape drive must use a data key for each unique key identifier encountered during read operations.

Write Request

The process for a Write Request to the TS1040 with encryption includes these steps:

1. The TS1040 tape drive receives a mount request for write with Beginning Of Tape (BOT) with encryption.
2. The TS1040 initiates a session with the EKM. The TS1040 communicates through the library using the TCP/IP protocol. The TS1040 request a data key and passes an optional key label.
3. The EKM authenticates the TS1040 in its Drive Table.
4. The EKM retrieves a pre-generated AES-256 Data Key from the TS1040.
5. The EKM sends a data key and key identifier to the TS1040 in a secure manner.
6. The TS1040 receives the key structures and embeds the key identifier in the data and encrypts and writes the data to the tape.

Read or Write-Append Request

When an encrypted cartridge is mounted in the TS1040 in response to a specific mount request, the following steps are taken:

1. The TS1040 receives a mount request for read or append operation.
2. The TS1040 begins reading and finds encrypted record. The key identifier is retrieved.
3. The TS1040 initiates a session with the EKM. The TS1040 communicates through the library using the TCP/IP protocol. The key identifier will be passed for decryption.
4. The EKM authenticates the TS1040 in the drive table.
5. The EKM retrieves the pre-generated data key referenced by the key identifier.
6. The EKM passes the data key to the TS1040 in a secure manner.
7. The TS1040 reads the data from or write appends data to the data cartridge.

1.4 Hardware and operating system platforms

This section gives information about operating system support, SCSI and FC adapter vendors, and some applications that support the IBM Open Systems Tape products.

1.4.1 Hardware server platforms

The IBM Open Systems Tape products are supported on the following operating systems and servers:

- ▶ IBM System i
- ▶ IBM System p with AIX and Linux
- ▶ IBM System x and other Intel-based systems (Windows 2000 and 2003)
- ▶ Sun SPARC with Solaris
- ▶ Hewlett-Packard with HP-UX
- ▶ Intel Linux (Red Hat and SLES)
- ▶ IBM System z™ and Linux
- ▶ Tru64 (IBM TS3500 Tape Library only)
- ▶ Other Open Systems using SCSI attachment or Fibre Channel attachment

Not all platforms and attachment methods are supported for all models — for current details for operating system and attachment support for each LTO model, see the Web site:

<http://www-03.ibm.com/servers/storage/tape/compatibility/>

Note: Always check the Web site for the most current, detailed, and accurate information.

1.4.2 ISV storage management software

Although operating systems provide utilities, such as **dd**, **tar**, and **cpio**, to perform basic read/write operations for tape drives, in most cases a storage management software package is used. These packages are designed to provide sophisticated capabilities that manage tape drives and libraries. They are available from companies known as Independent Software Vendors (ISVs). We discuss some of the most popular applications in Part 2, “IBM Open Systems Tape libraries and backup software” on page 173.

IBM publishes information about ISV storage management applications that are certified with LTO devices and on which operating system platforms. This is available at the Web site:

http://www.ibm.com/servers/storage/tape/lto/lto_isv.html

You should also check with the ISV for detailed support information.

1.5 Determining the number of drives on a SCSI bus

How do you determine how many SCSI drives to place on a host adapter? There are several factors to take into consideration, including:

- ▶ Tape drive speed capability
- ▶ Disk drive speed capability
- ▶ Application
 - Application requirements
 - Application characteristics
 - Read/write mix
 - Amount of data transferred
 - Streaming or stop/start
 - Data block size
- ▶ Adapter slot availability and capability
- ▶ Cost of more adapters

To ensure best performance, if possible, avoid daisy-chaining (connecting more than one drive to an adapter). If cost or slot availability considerations make daisy-chaining unavoidable, then connect no more than two drives per LVD adapter for LTO3.

When daisy-chaining with LTO3 drives, you must consider the data transfer rate of the drive and the capacity of the adapter. A single LTO3 SCSI drive, which is capable of transferring over 200 MB/sec of compressible data, can saturate a SCSI-160 adapter. A SCSI-160 adapter can transfer 160 MB/sec, but that does not include SCSI overhead. With overhead, the available bandwidth is approximately 140-150 MB/sec. Two LTO3 drives cannot run at their native drive rate of 80 MB/sec on a single adapter. If performance is not a primary consideration, it could be possible to daisy-chain two LTO3 drives on one adapter.

The type of application is also significant. If you are mainly doing smaller volume reads or writes, then more drives can be attached without saturating the adapter. A more typical use of tape is in high-volume backup, usually writing large blocks of data (for example, backing up large database files). In this scenario, a single drive per adapter will give the best performance.

1.6 Host Bus Adapters and device drivers

This section will cover the following:

- ▶ What are HBAs?
- ▶ Why are they necessary, and which one do you require?
- ▶ Are drivers required for HBAs?

Note: We recommend that you do not attach both disk and tape devices to the same HBA. See 4.1.3, "Tape and disk on the same HBA" on page 160 for more information.

1.6.1 What are HBAs?

HBA stands for Host Bus Adapter. An HBA is an I/O adapter (or card) that sits between the host computer's bus and the SCSI or Fibre Channel fabric and manages the transfer of information between the two channels. To minimize the impact on host processor performance, the HBA performs many low-level interface functions automatically or with minimal processor involvement.

1.6.2 Device drivers

A device driver is a program that controls a device. Every device, whether it be a printer, disk drive, or keyboard, must have a driver program. Many drivers, such as the keyboard driver are included with the operating system. For other devices, you might have to load a new driver either from the operating system CD, or as provided by the manufacturer when you first install the device on your computer.

A driver acts like a translator between the device and programs that use the device. Each device has its own set of specialized commands that only its driver knows. In contrast, most programs access devices by using generic commands, that is, Read, Write, Put, and Get. The driver, therefore, accepts generic commands from a program and then translates them into specialized commands for the device.

Figure 1-20 is an example of the data flow between an application program and a LTO tape device. Note the different pieces of code or microcode that are involved.

The HBA Device Driver is not always a separate piece of installable software; sometimes it is included as part of the standard operating system. This is true for many common SCSI adapters with Linux. You should check the documentation provided with the card to see if this applies. For Fibre Channel HBAs, driver software will almost always have to be installed.

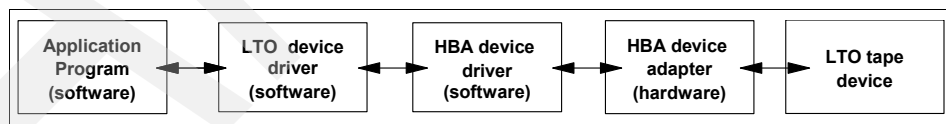


Figure 1-20 Device data flow

Data flow

The simplified list below reflects the components involved in the data path for moving data at a file level between disk storage devices and tape. Problem or performance analysis must be approached by determining which component of the data path impacts performance:

- ▶ Disk device
- ▶ SCSI Device Adapter
- ▶ Adapter device driver
- ▶ Disk device driver

- ▶ Logical Volume Manager
- ▶ File system
- ▶ Application program
- ▶ Atape Device Driver: Tape driver
- ▶ HBA Adapter Device Driver
- ▶ HBA (SCSI or FC-AL) Device Adapter
- ▶ Tape device

IBM device driver overview

The IBM LTO tape and medium changer device drivers are designed specifically to take advantage of the features provided by the IBM LTO tape drives and medium changer devices. The goal is to give applications access to the functions required for basic tape functions (such as backup and restore) and medium changer operations (such as cartridge mount and dismount), as well as to the advanced functions required by full tape management systems. Whenever possible, the LTO driver will take advantage of the device features transparently to the application.

1.7 LVD and SAS

IBM LTO3 full-high tape drives has only one type of SCSI attachment interface: low voltage differential (LVD). IBM LTO3 half-high and LTO4 tape drives have both LVD and SAS SCSI attachment interfaces.

LVD is available with Ultra160 SCSI at 160 MB/second and the speed capability of the bus will determine the number of LTO drives that can be attached on the same bus. But distance is also important. LVD can span 25 meters in a point-to-point configuration, while in a multidrop (daisy-chain) configuration, it is limited to 12 meters.

Serial Attached SCSI (SAS) can communicate with Advanced Technology Attachment (ATA) devices. SAS has a point-to-point architecture and a bandwidth of 300MB/sec. Because of its point-to-point architecture more devices can be handled in the same time on the bus with an maximum of 128 targets. Another advantage of SAS is that the connection cables between the HBA and the devices are much thinner and thus better scalable. SAS devices do not require external terminators. The I/O bus will be electronically terminated.

The total cable length from the device to the HBA is limited to 6 metres. Two different connecting interfaces are used for connecting the external devices: SSF-8088 and SSF-8470. SSF is the abbreviation for Small Form Factor Committee. All IBM SAS tape drives have a SSF-8088 interface. SAS cables are available in several lengths up to 5.5 m, and in any combination of the SSF-8470 and SSF-8088 connectors.

At the time of writing, IBM SAS Tape Drives are only supporting a point-to-point connection and there is no support to connect the SAS Tape Drive on an Expander Box. Two LTO tape drives are available with the SAS interface:

- ▶ IBM LTO3 Half High Tape Drive
- ▶ IBM LTO4 Full High Tape Drive

For additional information about the SAS interface, refer to *IBM System Storage Tape Library Guide for Open Systems*, SG24-5946.

1.8 SCSI HD68 and VHDCI cable connectors

There are three types of SCSI cables: HD68-HD68, HD68-VHDCI, and VHDCI-VHDCI. The HD68 connector is the normal 68-pin SCSI connector. The Very High Density Connector (VHDCI) is a mini SCSI connector that is about half the width of the HD68 connector. The server SCSI adapter can be either HD68 or VHDCI.

For System p, System i, and HP servers, LVD SCSI adapters are always VHDCI, and HVD adapters are always HD68. But Sun and Netfinity/Intel servers have some adapters that are reversed. The connector type for a given adapter can be found in either of two ways. You can look at the adapter and the plug will be either about 3 cm wide (VHDCI) or 6 cm wide (HD68). The other method is to look up the adapter characteristics to determine the plug type. One source of this information is the *IBM System Storage Tape Library Operator Guide*, GA32-0560-01, available online at:

<http://www-03.ibm.com/servers/storage/tape/resource-library.html#publications>

Before June 12, 2001, all the LTO tape drives used HD68 connectors. The current IBM TS3500 hot swappable canister LTO drive uses the VHDCI connectors. Check to make sure that you order the correct cable with the right-end plug to attach to your HBA.

Figure 1-21 shows the VHDCI and HD-68 connectors.

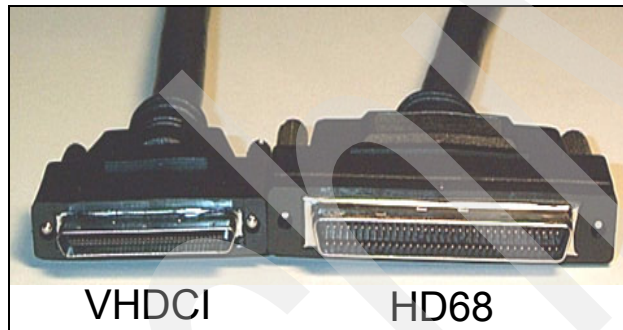


Figure 1-21 SCSI connectors

IBM Open Systems Tape Library sharing and partitioning

In this chapter we describe the sharing and partitioning of:

- ▶ IBM System Storage TS3100 Tape Library
- ▶ IBM System Storage TS3200 Tape Library
- ▶ IBM System Storage TS3310 Tape Library
- ▶ IBM System Storage TS3400 Tape Library
- ▶ IBM System Storage TS3500 Tape Library

We discuss the following topics:

- ▶ Tape library sharing and partitioning definitions
- ▶ Tape Library Specialist
- ▶ Advanced Library Management System - ALMS
- ▶ Partitioning the IBM System Storage TS3100 Tape Library / IBM System Storage TS3200 Tape Library using the Tape Library Specialist
- ▶ Partitioning the IBM System Storage TS3310 Tape Library using the Tape Library Specialist
- ▶ Partitioning the IBM System Storage TS3400 Tape Library using the Tape Library Specialist
- ▶ Partitioning the IBM System Storage TS3500 Tape Library using the Tape Library Specialist
- ▶ Partitioning the IBM System Storage TS3500 Tape Library using the Operator panel
- ▶ Using and partitioning the IBM System Storage TS3500 Tape Library with ALMS

For additional discussions on Tape Library Sharing, refer to the Redbooks publication:

- ▶ *Get More Out of Your SAN with IBM Tivoli Storage Manager*, SG24-6687

Details about the ALMS functionality and setup can be found in the TS3500 manuals:

- ▶ *IBM System Storage TS3500 Tape Library Operator Guide*, GA32-0560
- ▶ *IBM System Storage TS3500 Tape Library Introduction and Planning Guide*, GA32-0559

2.1 Definitions

In general, the sharing of devices improves the utilization of the devices and can reduce the total cost of ownership. Sharing of disk devices is a common practice. Compared to disk devices, which allow random access from different clients, tape drives are sequential devices that do not allow access from different clients at the same time.

Still, sharing can improve the utilization of the tape drive; indeed, a tape drive is normally not used 100% of the time by a single client (host), and there are different possible ways to share either a tape library or tape drives among multiple host. The most basic requirement in sharing any library between backup applications and servers is the ability to control the medium changer. The tape drives and media might or might not be shared, but the medium changer must be available to be manipulated by all of the backup applications and servers.

2.1.1 Library sharing

Next, we differentiate between outboard library management and the multipath approach.

Outboard library management

One approach is to share the library but not the tape drives. Multiple servers attached to a tape library can share the library robotics. Drives and cartridges are pooled, and such a drive and cartridge pool belong to one set of servers (one server or multiple servers) and cannot be shared with another set of servers.

Some applications, such as IBM Tivoli Storage Manager, use the name “library sharing” if they share drives and library. We will explain drive sharing later.

Some technique is required to share the library robotics. The most common way is to use an outboard library manager that controls the library. The library manager receives the commands from the attached servers, controls the resources inside the library, and executes the commands received from the servers. The communication between the library manager and attached servers normally takes place over the LAN using a proprietary command set.

The tape library manager controls access to and sequencing of the medium changer. The medium changer is physically available to all backup and application servers. The IBM 3494 tape library uses this type of library sharing. For communication with the IBM 3494, a command set called `mtlib` must be used (see Figure 2-1 on page 41). Other examples are STK with ACSLS, or ADIC with Scalar DLC.

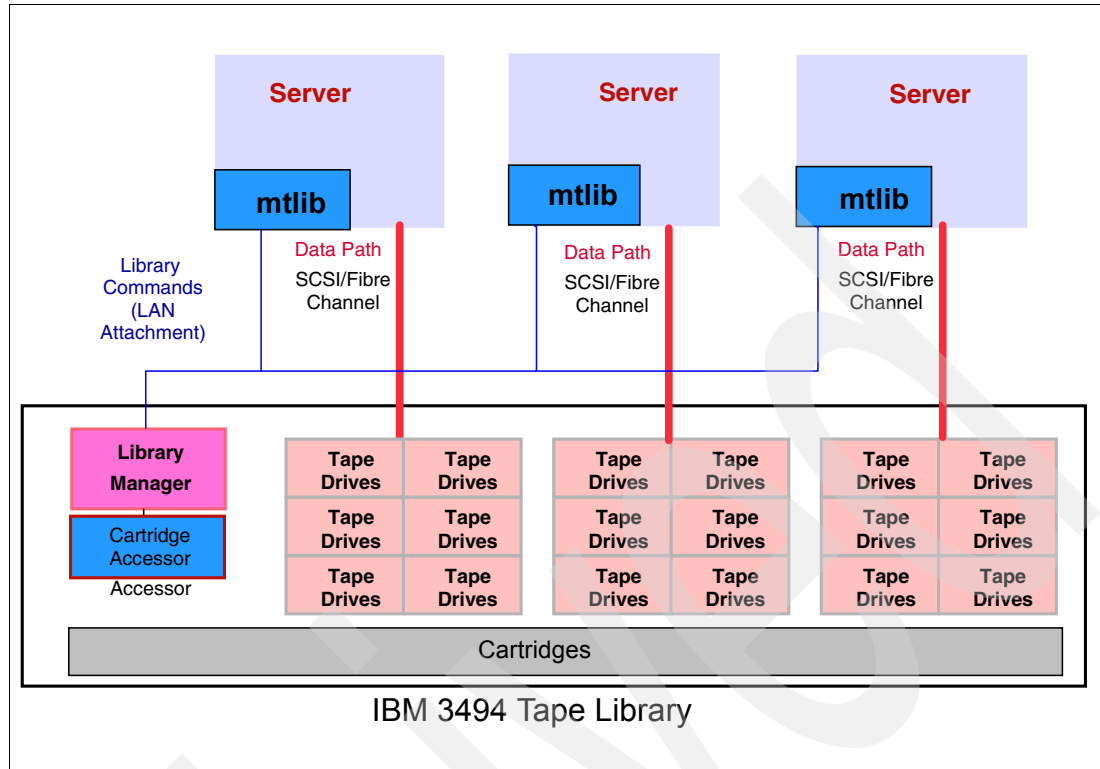


Figure 2-1 IBM 3494 tape library sharing

The IBM 3494 tape library pools cartridges by using categories. Drives, on the other hand, are pooled by simply connecting them to one set of servers.

Multi-path SCSI medium changer library

The disadvantage of the outboard library management is that it introduces an additional software layer. The IBM patented multi-path architecture eliminates this disadvantage.

Multi-path architecture is the capability of a tape library to provide multiple paths to the library robotics without requiring a library manager. This capability allows the partitioning of the physical library into several logical libraries. A logical partition (logical library) contains tape drives and storage slots. The library robotics are shared among all logical partitions, and the tape library controls access and sequencing to the medium changer. All IBM LTO tape libraries with more than one tape drive, including the high-end IBM System Storage TS3500 Tape Library, offer this partitioning capability at no additional cost. Partitioning is available for SCSI and FC drives.

Figure 2-2 shows the multipath design of an IBM LTO tape library. Every drive can have a path defined to the SCSI medium changer. The library in this example (Figure 2-2) has been partitioned into three logical libraries. Each logical partition has two tape drives and a set of cartridge slots. All the servers share the library robotics, but not the drives or the cartridges.

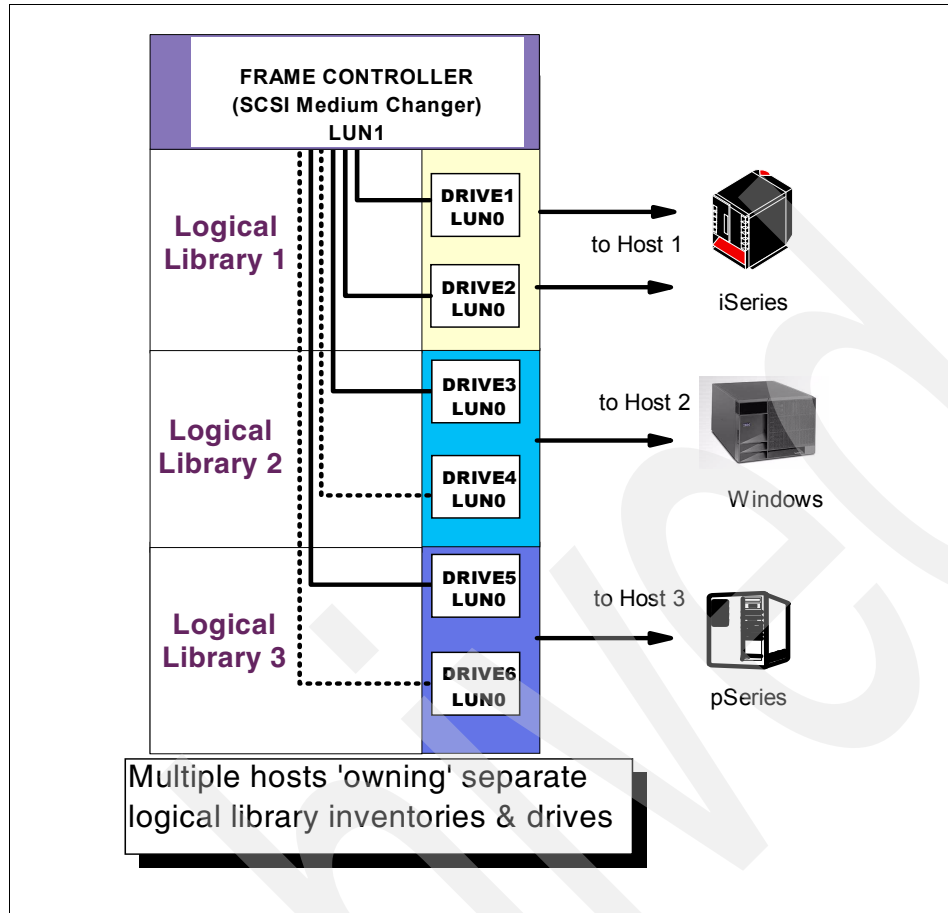


Figure 2-2 IBM multipath architecture and logical partitioning

This kind of partitioning uses static assigned resources. There is no sharing of these resources (tape drives and cartridge slots), which means servers from one partition cannot access tape drives or cartridges in another partition. The assignment of resources to the different logical partitions is defined through static rules and must use contiguous resources. In other words, you create barriers around the logical library. This type of partitioning is also called the first generation of multipath architecture.

The second generation of multipath architecture, also called Advanced Library Management System (ALMS), does not have to partition the library using static rules and contiguous resources. ALMS virtualizes the affinity to physical resources.

This second type of partitioning allows heterogeneous applications to share the library robotics independent of each other. ALMS is offered as a feature for the IBM TS3500. For further detail; see 2.3, “ALMS” on page 73.

2.1.2 Homogenous drive sharing

Because a tape drive cannot be accessed simultaneously by several servers, a mechanism is required to manage and control access. Currently, there are different solutions available that allow some kind of tape drive sharing. The most common way is to do a homogenous drive sharing. Homogenous means that one master host takes care of the access control, and allows other servers that are running the same application to share the tape drives. All servers access the medium changer through the master, such as multiple IBM Tivoli Storage Manager servers communicating through one IBM Tivoli Storage Manager Library Manager

server. The master server controls physical access (such as mount and demount cartridges) and sequencing to the medium changer (see Figure 2-3).

The tape drives appear to each server as locally attached devices. When a server requests a tape to be loaded for a tape operation, the server contacts the master with the request. The master mounts the tape, then passes control back to the requesting server. The server then reserves (SCSI reserve) the same drive to itself (to ensure that no other server can access the tape drive and overwrite data). When the operation is complete, the server unloads the cartridge, releases (SCSI release) the reserve on the drive, and notifies the master to demount the cartridge. The master then demounts the media.

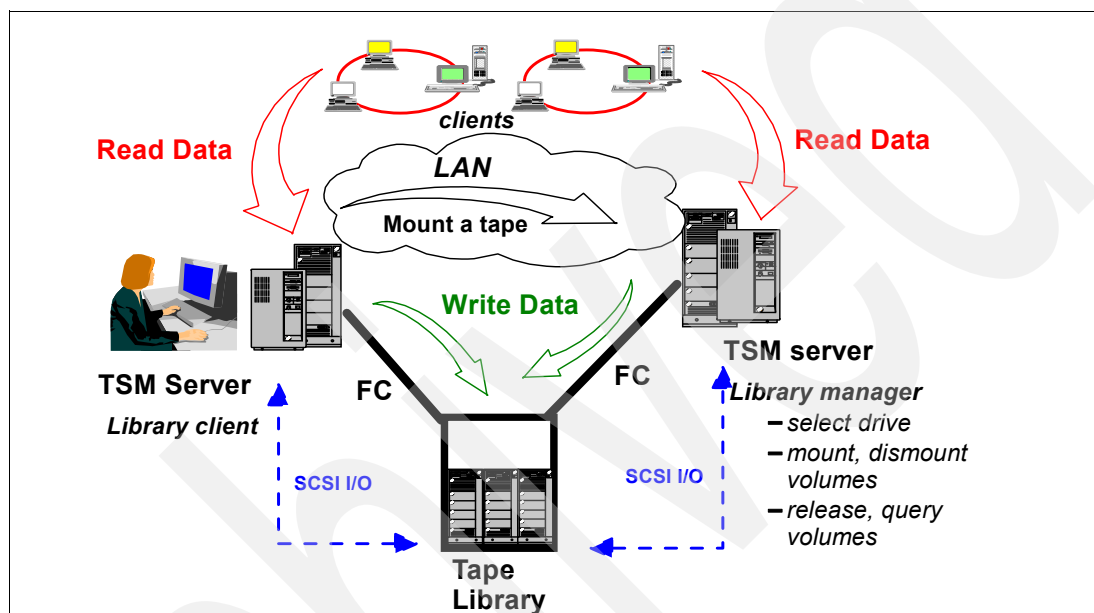


Figure 2-3 Tivoli Storage Manager library sharing

Such homogenous drive sharing is commonly used for LAN-free backups (see Figure 2-4).

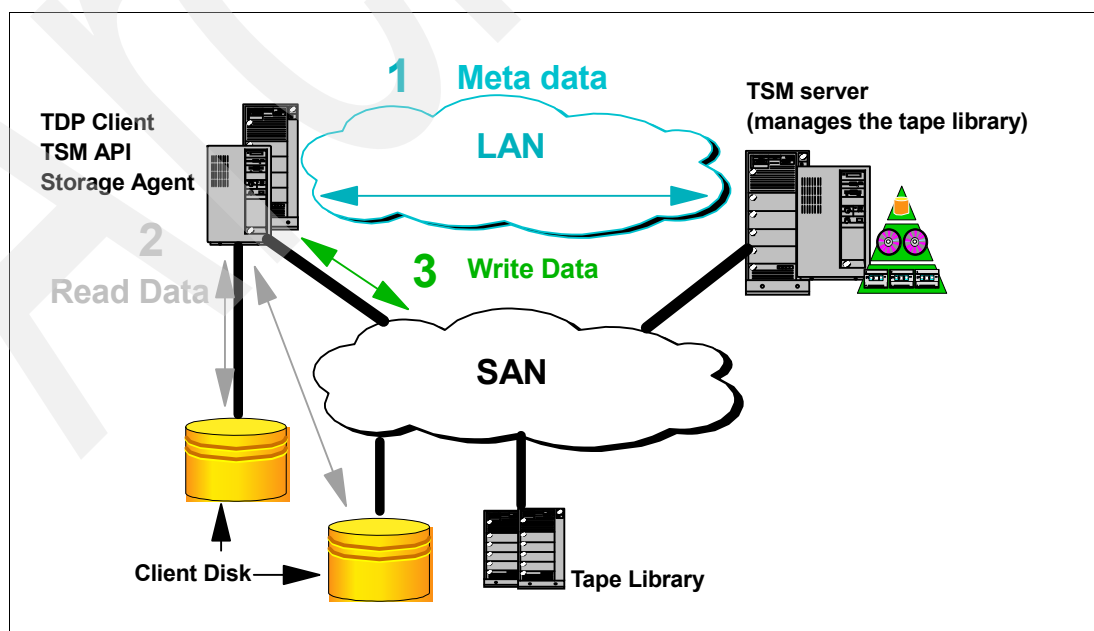


Figure 2-4 LAN-free backup

2.1.3 What should I use?

Whenever multiple servers running the same storage management (homogenous) application have to share the same tape library, we suggest using the application's own sharing capabilities. This will ensure the most efficient library and drive sharing. The master server can normally provide sharing functions for all tape drives to all client servers. The master server also manages the cartridges in the library; so that you require only one scratch pool, instead of several scratch pools (one for each server).

Figure 2-5 shows an example of how sharing capabilities from the application can address the sharing requirements. This example is built on IBM Tivoli Storage Manager, but it works also with other applications such as VERITAS NetBackup or EMC Legato NetWorker. There are two locations in the example, each with its own data processing application, server, and storage. The SAN spans over both locations. There are three backup servers, with many clients attached to them performing the backup jobs. For disaster recovery reasons, all backup data is copied to the second location. One or more tape libraries are installed in each location. In every location, one backup server manages the tape library (library manager) and handles all mount requests issued by the other backup servers. Any backup server from location 1 asks Library Manager Server 1 (TSM Server 1) to assign a tape to it and mount a cartridge in Library 1. If a backup server from location 1 copies the data to location 2, then it asks Library Manager Server 2 (TSM Server 2) to mount a tape on Library 2.

An overview of library sharing with IBM Tivoli Storage Manager is in Chapter 5, "Implementing IBM Tivoli Storage Manager" on page 175. For complete details, see the IBM Redbook *Get More Out of Your SAN with IBM Tivoli Storage Manager*, SG24-6687.

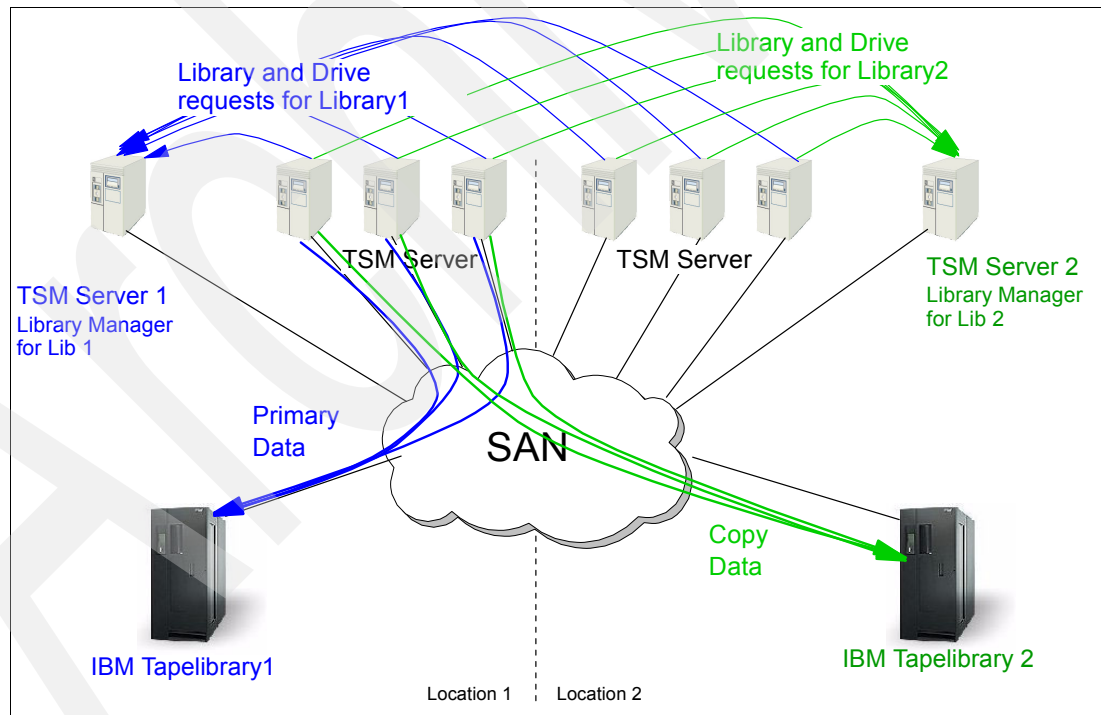


Figure 2-5 Library sharing done by TSM

However, in some cases, even if you use one homogenous backup application, it might not be adequate to use the sharing option of the application itself, and instead use the partitioning capabilities of the library. This is the case if you have to separate (for security reasons) the data coming from the different backup servers; in this situation you require the partitioning function of the library to guarantee separation of the data.

Of course, if you use different applications then you have to use the partitioning function (for example, if you have iSeries on one hand and Tivoli Storage Manager running on Windows or UNIX on the other hand, connected to the same library).

2.1.4 Tape Library Specialist

The IBM Tape Library Specialist is a Web-based graphical interface for configuring, updating, and administering IBM Open Systems Tape libraries. The Tape Library Specialist is an embedded functionality with the IBM TS3000 family of tape libraries.

The communication is through an Ethernet connection between the Web browser and the tape library. The Ethernet speed is 10/100MB full duplex, and it is auto-negotiated with the host or switch. Once the library is set up for using the IBM Tape Library Specialist, you can connect to the Library using a Web browser, for example, Microsoft Internet Explorer®. We recommend that you upgrade your Java runtime environment to the latest available version, if required by the Tape Library Specialist Web interface. The latest Java runtime environment is available at:

<http://java.com/en/>

In the following sections, we describe in more detail the IBM Tape Library Specialist applications for the IBM TS3100/TS3200, TS3310, TS3400, and TS3500. When the library has been connected to the network, use the Operator Panel to establish the IP address. It can then be accessed from the Web browser using a default user ID and password.

Note: In all our examples, we are using the default user ID and password to connect to the library. However, for obvious security reasons, we recommend that you change the default password, and also establish your own ID and password.

Make sure to update the password for secure access.

The layout of the Tape Library Specialist varies between the libraries, but the general content is similar. It includes functions to:

- ▶ Monitor the library
- ▶ Configure the library
- ▶ Manage the library
- ▶ Manage access to the library
- ▶ Service the library

These functions are exemplified in the library tasks for the TS3400 library; see Figure 2-6.

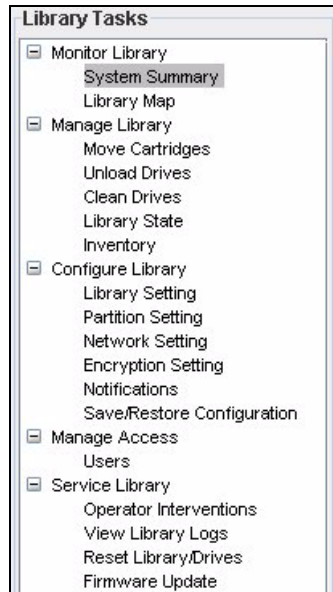


Figure 2-6 TS3400 Tape Library Specialist - Library Tasks

2.2 Partitioning multi-path tape libraries

The IBM TS3100/TS3200, TS3310, TS3400, and TS3500 tape libraries all use the patented multi-path architecture and those libraries can be partitioned. You can use multiple logical libraries to share the physical library between applications, or when allowed by the library (as for TS3500), to support mixed drive types for any application. You can create multiple logical libraries by partitioning the physical library storage slots and tape drives into two or more logical libraries. They can all be partitioned into as many libraries as there are tape drives installed.

Each logical library consists of:

- ▶ Tape drives
- ▶ Storage slots
- ▶ Input/output (I/O) slots
- ▶ Cartridge accessor

Each logical library has its own control path (a logical path into the library) through which a server sends standard SCSI medium changer commands to control the logical library. Each logical library control path is available to servers through a Logical Unit Number 1 (LUN 1) of the first drive that is defined within that logical library. A logical library cannot share another logical library's tape drives and storage slots. However, it does share the I/O slots, and the cartridge accessor on a first-come, first-served basis.

2.2.1 Setting up and configuring the IBM TS3100 / TS3200

Attach your library to the network. Using the TS3100/TS3200 operator panel, set the IP address, subnet mask, and gateway address. See the *IBM System Storage TS3100 Tape Library and TS3200 Tape Library Installation Quick Reference*, GA32-0548 for setup details:

1. Enter the Network Settings using the Operator Control Panel Configuration menu. We recommend setting a fixed IP address. Press **Down** to highlight the Network menu, and press **Enter** to display.
2. Press **Down** to select the IP Address:
 - a. Press **Enter** to highlight the IP Address field.
 - b. Press **Up** or **Down** to select the digit(s) of your library's IP Address.
 - c. Press **Enter** to highlight the next digit(s) in your IP Address.
 - d. After entering the final digits, press **Enter** to apply your entries.
3. Press **Down** to select Netmask. Continue as for the IP address.
4. Press **Down** to select Gateway. Continue as for the IP address.
5. After entering the final digits in your Gateway address, press **Down** and select one of the following possibilities:
 - Save: To save your network settings.
 - Cancel: To cancel all of your entries and leave the settings as they were.
6. Press **Enter** to return to the Configure menu. and click **Cancel** twice to return to the home screen.

You will now be able to access the Tape Library Specialist from a Web browser by entering the tape library IP address. Figure 2-7 shows the Login screen.

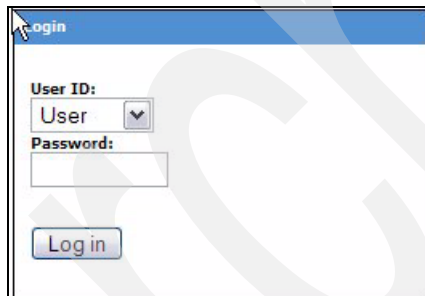


Figure 2-7 IBM TS3200 Tape Library Login screen

Log in as an Administrator; the default password is secure. When logged in as a standard user, you can only access the Status and Information functions; configuration changes cannot be made. If you cannot log on, check that the library is not in offline mode.

Click the **Login** button to log in. This will show the Home menu, and you can now perform any operations on the library; see Figure 2-8.

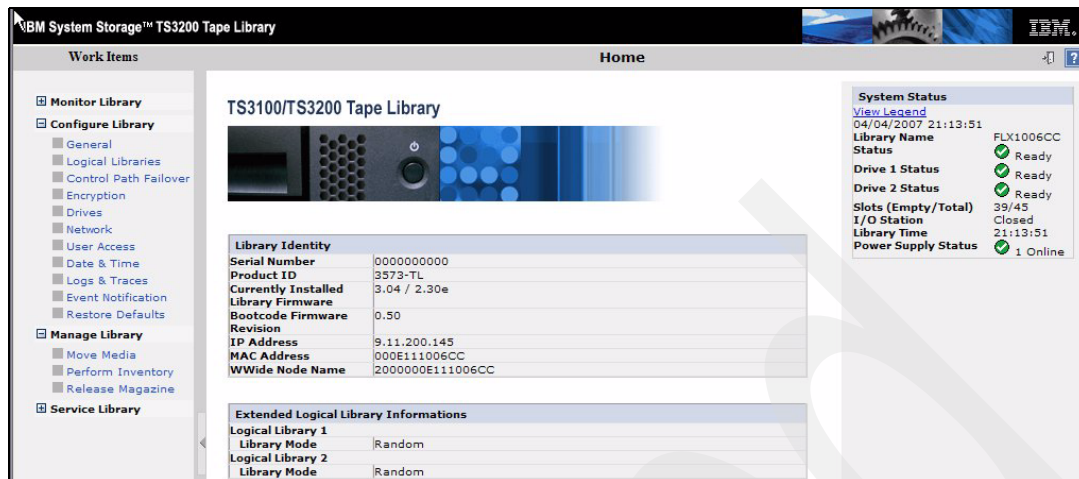


Figure 2-8 IBM TS3200 Home menu

2.2.2 Partitioning the IBM TS3100 / TS3200

The IBM TS3200 library can accommodate two full-high drives or four half-high drives, and can accordingly be partitioned into multiple libraries. Similarly, the TS3100 can accommodate two half-high drives and can then also be partitioned. They use the same Tape Library Specialist. Follow this procedure:

1. Start the Tape Library Specialist.
2. In the Home screen (see Figure 2-8 on page 48), select the **Configure Library** → **Logical Libraries** to define one or more partitions. Select the partitions, and **submit**. You are asked to verify the update, and then the reconfiguration will start. This will take some minutes.
3. Verify the definitions selecting **Configure Library** → **General**; see Figure 2-9.

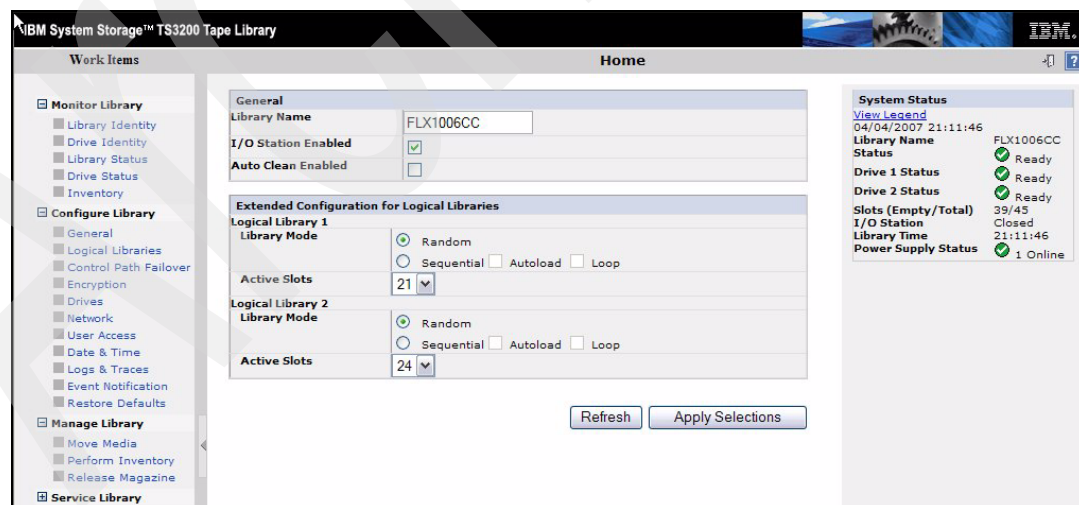


Figure 2-9 IBM TS3200 Partition details

For further description of how to configure the logical partitions, see the *IBM System Storage TS3100 Tape Library and TS3200 Tape Library Setup, Operator and Service Guide*, GA32-0545, available at:

<http://www-1.ibm.com/servers/storage/tape/resource-library.html#publications>

2.2.3 Setting up and configuring the IBM TS3310

Attach your library to the network. The TS3310 Operator panel is a touchscreen interface. Tap it slightly to get the login screen and login as default user admin, password secure. Remember to change this password, and define your own user ids and passwords. The main screen will appear; see Figure 2-10.

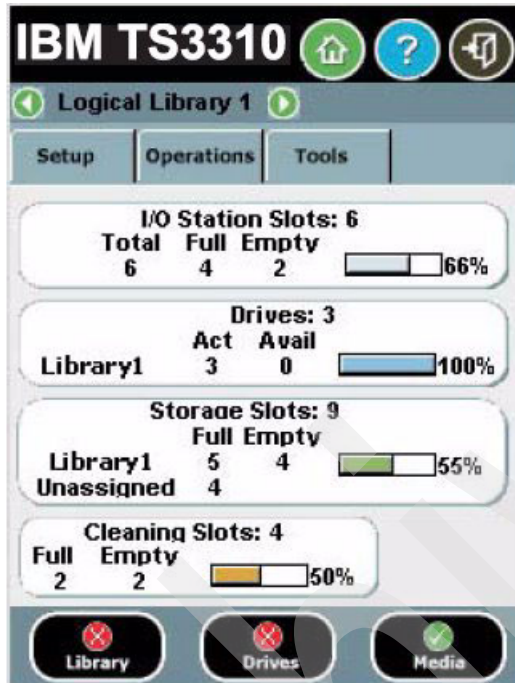


Figure 2-10 TS3310 Home Screen Capacity View

To modify the network settings, select **setup**, and **network config**. The network settings must be set through the Operator Panel.

Note: Make sure that the library is connected to the network before modifying network settings.

You must provide the data for the following fields:

- ▶ Library Name is the network name you want to assign to the library. The library name can be up to a maximum of twelve characters long.
- ▶ Dynamic Host Configuration Protocol (DHCP) setting defaults to enabled. We recommend using a fixed IP address. Set DHCP to *Disable* to make the IP Address, Subnet Mask, and Default Gateway text boxes available for you to manually set the library network settings.
- ▶ Set IP Address as the IP Address of the library, and set Default Gateway and Subnet Mask.

You will now be able to access the Tape Library Specialist from a browser by entering the IP address. Figure 2-11 shows the welcome window of the IBM TS3310 Tape Library Specialist.

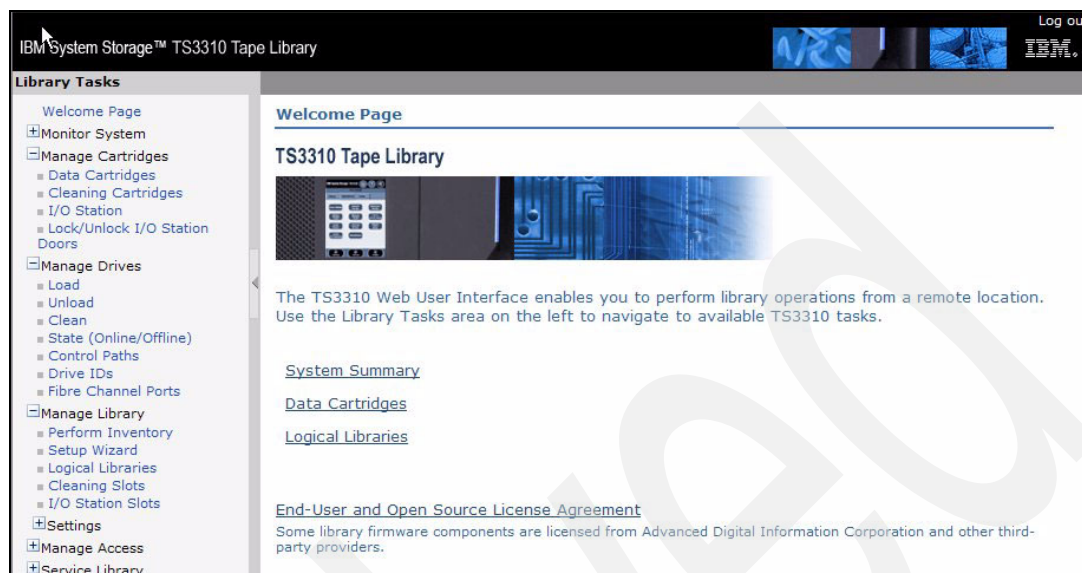


Figure 2-11 TS3310 tape Library Specialist welcome screen

The first time you use the Specialist, log in as `admin` with the password `secure`. Then you can access the Configuration menu to add any additional users that require access. Remember that every user defined can potentially access every option available on the IBM TS3310 operator panel.

From the main menu configuration operator panel in Figure 2-10 on page 49, you can set the network configuration parameters, as well as Simple Network Management Protocol (SNMP) settings to send the alerts generated by the library to an SNMP server in your private network. We describe setting up SNMP in “Configuring SNMP for the IBM TS3100/TS3200” on page 235. The configuration panel also provides user management for the Specialist interface.

2.2.4 Partitioning the IBM TS3310

The IBM TS3310 can be partitioned into as many logical libraries as there are tape drives installed. Each partition provides its own separate and distinct drive, control path, and storage slots. The input/output (I/O) slots are shared on a first-come-first-served basis. This type of partitioning allows heterogeneous applications to share the library robotics independent of each other. Cartridges under library control are not shared between logical libraries, but can manually be moved between logical libraries from the Web UI.

Follow this procedure:

1. Connect to the Tape Library Specialist, and login with default ID and password: *admin / secure*. Remember to change the password for security. The welcome screen will display; see Figure 2-12.

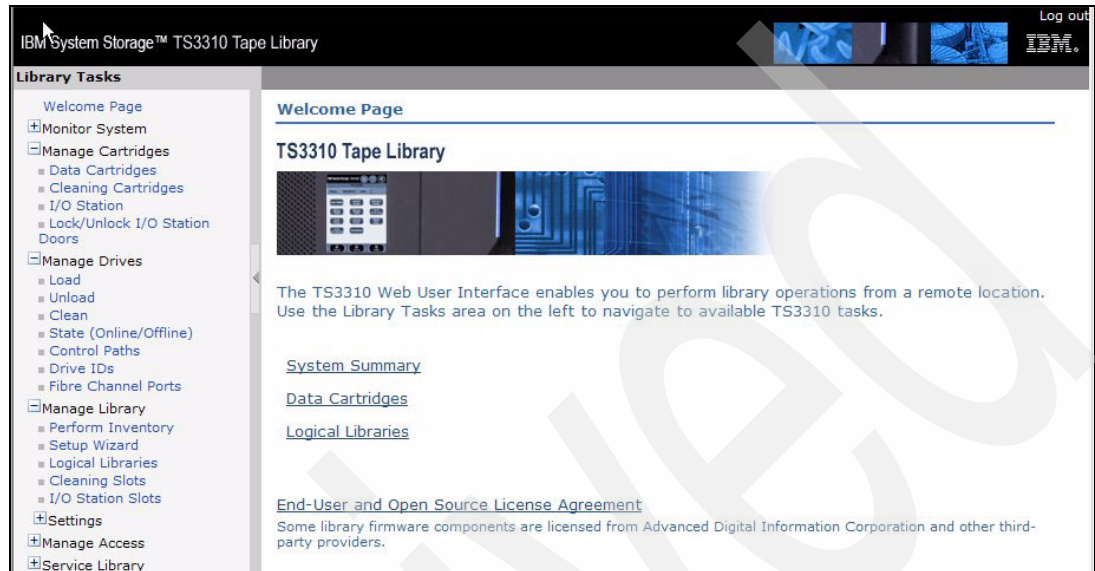


Figure 2-12 IBM TS3310 Welcome page

2. Select **Manage Library** → **Logical Libraries** to display the present setting of logical libraries, as in Figure 2-13.

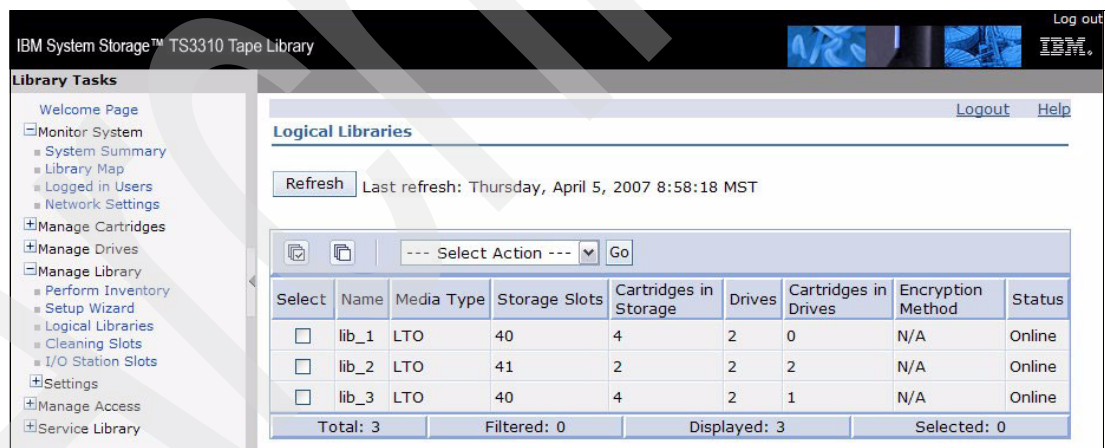


Figure 2-13 IBM TS3310 Logical Libraries.

3. From the drop-down menu, select **create** to add new logical libraries, or **modify** to change a defined library. Modify will give you several choices; see Figure 2-14. You can modify general properties, change storage slots, and assign tapes. Click **Apply** to activate.

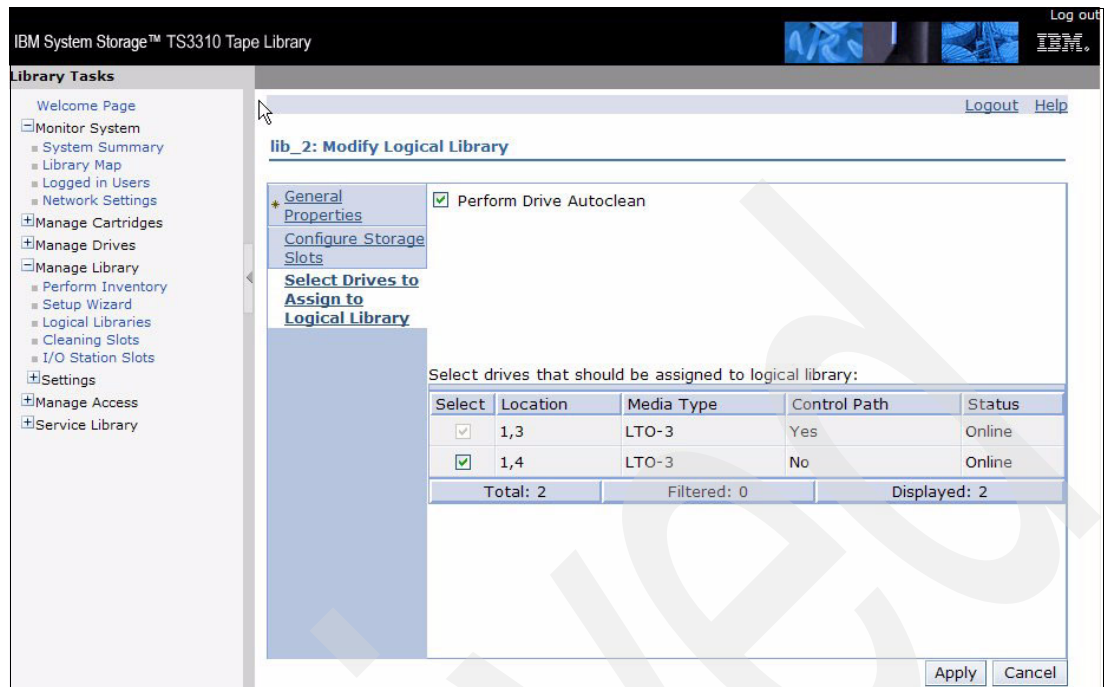


Figure 2-14 Modify a logical library

- With a new library, you can use the configuration wizard to automate some of the initial setup definitions. Select **Manage Library** → **Setup Wizard**; see Figure 2-15.

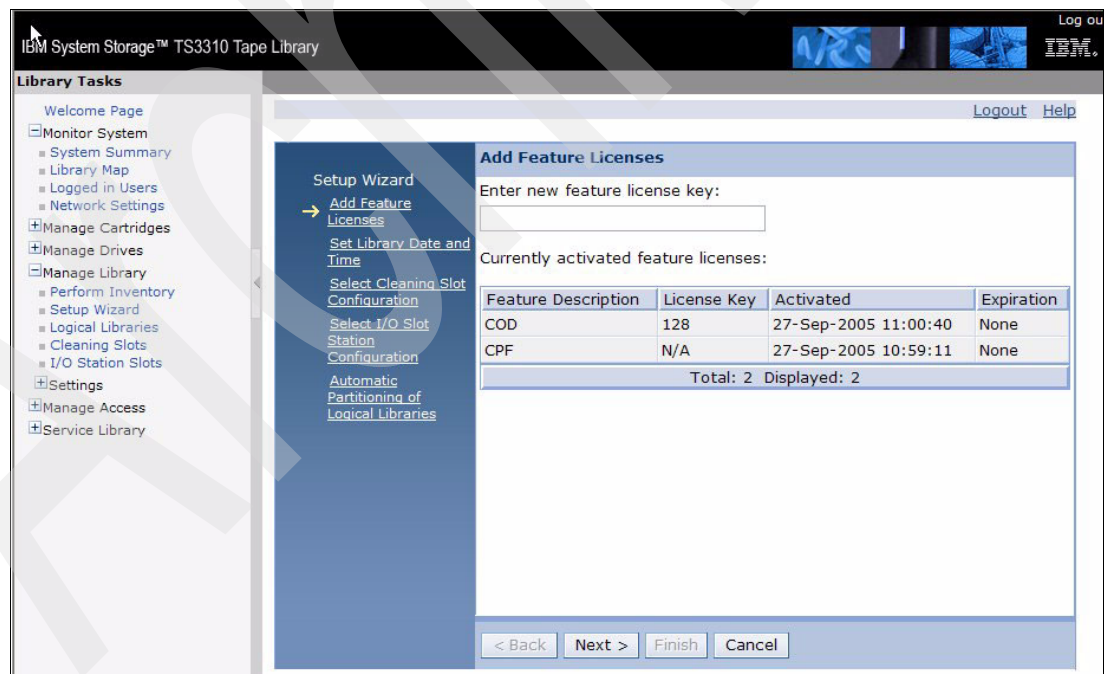


Figure 2-15 IBM TS3310 Setup Wizard

For further description on how to configure the logical partitions; see the *IBM System Storage TS3310 Tape Library Setup and Operator Guide*, GA32-0477, available at:

<http://www-1.ibm.com/servers/storage/tape/resource-library.html#publications>

2.2.5 Setting up and configuring the IBM TS3400

The IBM Tape Library Specialist is embedded in the firmware as a standard feature in the IBM TS3400. Set up the network connection using the operator panel. At library power on, the login screen will display; see Figure 2-16.



Figure 2-16 IBM TS3400 Welcome screen

Press **Enter**, and provide the default password **0000**. Remember to change this password from the Configuring Panel. This will display the Top Menu screen; see Figure 2-17.



Figure 2-17 TS3400 Top Menu screen

To set the network settings using the Operator Panel, complete the following procedure:

1. Press **Down** to select *Configuration*, and press **Enter**.
2. Select *Network Settings*, and press **Enter**.
3. Press **Down** to select *IP Address*, and press **Enter**.
4. Press **Up** or **Down** to select the digit(s) of your library's IP Address. Press **Enter** to select each digit. After the last digit press **Enter** to apply.
5. Press **Down** to select *Subnet Mask*, and press **Enter**. Follow the same procedure as for IP address.
6. Press **Down** to select *Gateway*, and press **Enter**. Follow the same procedure as for IP address.
7. Press cancel three times to return to the top menu screen.

You are now ready to log in to the Tape Library Specialist using a Web browser. You will require at least Java 1.5.0 installed on your computer. Log in using the default id *Admin* with password *secure*. Remember to change this password, and establish your own user ids and passwords. The Welcome screen will display; see Figure 2-18.

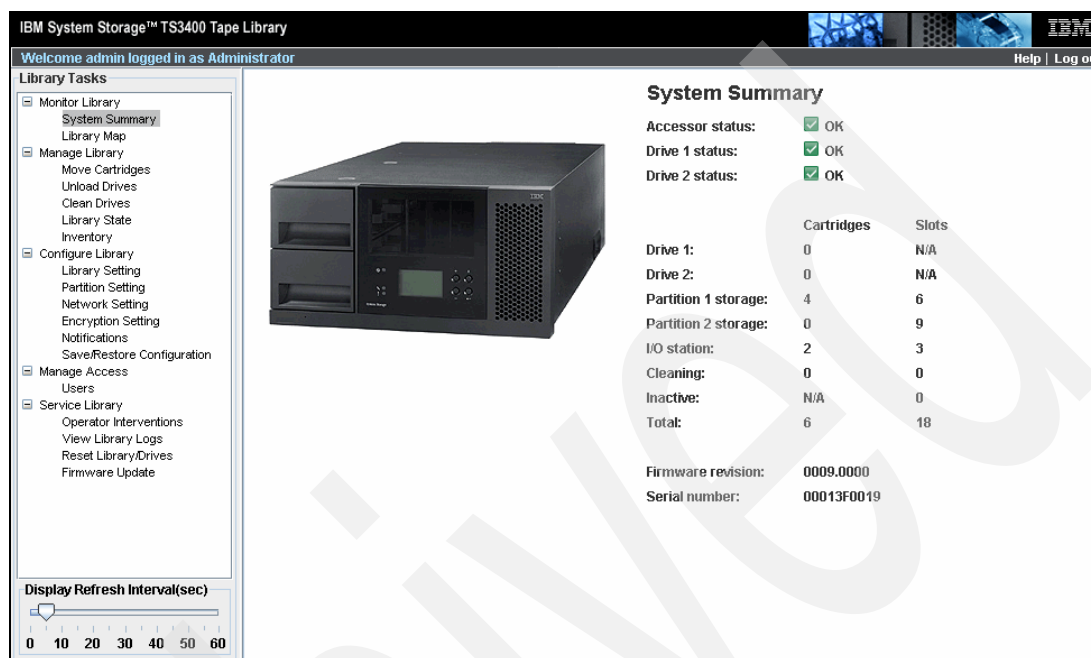


Figure 2-18 TS3400 Welcome screen - System Summary

You can now view or update the configuration, move tape cartridges, vary drives offline, and perform all other Operator panel tasks remotely from any browser window.

2.2.6 Partitioning the IBM TS3400

The IBM TS3400 can be partitioned into two logical libraries. Each logical library has its own drive, storage slots, and control paths. When Input/Output (I/O) slots are configured, they are shared on a first-come, first-served basis.

This library is using the IBM TS 1120 drives which provides built-in multipathing.

Guidelines for partitioning the IBM TS3400

Observe these guidelines:

- ▶ The library can have one or two drives. With two drives, they can either be in the same partition, or two partitions of one drive each.
- ▶ When there are two partitions, one drive will use the upper storage canister, and one drive the lower storage canister. If I/O and cleaning slots are defined, these are common for both partitions.
- ▶ If encryption is enabled, it must be enabled for both drives.

For an overview of the IBM TS3400 library settings; see Figure 2-19.

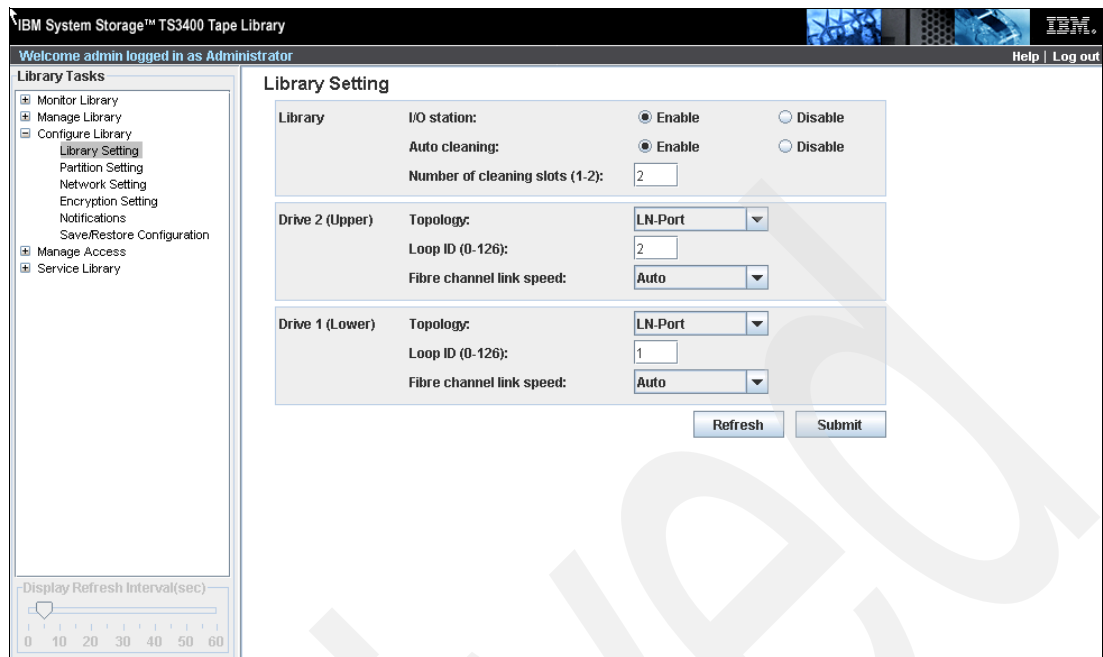


Figure 2-19 IBM TS3400 Library Setting example

Partitioning the IBM TS3400 with the Tape Library Specialist

1. Partitioning is set up using the Tape Library Specialist Web interface. Using this, you will be asked to authenticate and will then see the summary screen shown in Figure 2-20.

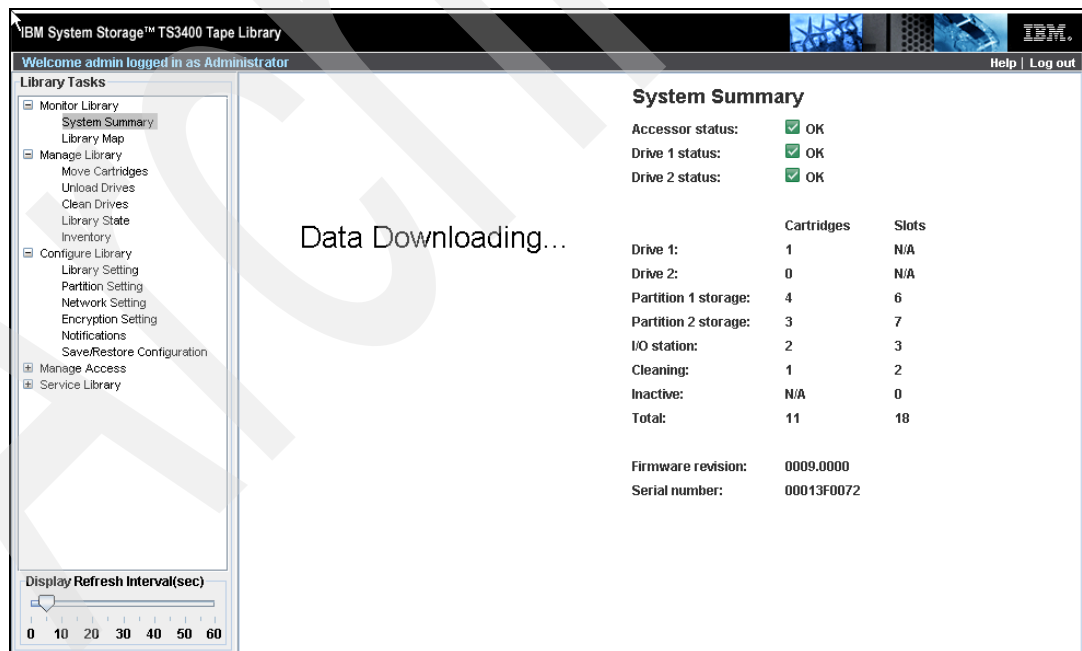


Figure 2-20 IBM TS3400Tape Library Specialist Summary panel

2. Select the **partition setting**, and you will see the map shown in Figure 2-21.

IBM System Storage™ TS3400 Tape Library

Welcome admin logged in as Administrator Help | Log out

Library Tasks

- Monitor Library
- Manage Library
- Configure Library
 - Library Setting
 - Partition Setting**
 - Network Setting
 - Encryption Setting
 - Notifications
 - Save/Restore Configuration
- Manage Access
- Service Library

Partition Setting

Partition: ☒ Enable ☐ Disable

Drive 2 control path: ☒ Enable ☐ Disable

Drive 1 control path: ☒ Enable ☐ Disable

Partition 2 (Upper)

Library mode: ☐ Sequential ☒ Random

Loop: ☒ Enable ☐ Disable

Auto load: ☒ Enable ☐ Disable

Number of active slots (1-7): All

Partition 1 (Lower)

Library mode: ☐ Sequential ☒ Random

Loop: ☒ Enable ☐ Disable

Auto load: ☒ Enable ☐ Disable

Number of active slots (1-6): All

Refresh Submit

Display Refresh Interval(sec): 0 10 20 30 40 50 60

Figure 2-21 IBM TS3400 Partition Setting example

3. To enable partitions, you require at least one tape drive and control path enabled for each partition. The panel indicates that both drives are enabled as a control path.

For more details on configuring partitions; see *The IBM System Storage TS3400 Tape Library Planning and Operator Guide*, GC27-2107, and the following Web site:

<http://www-03.ibm.com/systems/storage/tape/ts3400/index.html>

2.2.7 Setting up and configuring the IBM TS3500

The IBM TS3500 Tape Library Specialist is embedded in the library firmware. Attach the Ethernet port to your network and configure the TCP/IP address information from the library Operator Panel. Choose **Settings** → **Network** → **Ethernet**. You will see the current interface MAC address (which cannot be changed), and the assigned TCP/IP address, subnet mask, and gateway. If the library has more than one frame, and you want to use several connections, then each frame requires a separate address. Use the **Up** and **Down** buttons to access the panels for the additional frames. The current configuration window is shown in Figure 2-22.

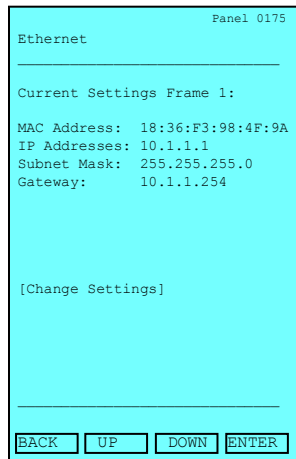


Figure 2-22 Change Ethernet parameters on IBM TS3500

Press **Enter** to make the changes. You can select to disable the Ethernet interface, use DHCP to automatically assign an address (if supported in your network), or manually configure the parameters. We recommend that you define a fixed IP address.

After configuring the network connection for the IBM Tape Library Specialist, enter the TCP/IP address of the library in your browser. The welcome page of the IBM TS3500 Tape Library Specialist Web interface displays, as shown in Figure 2-23. With the Specialist, you can monitor library status and perform library operations from a remote location. Use the Work Items area on the left to navigate to available Specialist tasks. For more information, click the **Help** button in the top right of the screen.

You have now a complete operational control of the TS3500 tape library. The library might have implemented the Advanced Library Management Services, ALMS. For more information about ALMS; see 2.3, “ALMS” on page 73.

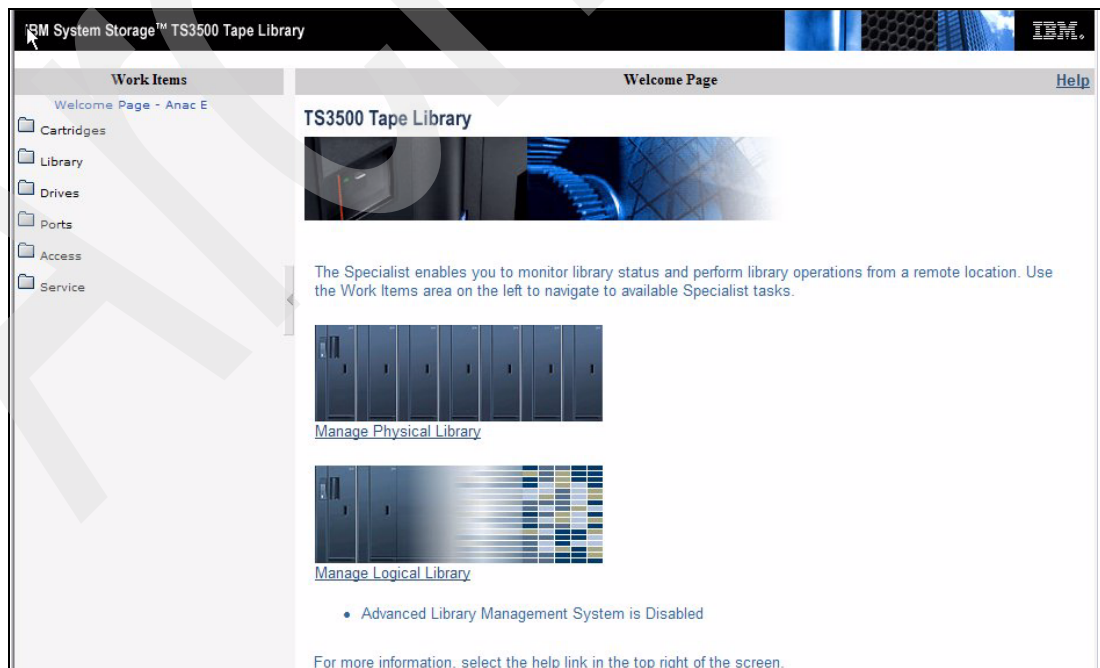


Figure 2-23 IBM TS3500 Tape Library Specialist: Welcome page

With the IBM TS3500 Tape Library Specialist you can easily configure and monitor the library operations with graphics and tables similar to those shown in Figure 2-24.

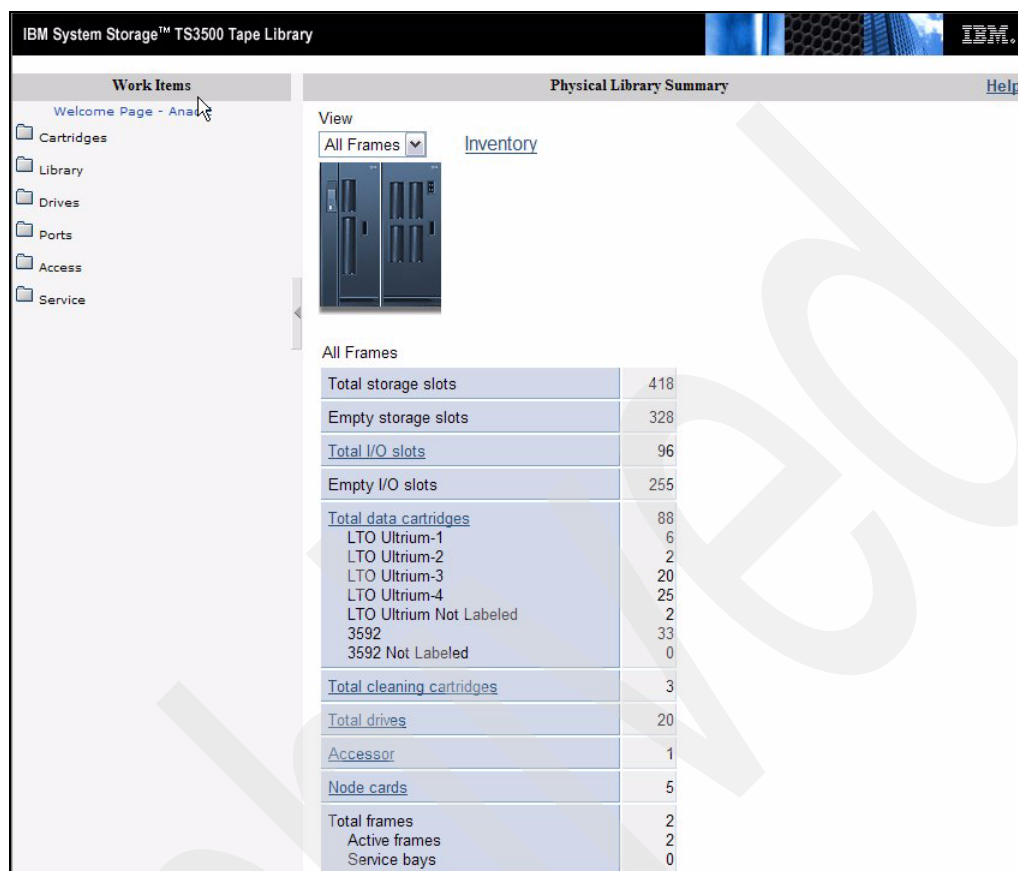


Figure 2-24 IBM TS3500 Physical Library summary panel

The IBM TS3500 Tape Library Specialist has menus to manage the cartridges, drives, and library. The available menus will vary depending upon whether ALMS is installed or not. For further examples, see the specific chapters for partitioning without or with ALMS. In the following discussion, all examples assumes that ALMS is installed and active.

For example with ALMS, to view a list of the cartridges in the library, select **Cartridges** → **Data Cartridges**. Using the drop-down boxes, you can filter the cartridges displayed by frame or logical library. Figure 2-56 on page 84 lists the cartridges for all logical libraries. After selecting a cartridge, you can move it to a tape drive, remove it from the library, or assign it to a logical library. For information on Cartridge Assignment Policy; see “Cartridge assignment policy” on page 82.

To view a list of the drives in the library, select **Drives** → **Drive Summary**. On the **Drives** screen, you can use the drop-down boxes to limit the drives selected to a specific frame or a specific logical library, or you can select all frames or all logical libraries. In Figure 2-61 on page 87, you see for example logical library Redbook1 with LTO4 tape drives.

From the drop-down menu, after selecting a tape drive, you can clean it, change its SCSI ID (or Loop ID if FC), view drive details, move a cartridge, or do a power cycle of a drive. This last feature can be especially useful when sharing drives in a SAN (for example, LAN-free backup). In this circumstance, when a server is using a drive, it issues a SCSI **reserve** command, which blocks it from other servers. The drive is unavailable to other jobs until the server with the **reserve** sends a **release** command to the tape drive. But if the server with the

reserve cannot **release** it (for example, because it is powered down), a power cycle is required on the tape drive to release the block.

To change a drive's settings, select that drive from the Drives screen and click **Change ID**. You will get a warning (Figure 2-25) stating that this function might interrupt the library activity. Indeed, changing the Drive SCSI/Loop ID will interrupt library and drive activities and might require reconfiguring the host computers.

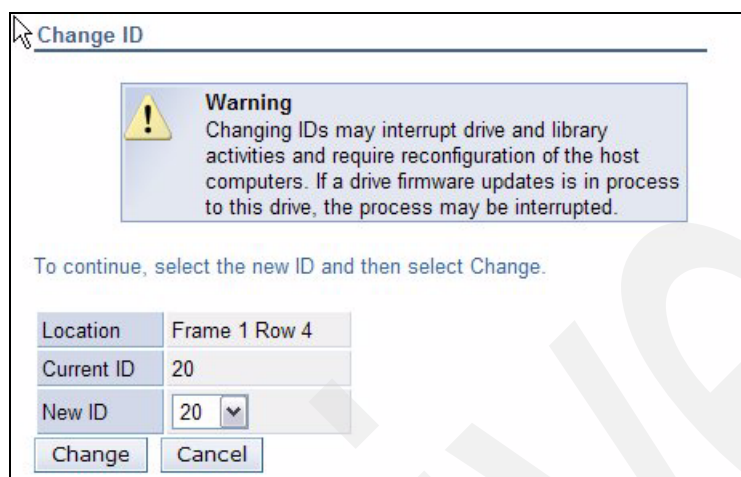


Figure 2-25 IBM TS3500 Tape Library Specialist: ID change warning

Select **Drives** → **Drive Assignment** to display the Drive Assignment Filter screen. You can select all drives or a specific drive, and all logical libraries or a specific logical library. In Figure 2-26, all drives are selected for display.

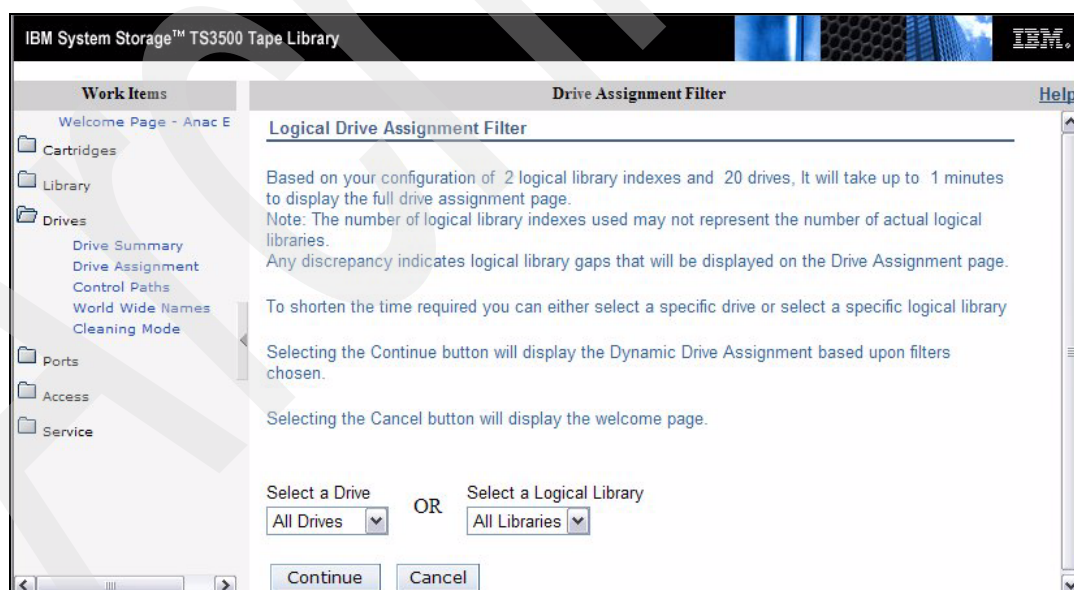


Figure 2-26 IBM TS3500 Tape Library Specialist: Drive Assignment Filter

As shown in Figure 2-27, after selecting a tape drive, you can unassign the drive or assign the drive as a control path. To assign a drive as a control path, click the block to the left of the check box for the drive and click the **Apply** button above the Drives column. In Figure 2-27, drive 30010E611 is a control path, as is indicated by the icon shown on the left of the check box in the **Tucson** column.

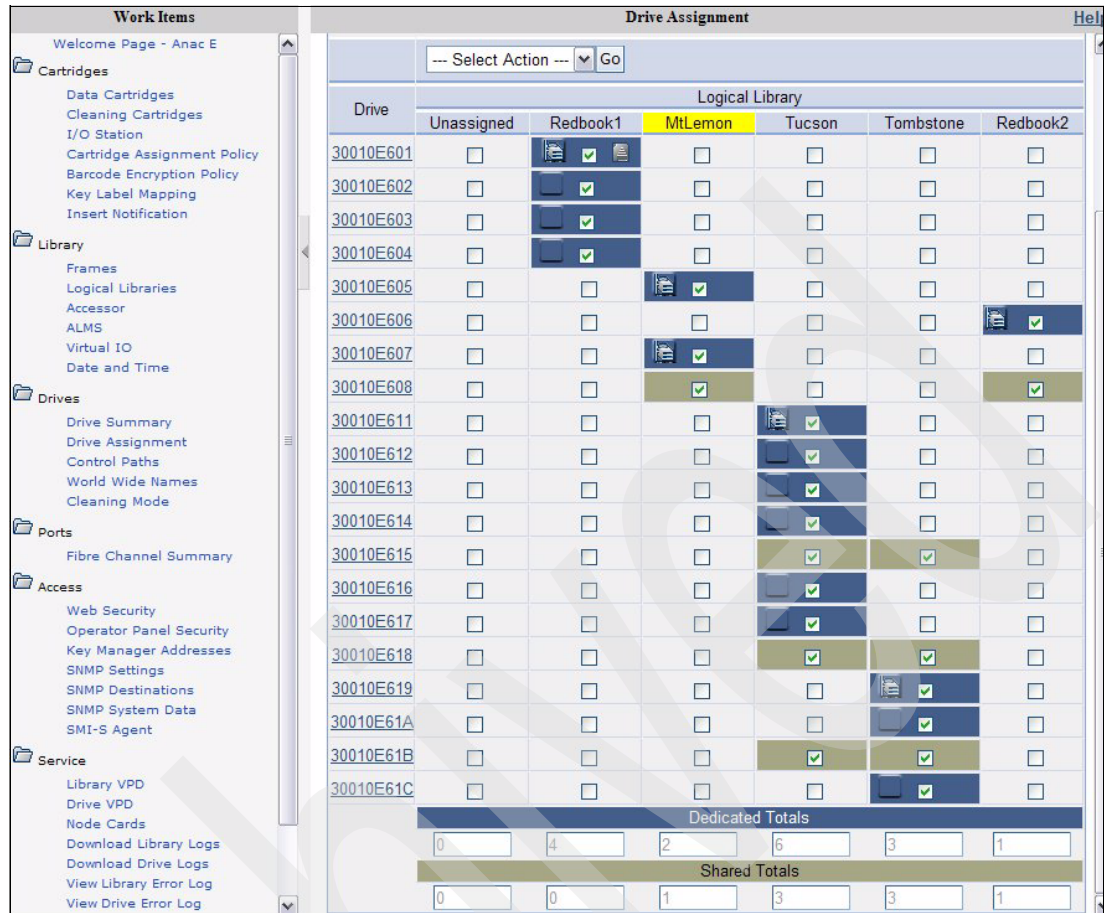


Figure 2-27 Drive Assignment

Adding a control path, you will see a warning (Figure 2-28) that changing a drive or control path assignment might affect the associated host applications and that a reset or rediscovery of its devices might be required.



Figure 2-28 IBM TS3500 Tape Library Specialist: Assignment change warning

You can make any configuration of the library directly from the Tape Library Specialist panels. Note, however, that the initial TCP/IP configuration function is not available from the IBM Tape Library Specialist. This must be done from the Operator Panel.

You should always set password protection on to assure secure access to the library. To turn it on, select **Access** → **Web Security**; see Figure 2-29. Once password security is set on, use the same selection to control users and passwords.

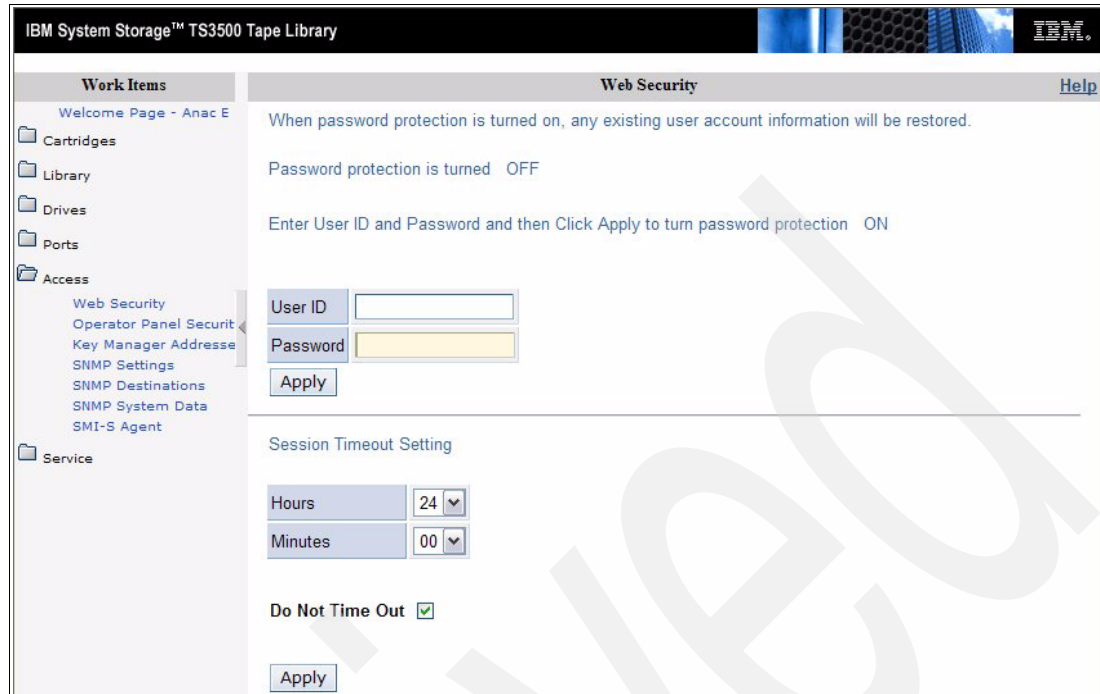


Figure 2-29 Set Password screen

For firmware update of the IBM TS3500 Tape Library; see 3.8.5, “Updating library or drive firmware for IBM TS3500” on page 152.

2.2.8 Partitioning the IBM TS3500 (ALMS not enabled)

You can partition the IBM TS3500 into multiple logical libraries. Each logical library requires at least one tape drive and one storage slot. Therefore, you can theoretically configure as many logical libraries as there are tape drives installed in the library, that is, the IBM TS3500 supports up to 192 logical libraries. LTO2, 3 and 4 drive types can be mixed in a logical library if the backup application supports it, but LTO and IBM 3592 tape drives cannot be mixed within a logical library, and they must be installed in different frames.

Note: If using mixed media and drives (LTO and 3592) within one IBM TS3500, then at least two logical libraries (one for LTO and one for 3592) must be created.

Storage slots within one logical library must be in contiguous order, but can span over different frames. Also, tape drives within one logical library must be in contiguous order, but can be in different frames, and can contain gaps in the order (such as having two drives installed in frame 1 and two drives in frame 2; then you have a gap of 10 drives).

However, although the IBM TS3500 allows you to have gaps in the tape drive order, some applications such as EMC Legato NetWorker or VERITAS NetBackup do not support such gaps. When using the ALMS feature, the tape drives will always be defined as consecutive. For details about ALMS; see 2.3, “ALMS” on page 73.

Plan your logical library configuration carefully, because the requirement for contiguous storage slots and drives makes future changes to the configuration very difficult. For instance, if you have an IBM TS3500 with six logical libraries defined, and you have to change the configuration of the first library, then all of the five remaining libraries must be changed also.

Consequently, plan your logical library configuration according to these rules:

- ▶ Put the logical library that has the most expected growth at the end of the library.
- ▶ Put the logical library that is the least likely to grow in the front.
- ▶ Do not configure logical libraries with just the required minimum of resources (tape drives and storage slots); rather, configure logical libraries with a buffer (reserve) of storage slots.
- ▶ Do not put the first drive of a logical library just behind the last drive of the preceding logical library. Keep some free drive locations between two logical libraries in order to install additional drives if required.

Figure 2-30 shows an example. This is an L53 frame with nine LTO drives installed, and with a capacity of 261 storage slots. Three logical libraries are required: logical library 1 requires 40 slots and two drives; logical library 2 requires 60 slots and two drives; logical library 3 requires 120 slots and five drives. The third library is expected to grow heavily.

The first logical library was configured with 60 slots and two tape drives.

The second logical library was configured with 81 slots and two tape drives. The first tape drive for logical library 2 was installed in the fourth drive location; this gives the possibility to install one additional drive in the first logical library if required.

The library with the highest expected growth was put at the end. If required, an additional D-frame can be added to the library and logical library 3 can be expanded to the next frame without changing the configuration of the first two libraries.

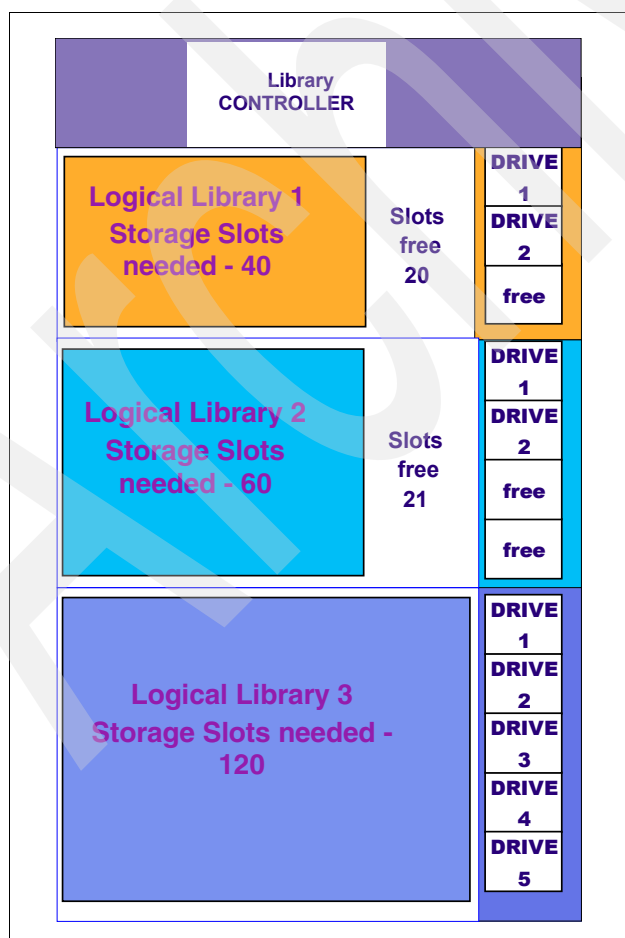


Figure 2-30 IBM TS3500 partitioning example

You can partition the IBM TS3500 into multiple logical libraries by using menus. You can choose the exact number of storage elements that you want by selecting them from the library display **Advanced Configuration** menu selection, or by using the **Tape Library Specialist** menu.

In both cases, the library will be set offline while configuring. For further details on setting up partitions using the Operator Panel; see the *IBM System Storage TS3500 Tape Library Operator Guide*, GA32-0560.

2.2.9 Partitioning the IBM TS3500 using the wizard (ALMS not enabled)

First, plan the number and location of storage slot columns and tape drives that you want in each logical library. Now, the logical libraries can be configured from the Tape Library Specialist using the configuration wizard or the menu system.

Using the Tape Library Specialist

In this example, we have a 2-frame library with one LTO frame and one 3592 frame. There are eight LTO4 drives, and twelve 3592 drives already installed. It is defined as three logical libraries, but we will reconfigure the logical libraries using the configuration wizard, to achieve this configuration:

- ▶ Logical library 'Redbook1', 4 LTO drives, 100 cartridge slots
- ▶ Logical library 'Mt Lemon', 4 LTO drives, 119 cartridge slots
- ▶ Logical library 'Tucson', 8 3592 drives, 120 cartridge slots
- ▶ Logical library 'Tombstone', 4 3592 drives, 79 cartridge slots

To use the IBM TS3500 Tape Library Specialist Web interface, do the following:

1. Enter the library's IP address as a Web site in your browser window; the introduction window displays (see Figure 2-23 on page 57). If login security is enabled, there will be a login prompt first.
2. Click **Manage Logical Library** on the main pane, or select **Library** and **Logical Libraries** on the left side. The Manage Logical Libraries window displays; see Figure 2-31.

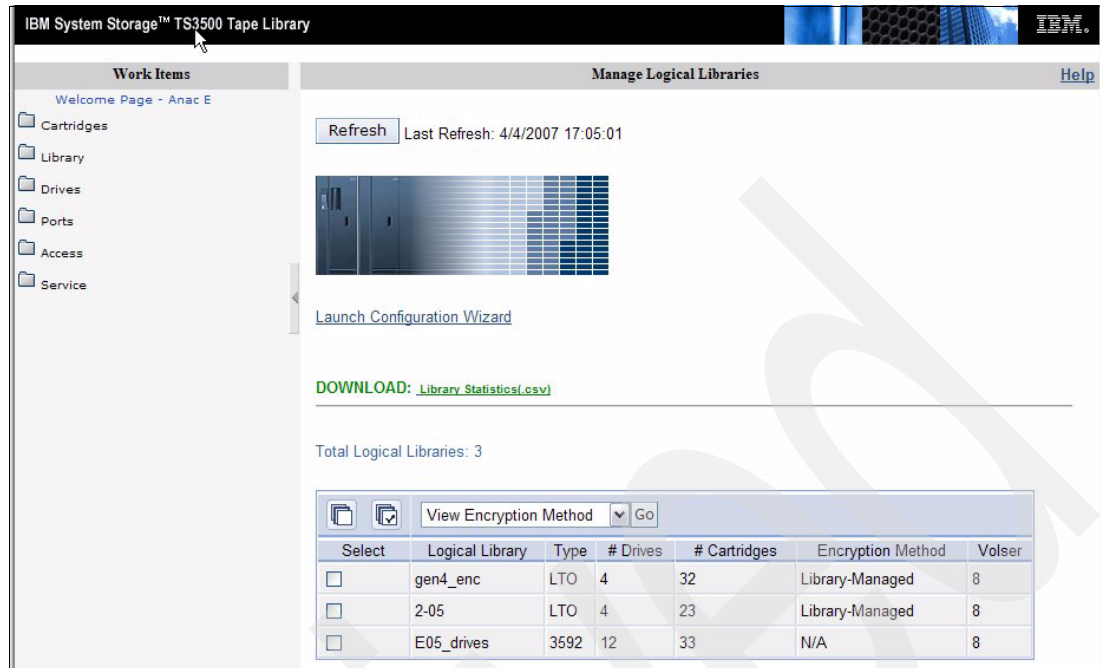


Figure 2-31 IBM TS3500 Tape Library Specialist Logical Libraries entry panel

3. This shows the library's current configuration. Select the **Launch Configuration Wizard**. A warning window informs you that the library goes offline and that it can take up to 30 minutes to complete, depending on the library configuration (a small library with just one or two frames and a few drives might take less than a minute). Click **Next** to continue.
4. The **Select Configuration Method** window displays (Figure 2-32), showing the alternatives: **Automated configuration** (configuration with barcode labels) or **Advanced configuration**. Select **Advanced configuration** and click **Next**.

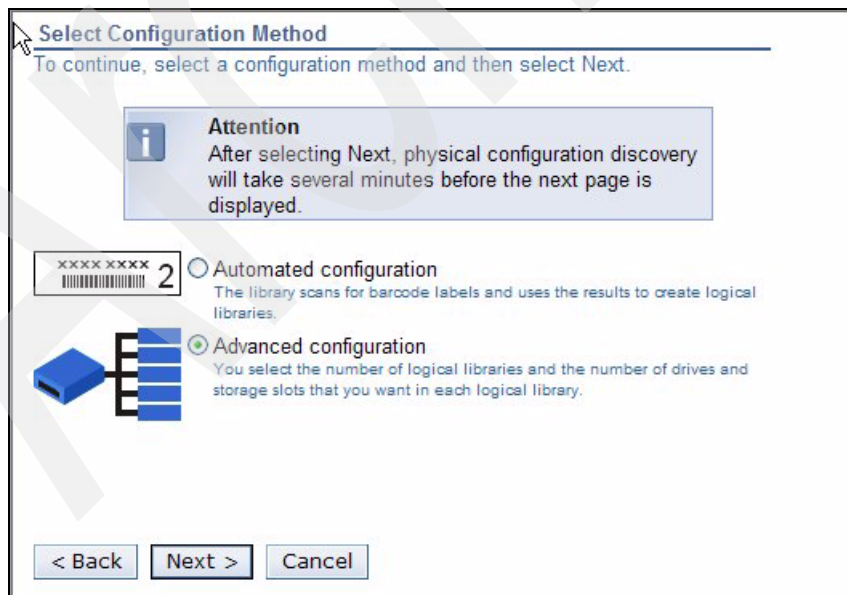


Figure 2-32 IBM TS3500 Tape Library Specialist configuration wizard

5. The library starts its configuration discovery, which can take several minutes. The current configuration will be displayed. Check that the displayed configuration matches the real configuration (Figure 2-33). If not, then stop here and try the configuration discovery again. If the problem is still not solved, call your service representative.

	Frames	Total Drives	Restricted Drives	Storage Slots	I/O Slots
LTO	1	8	0	219	16
3592	1	12	0	199	80
Total	2	20	0	418	96

Verify that this is your current configuration. If you agree, select Next to continue.

If this does not reflect your physical configuration, select Retry to perform another physical device discovery.

Figure 2-33 Current physical configuration

6. Click **Next**. As this is a mixed device library, you get a warning about this, and that multiple configurations are necessary; see Figure 2-34.

Current Physical Configuration

Your library has more than one media type and will require multiple configurations.

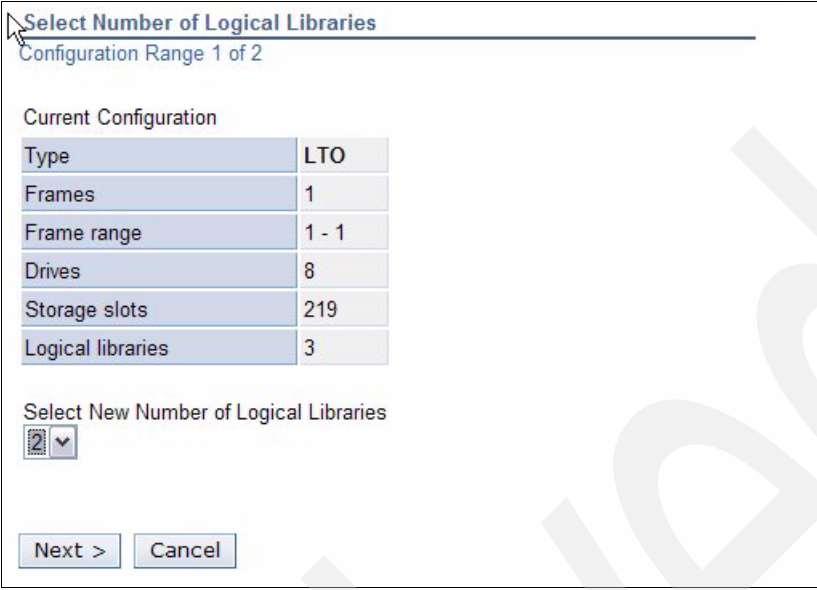
A configuration range will include all contiguous available drives and storage of a single media type.

If you have more than one media type in your physical library, you will have more than one range and therefore will have more than one selection in the following screens.

For example, you may be prompted to first configure your LTO range and after completing that media type, you will be prompted to work with your 3592 range.

Figure 2-34 Multiple configurations warning.

7. Click **Next**. The number of logical partitions can now be selected (Figure 2-35).



Select Number of Logical Libraries
Configuration Range 1 of 2

Current Configuration

Type	LTO
Frames	1
Frame range	1 - 1
Drives	8
Storage slots	219
Logical libraries	3

Select New Number of Logical Libraries
2

Next > Cancel

Figure 2-35 IBM TS3500 Tape Library Specialist Logical Libraries

8. Select the number of logical libraries from the pull-down list. Select **Next**. The desired number of drives and slots can now be assigned to each logical library (Figure 2-36 on page 67). Begin with the first logical library and use the Tab key to jump from one field to the other. Every time you press the Tab key, the remaining number of drives and storage slots is re-calculated.

Note: All resources (tape drives and cartridge slots) must be assigned!

If you have both LTO and 3592 in the physical library, there will be more than one configuration range, and more than one set of selection and configuration details in the screens. That means you can first configure a range of LTO elements, and then a range of 3592 elements.

Select **Next** when finished.

Customize Logical Libraries
Configuration Range 1 of 2

Enter the number of drives and storage slots per logical library.

Logical Library	Drives	Storage Slots
1	4	100
2	4	119
Total:	8	219

Total Summary

Type	LTO
Logical Libraries	2
Drives	8
Storage Slots	219

< Back Next > Cancel

Figure 2-36 IBM TS3500 Tape Library Specialist customize drives and slots - LTO

9. In the same way, select and customize the 3592 libraries; see Figure 2-37.

Customize Logical Libraries
Configuration Range 2 of 2

Enter the number of drives and storage slots per logical library.

Logical Library	Drives	Storage Slots
3	8	120
4	4	79
Total:	12	199

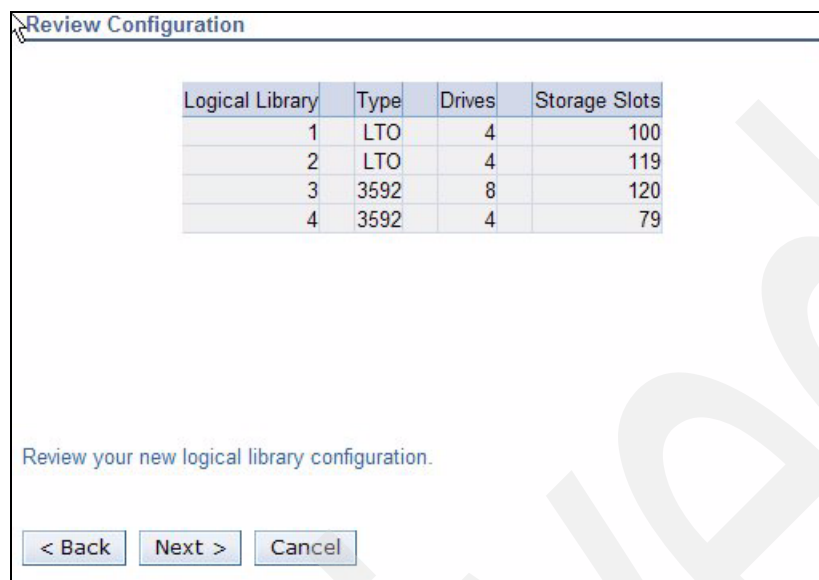
Total Summary

Type	3592
Logical Libraries	2
Drives	12
Storage Slots	199

< Back Next > Cancel

Figure 2-37 Customize drives and slots - 3592

10. A new window shows the selections. The configuration can now be reviewed before being applied; see Figure 2-38.



Review Configuration

Logical Library	Type	Drives	Storage Slots
1	LTO	4	100
2	LTO	4	119
3	3592	8	120
4	3592	4	79

Review your new logical library configuration.

< Back Next > Cancel

Figure 2-38 Review configuration

11. Select **Next** to accept the configuration, and then select **Finish** to apply the new configuration, which takes some minutes. After completion, the library informs you with a Library configuration successful message.

After setting a new configuration, the new logical libraries are simply named using numbers. You can change this to more meaningful names: From the Manage Logical Libraries screen (Figure 2-31 on page 64), select the library to be renamed and click **rename**. On the next screen (Figure 2-39) enter a new name. The logical library name is only used by the Library Specialist, and has no affect on the communication with your backup application.



Rename Logical Library

Rename the Logical Library.

Current Logical Library Name

New Logical Library Name

Apply Cancel

Figure 2-39 Rename logical library

When all logical libraries are renamed, we have our library layout; see Figure 2-40.

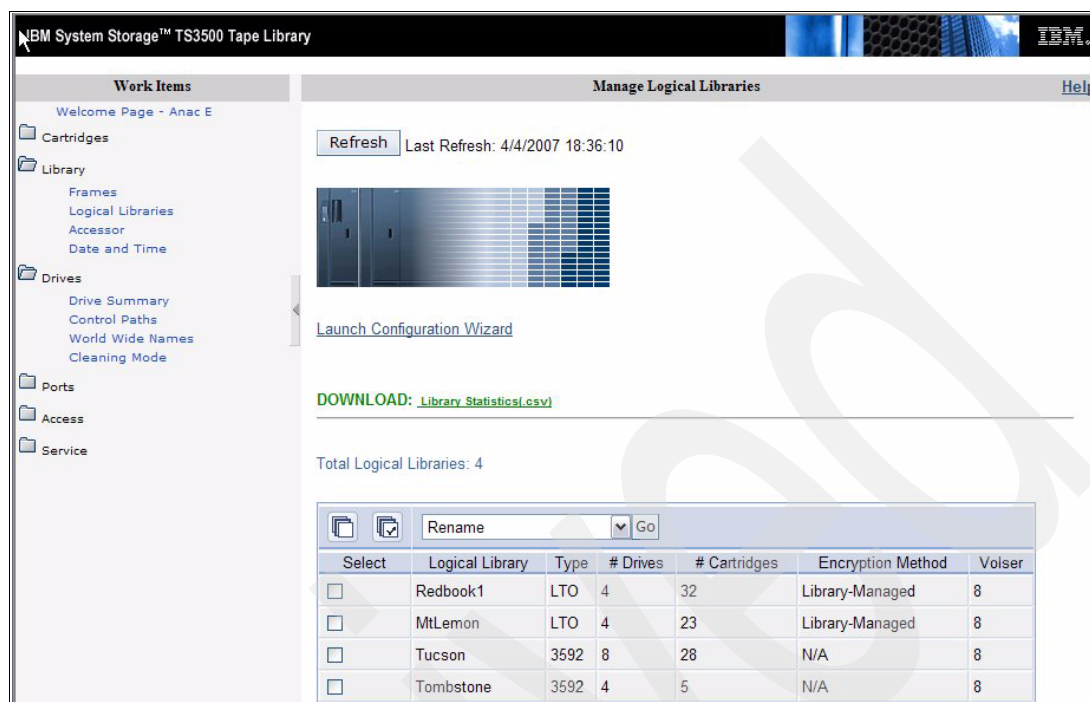


Figure 2-40 IBM TS3500 Logical Library status

Before we can work again with the library, we have to adjust the logical library configuration with the backup application which uses this library. If the storage slot capacity on the logical library is increased or decreased, the backup application must reflect this change. Refer to your backup application manuals for information on how to change an existing library configuration. Some applications such as IBM Tivoli Storage Manager handle this easily; other applications such as Legato NetWorker require that you run configuration wizards (NetWorker's `jbconfig`) in order to reflect the changes.

Also, cartridges that belong to the logical library must be moved to the appropriate set of storage cells.

2.2.10 Partitioning the TS3500 using the operator panel (ALMS not enabled)

For further details using the operator panel, refer to the *IBM System Storage TS3500 Tape Library Operator Guide*, GA32-0560. These are the steps, but your screens might vary slightly.

1. From the library's Activity window, click **Menu**. The Main Menu displays as shown in Figure 2-41.

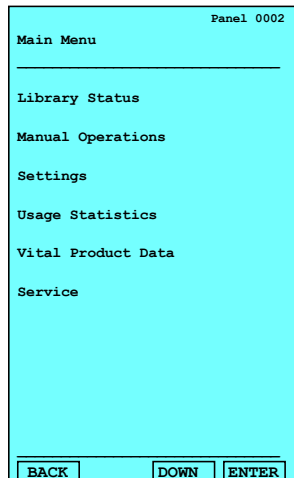


Figure 2-41 IBM TS3500 operator panel: Main Menu

2. Press **Up** or **Down** to highlight *Settings*, then press **Enter**. The Settings menu displays.
3. Press **Up** or **Down** to highlight *Configuration* and press **Enter**. The Configuration menu displays.
4. Press **Up** or **Down** to highlight *Advanced configuration* and press **Enter** (Figure 2-42). The library displays the message: If you continue with configuration the library will go offline. Press **Enter** to continue.

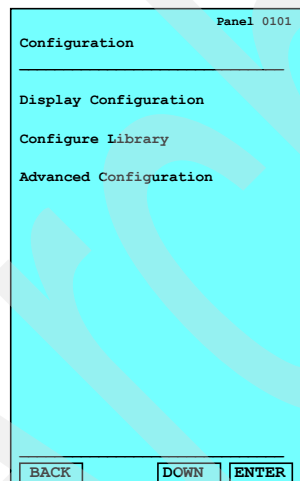


Figure 2-42 IBM TS3500 operator panel: Configuration

5. Press **Enter** twice. The library displays the message: Searching for installed devices and might take several minutes to discover the physical configuration. The Physical Configuration panel displays, identifying the library's existing physical configuration (Figure 2-43). The panel shows the total quantity of drives, storage slots, and I/O slots in the library's physical configuration. If the configuration includes both LTO and 3592 drives, the list will show them separately.

Check that the displayed configuration matches the real configuration. If not, stop here, resolve the problem, and start again.

Panel 0102
Physical Configuration

Total Frames:	3
Total LTO:	2
Total 3592:	1
Service bays:	2
Total Drives:	34
Total LTO:	22
Total 3592:	12
Restricted	2*
Total Storage Slots:	930
Total LTO:	571
Total 3592:	359
Total I/O Slots:	26
Total LTO:	10
Total 3592:	16
Configuration Mode: Advanced	

BACK DOWN ENTER

Figure 2-43 IBM TS3500 Configuration display

- Press **Enter**. The library displays the message: Do you want to commit the new physical configuration?
- Click **Yes** to accept the new physical configuration and to set up any logical library configurations. The Set Logical Libraries panel displays indicating the type of media used by the logical library (Figure 2-44). The following panels will not display if the ALMS feature has been enabled.

Panel 0105
Set Logical Libraries

Media Type : LTO
Frames 1 - 1

Number of Logical Libraries

Select 1 - 12

CANCEL UP ENTER

Figure 2-44 IBM TS3500 operator panel: Set Logical Libraries

- Specify the number of logical libraries that you want by clicking **Up** or **Down** to increase or decrease the value.

9. When the desired quantity of libraries displays, press **Enter**. The Set Storage Slots panel displays (Figure 2-45).

Panel 0106

Set Storage Slots

Logical Library 1

Storage Slots 139

Select 1 - 140

Cartridges in the following
storage slots will now be
part of logical library 2

Location Start: [F1,C07,R42]
Location End: [F1,C07,R43]

BACK UP DOWN ENTER

Figure 2-45 IBM TS3500 operator panel: Set Storage Slots

10. Specify the quantity of storage slots that you want in the logical library by clicking **Up** or **Down** to increment or decrement the value. When the desired quantity of storage slots displays, press **Enter**. The Set Drives panel displays (Figure 2-46).

Panel 0107

Set Drives

Logical Library 1

Number of Drives 1

Select 1 - 12

BACK UP DOWN ENTER

Figure 2-46 IBM TS3500 operator panel: Set Drives

11. Specify the quantity of drives that you want in the logical library by clicking **Up** or **Down** to increment or decrement the value. When the desired quantity of drives displays, press **Enter**.
12. The Configuration Summary panel for Logical Library 1 is displayed (Figure 2-47). The panel contains the range of SCSI element addresses for the cartridge storage slots and the drives.

```

Panel 0103
Configuration Summary
-----
Key: [LL=Logical Library,
F=Frame, C=Column, R=Row]
LL Logical Library 1
Media type          LTO

Storage Slots:      0064
Elem Addr Range:    1025 - 1088
First Location:     [F1,C01,R02]
Last Location:      [F1,C03,R21]

Drives:             001
Elem Addr Range:    0257 - 0257
First Location:     [F1,R01]
Last Location:      [F1,R01]

Control Path:

2
Back Up Down      ENTER

```

Figure 2-47 IBM TS3500 operator panel: Configuration Summary

13. press **Enter** to display the Configuration Summary panel for each logical library. After displaying the panel of the last logical library, the library displays the message:
Do you want to commit the new logical configuration?
14. Click **Yes** to accept the new configuration (the library can take several minutes to process).
When finished, it displays the message: The configuration process is complete.

2.3 ALMS

The Advanced Library Management System (ALMS), an optional extension to the IBM patented multi-path architecture (FC1690), provides enhanced flexibility and capabilities for partitioning the IBM TS3500 Tape Library. ALMS virtualizes the SCSI element addresses while maintaining the approach of the multi-path architecture and using SCSI3 Medium Changer commands. Without ALMS, tape handling is based on the SCSI element address (location-centric) and partitioning is based on real cartridge slots and drive slots. With ALMS, there is no affinity between a real slot address and a SCSI Element address reported to the server and used by the server. Instead there is now an affinity with the VOLSER (volume serial numbers on the barcode label of the cartridge).

ALMS allows the following new capabilities on the IBM TS3500 Tape Library:

- ▶ Dynamic partitioning:
 - Storage slot pooling
 - Flexible drive assignment
- ▶ Add/remove storage capacity transparent to any host application.
- ▶ Configure drives or Lxx storage capacity without taking the library offline.
- ▶ Virtualize I/O slots to automatically manage the movement of cartridges between I/O station slots and storage slots.

The IBM TS3500 Tape Library is compliant with the SCSI Medium Changer standard whether ALMS is enabled or not; when enabled, ALMS is completely transparent to the application. The SCSI Medium Changer can be thought of as a “location-centric” interface. The application controlling a SCSI Medium Changer device specifies a source and destination location for each request to move a cartridge. The traditional SCSI library does not have control of the cartridge locations; instead the SCSI library just acts on behalf of the server.

Restriction: ALMS is available only for the IBM TS3500 Tape Library and requires FC1690 for enablement.

2.3.1 Functional description

In this section, we give a functional description of the ALMS features. The information is based on the *IBM TotalStorage UltraScalable Tape Library TS3500 Tape Library Advanced Library Management System Technology White Paper* by Lee Jesionowski, which can be found at:

<http://www.ibm.com/servers/storage/tape/resource-library.html#whitepapers>

Storage slot virtualization

The host-view of a cartridge location is known as the *SCSI storage element address*. Without ALMS, the storage element address maps directly to a specific storage slot after the library is configured. With ALMS enabled, a given storage element address is no longer associated with a specific storage slot. Instead, storage slots are virtualized by dynamically associating them with element addresses, as required. An element address will be associated with a storage slot, selected by the library, as cartridges are moved and inventoried. In the case of a storage element that is empty due to a move, that source element address will become unassociated. Association of storage element addresses is accomplished in a way that is completely transparent to the application software.

The number of storage element addresses for a logical library (as reported to the host application software) is selectable by changing the Maximum Number of Cartridges setting for that logical library using the Web user interface (Tape Library Specialist). For each logical library, the default value for Maximum Number of Cartridges is the number of addressable storage slots that are installed in the library for that cartridge type at the time that ALMS is first enabled or, after ALMS is enabled, at the time the logical library is created. The Maximum Number of Cartridges setting can be changed for each logical library, but the value must always be greater than or equal to the number of actual cartridges currently assigned to that logical library. It is possible to set Maximum Number of Cartridges to a value that is higher than the number of addressable storage slots installed at the time. This will allow future library capacity expansion to be transparent to the host application software. However, application performance might degrade slightly due to the greater number of addresses. Care should be taken to not exceed the license limitations of the host application software.

The starting element address for storage slots of each logical library will be x'400' (1024) plus the associated logical library number. For example, logical library 1 would start at x'401' (1025), logical library 2 would start at x'402', and so on (see Figure 2-48 on page 75). The reason they do not all start at x'401' is because some applications have to be able to differentiate between different logical libraries from the same physical library.

Drive assignment

Using the ALMS flexible drive assignment capability, any drive in any position within any frame can be assigned to any logical library without creating any gaps in drive addresses. Drive (data transfer) element addresses will still be mapped to specific drive locations when the drive is assigned, but any drive location can now be assigned to any logical library (intermix supported) using the Tape Library Specialist. Each drive added to a logical library will be assigned to the lowest available element address, regardless of drive location.

When ALMS is first enabled, the Data Transfer Element (DTE) addresses of all installed and assigned drives are not changed from their previous values. However, after ALMS is enabled, the DTE addresses for any newly installed and assigned drives no longer depend on the drive's position. Instead, the DTE address for any newly installed or assigned drive is

determined by the sequence in which the drive is assigned to each logical library. After enabling ALMS, drives are assigned to logical libraries using the Drive Assignment page of the Tape Library Specialist.

Using this interface, the DTE address for the first drive assigned to a new logical library is 257 (x'101'); see Figure 2-48. The DTE address for any other drive assigned to a logical library is based on the next available DTE address in that particular logical library. The next available DTE address is the lowest available DTE address after the starting DTE address. (This will fill any gaps that are created when drives are unassigned and removed from a logical library.) When a drive is unassigned from a logical library using the Web interface, only that DTE address is made available for future usage, no other DTE addresses are affected.

The Drive Assignment page also supports the option to share a drive between two or more logical libraries. The drive will be assigned a DTE address in more than one logical library. Note that the DTE addresses that are assigned to a shared drive might differ by logical library.

By using ALMS' dynamic Drive Assignment capability, any drive in any position in any frame is available to be assigned to any logical library without creating gaps in DTE addresses.

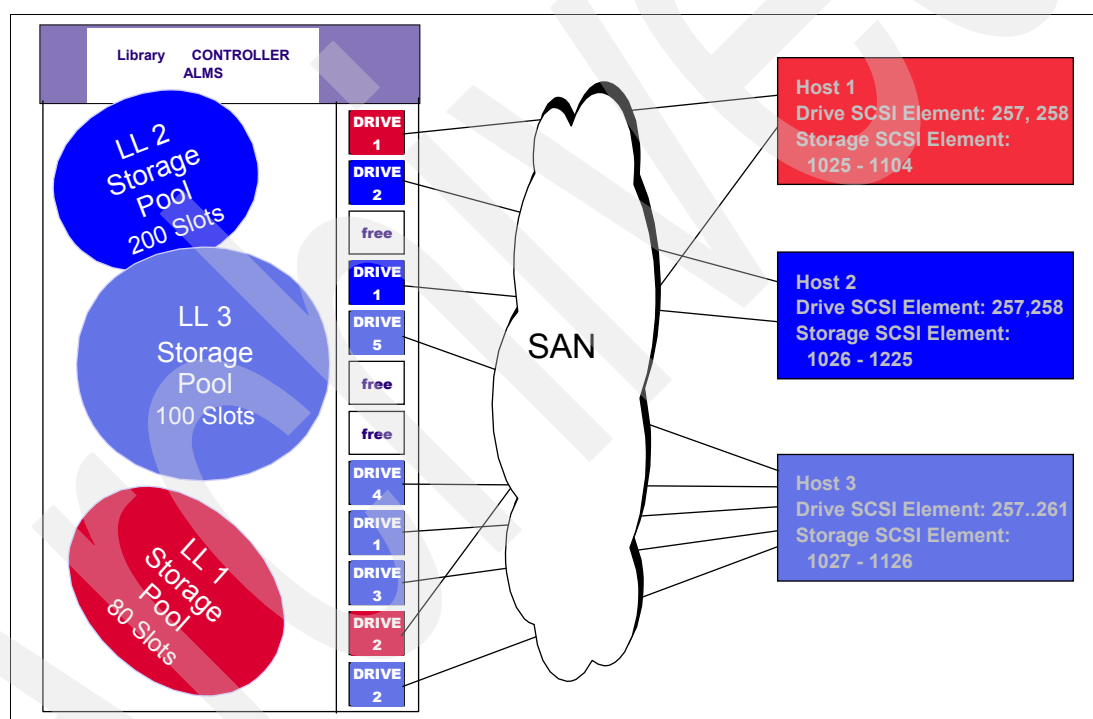


Figure 2-48 IBM TS3500 Tape Library with ALMS

Storage slot pooling

With ALMS, logical libraries can be added or deleted non-disruptively. All storage slots are first-come-first-served to each logical library based on cartridge insert operations. Therefore, storage slots are pooled as a shared resource such that changes to the capacity allocation for each logical library can occur without any down time or administrator involvement whatsoever. Indications of a full or nearly full physical library will continue to be provided via the Operator Panel, Tape Library Specialist, and SNMP traps.

The minimum logical library simply has a name and can be thought of as a file folder that has no content. Drives can be placed in the file folder using the Drive Assignment screen of the Tape Library Specialist. Cartridges can also be placed in the file folder, based on their volume serial (VOLSER) numbers and by using one of the following methods (in priority order):

- ▶ Migration from static partitioning (UI enablement of ALMS)
- ▶ Cartridge assignment policy (automatic at time of insertion)
- ▶ Insert notification (Operator Panel selection at time of insertion)
- ▶ Software application move from I/O station (based on source of command)
- ▶ Manual assignment using the Tape Library Specialist

The VOLSER assignment and physical location of cartridges are stored in non-volatile RAM (both primary and backup copies).

Shared drive assignment

Some customers require the ability to easily share a drive on an exception basis. For example, a drive might be required for a once-a-month job or as a temporary replacement for a failed drive. The Tape Library Specialist drive assignment UI supports the ability to assign a drive to multiple logical libraries. Therefore, each logical library will consist of dedicated drives and shared drives. Each logical library will map a drive element address to the location of both dedicated and shared drives.

This option reduces the requirement to configure and unconfigure the tape drive every time, whether it is required or not.

The Drive Assignment Web window supports the following point-and-click capabilities, which are non-disruptive to other logical libraries:

- ▶ Assign the drive
- ▶ Remove the drive assignment
- ▶ Reassign the drive

When a cartridge is mounted in a shared drive, the library will only accept a de-mount command requested via the source logical library; any de-mount command requested via other logical libraries will be rejected.

However, the data path to the tape drive itself is not protected by the library. Therefore, the administrator must ensure that shared drives are not accessed by the wrong application via the data path. One option to ensure this is to use the SCSI reserve and release option on open and close. The device driver together with the application handles this. On a device open, the application initiates a SCSI reserve through the tape device driver. No other server can now access the tape drive (except for commands such as inquiry), ensuring that data is not overwritten by any other host or application. After the device is closed, the application must send a SCSI release to the tape drive. Most applications handle this, but it is best to check with the backup software provider to confirm.

SAN zoning can also be used to prevent access to the same tape drives by different servers.

When a tape drive is shared by applications, any application using the drive has no knowledge of the other applications sharing the tape drive. Therefore, a cartridge could be loaded already and in use by application A, but if application B does not know it and tries to mount a cartridge in the same drive, application B would get a failure and the job that application B was executing would fail. Some applications periodically scan all the tape drives and if they recognize that there is a cartridge mounted without initiation from the application itself, the application would consider this tape drive offline.

In any case, we recommend not allowing multiple applications to use shared tape drives concurrently. In other words, set tape drives offline (or in service mode) from the application whenever they are not in use by that application.

The sharing option is mainly intended for environments where some drives are required only occasionally and must be preconfigured for the application.

Note: An application that occasionally leaves cartridges in drives or periodically scans all configured drives is not a good candidate for sharing drives between logical libraries.

Eliminates down time for total capacity changes

With ALMS enabled, the total library capacity (number of addressable storage slots) can be changed transparently to each application because the Maximum Number of Cartridges value is not affected by changes to the number of storage slots. The additional storage slots are simply new slot candidates for cartridges to be moved to upon insertion.

Furthermore, using the new Intermediate and full Capacity on Demand capabilities of the TS3500 Tape Library Model L23 and L53, updates requires no down time at all for the change to total L-frame capacity.

Cartridge assignment policy

The cartridge assignment policy (CAP) of the IBM TS3500 allows you to assign ranges of cartridge volume serial (VOLSER) numbers to specific logical libraries through the Tape Library Specialist. When a cartridge is inserted into the I/O station, the cartridge assignment policy will be used to attempt to associate the cartridge with a logical library. If the cartridge is not in the CAP and insert notification (discussed in the next section) is enabled, you can assign the cartridge to a logical library by using the Insert Notification process on the library's operator panel or keep the cartridge as unassigned and assign it later using the Tape Library Specialist. If the insert notification feature is not enabled, and the cartridge was not in the CAP, the cartridge will eventually be available to all hosts. Unassigned cartridges can also be assigned to a logical library by creating a new VOLSER range, then performing a manual inventory to assign those cartridges through the cartridge assignment policy.

The cartridge assignment policy is media-type specific. As such, it is based on the six most significant characters of the cartridge label, and the ranges of VOLSERs do not include the media-type indicator (L3, L4, JA, JJ and so forth). This means that two identical labels (except for the media-type indicator) could be assigned to two different logical libraries; for example, libraries that contain LTO or 3592 drives.

Note: The cartridge assignment policy does not reassign an assigned tape cartridge. To reassign a cartridge, use the procedure for assigning cartridges to a logical library.

Insert notification

Insert notification is an option that enables the IBM TS3500 to monitor the I/O station for any new media which does not have a logical library assignment. This feature can be enabled through the Operator Panel or through the Tape Library Specialist. With Insert Notification enabled, when new media is detected the operator panel displays a message that asks to select a logical library. Any unassigned cartridges in the I/O station will be assigned to the logical library that you select (and all other logical libraries will not be able to access the cartridges). The library includes an option to defer any assignment and there is a time-out period when the deferral will automatically take effect.

2.3.2 Virtual I/O

The IBM TS3500 Tape Library has I/O stations and I/O slots that enable you to import and export up to 32 cartridges at any given time. With the special 64slot I/O frames, a total of 224 I/O slots can be available. The I/O slots are also known as *import/export elements (IEEs)*. Virtual I/O (VIO) slots increase the quantity of available I/O slots by allowing storage slots to appear to the host as I/O slots. Storage slots that appear to the host as I/O slots are called

virtual import/export elements (VIEEs). The goal of virtual I/O slots is to reduce the dependencies between the system administrator and library operator so that each performs their import and export tasks without requiring the other to perform any actions. With virtual I/O slots, the library automatically moves cartridges from the I/O stations to physical storage slots and from physical storage slots to the I/O stations.

With virtual I/O slots, you can configure up to 255 VIEEs per logical library. This can be set using the **Max VIO Slots** button for the logical libraries. Each logical library will have a unique VIEE address space that is not accessible by other logical libraries.

New logical libraries will by default be assigned the maximum number of virtual I/O slots, while logical libraries defined before ALMS is enabled initially have the number of physical I/O slots in the library.

Prior to virtual I/O slots, the IEE space was comprised of physical I/O station slots in the L-frame (10, 30, 16, or 32 depending on the frame model type). Additionally 3 times 64 slots are now available with the extended I/O frames. The I/O slots were shared by all logical libraries. If the application or system administrator did not explicitly import the cartridges from the I/O station into library storage, the cartridges would remain in the I/O station. This reduced the number of IEEs available to process imports and exports.

With virtual I/O slots, when cartridges are inserted into the I/O station, the library will work with the cartridge assignment policy or insert notification to assign a cartridge to the correct logical library VIEE space, and cartridges will automatically be moved into library storage slots. If there is no cartridge assignment policy assigned and insert notification is disabled for a particular cartridge, then that cartridge will be inserted into the VIEE space of all logical libraries and automatically get moved into a library storage slot. The VIEE temporarily takes on the attributes of an IEE until a host moves the cartridge into a storage element (StE). When the host move occurs, if the cartridge is in a storage slot, no physical move is required, and the element transitions from a VIEE to an StE. Similarly, when a host exports a cartridge from an StE, the physical storage slot will be reported as a VIEE without moving the cartridge to the I/O station. The library will monitor when free space is available in the I/O station and move exported cartridges at the library's convenience.

If a cartridge cannot be assigned, this will be reported as *Assignment Pending*. This can occur if the assigned logical library does not have any available VIEE slots, or if all of the logical libraries do not have a common VIEE to share. To resolve this, either free up VIEE addresses so this is available in all libraries, or make a specific assignment of this cartridge to a logical library.

With VIO, there is an option to *Hide/Show Exports*. Show Exports, the default, shows a VIEE inventory of cartridges exported from the logical library. These cartridges then fill one of the VIEE slots for that logical library. Exporting a cartridge will be reported as *Export in Progress* if there is no available VIEE and will not complete until one is available. *Export Complete* is shown when the exported cartridge is physically in an I/O station slot.

Selecting Hide Exports moves the exported cartridges to a library-maintained export queue, the VIEE is free immediately for other import/exports, and the exported cartridge disappears from the host application's inventory data.

Support for Virtual I/O slots is provided at library microcode level 5360 and above, and is enabled by default when ALMS is enabled. Existing customers who have already enabled ALMS on their IBM TS3500 Tape Library will have to install a newer level of library microcode that supports virtual I/O and then manually enable the virtual I/O slots.

For VIO examples, see also *IBM System Storage Tape Library Guide for Open Systems*, SG24-5946.

2.3.3 Configuring ALMS

The ALMS Feature Code #1690 is required for ALMS operation. This feature code provides a License Key that must be installed through the Operator panel (unless it was part of the initial order and was thus already installed by manufacturing.

Enter ALMS license key

To enter the ALMS license key, do the following steps:

1. From the library Operator Panel, select **Menu** → **Service Library** → **Firmware Update** → **Features** → **Enter**. The Features screen displays a list of features, including the **Advanced Library Management System**. Select this and press **Enter**.
2. For each character of the license key, press **Up** or **Down** to select the value you want, and press **Enter** to move to the next digit. If you enter an incorrect number, press **Back** to return to the previous digit.
3. Press **Enter**. The Features screen now indicates Advanced Library Management Feature Is Installed.

Press **Back** until you return to the main screen.

Enable ALMS

After the License Key is installed, you can enable ALMS using the Tape Library Specialist and performing the following steps:

1. Enter the library's IP address as a Web site in your browser. If login security has been enabled there will be a login prompt, and then you will see the welcome screen with the message that ALMS is disabled at the bottom; see Figure 2-49.

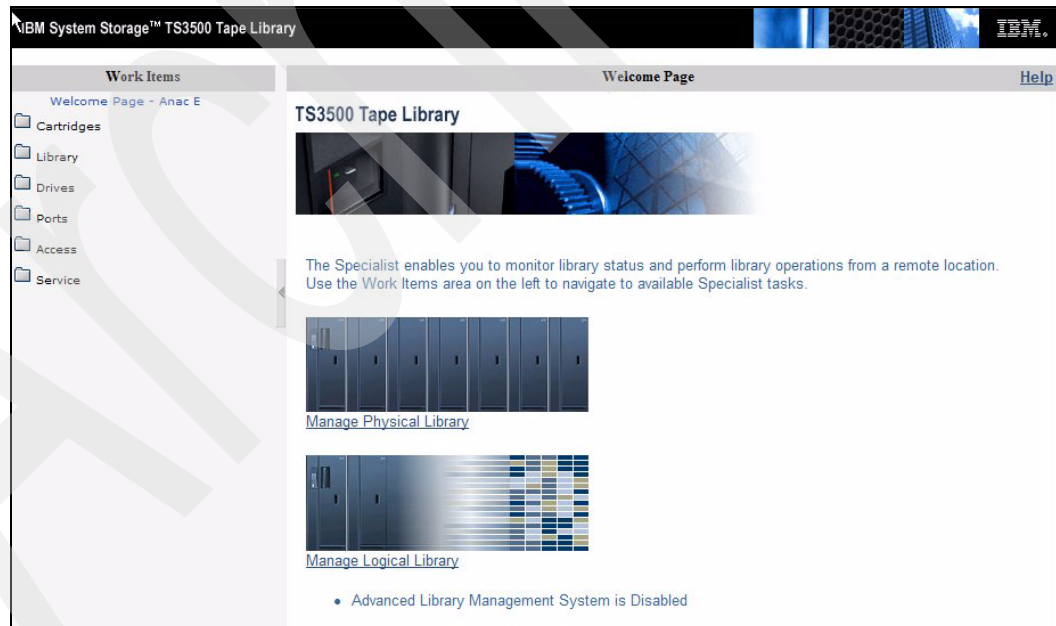


Figure 2-49 Welcome screen before enabling ALMS

2. On the left side of the screen, select **Library** → **ALMS**. This will display a warning and a specific selection to **Enable ALMS** (Figure 2-50). The operation will take many minutes, according to the size of your library.

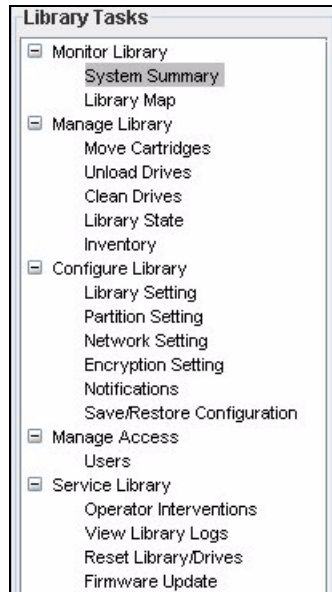


Figure 2-50 Enable ALMS

Note: You can enable or disable ALMS in the IBM TS3500 using the Tape Library Specialist, but not the operator panel.

When ALMS is enabled, you can easily:

- ▶ Name, add, and remove logical libraries
- ▶ Reassign a cartridge to another logical library
- ▶ Change the maximum quantity of cartridges that can be assigned to a logical library
- ▶ Add, remove, and edit ranges of volume serial (VOLSER) numbers (also known as cartridge assignment policy)
- ▶ Assign shared drives, change control path drives, unassign drives, and assign new drives without using manual configuration methods

ALMS can also be disabled, but this should be done with care. After ALMS is enabled, the screen shown in Figure 2-50 has the option **Disable ALMS** instead.

Important: When you disable ALMS, the library returns to an unconfigured state and all cartridge and drive assignments are lost. You must manually reconfigure the library. However, switching between definitions, the library will use the previous definitions as a basic starting configuration.

Note: If you manually configure the library, your changes might result in the loss of cartridge or logical library assignments, cartridge assignment policies, maximum cartridge assignments, and logical library names.

When using ALMS, cartridges belong to one logical library based on their VolSer. Without ALMS, logical libraries are based on physical boundaries within the library. This means that after disabling ALMS you might have to move several cartridges.

When switching from an environment with ALMS disabled, to one with ALMS enabled, the library will use the previous definitions as a basic starting configuration. The library will perform an inventory operation similar to when the frame door has been opened. The library status during this inventory process will show a cartridge assignment status of pending (Figure 2-51).

Create and manage logical libraries

1. From the Tape Library Specialist (Figure 2-49 on page 79), select **Library** → **Logical Library** and on the next screen, Figure 2-51, click **Create**.

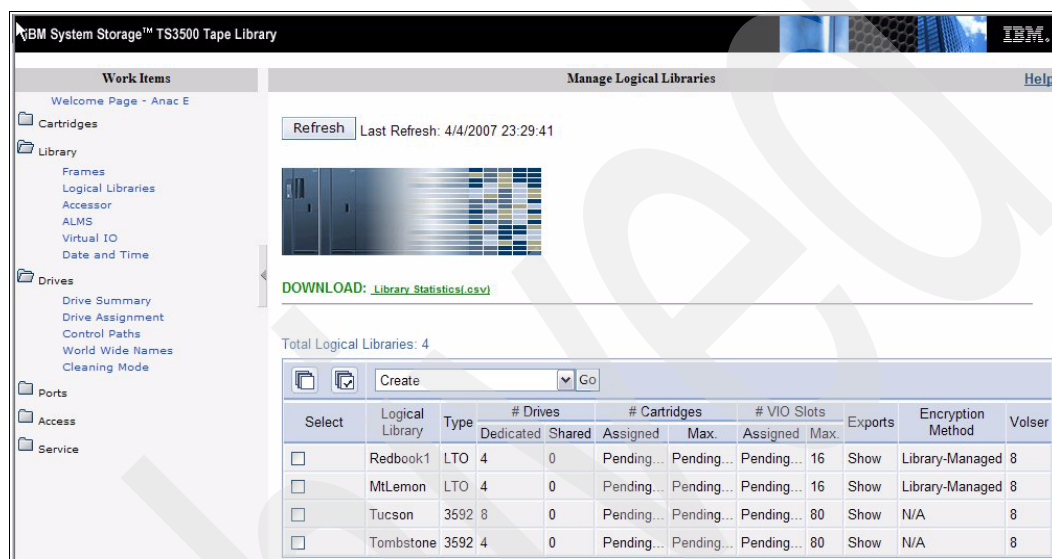


Figure 2-51 Create Logical Library

2. Type a unique name (up to 15 characters) for your new logical library (in our case, Redbook2) and select a **Media Type** (LTO or 3592) for this logical library, as in Figure 2-52. Click **Apply**. You cannot mix LTO and 3592 media types in one logical library, but you can have different LTO generations in one logical library, for example, LTO2, LTO3 and LTO4.

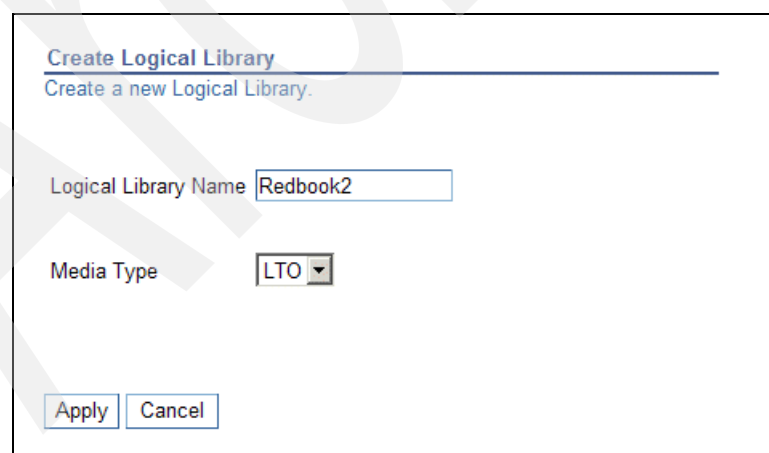


Figure 2-52 Create Logical Library

- The library created will appear in the Manage Logical Library display, as in Figure 2-53, but with no cartridges or drives assigned; these columns show a zero count. Therefore, after creating a new logical library, you have to add cartridge pools and tape drives.

IBM System Storage™ TS3500 Tape Library

Work Items Manage Logical Libraries Help

Welcome Page - Anac E

Cartridges

Library

Frames

Logical Libraries

Accessor

ALMS

Virtual IO

Date and Time

Drives

Drive Summary

Drive Assignment

Control Paths

World Wide Names

Cleaning Mode

Ports

Access

Service

Refresh Last Refresh: 4/4/2007 23:45:58

DOWNLOAD: [Library Statistics\(.csv\)](#)

Total Logical Libraries: 4

Create Go

Select	Logical Library	Type	# Drives		# Cartridges		# VIO Slots		Exports	Encryption Method	Volser
			Dedicated	Shared	Assigned	Max.	Assigned	Max.			
<input type="checkbox"/>	Redbook1	LTO	4	0	32	100	0	16	Show	Library-Managed	8
<input type="checkbox"/>	MtLemon	LTO	4	0	23	119	0	16	Show	Library-Managed	8
<input type="checkbox"/>	Tucson	3592	8	0	28	120	0	80	Show	N/A	8
<input type="checkbox"/>	Tombstone	3592	4	0	5	79	0	80	Show	N/A	8
<input type="checkbox"/>	Redbook2	LTO	0	0	0	219	0	255	Show	None	8

Figure 2-53 Added new logical library

Cartridge assignment policy

A new logical library does not have any cartridges assigned to it. You can assign single cartridges that are currently unassigned, or that are assigned to another logical library (the cartridge will then be removed from this logical library).

Or, you can assign a pool of unassigned cartridges (establish a *cartridge policy*) to the logical library. Such a *cartridge assignment policy* defines a range based on the VOLSER.

- To assign a cartridge assignment policy, on the left-hand side, select **Cartridges** → **Cartridge Assignment Policy**. The Cartridge Assignment Policy window appears (Figure 2-54).

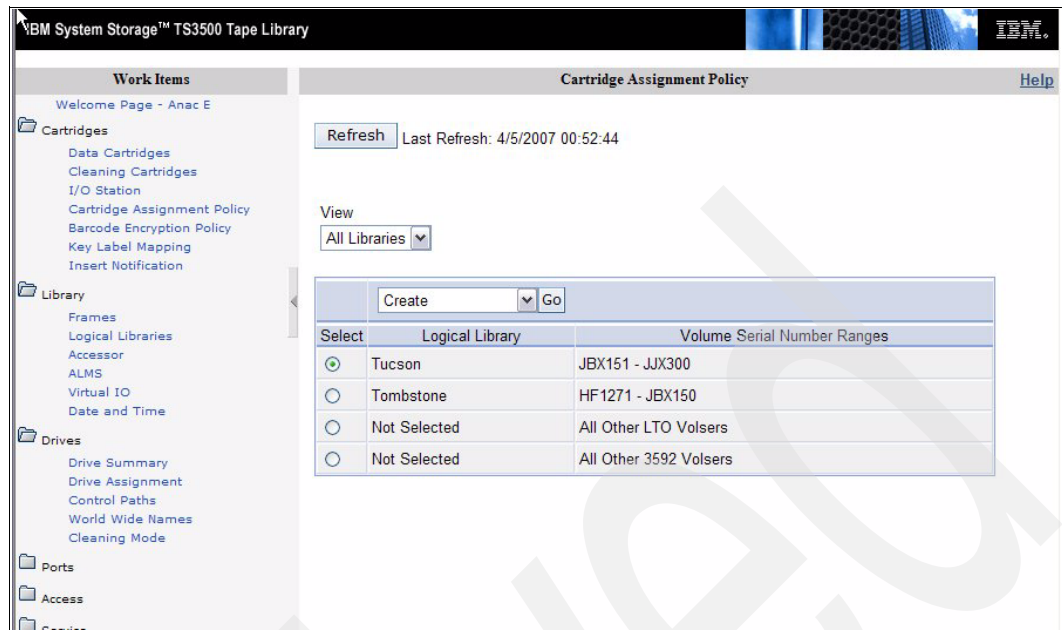


Figure 2-54 Cartridge assignment policy main screen

- Choose the logical library to which you want to assign the cartridge policy. Enter the starting and ending VolSer for the range to be defined (see Figure 2-55), and click **Apply**.

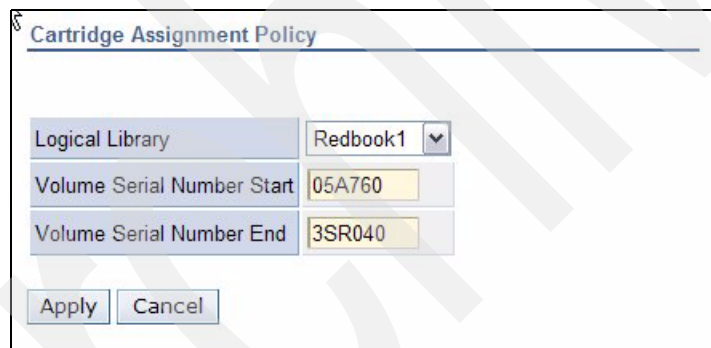


Figure 2-55 Cartridge Assignment Policy assignments

- All unassigned cartridges and all new inserted cartridges within the specified range do now, by definition, belong to the specified logical library. However, new cartridges have to be inserted, or there must be a re-inventory to have existing unassigned cartridges in this range assigned into the logical library.

Previously assigned cartridges within the specified range remain untouched.

Cartridge assignment

A single cartridge can be assigned to a specified logical library as well, or even be moved between libraries.

- To begin, navigate **Cartridges** → **Data Cartridges** (see Figure 2-56). Select the frame or logical library, select one or more cartridges to assign, and select **Assign** in pull-down, and click **Go**.

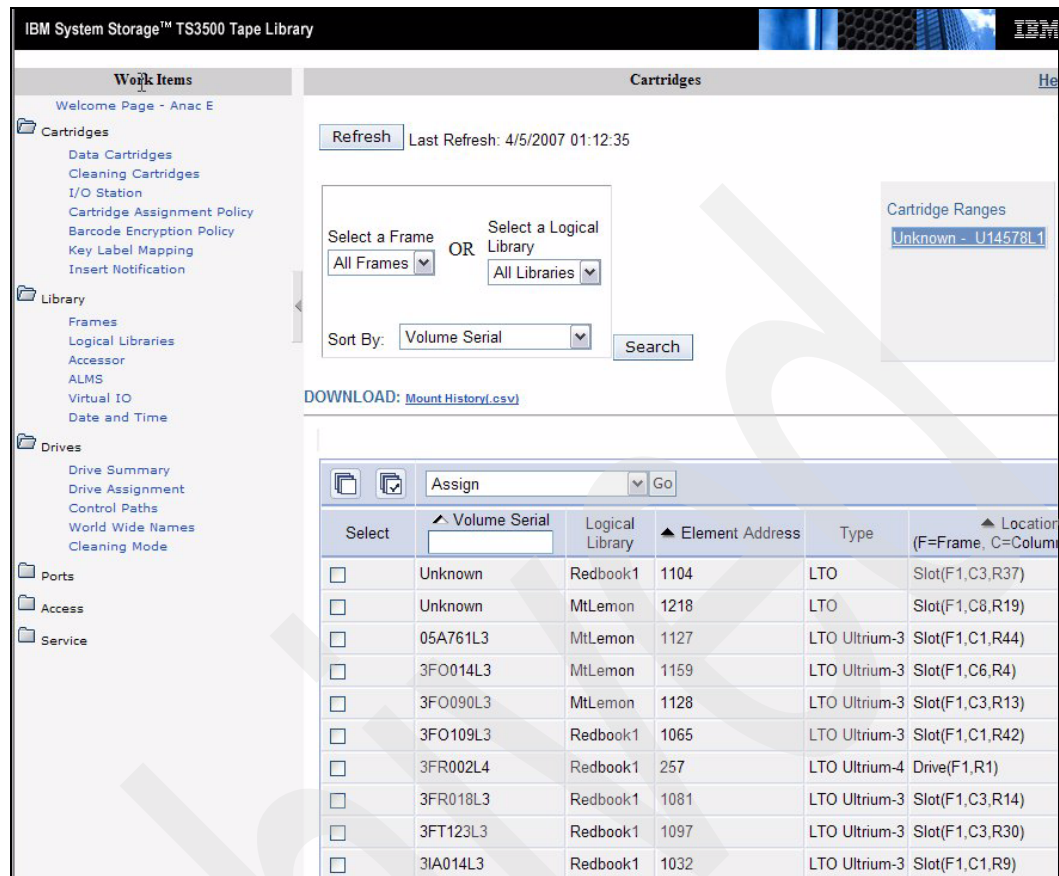


Figure 2-56 Assign Data Cartridge menu

2. Select the library to which you want to assign the cartridge(s) (see Figure 2-57). Click **Next** to complete the operation. The cartridge will then logically be moved to the new library.

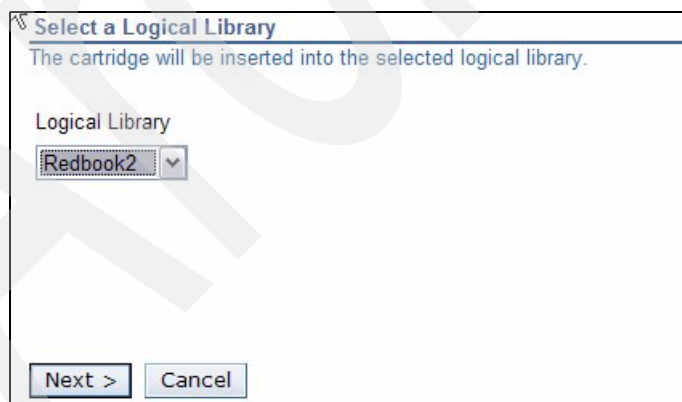


Figure 2-57 Assign cartridge to a logical library

3. In Figure 2-58, the Data Cartridges menu shows that the cartridge has moved to the new library. The cartridges has been given new element addresses according to the sequence of the new library, however, the cartridges remains in the same physical slots as before.

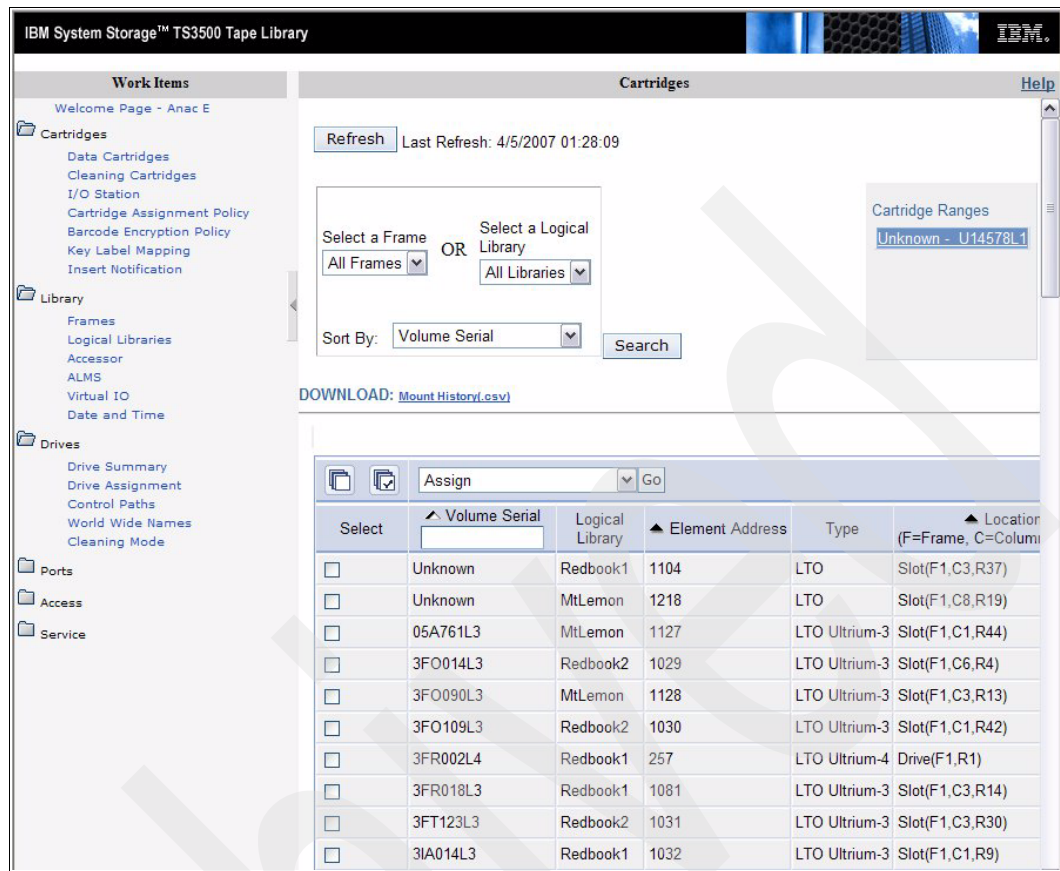


Figure 2-58 Cartridge list

In our example, we now have cartridges assigned to the logical library, but no tape drives have been assigned. With ALMS, you can configure a logical library without any drives assigned to it. A driveless logical library can be used for:

- ▶ Tape vaulting: Move the cartridge to a location that cannot be accessed by the application.
- ▶ Use as a scratch pool.

Assign drives

The flexible drive assignment option supports the following capabilities:

- ▶ Assign drive (non-disruptive to other logical libraries)
- ▶ Unassign drive (non-disruptive to other logical libraries)
- ▶ Reassign drive (non-disruptive to other logical libraries)
- ▶ Assign drive to multiple logical libraries
- ▶ Change control paths

Although the drive assign procedure is non-disruptive, the application or server to which the drive is assigned must be configured. This server or application configuration might not necessarily be non-disruptive. In addition, a reconfiguration of the SAN might be required.

At least one assigned drive must have the control path enabled. Therefore, the first assigned tape drive will get the control path enabled by default. However, you can enable or disable control paths for your drives. Drives with control path enabled cannot be shared with other logical libraries. You cannot assign LTO and IBM 3592 tape drives to the same logical library.

Be sure that the drives you are working on do not have any cartridges loaded. The Tape Library Specialist will not allow you to change any assignment of tape drives with a cartridge loaded. Therefore, we suggest first running a manual inventory to be sure that there is not a forgotten cartridge in any drive.

To assign tape drives, select **Drives** → **Drive Assignment**. On the introduction panel you can select specific drives or logical libraries, or a list of the full drive assignment. If you select the last option, the full assignment displays. On the drive assignment panel, you can easily assign and unassign tape drives to a logical library. On the left-hand side of the screen, you can see all available tape drives identified by their WWN. At the top, you see all the logical libraries. The first column is called Unassigned. All unassigned drives (such as newly installed drives) belong to this column. By simply clicking on the check boxes you can easily assign tape drives to logical libraries, as has been done in Figure 2-59.

After you have completed your selections, select action **Apply** to make the changes effective.



Figure 2-59 Drive Assignment

Tape drives with control path enabled are indicated by the icon shown in Figure 2-60.



Figure 2-60 Drive with control path

The first tape drive assigned to a logical library automatically gets the control path enabled; if you want to enable more control paths, click the **placeholder** for the control path icon of the selected drive.

If you want to delete a tape drive from one logical library, you have to set this tape drive to unassigned by checking the **Unassigned** check box for this tape drive.

We do not recommend that you assign a tape drive to multiple logical libraries unless required. If you have to share a tape drive, follow the recommendations given in “Shared drive assignment” on page 76. One drive can be shared by a maximum of 10 logical libraries.

In the example in Figure 2-59 on page 86, all logical libraries and applications require at least one tape drive to fulfill their backup jobs. Therefore, we assigned at least one tape drive to each logical library. In addition to the minimum required tape drive, we assigned some shared tape drives to some logical libraries. For all applications, we thus configured at least two tape drives for use, but set the shared tape drive as offline, in service, or unavailable depending on the application. This enables us to easily use a shared tape drive (by setting it online, out of service, or available from the application) whenever it is required, for example, if one dedicated tape drive becomes defective, or one application temporarily requires more tape bandwidth due to additional workload (additional restores).

Because the application has to know the SCSI element address of the drive for configuring the library, check the SCSI element address of all tape drives by selecting **Drives** → **Drive Summary**. This displays the drive information as shown in Figure 2-61 on page 87. Notice that this is now the virtualized element addresses, and that each logical library can show the same element address.

Select	Drive	Location Frame Row	Logical Library	Element Address	Type	Contents	SCSI/Loop ID	Mode	Drive Interface	Status
<input type="checkbox"/>	30010E601	1 1	Redbook1	257	LTO Ultrium-4	3FR002L4	17	-	Fibre	Online
<input type="checkbox"/>	30010E602	1 2	Redbook1	258	LTO Ultrium-4	Empty	18	-	Fibre	Online
<input type="checkbox"/>	30010E603	1 3	Redbook1	259	LTO Ultrium-4	Empty	19	-	Fibre	Online
<input type="checkbox"/>	30010E604	1 4	Redbook1	260	LTO Ultrium-4	Empty	20	-	Fibre	Online
<input type="checkbox"/>	30010E605	1 5	MtLemon	261	LTO Ultrium-4	Empty	21	-	Fibre	Online
<input type="checkbox"/>	30010E606	1 6	Redbook2	257	LTO Ultrium-4	Empty	22	-	Fibre	Online
<input type="checkbox"/>	30010E607	1 7	MtLemon	263	LTO Ultrium-4	Empty	23	-	Fibre	Online
<input type="checkbox"/>	30010E608	1 8	Shared	Shared	LTO Ultrium-4	Empty	24	-	Fibre	Online
<input type="checkbox"/>	30010E611	2 1	Tucson	269	3592-E05	Empty	33	E05	Fibre	Online
<input type="checkbox"/>	30010E612	2 2	Tucson	270	3592-E05	Empty	34	E05	Fibre	Online
<input type="checkbox"/>	30010E613	2 3	Tucson	271	3592-E05	Empty	35	E05	Fibre	Online
<input type="checkbox"/>	30010E614	2 4	Tucson	272	3592-E05	Empty	36	E05	Fibre	Online
<input type="checkbox"/>	30010E615	2 5	Shared	Shared	3592-E05	Empty	37	E05	Fibre	Online
<input type="checkbox"/>	30010E616	2 6	Tucson	274	3592-E05	Empty	38	E05	Fibre	Online
<input type="checkbox"/>	30010E617	2 7	Tucson	275	3592-E05	Empty	39	E05	Fibre	Online
<input type="checkbox"/>	30010E618	2 8	Shared	Shared	3592-E05	Empty	40	E05	Fibre	Online

Figure 2-61 Drive details

Alternatively, if you let the cursor hover over assigned element as in Figure 2-62, you will get a small pop-up identifying the element number for that drive.



Figure 2-62 Display drive element number

By default, all drives will be assigned the lowest available SCSI element address, which for Redbook1 will be elements 257 to 260. It is possible to be creating gaps in the assignment. If Redbook1 drive 2 is set to unassigned, and you try to **Apply**, you will get a warning message indicating that there might be an element gap, as shown in Figure 2-63.

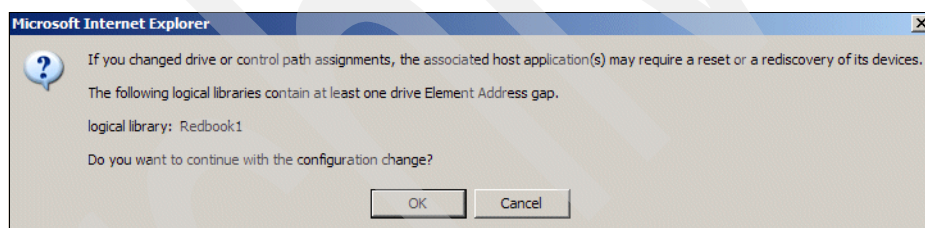


Figure 2-63 Drive gap warning

Avoid any gaps in the drive assignment. Gaps can easily be removed by simply unassigning and then reassigning the drive with the highest SCSI element address until all gaps are filled. Gaps in the drive SCSI element address will cause configuration problems on some backup applications such as EMC Legato NetWorker and VERITAS NetBackup.

Change the maximum number of storage slots

Since ALMS virtualizes the SCSI element address of the storage slots, the library is able to report any desired amounts of storage slots. Of course the number reported cannot be less than the actual number of cartridges in the library. The library will allow the user to select a 16-frame maximum limit (6887). The default value is based on the physical slots currently in the library.

In Example 2-1, we want to set the maximum reported number of storage slots. In this example, there are 219 slots available (because we are working with one frame with a total of 219 slots), but there are just two slots assigned and the assigned maximum is set to 15 for the logical library Tucson. Therefore, we must set the maximum to a number equal or greater than two (we will set it to 80). Here we are using the `tapeutil` program, which is part of the IBM-supplied device driver. For more information on `tapeutil`; see 3.5, “Testing the library with `tapeutil`” on page 141.

Example 2-1 Reported storage slots

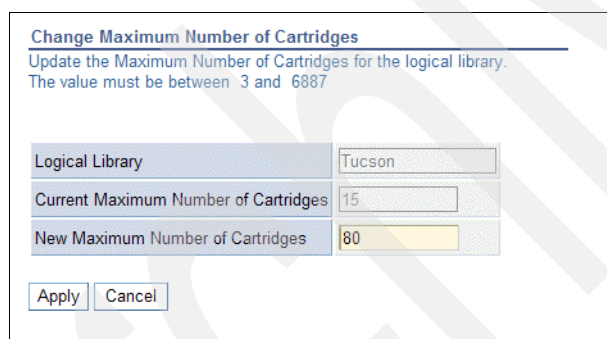
```
# tapeutil -f /dev/smc1 elementinfo
Getting element information...

Number of Robots ..... 1
First Robot Address ..... 1
Number of Slots ..... 15
First Slot Address ..... 1185
Number of Import/Exports ..... 30
First Import/Export Address ... 769
Number of Drives ..... 1
First Drive Address ..... 257
```

To change the Maximum Number, select **Library** → **Logical Libraries**; select the logical library and select **Maximum Cartridges** from the drop-down menu, as shown in Figure 2-53 on page 82.

Warning: Changing maximum settings for a logical library might interrupt drive and library activities and require reconfiguration of the host applications for the selected logical library.

A window similar to Figure 2-64 appears. Enter the new maximum number of cartridges and click **Apply**.



Change Maximum Number of Cartridges
Update the Maximum Number of Cartridges for the logical library.
The value must be between 3 and 6887

Logical Library	Tucson
Current Maximum Number of Cartridges	15
New Maximum Number of Cartridges	80

Apply Cancel

Figure 2-64 Change maximum number of cartridges

Now, the library reports the new maximum storage slots as 80, as shown in Example 2-2.

Example 2-2 Reported storage slots

```
#tapeutil -f /dev/smc1 elementinfo
Getting element information...

Number of Robots ..... 1
First Robot Address ..... 1
Number of Slots ..... 80
First Slot Address ..... 1185
Number of Import/Exports ..... 30
First Import/Export Address ... 769
Number of Drives ..... 1
First Drive Address ..... 257
```

You can also look at these details by selecting the drop-down **Details** in the Logical Library menu (Figure 2-53 on page 82). This will then display as in Figure 2-65.


Logical Library Tucson	
Type	LTO
Drive element address range	257 - 258
Drives	<div>  Frame 1 Row 4 Frame 1 Row 5 </div>
Storage element address range	1185 - 1264
Cartridges	2
Virtual I/O element address range	769 - 798
<div>Close</div>	

Figure 2-65 Logical Library details

This change is non-disruptive for the library operation, but not necessarily for your backup application. For example, with NetWorker you must run **jbconfig**, and with IBM Tivoli Storage Manager you must halt and re-start the server.

The ability to change the maximum number can be helpful if:

- ▶ You just have a license for a smaller library.
- ▶ You expect capacity growth, which will force you to enlarge your library physically over time, but want to avoid configuration changes in your application. Therefore, on the first setup, configure your logical library with a greater number of logical slots to avoid an outage later on, because you would then have to reconfigure the application.

However, a large number of reported storage slots might decrease the application performance in working with the library (such as an inventory or audit library, which takes longer from the application point of view).

Migration from partitioning without ALMS to ALMS

A library that was previously installed without ALMS can be upgraded to ALMS by enabling the ALMS license key. The license key must be entered using the operator panel; see “Enter ALMS license key” on page 79.

When enabling ALMS, it reuses the existing library configuration. This means that you get the same number of logical libraries. Cartridges and tape drives which were already assigned to the logical library remain assigned to the same logical library. Tape drives will get the same SCSI element address (even if there was a gap in the SCSI element address) and all cartridges will get the same SCSI element address as in the non-ALMS definition.

However, the storage element address of the storage slots for new logical libraries will change as described in “Storage slot virtualization” on page 74. For the first logical library, the storage address begins with 1025, for the second one with 1026, and so on. Adding a new logical library (Redbook2) to the four logical libraries that were already defined without ALMS, means that this library will be number four, and accordingly, will start with a cartridge element address of 1029.

Also, in libraries with mixed media, the reported number of maximum storage slots might change to the number of currently installed cartridge slots. Consequently, when you enable ALMS, your application might also have to be reconfigured. For some applications, such as the IBM Tivoli Storage Manager, you just have to stop and restart the server; for other applications, such as EMC Legato NetWorker, you have to run a configuration wizard (run **jbconfig**).

You can enable ALMS using the Tape Library Specialist. Select **Library** → **ALMS** (refer to “Enable ALMS” on page 79 for details).

To illustrate how ALMS changes the configuration of the logical libraries, in Figure 2-66 and Example 2-3 we show the detailed information for a logical library named Redbook1. It indicates three tape drives with SCSI element addresses 257, 258, and 259. The storage element address range is 1025 to 1104 (80 storage slots). The physical library has 175 storage slots in total.


Logical Library Redbook1	
Type	LTO
Drive element address range	257 - 259
Drives	 Frame 1 Row 1 Frame 1 Row 2 Frame 1 Row 3
Storage element address range	1025 - 1104
Cartridges	9
<input type="button" value="Close"/>	

Figure 2-66 Detailed information before ALMS is enabled

Example 2-3 Elementinfo from logical library Redbook 1

```
# tapeutil -f /dev/smc4 elementinfo
Getting element information...

Number of Robots ..... 1
First Robot Address ..... 1
Number of Slots ..... 80
First Slot Address ..... 1025
Number of Import/Exports ..... 30
First Import/Export Address ... 769
Number of Drives ..... 3
First Drive Address ..... 257
```

Then we enable ALMS.

In Figure 2-67 and Example 2-4, we again show the detailed view of the logical library. The drive element addresses are the same as before, but the storage element addresses were changed. Because it is seen as the first logical library, the storage element addresses begin with 1025. With ALMS the physical limitation of 175 cartridge slots is removed, and we have assigned 160 slots to this one logical library. There is now also a listing of the default 30 Virtual IO elements.


Logical Library Redbook1	
Type	LTO
Drive element address range	257 - 259
Drives	 Frame 1 Row 1 Frame 1 Row 2 Frame 1 Row 3
Storage element address range	1025 - 1184
Cartridges	9
Virtual I/O element address range	769 - 798
<input type="button" value="Close"/>	

Figure 2-67 Detailed Information after ALMS enabled

Example 2-4 Element info after ALMS enabled

```
# tapeutil -f /dev/smc4 elementinfo
Getting element information...

Number of Robots ..... 1
First Robot Address ..... 1
Number of Slots ..... 160
First Slot Address ..... 1025
Number of Import/Exports ..... 30
First Import/Export Address ... 769
Number of Drives ..... 3
First Drive Address ..... 257
```

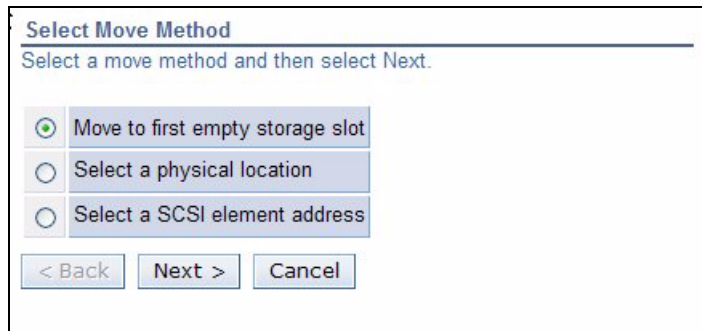
2.3.4 Using ALMS

Because ALMS virtualizes the SCSI element addresses of the cartridge slots, some library commands will not generate a physical action on the library. If you issue a **move media** command, the library replies with a new SCSI element address even though the cartridge was not moved. For example, suppose that we want to move the cartridge stored in Frame 1, Column 3, Row 13 (see Figure 2-68) from SCSI element address 1128 to a vacant SCSI element address. Use the menu selection **Cartridges** → **Data Cartridges**, and select from the drop-down **Move** to move the cartridge.

Select	Volume Serial	Logical Library	Element Address	Type	Location (F=Frame, C=Column, R=Row)
<input type="checkbox"/>	Unknown	Redbook1	1104	LTO	Slot(F1,C3,R37)
<input type="checkbox"/>	Unknown	MtLemon	1218	LTO	Slot(F1,C8,R19)
<input type="checkbox"/>	05A761L3	MtLemon	1127	LTO Ultrium-3	Slot(F1,C1,R44)
<input type="checkbox"/>	3F0014L3	Redbook2	1029	LTO Ultrium-3	Slot(F1,C6,R4)
<input checked="" type="checkbox"/>	3F0090L3	MtLemon	1128	LTO Ultrium-3	Slot(F1,C3,R13)
<input type="checkbox"/>	3F0109L3	Redbook2	1030	LTO Ultrium-3	Slot(F1,C1,R42)
<input type="checkbox"/>	3FR002L4	Redbook1	257	LTO Ultrium-4	Drive(F1,R1)
<input type="checkbox"/>	3FR018L3	Redbook1	1081	LTO Ultrium-3	Slot(F1,C3,R14)

Figure 2-68 Inventory before move medium

A pop-up will let you choose your move method. We select *first empty slot* as in Figure 2-69.

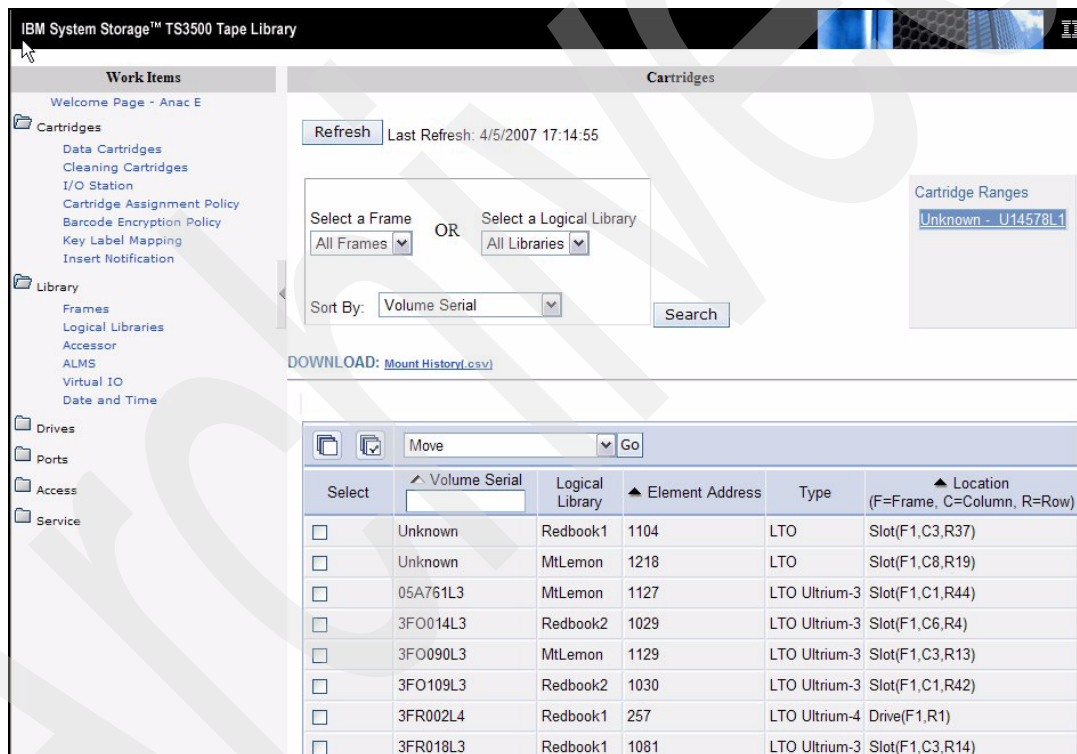


Select Move Method
Select a move method and then select Next.

☒ Move to first empty storage slot
☐ Select a physical location
☐ Select a SCSI element address

Figure 2-69 Select move method

Now, we again check the inventory of the library (see Figure 2-70 on page 93). We see that the SCSI element address has changed to 1129, but the cartridge is still in the same physical location: Frame 1, Column 3, Row 13.



IBM System Storage™ TS3500 Tape Library

Work Items
Welcome Page - Anac E

Cartridges
Data Cartridges
Cleaning Cartridges
I/O Station
Cartridge Assignment Policy
Barcode Encryption Policy
Key Label Mapping
Insert Notification

Library
Frames
Logical Libraries
Accessor
ALMS
Virtual IO
Date and Time

Drives
Ports
Access
Service

Cartridges
Refresh Last Refresh: 4/5/2007 17:14:55

Select a Frame: All Frames OR Select a Logical Library: All Libraries

Sort By: Volume Serial

Cartridge Ranges: Unknown - U14578L1

DOWNLOAD: Mount History(.csv)

Move Go

Select	Volume Serial	Logical Library	Element Address	Type	Location (F=Frame, C=Column, R=Row)
<input type="checkbox"/>	Unknown	Redbook1	1104	LTO	Slot(F1,C3,R37)
<input type="checkbox"/>	Unknown	MtLemon	1218	LTO	Slot(F1,C8,R19)
<input type="checkbox"/>	05A761L3	MtLemon	1127	LTO Ultrium-3	Slot(F1,C1,R44)
<input type="checkbox"/>	3FO014L3	Redbook2	1029	LTO Ultrium-3	Slot(F1,C6,R4)
<input type="checkbox"/>	3FO090L3	MtLemon	1129	LTO Ultrium-3	Slot(F1,C3,R13)
<input type="checkbox"/>	3FO109L3	Redbook2	1030	LTO Ultrium-3	Slot(F1,C1,R42)
<input type="checkbox"/>	3FR002L4	Redbook1	257	LTO Ultrium-4	Drive(F1,R1)
<input type="checkbox"/>	3FR018L3	Redbook1	1081	LTO Ultrium-3	Slot(F1,C3,R14)

Figure 2-70 Inventory after moving cartridge

On a library without ALMS, you have to run a library inventory every time after moving some cartridges manually to get the application in a state consistent with the library. With ALMS this might no longer be required, as ALMS always tries to assign the same SCSI element address to the cartridge, even though the cartridge was moved manually.

Because ALMS is based on the affinity between VolSer (barcode label) and the reported SCSI element address, you have to make sure that the barcode label is readable. The library tries to keep the same SCSI element address for an unreadable barcode label if this cartridge is stored in the same physical slot. But, if the cartridge was moved manually, and the library does an inventory, a cartridge with an unreadable barcode label is placed in an unassigned status.

The same is true if you work with unlabeled cartridges (no barcode label). As long as you do not move this cartridge manually, the library tries to assign a SCSI element address. If you move such a cartridge manually, the cartridge will be placed in an unassigned status.

The same happens with cartridges having duplicate barcode labels. Anyway, using duplicate barcode labels is generally not supported, and can easily lead to confusion.

It is possible that the storage capacity of the library, as reported by each logical library, might exceed the physical storage capacity of the library. As such, it is possible to run out of storage space while still reporting available space to a host. SNMP and operator panel messages will notify the customer as the library approaches near full capacity. In addition, if cartridges are placed in the I/O station when a library has reached its capacity, the cartridges will be marked inaccessible to all hosts to prevent the condition where the host tries to move the cartridge to storage that does not really exist.

When ALMS is enabled, auto clean is automatically enabled, and there will be no mechanism to disable it. Cleaning cartridges are never associated to a logical library, so there will be no host awareness that they exist in the library.

Static partitioning cannot be used when ALMS is enabled. The partitioning for the entire library is either static or dynamic.

Basic IBM Open Systems Tape setup for UNIX systems

In this chapter we provide detailed information for the basic setup of IBM tape drives and libraries, including:

- ▶ Device and library drivers installation and update:
 - AIX environment
 - Solaris environment
 - HP-UX environment
- ▶ SAN environment discussion
- ▶ Device and library firmware upgrade

For additional discussions about SAN and tape setup, refer to the following Redbooks publications:

- ▶ *Get More Out of Your SAN with IBM Tivoli Storage Manager*, SG24-6687
- ▶ *IBM System Storage Implementing an IBM SAN*, SG24-6116

For additional details about driver installation and setup, refer to the new manual:

- ▶ *IBM Tape Device Drivers Installation and User's Guide*, GC27-2130

Or, you can refer to these previous versions:

- ▶ *IBM Ultrium Device Drivers Installation and User's Guide*, GA32-0430
- ▶ *IBM TotalStorage and System Storage Tape Device Drivers Installation and User's Guide*, GC35-0154

3.1 Installing library and device drivers

After physically installing and connecting an IBM tape drive or library to your environment, the next step in the basic implementation is to install the device driver.

Note: Installation and configuration of Fibre Channel Host Bus Adapters (HBAs) is discussed in 3.7, “Fibre Channel HBA driver implementation comments” on page 145.

The IBM tape and medium changer device drivers are designed specifically to take advantage of the features provided by the IBM tape drives and medium changer devices.

The objective is to give applications access to the functions required for basic tape operations (such as backup and restore) and medium changer operations (such as cartridge mount and dismount), as well as to the advanced functions needed by full tape management systems.

Note: IBM tape drives and libraries are usually used with vendor-provided software applications. These applications can work with the IBM provided device drivers, their own provided device drivers, or native OS device drivers for the tape drive and medium changer (or even some combination of these, for example, the IBM drive device driver and application-provided medium changer driver). For correct operation, follow the specific implementation instructions for the software that you are installing to determine if the IBM-supplied device drivers are suitable for your installation.

In Part 2, “IBM Open Systems Tape libraries and backup software” on page 173, we describe the implementation of IBM tape devices for some of the most common application software in UNIX environments.

For more information and specific installation instructions for every platform, refer to the *IBM Tape Device Drivers Installation and User's Guide*, GC27-2130, or the previous books: *IBM Ultrium Device Drivers Installation and User's Guide*, GA32-0430 for LTO tape drives and libraries, and *IBM TotalStorage and System Storage Tape Device Drivers Installation and User's Guide*, GC35-0154 for the IBM TS1120.

Note: The previous manuals were separate for LTO and TS1120 drives; however, the device driver and the setup procedures for both types of drives are basically the same for the platforms mentioned in this publication. Unless otherwise noted, follow the procedures for both LTO and TS1120 drives.

The device drivers allow the operating system and the application software to manage tape devices and medium changers to automate the use of the tape media. The tape devices and medium changer are managed using a *special device file name*, which is the name used to address each tape operation (mount, dismount, write, read) to the required device or robotic changer.

This special device file name is specific for each OS platform. Table 3-1 shows the most commonly used names for AIX, Solaris, and HP-UX.

Table 3-1 Special device file names used with UNIX operating systems

	AIX	Solaris	HP-UX
Medium changer	smc[0-255]	[0-255]smc	[0-255]chnng
Tape device	rmt[0-255] rmt[0-255].1 ^a	[0-255]st [0-255]stb ^b [0-255]stc ^c [0-255]stn ^d [0-255]stbn ^{b,d} [0-255]stcb ^{b,c} [0-255]stcn ^{c,d} [0-255]stcbn ^{b,c,d}	[0-255]m [0-255]mb ^b [0-255]mn ^d [0-255]mnb ^{b,d} [tTGTdLUN ^e]BEST [tTGTdLUN ^e]BESTb ^b [tTGTdLUN ^e]BESTn ^d [tTGTdLUN ^e]BESTnb ^{b,d}

a. Adding (.1) to the device name, means that it is a *No Rewind on Close* device. Some backup applications write a file mark on the volume at the end of each backup. When the next backup occurs, the backup application appends data to the volume based on the position of the file mark. If a device automatically rewinds the tape, the file mark position is lost and the next backup overwrites the data! This option is used by some application software, such as EMC Legato NetWorker.

b. A (b) stands for Berkeley Software Distribution (BSD) compatibility. The BSD device special file modifies close behavior for non-rewind devices. If the device is opened for no rewind on close, in non-BSD mode, if the last command before closing the device was a read, then the tape is positioned after the file mark immediately following the last block read. If the device is opened for no rewind on close, in BSD mode, if the last command before closing the device was a read, the tape is left positioned exactly where it was following the last block read. If the device is opened for rewind on close, the BSD mode is not relevant.

c. A (c) stands for compression. The compression device special file determines whether the tape device will use built-in hardware compression while storing data on the tape.

d. An (n) stands for No rewind on close. The no rewind on close device special file does not rewind the tape during a close operation. Otherwise, the tape is rewound when the device is closed.

e. The TGT is the SCSI target ID, and LUN is the Logical Unit Number associated with the device.

In the following section, we give detailed examples of installing the drivers in AIX, SUN Solaris, and HP-UX environments.

3.2 Installing IBM tape device driver for AIX

The device driver used for IBM pSeries® AIX platforms is called *Atape.driver*, and it includes both the tape drive and medium changer drivers.

To check if your environment has the correct OS level for your pSeries, consult the following link, and look for *interoperability*:

<http://www.ibm.com/servers/storage/tape/resource-library.html#interoperability>

Select your library, and *plan/upgrade*, and the *interoperability matrix*. Look for the section IBM pSeries, and RS/6000® for information about operating systems and supported HBAs. To search for the supported HBA firmware level and SAN fabric components, see:

<http://www-01.ibm.com/systems/support/storage/config/hba/index.wss>

You must have AIX *root* authority to proceed with the installation of the driver.

Use **ls1pp** to determine if the `Atape.driver` is installed and to determine the version, as shown in Example 3-1.

Example 3-1 Checking if `Atape.driver` is installed on AIX

# ls1pp -l Atape.driver			
Fileset	Level	State	Description

Path: /usr/lib/objrepos			
Atape.driver	10.3.9.0	COMMITTED	IBM AIX Enhanced Tape and Medium Changer Device Driver

You can see that the driver is installed at level 10.3.9.0. If the driver is not installed, or to check for a later version, see:

<ftp://ftp.software.ibm.com/storage/devdrv/AIX/>

Or select your library, download and device drivers, from:

<http://www.ibm.com/servers/storage/support/lto/index.html>

Be sure to check the readme file for the latest installation notes and prerequisites.

In our example, we are installing the `Atape` driver in the following environment:

- ▶ IBM System p server with IBM AIX Version 5.3.0
- ▶ IBM System Storage TS3400 Tape Library with two TS1120 FC drives
- ▶ IBM System Storage TS3100 Tape Library with one LTO4 FC drive

The installation process is the same for any AIX system and IBM System Storage Open library model.

You can use either the command line or SMIT to install the driver. If the `Atape` device driver is already installed in your system and you just want to update it, first uninstall the previous `Atape` driver following the instructions in 3.2.9, “Removing `Atape` driver from the system” on page 120.

3.2.1 `Atape` driver installation using the command line interface

To install from a CD, put it in the CD drive. Assuming the default system CD drive, use the following command to install:

```
installp -acXd /dev/rcd0 Atape.driver
```

Otherwise, if you have downloaded the driver to your local system, use this command:

```
installp -acXd /directory/filename Atape.driver
```

Assuming you have downloaded the file `Atape.10.3.9.0.bin` to the directory `/tmp`, the command string will be:

```
installp -acXd /tmp/Atape.10.3.9.0.bin Atape.driver
```

This will install and commit the `Atape` driver in your system. Example 3-2 is an example of the **installp** command output.

Example 3-2 AIX Atape installation output

```
(root@poco) />installp -acXd /tmp/Atape.10.3.9.0.bin Atape.driver
+-----+
Pre-installation Verification...
+-----+
Verifying selections...done
Verifying requisites...done
Results...

SUCSESSES
-----
Filesets listed in this section passed pre-installation verification
and will be installed.

Selected Filesets
-----
Atape.driver 10.3.9.0 # IBM AIX Enhanced Tape and Me...

<< End of Success Section >>

FILESET STATISTICS
-----
1 Selected to be installed, of which:
1 Passed pre-installation verification
----
1 Total to be installed

0503-409 installp: bosboot verification starting...
installp: bosboot verification completed.
+-----+
Installing Software...
+-----+

installp: APPLYING software for:
Atape.driver 10.3.9.0

. . . . . << Copyright notice for Atape >> . . . . .

IBM AIX Enhanced Tape and Medium Changer Device Driver

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US Government Users Restricted Rights - Use, duplication or
disclosure restricted by GSA ADP Schedule Contract with IBM Corp.

. . . . . << End of copyright notice for Atape >>. . . . .

Checking for existing Atape devices...
Installing AIX Version 5.3 Atape.driver...
Adding device prototype...
Adding odm and smit entries...
Adding catalogs...
Adding trace template...
Adding error template...
5 entries added.
0 entries deleted.
0 entries updated.
```

```

Adding utility programs...
Finished processing all filesets. (Total time: 10 secs).

0503-409 installp: bosboot verification starting...
installp: bosboot verification completed.
0503-408 installp: bosboot process starting...

bosboot: Boot image is 22645 512 byte blocks.
0503-292 This update will not fully take effect until after a
        system reboot.

    * * * A T T E N T I O N * * *
    System boot image has been updated. You should reboot the
    system as soon as possible to properly integrate the changes
    and to avoid disruption of current functionality.

```

```

installp: bosboot process completed.
+-----+
|                               Summaries:                               |
+-----+

```

Installation Summary				
Name	Level	Part	Event	Result
Atape.driver	10.3.9.0	USR	APPLY	SUCCESS

After installing the driver, go to 3.2.3, “Configuring tape and medium changer devices” on page 101.

3.2.2 Installation using SMIT

Start Systems Management Interface Tool (SMIT) by typing `smit` at the command line. Choose the following options: **Software Installation and Maintenance** → **Install and Update Software** → **Install and Update from all Available Software** (includes devices and printers).

We show the ASCII SMIT interface; however, if you have an X Windows-capable display, you will see the GUI version. Both have identical function. Your screen will look like Example 3-3. Enter the directory where you have downloaded the driver (or `/dev/cd0` if on a CD).

Example 3-3 ATape installation using SMIT

```

Install and Update from ALL Available Software

Type or select a value for the entry field.
Press Enter AFTER making all desired changes.

* INPUT device / directory for software

```

	[Entry Fields]
	[/tmp] +

Press Enter. A pop-up list will display. Select **Atape** and press Enter again. Another pop-up will show a line similar to:

```
@ 10.3.9.0 IBM AIX Enhanced Tape and Medium Changer Device Driver
```

Select this by pressing F7 and Enter. Complete the installation options on the next screen, as illustrated in Example 3-4.

Example 3-4 AIX Atape SMIT installation options

Install and Update from ALL Available Software

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

	[Entry Fields]
* INPUT device / directory for software	/tmp
* SOFTWARE to install	[+ 10.3.9.0 IBM AIX Enhanced Tape and
Medium Changer Device Drive> +	
PREVIEW only? (install operation will NOT occur)	no +
COMMIT software updates?	yes +
SAVE replaced files?	no +
AUTOMATICALLY install requisite software?	yes +
EXTEND file systems if space needed?	yes +
OVERWRITE same or newer versions?	no +
VERIFY install and check file sizes?	no +
DETAILED output?	no +
Process multiple volumes?	yes +
ACCEPT new license agreements?	no +
Preview new LICENSE agreements?	no +

After this selection, the installation process begins. You see the same messages as in Example 3-2 on page 99.

You are now ready to configure the devices.

3.2.3 Configuring tape and medium changer devices

After the driver software is installed and the tape drives are connected to the server, the device can be configured and made available for use. You cannot access the devices until this step is completed.

Configure a tape device by using either of the following procedures:

- ▶ Enter the following command without parameters:

```
cfgmgr
```

This command configures all devices automatically, and will make available any new tape or medium changer device.

- ▶ Power off your system and reboot to configure all devices automatically during the startup, and make available any new tape or medium changer devices in the system.

3.2.4 Verifying the Atape driver installation

To verify the correctness of the installation and configuration of the Atape device driver, use the following commands:

- ▶ **lsdev -Cc tape**
- ▶ **lsattr -El device_name**
- ▶ **lscfg -vl device_name**

In this section we show you different outputs from these commands:

- ▶ **lsdev** of IBM TS3100 single-path with LTO4 drive, and IBM TS3400 multi-path configured with IBM TS1120 drives, Example 3-5 on page 102
- ▶ **lsattr** of FC LTO4 drive in Example 3-6 on page 102
- ▶ **lscfg** of FC LTO4 drive in Example 3-7 on page 103

- ▶ **lsattr** of IBM 3582 in Example 3-8 on page 103
- ▶ **lscfg** of IBM TS1120 in Example 3-9 on page 104
- ▶ **lsattr** of an IBM TS3500 FC SCSI medium changer in Example 3-10 on page 104
- ▶ **lscfg** of an IBM TS3500 FC SCSI medium changer in Example 3-11 on page 104

Example 3-5 TS3100 single-path and TS3400 multi-path configured tape devices

```
# lsdev -Cc tape
rmt0 Available 34-08-02 IBM 3580 Ultrium Tape Drive (FCP)
rmt1 Available 14-08-02 IBM 3592 Tape Drive (FCP)
rmt2 Available 14-08-02 IBM 3592 Tape Drive (FCP)
smc0 Available 34-08-02 IBM 3573 Tape Medium Changer (FCP)
smc1 Available 14-08-02 IBM 3577 Library Medium Changer (FCP)
smc2 Available 14-08-02 IBM 3577 Library Medium Changer (FCP)
```

In Example 3-5 you can see that:

- ▶ **smcX**, and **rmtX** are the device special file names for the medium changer and the tape drives. See Table 3-1 on page 97 for a list of the device special file names for each platform. The installed 3580 drive belong to the TS3100 library, and the 3592 drives belongs to the TS3400 library.
- ▶ Available means that the device is installed correctly and ready.
- ▶ We are using a Fibre Channel HBA indicated by the description (*FCP*). 14-08-02 is the location ID of the HBA for the TS3400. You do not see a SCSI or FC WWN. If you want to see the WWN, use **lsattr -El rmtx** as shown in Example 3-6.
- ▶ For each drive, the control path is enabled. Therefore, you see devices **smc0** to **smc2**. As you will see in the following examples, with a multi-path architecture library the SCSI medium changer uses LUN 1, and does not have its own SCSI (or FC) ID.
- ▶ Also take into consideration that because each TS1120 drive has two FC ports, depending on your configuration, hosts can configure double the number of device files as compared to using LTO drives. The automatic failover of data path between those two device files, which represent one physical tape drive, is mentioned in 3.2.7, “Data path failover for LTO and TS1120 drives on AIX” on page 113.

Example 3-6 Details of FC connected IBM LTO4

```
# lsattr -El rmt0
alt_pathing      no          Enable Alternate Pathing Support      True
autoload         no          Use Autoloading Feature at End-of-Tape True
block_size       0          Block Size (0=Variable Length)       True
compress         yes        Use Hardware Compression on Tape     True
debug_trace      no          Debug Trace Logging Enabled          True
dev_status       N/A         N/A                                   False
devtype          ULT3580-   Device Type                           False
drv_encryption    no          Drive Encryption Support              False
location         Location    Location                              True
logging          no          Activate volume information logging   True
lun_id           0x0        Logical Unit Number                  True
max_log_size     500        Maximum size of log file (in # of entries) True
new_name         New Logical Name                      True
node_name        0x2001000e11105b14 World Wide Node Name                  False
primary_device    rmt0       Primary Logical Device                False
retain_reserve    no          Retain Reservation                    False
rew_immediate     no          Use Immediate Bit in Rewind Commands  True
scsi_id          0xble26    SCSI Target ID                       True
space_mode        SCSI       Backward Space/Forward Space Record Mode True
sys_encryption    no          Use System Encryption FCP Proxy Manager True
trace_logging     no          Trace Logging Enabled                 True
```

trailer_labels	no	Trailer Label Processing	True
wrt_encryption	custom	System Encryption for Write Commands at BOP	True
ww_name	0x2002000e11105b14	World Wide Port Name	False

Example 3-6 on page 102 shows:

- ▶ All the device driver configuration parameters. See 3.2.5, “Configuring the IBM tape device parameters” on page 105.
- ▶ Because this is an FC-attached tape drive, `scsi_id` is the port ID of the SAN switch.
- ▶ `ww_name` shows the WWN of the FC tape drive.

Example 3-7 *lscfg of FC IBM LTO4*

```
# lscfg -v1 rmt0
rmt0          P1-I11/Q1-W2002000E11105B14-L0  IBM 3580 Ultrium Tape Drive (FCP)

Manufacturer.....IBM
Machine Type and Model.....ULT3580-TD4
Serial Number.....1300000978
Device Specific.(FW).....73FA
```

Example 3-7 shows:

- ▶ The WWN, serial number, and the firmware level of the drive.
- ▶ ULT3580-TD4 under Machine Type and Model indicates that this is an IBM LTO4 drive.

Example 3-8 *Details of FC connected IBM TS1120*

```
# lsattr -El rmt1
alt_pathing    no          Enable Alternate Pathing Support      True
block_size     0          Block Size (0=Variable Length)       True
compress       yes       Use Hardware Compression on Tape     True
debug_trace    no          Debug Trace Logging Enabled          True
dev_status     N/A         N/A                                   False
devtype        03592E05    Device Type                           False
drive_port     1          Drive Port Number                     False
drive_scsi_id  00          Drive SCSI ID                         False
drv_encryption no          Drive Encryption Support              False
emulate_3592J1A no       Emulate 3592 J1A Tape Drive          True
limit_readerp  no          Limit Read Error Recovery Time to 5 Seconds True
location       True         Location                              True
logging        no          Activate volume information logging   True
lun_id         0x0        Logical Unit Number                   True
max_log_size   500        Maximum size of log file (in # of entries) True
mode           yes       Use Buffered Writes                   True
mtdevice       True         Library Device Number                 True
new_name       True         New Logical Name                      True
node_name      0x5003013d38357020 World Wide Node Name                  False
primary_device rmt1       Primary Logical Device                False
retain_reserve no          Retain Reservation                    False
rew_immediate  no          Use Immediate Bit in Rewind Commands  True
scsi_id        0x650be4    SCSI Target ID                       True
space_mode     SCSI       Backward Space/Forward Space Record Mode True
sys_encryption no          Use System Encryption FCP Proxy Manager True
trace_logging  yes       Trace Logging Enabled                 True
trailer_labels no          Trailer Label Processing              True
wrt_encryption custom     System Encryption for Write Commands at BOP True
ww_name        0x5003013d38357022 World Wide Port Name                  False
```

Example 3-8 on page 103 shows that:

- ▶ Because this is a FC-attached tape drive, `scsi_id` is the port ID of the SAN switch.
`ww_name` shows the WWN of the FC tape drive.

Example 3-9 lscfg of FC IBM TS1120

```
# lscfg -vl rmt1
rmt1          P1-I5/Q1-W5003013D38357022-L0  IBM 3592 Tape Drive (FCP)

Manufacturer.....IBM
Machine Type and Model.....03592E05
Serial Number.....000001350740
Device Specific.(FW).....1A39
Loadable Microcode Level....A1700D5C
```

Example 3-9 shows:

- ▶ The WWN, serial number and firmware level of the drive.
- ▶ 3592E05 under Machine Type and Model indicates this is an IBM TS1120 drive.

Example 3-10 Details of FC IBM TS3400 Medium Changer

```
# lsattr -El smc1
alt_pathing    no          Enable Alternate Pathing Support      True
debug_trace    no          Debug Trace Logging Enabled           True
dev_status     N/A              N/A                                   False
devtype        3577-TL      Device Type                           False
location       Location         Location                               True
lun_id         0x10000000000000 Logical Unit Number                   True
new_name       New Logical Name New Logical Name                       True
node_name      0x5003013d38357020 World Wide Node Name                  False
primary_device smc1       Primary Logical Device                 False
reserve_support yes        Use Reserve/Release on Open and Close True
retain_reserve no          Retain Reservation                     False
scsi_id        0x650be4        SCSI Target ID                        True
trace_logging  no          Trace Logging Enabled                 True
ww_name        0x5003013d38357022 World Wide Port Name                  False
```

Example 3-10 shows:

- ▶ The Control path (smc) uses the `lun_id 1`. However, it also uses the same `node_name` and `WWN` as `rmt1` (Example 3-8 on page 103) because the control path goes through `rmt1`.
- ▶ Alternate pathing support is not enabled, since `alt_pathing` is `no`. For more details on alternate pathing, see 3.2.6, “Setting up control path failover for AIX” on page 106.

Example 3-11 lscfg of FC IBM TS3400

```
# lscfg -vl smc1
smc1          P1-I5/Q1-W5003013D38357022-L1000000000000  IBM 3577 Library Medium
Changer (FCP)

Manufacturer.....IBM
Machine Type and Model.....3577-TL
Serial Number.....0000013F00721009
Device Specific.(FW).....0009
```

Example 3-11 on page 104 (**1scfg**) shows:

- The WWN, serial number, and the firmware level of the library.

You can now use the **tapeutil** utility to test the library. Go to 3.5, “Testing the library with tapeutil” on page 141 to learn how to use this utility. Open the device, issue inquiry commands (**read** and **write**), and move media across the library to check the driver functionality.

The drives can also be used with OS commands such as **tar**.

3.2.5 Configuring the IBM tape device parameters

You can change the default operating parameters for the tape drive and device drivers using SMIT.

From the SMIT menu, select **Devices** → **Tape Drive** → **Change/Show Characteristics of a Tape Drive**. Select the **device (rmtx)** you want to change from the list. An output similar to Example 3-12 or Example 3-13 appears.

Example 3-12 SMIT characteristics of an IBM LTO drive

Change/Show Characteristics of a Tape Drive

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[TOP]	[Entry Fields]	
Tape Drive	rmt0	
Tape Drive type	3580	
Tape Drive interface	fc	
Description	IBM 3580 Ultrium Tape>	
Status	Defined	
Location	34-08-02	
Parent adapter	fscsi1	
Connection address	1	
SCSI ID	0xb1e26	
Logical Unit ID	0x0	
World Wide Port Name	0x2002000e11105b14	
World Wide Node Name	0x2001000e11105b14	
New Logical Name	[]	
Enable Alternate Pathing Support	no	+
Block size (0=variable length)	[0]	+#
Use Hardware Compression on Tape	yes	+
Use Autoloading Feature at End-of-Tape	no	+
Activate volume information logging	no	+
Maximum size of log file (in # of entries)	[500]	+#
Backward Space/Forward Space Record Mode	SCSI	+
Use Immediate Bit in Rewind Commands	no	+
Trailer Label Processing	no	+
	no	+
	custom	+

Example 3-13 SMIT characteristics of an IBM TS1120 drive

Change/Show Characteristics of a Tape Drive

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

[TOP]	[Entry Fields]	
Tape Drive	rmt2	
Tape Drive type	3592	
Tape Drive interface	fc	
Description	IBM 3592 Tape Drive (FCP)	
Status	Available	
Location	14-08-02-PRI	
Parent adapter	fscsi0	
Connection address	3	
SCSI ID	0x6504e8	
Logical Unit ID	0x0	
World Wide Port Name	0x5003013d38357012	
World Wide Node Name	0x5003013d38357010	
New Logical Name	[]	
Enable Alternate Pathing Support	no	+
Block size (0=variable length)	[0]	+#
Use DEVICE BUFFERS during writes	yes	+
Use Hardware Compression on Tape	yes	+
Activate volume information logging	no	+
Maximum size of log file (in # of entries)	[500]	+#
Backward Space/Forward Space Record Mode	SCSI	+
Use Immediate Bit in Rewind Commands	no	+
Trailer Label Processing	no	+
	yes	+
	custom	+

Change any updateable device options required and press Enter. Check for the output message `rmtx Changed`. The default for hardware compression on the tape is yes for every LTO and TS1120 devices, which is the normal recommended setting for performance reasons. (However, this might vary with particular applications; check with your vendor.) `Blocksize=0` means that the device uses variable block size. Some application software might override this value. Refer to Part 2, “IBM Open Systems Tape libraries and backup software” on page 173 for specific application software related information.

3.2.6 Setting up control path failover for AIX

The Atape device driver alternate pathing support can optionally configure multiple physical control paths (communications paths for controlling the library) to the same logical library, and provide automatic failover to an alternate control path when a permanent error occurs on one path. This is transparent to the running application. Control path failover is for the LTO libraries an optional priced feature that must be enabled with a license key, but for the IBM TS3400 it is included as a standard feature.

For example, consider a simple multi-path architecture connection with two HBAs in an AIX host, connected to a library with two drives. Each drive has the control port enabled. The first HBA is connected to the first drive, and the second HBA is connected to the second drive. This simple configuration provides two physical control paths to the same library (one on each drive) for redundancy if one path from an HBA to the library fails. When the AIX server is booted or `cfgmgr` is run, each HBA detects a control port to the library and two medium changer devices (`smc0` and `smc1`) will be configured. Each logical device is a physical path to the same library; however, an application can open and use only one logical device at time, either `smc0` or `smc1`.

Without the Atape alternate pathing support, if an application opens smc0 and a permanent path error occurs (for example, because of an HBA, cable, or drive control port failure), the current command to the library fails. It is possible to initiate manual failover by changing the device path to the alternate path (smc1), but this is a manual operation, and the last failing command has to be resent.

When alternate pathing support is enabled on both smc0 and smc1, the device driver configures them internally as a single device with multiple paths. The application can still open and use only one logical device at a time (either smc0 or smc1). If an application opens smc0 and a permanent path error occurs, the current operation continues on the alternate path without interrupting the application.

Note: The library control path failover feature code 1682 must be installed and enabled on the TS3200, TS3310 or TS3500 library with Lx3 frames before enabling the alternate pathing support in the Atape device driver. In addition, you have to enable the control path for additional drives on the library using either the library operator panel or the Tape Library Specialist. This is shown in the following section for the TS3500.

The TS3400, and TS3500 with TS1120 tapes have alternate pathing as a standard feature, and do not need this feature code. For TS3500 with Lx2 frames, the necessary feature code is 1680.

Enabling additional control paths

The following three sections show how to enable additional control paths via the Operator Panel and/or preferably by using the Tape Storage Specialist for the TS3200, TS3310, TS3400 and TS3500.

Enable additional control paths on IBM TS3200

Log in to the Tape Library Specialist and select **Configure Library** → **Control Path Failover**. This will enable you to activate control path failover by entering the password key provided with feature 1682. In Figure 3-1 we see that the license key has been applied and the path failover is activated.



Figure 3-1 IBM TS3200 Control Path Failover

Next use **Configure Library** → **Drives** to set the control path for each drive, see Figure 3-2. We see that the control path has been enabled automatically for drive 1. Add control path for drive 2, and **Submit**. The reconfiguration might take a few minutes.

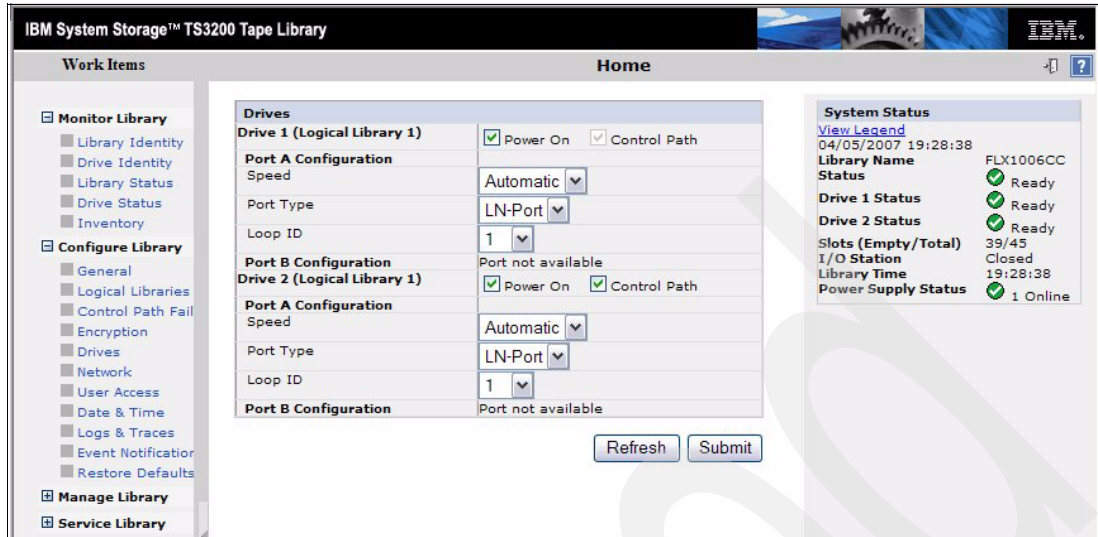


Figure 3-2 IBM TS3200: Enable control paths

Enable additional control path on IBM TS3310

The IBM TS3310 requires a license key provided with the feature 1682 to support path failover. There are two license keys, one for control path (5 digits long), and one for the data path (16 digits long). The Control Path license key is entered on the library Operators Panel, select **Setup** → **Licenses**; or from the Tape Library Specialist, by selecting **Manage Library** → **Settings** → **Feature Licences**, see Figure 3-3.

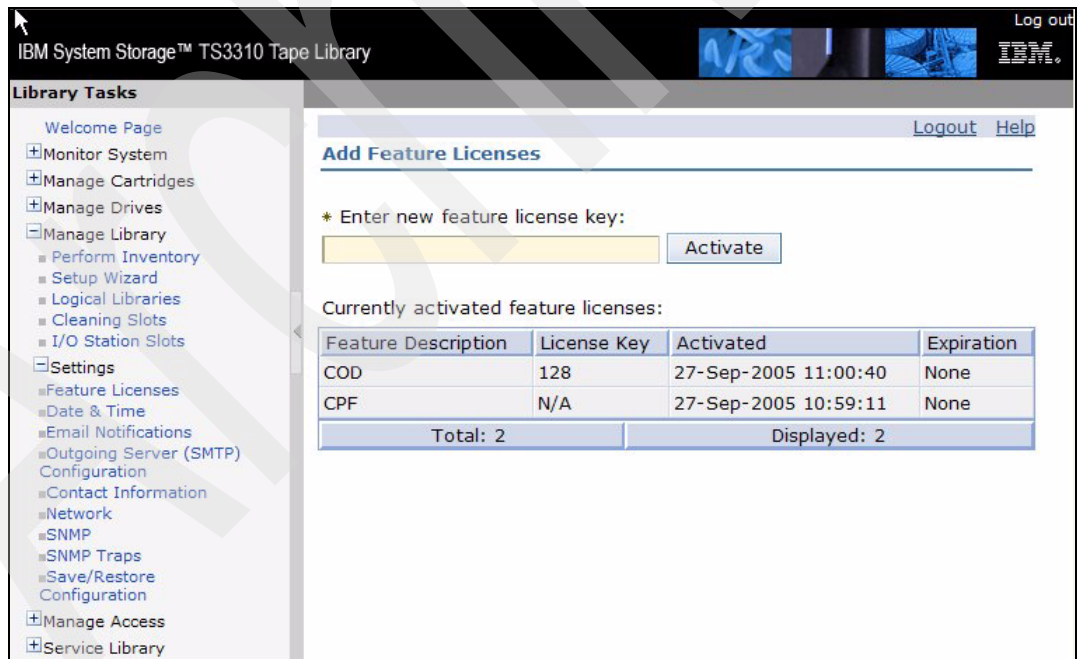


Figure 3-3 IBM TS3310 Add feature license

The Data Path license key must be entered on any host using this feature. Refer to the device driver documentation and the license key installation instructions shipped with the library for further installation details.

Then you can use the Tape Library Specialist to add or delete control paths within each logical library, see Figure 3-4. Make your selection and **Submit**.

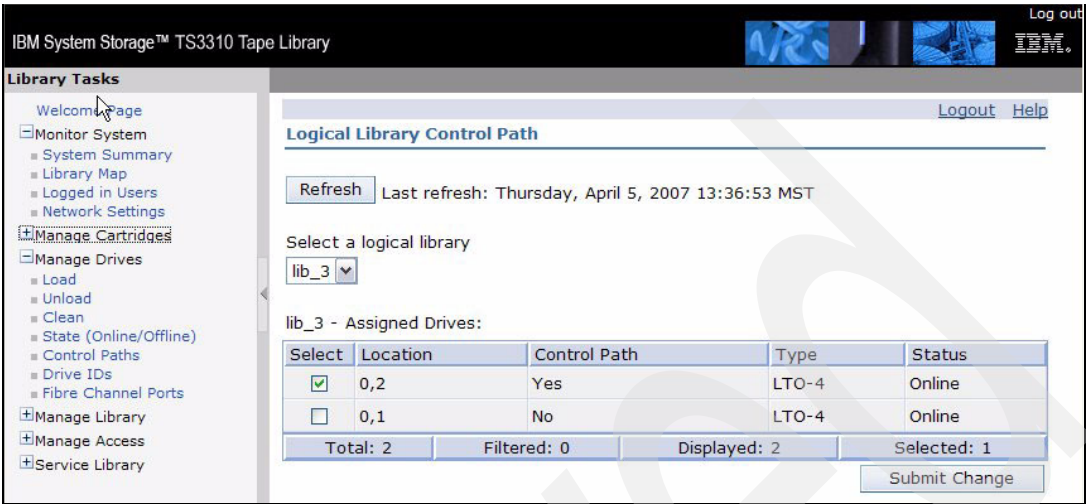


Figure 3-4 IBM TS3310 Enable control path

Enable additional control path on IBM TS3400

Both Control Path and Data Path failover is a standard feature on the TS3400. To enable it, both drives must be defined as a control path (see Figure 3-5).

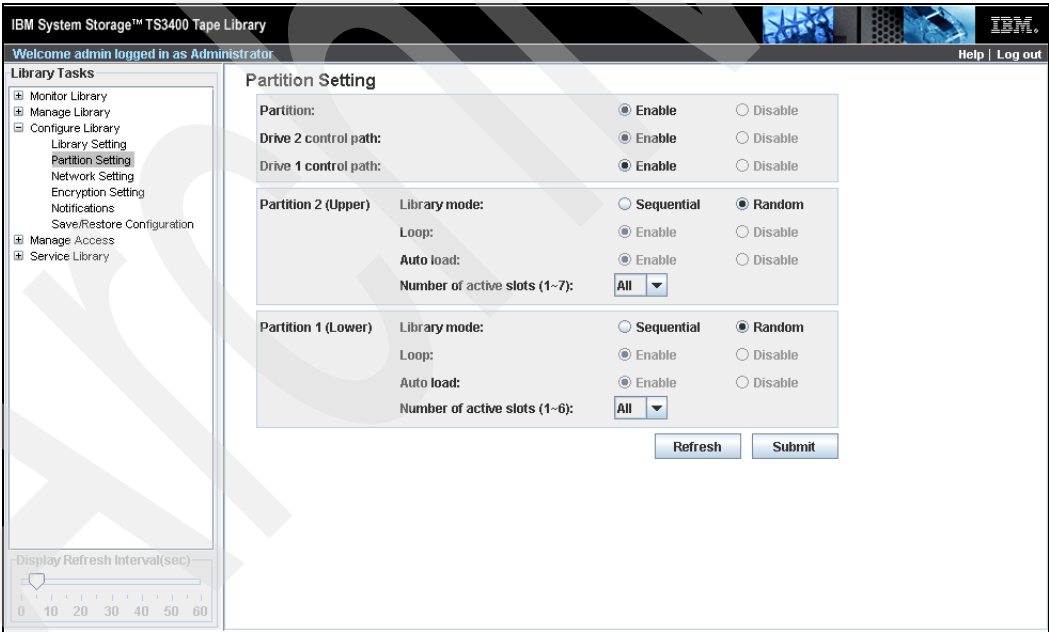


Figure 3-5 IBM TS3400 Enable Drive Control Path

Enable additional control path on IBM TS3500

To enable additional control paths with the operator panel on an IBM TS3500, select **Menu** → **Settings** → **Control Paths** → **Change Control Paths**, and press UP or DOWN to select the drive for which you want to enable the control path.

To enable additional control paths using the Tape Library Specialist without ALMS, select **Drives** → **Control Paths**, select the drive which you want to enable for the control path and click **Change** (see Figure 3-6).

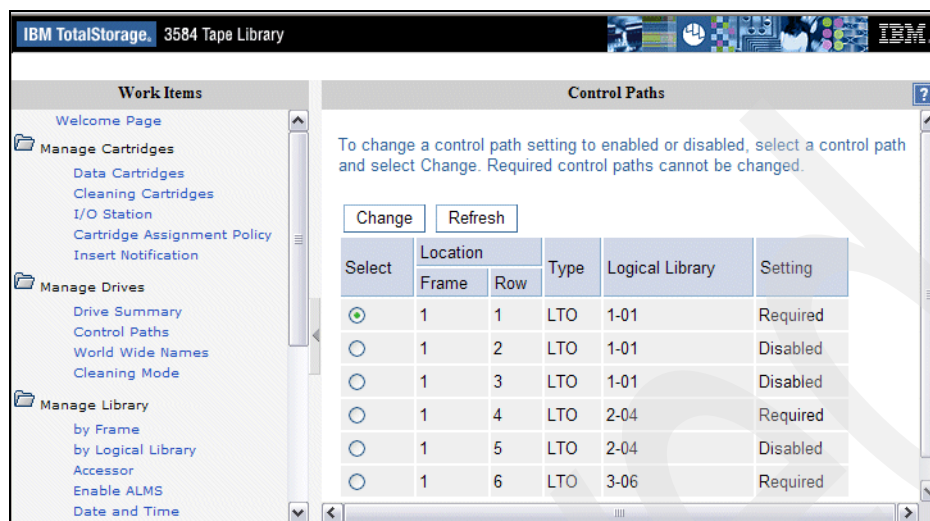


Figure 3-6 IBM TS3500: Enabling additional control paths without ALMS

To enable additional control paths using the Tape Library Specialist with ALMS enabled, perform the followings steps:

1. Select **Drives** → **Drive Assignments**.
2. From the Drive Assignments page, either select the Drive you want to enable or select the Logical Library from which you would like to select a drive to enable and click **Continue**.
3. Locate the drive that you want to enable (or disable) as the control path drive by selecting the blue icon to the left of the checkbox such that a drive icon appears as shown in Figure 3-7. In the example, drive 2703 was selected to enable as an alternate control path.
Note: Do not select a drive with a cartridge in it, such as drive 2702 in the example.
4. To confirm the changes, click **Apply**.
5. The Operation in Progress panel displays, followed by a Success screen that indicates that the changes are complete. Click **Close**.
6. The Drive Assignment screen re-displays with the new assignments.

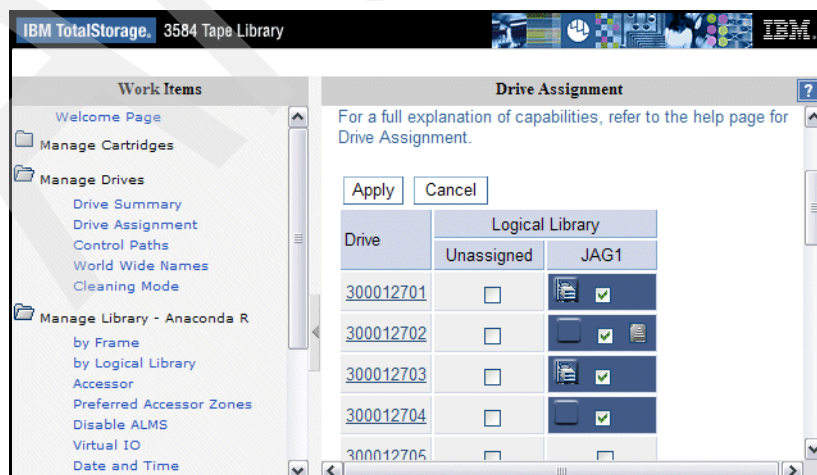


Figure 3-7 IBM TS3500: Enabling additional control paths with ALMS enabled

Enabling/disabling alternate control path support

Alternate pathing support is not enabled automatically when the device driver is installed. It must be configured initially *on each logical device* after installation. When alternate pathing support is enabled for a logical device, it remains set until either the device is deleted or the support is unconfigured; hence, the setting is retained even if the system is rebooted. To enable or disable the support on a single logical device, use **SMIT Devices → Tape Drive → Change/Show Characteristics of a Tape Drive**. Select the logical device to change (smcx), then select **Yes** for Enable Alternate Pathing Support (see Example 3-14).

Example 3-14 Enable alternate pathing support with SMIT

Change/Show Characteristics of a Tape Drive

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

	[Entry Fields]	
Tape Drive	smc1	
Tape Drive type	3577	
Tape Drive interface	fc	
Description	IBM 3577 Library Medium Cha>	
Status	Available	
Location	14-08-02-PRI	
Parent adapter	fscsi0	
Connection address	2	
SCSI ID	0x650b00	
Logical Unit ID	0x1000000000000	
World Wide Port Name	0x5003013d38357022	
World Wide Node Name	0x5003013d38357020	
New Logical Name	[]	
Enable Alternate Pathing Support	yes	+
Use Reserve/Release on Open and Close	yes	+

The support can also be enabled or disabled using the **chdev** command.

chdev -l *device_name* -a alt_pathing=yes

Example 3-15 shows the output of the **chdev** command.

Example 3-15 Enable alternate pathing support on command line

```
chdev -l smc1 -a alt_pathing=yes
smc1 changed
```

When the device driver configures a logical device with alternate pathing support enabled, the first device configured always becomes the primary path. On SCSI-attached devices, **-P** is appended to the location field, and on Fibre-attached devices **-PRI** is appended to the location field of the device.

When a second logical device is configured with alternate pathing support enabled for the same physical device, it configures as an alternate path. On SCSI-attached devices, **-A** is appended to the location field, and on Fibre-attached devices **-ALT** is appended to the location field of the device. A third logical device is also configured as an alternate path with either **-A** or **-ALT** appended, and so on. The device driver supports up to 16 physical paths for a single device.

For our example, alternate pathing is enabled for the TS3400 library, and for both tapes. There are no alternate paths defined, as there is only one tape drive for each logical partition, however, there are two control paths to the physical library. See Example 3-16.

Example 3-16 TS3500 multi-path architecture - configured FC tape devices

```
# lsdev -Cc tape
rmt0 Available 34-08-02      IBM 3580 Ultrium Tape Drive (FCP)
rmt1 Available 14-08-02-PRI IBM 3592 Tape Drive (FCP)
rmt2 Available 14-08-02-PRI IBM 3592 Tape Drive (FCP)
smc0 Available 34-08-02      IBM 3573 Tape Medium Changer (FCP)
smc1 Available 14-08-02-PRI IBM 3577 Library Medium Changer (FCP)
smc2 Available 14-08-02-PRI IBM 3577 Library Medium Changer (FCP)
```

The labeling of a logical device as either a primary or alternate path is for information only, in order to:

- ▶ Enable you to identify the actual number of physical devices configured on the system, and the specific logical device associated with them. There will be only one logical device labeled the primary path for each physical device. However, there might be many (multiple) logical devices labeled as an alternate path for the same devices.
- ▶ Provide information about which logical devices configured on the system have alternate pathing support enabled. You can display the primary and alternate path configuration for all devices with the `lsdev` command. There might be two or more logical devices configured for a single physical device, but the first device configured is labeled the primary device. All other logical devices configured after the first device are labeled as alternate devices. To see this, run the `lsdev -Cc tape` command and look at the location field in the data. By running `lsdev -Cc tape | grep P`, for example, you can easily determine how many physical devices are configured with alternate pathing support.

IBM TS3500 high availability

The IBM TS3500 already provides many high availability options as described in *IBM System Storage Tape Libraries Guide for Open Systems*, SG24-5946.

By using control path failover, you can achieve a fully redundant configuration as shown in Figure 3-8 on page 113.

You should also consider your infrastructure and attach the additional control paths on redundant components, including:

- ▶ SAN switch
- ▶ SAN fabric
- ▶ Server HBA

If you have a multi-frame configuration, enable the additional control paths on a different frame, so that you can still use your library even if the AC power for the first frame is lost. In Figure 3-8 on page 113, the second control path is enabled on the second frame, and goes over a separate SAN switch and fabric (there is no inter-switch link between these switches) to a second HBA. You can still work with the library if any *one* of these conditions occurs:

- ▶ AC power is lost on the first frame.
- ▶ Drive one in the first frame is down.
- ▶ The FC cable between the drive and switch, or switch and HBA is broken.
- ▶ One switch fails.
- ▶ One SAN fabric is down.
- ▶ One HBA is broken.

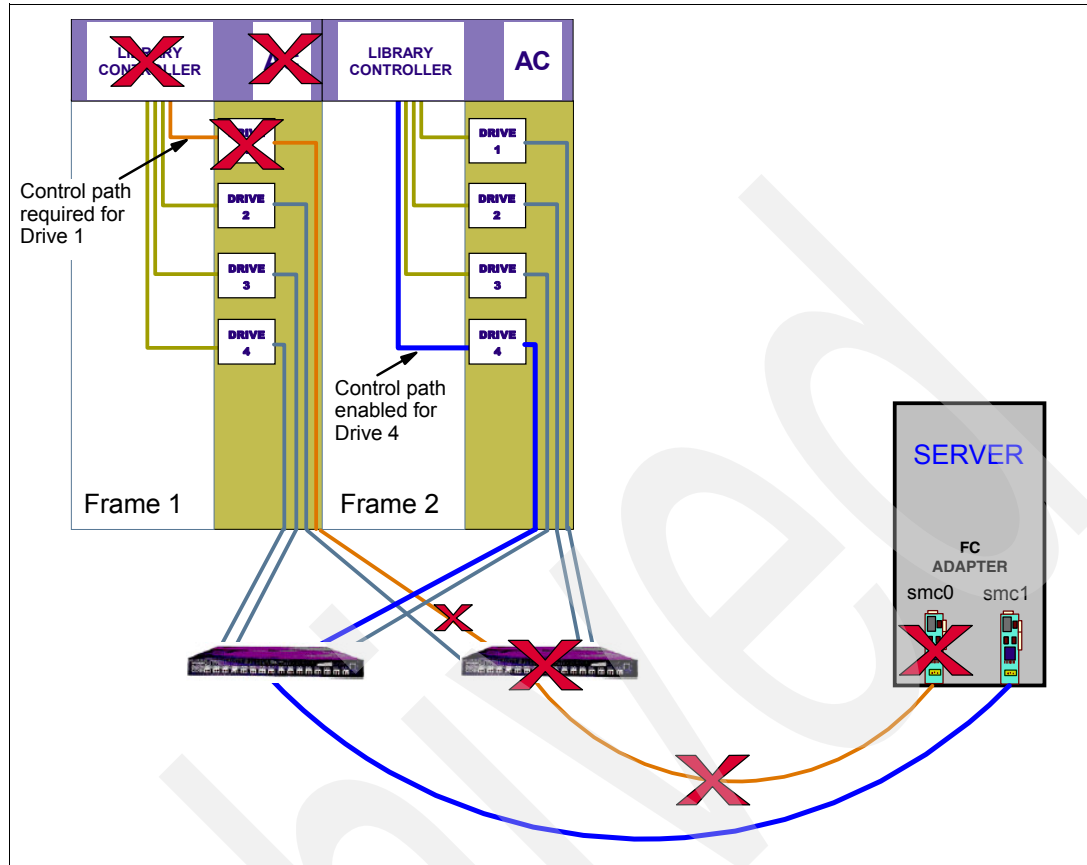


Figure 3-8 High availability control path configuration on an IBM TS3500

3.2.7 Data path failover for LTO and TS1120 drives on AIX

The Atape.driver for AIX supports alternate drive pathing, which will configure multiple physical paths to the same drive within the device driver. It provides two basic functions:

- ▶ Automatic failover to an alternate physical drive path when a permanent error occurs on one path
- ▶ Dynamic load balancing for devices using multiple HBAs

Automatic failover

The automatic failover support provides error recovery on an alternate path when a permanent error occurs on one path. This is transparent to the running application.

Note: This function is supported only on IBM LTO2, 3, and 4 native Fibre Channel drives and IBM TS1120 Enterprise tape drives.

For example, consider a simple multi-path connection with two HBAs in an AIX host, connected over a SAN to an LTO3 drive (see Figure 3-9 on page 114). This simple configuration provides two physical paths to the same LTO drive for redundancy if one path from an HBA to the drive fails. When the AIX server is booted or `cfgmgr` is run, each HBA detects an LTO drive and two logical devices will be configured (for example, `rmt0` and `rmt1`). Each logical device is a physical path to the same drive. An application can open and use only one logical device at a time, either `rmt0` or `rmt1`.

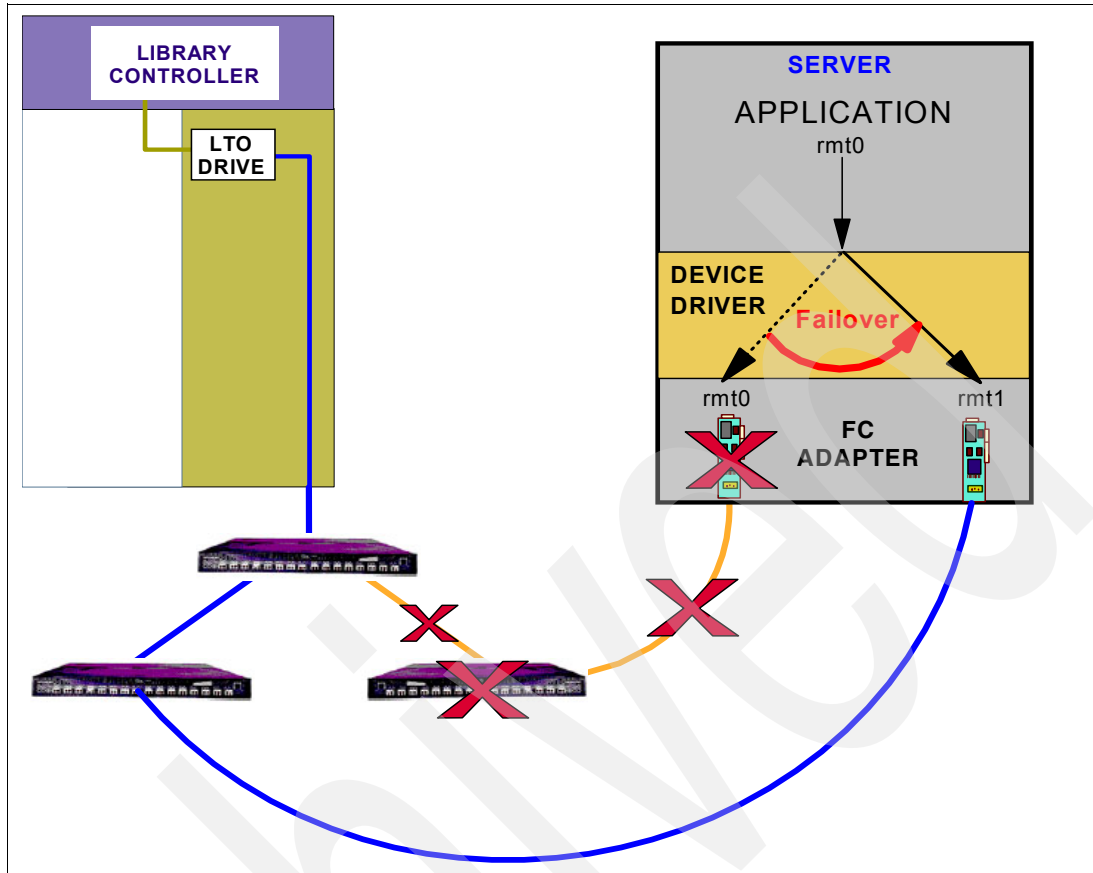


Figure 3-9 Datapath failover with LTO 3 FC drive

The IBM TS1120 has two fibre ports available on the back of each drive for increased redundancy. With the IBM TS1120, complete redundancy of the SAN components can be achieved (see Figure 3-10).

Without the Atape alternate pathing support, if an application opens rmt0, and a permanent path error occurs (for example, because of an HBA or cable failure), the application fails. It is possible to initiate manual failover by changing the device path to the alternate path (rmt1), but this is a manual operation, and the last failing job has to be resent. Sometimes manual failover might require operator intervention to reset the drive (like a power cycle through Tape Storage Specialist) because a SCSI reservation can still exist on the failing HBA path.

When the alternate pathing support is enabled on both rmt0 and rmt1, the device driver configures them internally as a single device with multiple paths. The application can still open and use only one logical device at a time (either rmt0 or rmt1). If an application opens rmt0 and a permanent path error occurs, the driver initiates failover error recovery automatically on the alternate path (rmt1), and the current operation continues on the alternate path without interrupting the application. Use of this function with TSM is described in 5.9, "Tivoli Storage Manager and data path failover" on page 212.

Note: The library data path failover feature code 1682 must be installed on the library (TS3200, TS3310 or TS3500 Lx3 frames) before enabling alternate data path support in the AIX device driver, for IBM LTO3 or 4 drives only.

The TS3500 with Lx2 frames requires feature code 1680 for CPF, and feature code 1681 for DPF. No failover feature code is required for the IBM TS3400 library or in general for the IBM TS1120 Enterprise drives.

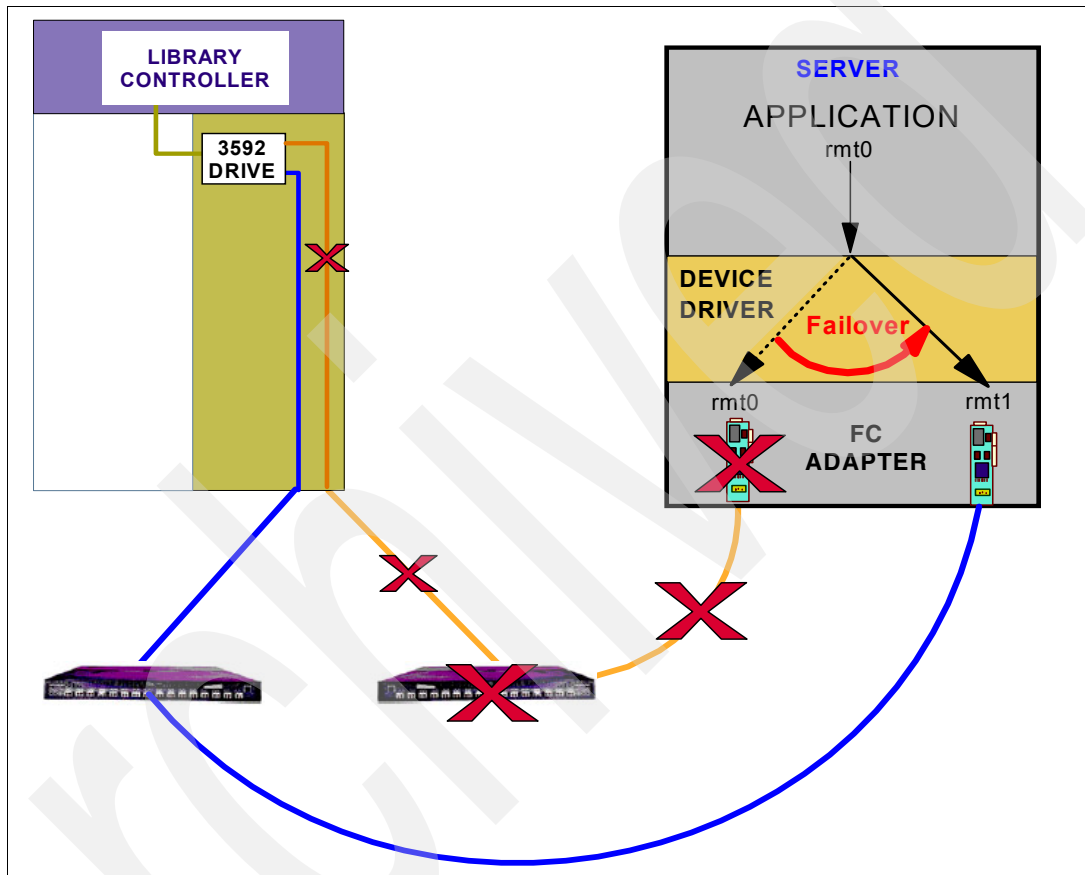


Figure 3-10 Datapath failover with IBM TS1120

Dynamic load balancing

The dynamic load balancing support optimizes resources for devices that have physical connections to multiple HBAs in the same machine. When an application or job opens a device that has multiple HBA paths configured, the device driver determines which path has the HBA with the lowest usage, and assigns that path to the application or job. When another application or job opens a different device with multiple HBA paths, the device driver again determines the path with the lowest HBA usage, and assigns that path to the second application or job. The device driver will update the usage on the HBA assigned to the application when the device is closed. Dynamic load balancing will use all HBAs whenever possible, and balance the load between them to optimize the resources in the machine.

For example, consider a machine with two HBAs: HBA1 and HBA2, which each have four tape drives attached (Figure 3-11). Each tape drive is connected to both HBA1 and HBA2. The server sees rmt0 to rmt3 through HBA1, and rmt4 to rmt7 through HBA2. The device files rmt0 and rmt4 point to the same physical tape drive (similarly, for rmt1 and rmt5, and so on).

Initially, all tape drives are idle. The application is assigned just the first four tape drives (rmt0 - rmt3). When the first job opens a tape drive (rmt0) for use in Job 1, the device driver will assign the application to use HBA1. When the application starts a second job which opens rmt1 for use, the device driver will assign the second job to use HBA2 and assign rmt5. A third job would be assigned to HBA1 (rmt2), and a fourth job would be assigned to HBA2 (rmt7). There would be two jobs using HBA1 and two jobs using HBA2. If the first job finishes and closes the device, there would now be one job using HBA1, and two jobs using HBA2.

When the next job opens a tape drive (rmt0), it would be assigned to HBA1, so again there would be two jobs using HBA1 and two jobs using HBA2. Likewise, if the second job finishes and closes the device, HBA2 would have one job using it, and the next job that opens a tape drive (rmt1) would be assigned to HBA2. The dynamic load balancing support is independent from automatic failover support. Regardless of the path assigned initially for load balancing, if that path fails, the automatic failover support will attempt recovery on the next available path.

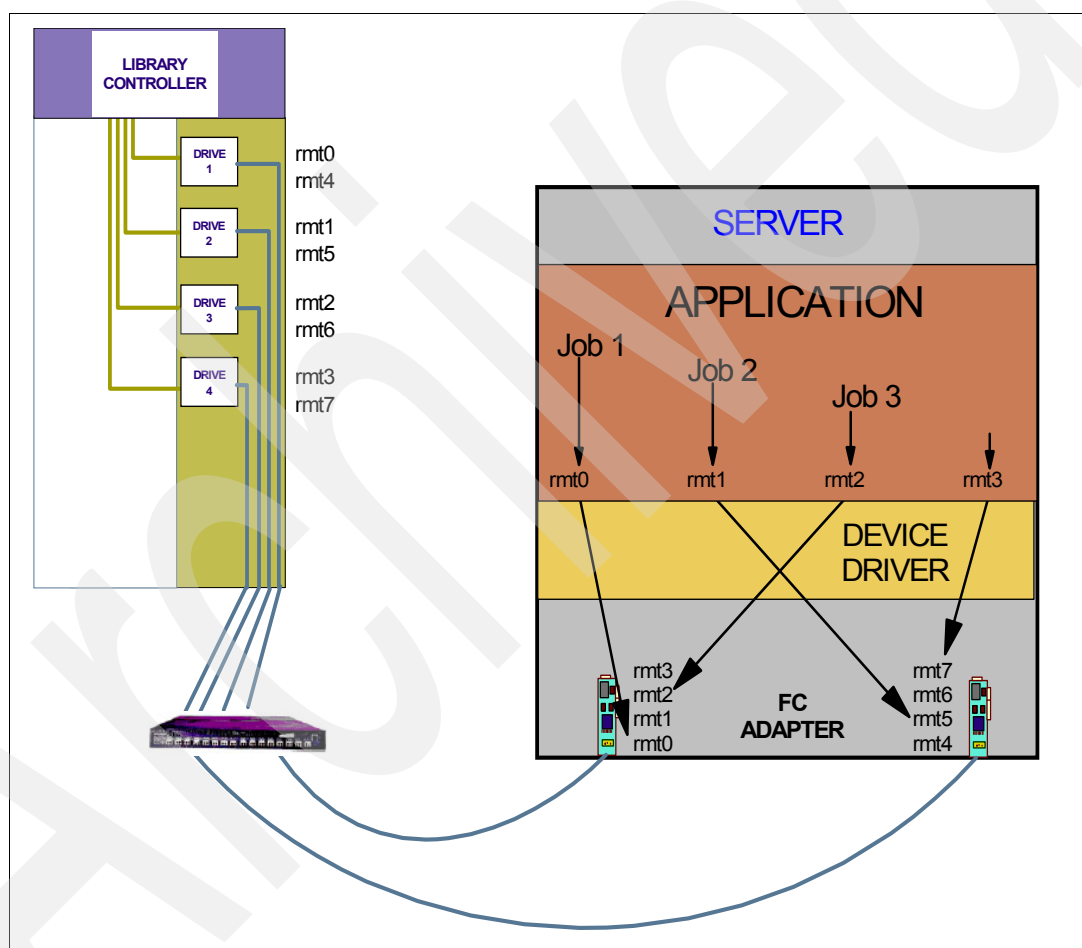


Figure 3-11 Dynamic load balancing

It should be noted that dynamic load balancing works when the tape drive is opened, not loaded. The device driver tries to balance the usage of drive opens over several HBAs, but it is not possible to precisely balance the workload or throughput of HBAs. This means it can still happen that the throughput of one HBA is significantly higher than that of other HBAs.

Also, if a failover happens, then all open devices will be switched to the next available HBA, regardless of dynamic load balancing. The next open will then try to balance. Thus, recovering from failover is more important than load balancing, and failover must happen fast to avoid application impact.

Note: If you are using alternate paths for tape drives, the instructions in 4.1.2, “Multiple paths to tape drives” on page 159 is redundant.

Enabling/disabling alternate data pathing

Alternate pathing support is not enabled automatically when the device driver is installed. It can be enabled on all configured devices at one time, or it can be enabled or disabled selectively by logical device. When alternate pathing support is enabled for a logical device, it remains set until the device is deleted or the support is unconfigured, and is preserved across reboots.

Note: Before enabling alternate pathing support for the LTO tape drives, you must first install the DPF license key. To install the license key, use the following command (all letters should be entered in lowercase). Also refer to the *IBM Tape Device Drivers Installation and User's Guide*, GC27-2130, for installation details.

```
# dpf_keys -a key
```

To enable the support globally on all currently configured devices, run this command:

```
/usr/lpp/Atape/instAtape -a
```

To enable or disable the support on a single logical device, run the following command:

```
chdev -l device_name -a alt_pathing=yes
```

Example 3-17 shows sample output of the **chdev** command.

Example 3-17 Enable alternate pathing support for rmt0 on command line

```
chdev -l rmt0 -a alt_pathing=yes
rmt0 changed
```

The support can also be enabled or disabled through the SMIT interface, by selecting **Devices** → **Tape Drive** → **Change/Show Characteristics of a Tape Drive**. Select the logical device to change, such as rmt0, rmt1, and so on; then select **Yes** for Enable Alternate Pathing Support (see Example 3-18).

Example 3-18 Enable alternate pathing support for rmt 0 through SMIT

Change / Show Characteristics of a Tape Drive

Type or select values in entry fields.

Press Enter AFTER making all desired changes.

Tape Drive	rmt0
Tape Drive type	3580
Tape Drive interface	fc
Description	IBM 3580 Ultrium Tape Drive>
Status	Available
Location	34-08-02
Parent adapter	fscsi1
Connection address	1
SCSI ID	0xb1e26
Logical Unit ID	0x0
World Wide Port Name	0x2002000e11105b14
World Wide Node Name	0x2001000e11105b14
New Logical Name	[]
Enable Alternate Pathing Support	yes +

Block size (0=variable length)	[0]	+#
Use Hardware Compression on Tape	yes	+
Use Autoloading Feature at End-of-Tape	no	+
Activate volume information logging	no	+
Maximum size of log file (in # of entries)	[500]	+#
Backward Space/Forward Space Record Mode	SCSI	+
Use Immediate Bit in Rewind Commands	no	+
Trailer Label Processing	no	+
	no	+
	custom	+

When the device driver configures a logical device with alternate pathing support enabled, the first device configured always becomes the primary path. On fibre-attached devices, -PRI is appended to the location field of the device.

When a second logical device is configured with alternate pathing support enabled for the same physical device, it configures as an alternate path. On fibre-attached devices, -ALT is appended to the location field of the device. A third logical device is also configured as an alternate path with -ALT appended, and so on. The device driver supports up to 16 physical paths for a single device.

For example, if an rmt0 is configured first, then an rmt1 and an rmt2, the **lsdev -Cc tape** command looks as shown in Example 3-19.

Example 3-19 Alternate data path - configured LTO FC tape devices

```
# lsdev -Cc tape
rmt0 Available 34-08-02-PRI IBM 3580 Ultrium Tape Drive (FCP)
rmt1 Available 20-58-01-ALT IBM 3580 Ultrium Tape Drive (FCP)
rmt2 Available 10-70-01-ALT IBM 3580 Ultrium Tape Drive (FCP)
```

You can see by the location code which HBA connection is associated with the primary and alternate paths. In Example 3-19, rmt0 is the primary device, connected to the HBA in location 34-08-02. (Also, the serial number or WWN shown with an **lscfg -v1** or **lsattr -El** command for each device file would indicate that each represents the same physical drive.) You also see that the three HBAs are on three separate PCI buses to split the I/O workload between them, which should improve performance.

Different types of PCI buses have different performance specifications as shown in Table 3-2. It makes sense to put one 2 Gbps HBA in a 32/33 PCI bus; however, it does *not* make sense to put more than one 2 Gbps HBA in a 64/33 PCI bus because throughput will be saturated.

Note: Bandwidth throughputs in Table 3-2 are burst rates. Sustained throughput rates are typically around 50% of the burst rates.

Table 3-2 PCI buses

Width	Speed	Bandwidth
32 bit	33 MHz	132 MB/sec
64 bit	33 MHz	264 MB/sec
64 bit	64 MHz	512 MB/sec
64 bit	132 MHz	1056 MB/sec

The labeling of a logical device as either a primary or alternate path is for information only in order to:

- ▶ Enable you to identify the actual number of physical devices configured on the system and a specific logical device associated with them. There will be only one logical device labeled as the primary path for each physical device. However, there might be many (multiple) logical devices labeled as alternate paths for the same devices.
- ▶ Provide information about which logical devices configured on the system have alternate pathing support enabled. You can display the primary and alternate path configuration for all devices with the `lsdev` command. There might be two or more logical devices configured for a single physical device, but the first device configured is labeled the primary device. All other logical devices configured after the first device are labeled as alternate devices. To see this, run the `lsdev -Cc tape` command and look at the location field in the data. By running `lsdev -Cc tape | grep P` for example, you can easily determine how many physical devices are configured with alternate pathing support.

3.2.8 Deleting tape devices

It can be necessary to remove the tape device or the medium changer from the AIX device configuration. This is a required step for some application software that provides its own device driver for a tape drive and medium changer. Refer to Part 2, “IBM Open Systems Tape libraries and backup software” on page 173 for more information on specific application software driver requirements.

Remove the devices from the configuration using either of the following procedures:

- ▶ The first method leaves the device defined in the configuration database. It is similar to bringing the device offline. Enter the following command to bring the `/dev/rmtn` device offline, but leave it defined in the device database:

```
rmdev -l rmtn
```

In this case, the removed device will appear as:

```
rmt0 Defined 14-08-00-0,0 IBM 3580 Ultrium Tape Drive
```

- ▶ The second method brings the device offline, and also removes its definition from the device database. Enter the following command:

```
rmdev -l rmtn -d
```

After this, the removed device will no longer appear in the device listing.

Use the actual device number (for example, `/dev/rmt0`), and repeat for each drive to be removed. If you are removing a medium changer as well, repeat with `/dev/smcx`.

Alternatively, you can use **SMIT Devices → Tape Drive → Remove a Tape Drive**. From the list of devices, select the device that you want to remove from the configuration as shown in Example 3-20.

Example 3-20 Select tape device to delete

	Tape Drive	
	Move cursor to desired item and press Enter.	
	rmt0 Available 1V-08-01 LTO Ultrium Tape Drive (FCP)	
	rmt1 Available 1V-08-01 LTO Ultrium Tape Drive (FCP)	
	rmt2 Available 1V-08-01 LTO Ultrium Tape Drive (FCP)	
	smc0 Available 1V-08-01 IBM 3584 Library Medium Changer (FCP)	

Now you can uninstall the Atape driver. You cannot unload the device driver from the kernel until the last device used by this driver has been unconfigured.

To uninstall the Atape device driver using SMIT, navigate to **Software Installation and Maintenance** → **Software Maintenance and Utilities** → **Remove Installed Software** and select **Atape.driver**. Otherwise, you can use the `installp` command:

Note: All tape devices that use the Atape driver must be closed and idle when uninstalling Atape, or the uninstall will fail.

Example 3-21 AIX uninstall Atape driver

There are 4 Atape devices configured:

```

rmt0 Available
smc0 Available
rmt1 Available
rmt2 Available

Deleting rmt0...
rmt0 deleted
Deleting rmt1...
rmt1 deleted
Deleting rmt2...
rmt2 deleted
Deleting smc0...
smc0 deleted
De-installing Atape.driver...
Atape.driver de-installed
Finished processing all filesets. (Total time: 12 secs).

0503-409 installp: bosboot verification starting...
installp: bosboot verification completed.
0503-408 installp: bosboot process starting...

bosboot: Boot image is 22610 512 byte blocks.
0503-292 This update will not fully take effect until after a
        system reboot.

* * * A T T E N T I O N * * *
System boot image has been updated. You should reboot the
system as soon as possible to properly integrate the changes
and to avoid disruption of current functionality.

installp: bosboot process completed.

```

```

+-----+
Summaries:
+-----+

```

Installation Summary

Name	Level	Part	Event	Result
Atape.driver	9.3.5.0	USR	DEINSTALL	SUCCESS

3.3 Installing IBM tape device driver for Solaris

The device driver used for SUN Solaris platforms is called *IBMtape*, and it includes both the tape drive and medium changer drivers.

This driver supports SCSI and FC attachment for IBM magnetic tape and library subsystem products for Sun Microsystems SPARC and UltraSPARC platforms running Solaris, including the Ultra/Enterprise family of servers.

To check if your environment has a supported OS level and Sun system, look up the interoperability section at:

<http://www.ibm.com/servers/storage/tape/resource-library.html#interoperability>

Or select the tape library, the folder *plan/upgrade*, and then *interoperability matrix*. Look for the section **SUN Servers** for information about operating systems and supported HBAs.

To directly search for the supported HBA firmware level and SAN fabric components, see:

<http://www-01.ibm.com/systems/support/storage/config/hba/index.wss>

You can download the latest IBMtape drivers from the *resource-library* entry above, or directly from:

<ftp://ftp.software.ibm.com/storage/devdrv/Solaris/>

Select the desired file with the .bin extension and read the IBMtape.readme for latest release information, fixes, and prerequisites.

You must have Solaris *root* authority to proceed with the installation of the driver. The configuration process for SUN Solaris systems have been much improved from the earlier versions. We are showing the necessary requirements for a Solaris 10 installation.

3.3.1 IBMtape driver installation

Note: A reboot of the host system is required to complete the installation, so you should schedule this operation accordingly.

The IBMtape device driver attempts to claim and operate only the supported IBMtape devices (including LTO Ultrium and TS1120 drives, among others). However, Solaris includes its own SCSI tape device driver, named *st*, which will automatically claim any SCSI-compliant tape drive it detects, including devices that IBMtape should be managing.

In order to avoid conflicts between IBMtape and *st*, you must prevent the *st* driver from claiming and attempting to operate IBMtape-owned devices. Similarly, other supplier's SCSI tape device drivers that you have installed must be prevented from claiming IBM tape-owned devices.

For detailed information, refer to *IBM Tape Device Drivers Installation and User's Guide*, GC27-2130.

The following steps are required to complete the process. As an example, we detail the installation for a Solaris system without any previous tape subsystem configured, and where all drives will be controlled by the IBMtape driver.

We are installing the IBMtape driver in the following environment:

- ▶ SUN Microsystems SPARC server with Sun Solaris 10
- ▶ IBM System Storage TS3400 Tape Library with native FC drives

This example assumes we have downloaded a package file named IBMtape.4.1.1.9.bin into the /export/home/pkgadd/IBMtape directory.

1. Log on to the target system as root.
2. Ensure that all user and tape drive activity on the system has halted.
3. Use **pkgadd** to install the driver:

```
pkgadd -d /export/home/pkgadd/IBMtape/IBMtape.4.1.1.9.bin
```

4. You should see an output similar to Example 3-22. In this case, an older version of the driver was already installed. Your output will look slightly different if it is a fresh installation. Also, an installed version should first be removed using the **pkgrm** command as in 3.3.5, "Removing IBMtape driver from the system" on page 127:

```
pkgrm IBMtape
```

Example 3-22 IBMtape install output on Solaris

```
# pkgadd -d /export/home/pkgadd/IBMtape/IBMtape.4.1.1.9
The following packages are available:
  1  IBMtape      IBM Tape & Medium Changer Device Driver 4.1.1.9
                        (sparc) 4.1.1.9

Select package(s) you wish to process (or 'all' to process
all packages). (default: all) [?,??,q]:

Processing package instance <IBMtape> from </export/home/pkgadd/IBMtape/IBMtape.
4.1.1.9>

IBM Tape & Medium Changer Device Driver 4.1.1.9
(sparc) 4.1.1.9

IBM Tape & Medium Changer Device Driver for Sun Solaris 7, 8, 9 and 10
Version 4.1.1.9

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Using </opt> as the package base directory.
## Processing package information.
## Processing system information.
  1 package pathname is already properly installed.
## Verifying disk space requirements.
## Checking for conflicts with packages already installed.
## Checking for setuid/setgid programs.

This package contains scripts which will be executed with super-user
permission during the process of installing this package.

Do you want to continue with the installation of <IBMtape> [y,n,?] y

Installing IBM Tape & Medium Changer Device Driver 4.1.1.9 as <IBMtape>

## Installing part 1 of 1.
/opt/IBMtape/IBMtape.conf
/opt/IBMtape/diags_info
/opt/IBMtape/tapelist
/opt/IBMtape/tapeutil
/opt/IBMtape/tapeutil.c
/opt/IBMtape/tmd
/opt/IBMtape/tmd.conf
/usr/include/sys/oldtape.h
/usr/include/sys/smc.h
/usr/include/sys/st.h
/usr/include/sys/svc.h
/usr/kernel/drv/IBMtape
```

```

/usr/kernel/drv/sparcv9/IBMtape
[ verifying class <none> ]
## Executing postinstall script.
## The /usr/kernel/drv/IBMtape.conf file already exists.
## It will be preserved as the current configuration file
## for the IBM Tape & Medium Changer Device Driver.

## Stopping any running instances of tape monitor daemon...

## The /etc/tmd.conf file already exists.
## It will be preserved as the current configuration file
## for the IBM tape monitor daemon.

## The /var/opt/IBMtape already exists.
## It will be preserved as the current directory
## for the IBM tape monitor daemon.

## The /usr/kernel/drv/IBMtape.conf already contains
## a control node entry. It will be preserved.

## Adding new tmd entry to /etc/inittab...
## Loading IBM Tape & Medium Changer Device Driver.

## Starting IBMtape Monitor Daemon (tmd)...

Installation of <IBMtape> was successful.

```

Before using the tape devices and the library, configure the device driver parameters, as described in the following section.

3.3.2 Configuring tape and medium changer devices

The file `/usr/kernel/drv/IBMtape.conf` will originally have an entry for each device target 0-255, and LUN 0 and 1 for each. Additionally, the specific targets found for the connected tape devices are listed. Edit this file to make sure that all the required target and LUN definitions for the drives and medium changer are in place. Also remove all unused entries, to simplify the boot process.

The file `/kernel/drv/st.conf` list devices that will be claimed by standard tape device drivers. Edit this file and comment out all the required target and LUN definitions used for IBMtape to avoid that they are claimed by the Solaris standard tape device driver.

Example with native FC drives

If you are using native FC LTO drives or TS1120 drives, then LUN 0 is used for the tape drive, and LUN 1 is used for the medium changer. It is recommended to use persistent binding as described in 4.3, “Persistent binding” on page 167, so that you can identify or indicate the SCSI ID that should be used. This is especially important if you are running a Symantec Netbackup application. Refer to 4.3.1, “Persistent binding with Solaris 10” on page 168.

The two tapes in our TS3400 are then represented in `IBMtape.conf` as seen in Example 3-23. The target assignment is provided directly from the HBA driver when checking for new devices. Because of multi-path architecture, for every target ID we also use LUN 1 for the medium changer.

Example 3-23 IBMtape.conf for two FC drives

```

name="IBMtape" class="scsi" target=1 lun=0 block_size=0 buffering=1 immediate=0 trailer=0
sili=0;

```

```
name="IBMtape" class="scsi" target=1 lun=1 block_size=0 buffering=1 immediate=0 trailer=0
sili=0;

name="IBMtape" class="scsi" target=2 lun=0 block_size=0 buffering=1 immediate=0 trailer=0
sili=0;
name="IBMtape" class="scsi" target=2 lun=1 block_size=0 buffering=1 immediate=0 trailer=0
sili=0;
```

We see the same target and LUN IDs as assigned to the devices by using the **dmesg** command, looking for the IBMtape_probe entries; see Example 3-24.

Example 3-24 Tape entries in the dmesg command output

```
Mar 22 13:26:20 t2000 IBMtape: NOTICE: IBMtape_probe: Found Medium Changer 3577-TL, Inst
3    , Tgt 1, Lun 1
Mar 22 13:26:20 t2000 IBMtape: NOTICE: IBMtape_probe: Found Medium Changer 3577-TL, Inst
4    , Tgt 2, Lun 1
Mar 22 13:26:20 t2000 IBMtape: NOTICE: IBMtape _probe: Found Tape Drive    03592E05, Inst
1    , Tgt 1, Lun 0
Mar 22 13:26:20 t2000 IBMtape: NOTICE: IBMtape _probe: Found Tape Drive    03592E05, Inst
2    , Tgt 2, Lun 0
```

To prevent Solaris standard tape driver from claiming the devices, comment out the target ID and LUN for the IBM tape devices from the file `/kernel/drv/st.conf`, as in Example 3-25.

Example 3-25 /kernel/drv/st.conf example

```
#name="st" class="scsi" target=0 lun=0;
#name="st" class="scsi" target=1 lun=0;
#name="st" class="scsi" target=2 lun=0;
#name="st" class="scsi" target=3 lun=0;
#name="st" class="scsi" target=4 lun=0;
#name="st" class="scsi" target=5 lun=0;
#name="st" class="scsi" target=6 lun=0;

#
# In case there are wide tape drives, one can use these targets
#
#name="st" class="scsi" target=8 lun=0;
#name="st" class="scsi" target=9 lun=0;
#name="st" class="scsi" target=10 lun=0;
#name="st" class="scsi" target=11 lun=0;
#name="st" class="scsi" target=12 lun=0;
#name="st" class="scsi" target=13 lun=0;
#name="st" class="scsi" target=14 lun=0;
#name="st" class="scsi" target=15 lun=0;
```

After editing the files, reboot the system to enable the changes. One common method to perform a reboot is shown here, but use your installation's normal procedures:

```
reboot -- -r
```

Verify operation of the newly installed or readdressed equipment.

3.3.3 Verifying the IBMtape driver installation

To verify the correctness of the installation and configuration of the IBMtape device driver, use the command as in Example 3-26. It shows an IBM tape library with native FC drives connected.

Example 3-26 Verifying Solaris device configuration

```
ls -l /dev/rmt/*stbn /dev/rmt/*smc
lrwxrwxrwx 1 root root 58 Mar 24 17:33 /dev/rmt/0stbn ->
../../../../devices/pci@1f,4000/fibre-channel@2/IBMtape@8,0:stbn
lrwxrwxrwx 1 root root 57 Mar 29 13:22 /dev/rmt/1smc ->
../../../../devices/pci@1f,4000/fibre-channel@2/IBMtape@8,1:smc
lrwxrwxrwx 1 root root 58 Mar 24 17:33 /dev/rmt/2stbn ->
../../../../devices/pci@1f,4000/fibre-channel@2/IBMtape@9,0:stbn
lrwxrwxrwx 1 root root 57 Mar 29 13:22 /dev/rmt/3smc ->
../../../../devices/pci@1f,4000/fibre-channel@2/IBMtape@9,1:smc
```

In this example, the fields are:

- 0stbn** This device has a SCSI ID of 8 and LUN of 0 (8,0), as the first tape drive.
- 1smc** Here, 8,1 indicates that it is the device special file name for the medium changer recognized from the first tape drive
- 2stbn** The device special file name for the second tape drive
- 3smc** The device special file name for the medium changer

You can also use the **tape1ist** tool for identifying the relationship between the device special file and which physical device it represents. This example is from another library, see the Example 3-27.

Example 3-27 Tape entries in the server using *tape1ist* tool

```
# /opt/IBMtape/tape1ist -l
Inst # Special File Device Serial No TGT/LUN Ucode World Wide NN World Wide PN Device
Physical Path Path Type
-----
2865 /dev/rmt/83st 03592E05 000001350801 54/0 1A38 5003013D38316010 5003013D38316011
/devices/pci@8,600000/fibre-channel@1/IBMtape@36,0 N/A
2866 /dev/rmt/91smc 3577-TL 0000013F00231000 54/1 0009 N/A N/A
/devices/pci@8,600000/fibre-channel@1/IBMtape@36,1 Primary
```

Example 3-27 shows that device special file `/dev/rmt/83st` is representing an IBM 3592-E05 tape drive with assigned SCSI target ID of 54 and LUN of 0, serial number of 1350801, and WWNN of 5003013D38316010.

IBMtape is listed correctly as the owner of these devices. Refer to Table 3-1 on page 97 for a list of the device special file names for each platform. For performance reasons, it is suggested to use a special device file name that has compression turned on. If you have installed an IBM 3580, you will not see any entry for the medium changer because it does not have one.

You can now use the **tapeutil** utility to test the library. See 3.5, “Testing the library with tapeutil” on page 141 to learn how to use this utility. Open the device, issue inquiry commands **read** and **write**, and move the media across the library to check the driver functionality.

The drives can also be used with OS commands such as **tar**.

3.3.4 Deleting tape devices

It can be necessary to remove the tape device or the medium changer from the Solaris device configuration. This is a required step for some application software, which provides its own

device driver for a tape drive and medium changer. Refer to Part 2, “IBM Open Systems Tape libraries and backup software” on page 173 for more information on specific application software driver requirements.

To remove the IBMtape driver support for a specific device, edit `/usr/kernel/drv/IBMtape.conf`, and remove (comment out) the stanza for the device that is no longer to be configured with this driver.

Then reboot the system in order for the changes to take effect.

3.3.5 Removing IBMtape driver from the system

Use the **pkgrm** command to remove the IBMtape package from the system:

```
/usr/sbin/pkgrm IBMtape
```

All active processes using any IBM device supported by the IBMtape driver must be stopped in order for the removal procedure to complete successfully.

Example 3-28 shows sample output of the **pkgrm** command.

Example 3-28 Uninstall IBMtape driver 4.1.1.4 on Solaris

```
# /usr/sbin/pkgrm IBMtape
```

The following package is currently installed:

```
IBMtape          IBM Tape & Medium Changer Device Driver 4.1.1.4
                  (sparc) 4.1.1.4
```

```
Do you want to remove this package? yes
```

```
## Removing installed package instance <IBMtape>
```

```
This package contains scripts which will be executed with super-user
permission during the process of removing this package.
```

```
Do you want to continue with the removal of this package [y,n,?,q] y
```

```
## Verifying package dependencies.
## Processing package information.
## Executing preremove script.
## Stopping any running instances of tape monitor daemon...
## Unloading IBM Tape & Medium Changer Device Driver.
## Deleting device special file nodes.
## Removing old tmd entry from /etc/inittab...
## The /usr/kernel/drv/IBMtape.conf file will not be removed
##   to preserve previously established configurations.
## Removing pathnames in class <none>
/usr/kernel/drv/sparcv9/IBMtape
/usr/kernel/drv/IBMtape
/usr/include/sys/svc.h
/usr/include/sys/st.h
/usr/include/sys/smc.h
/usr/include/sys/oldtape.h
/opt/IBMtape/tmd.conf
/opt/IBMtape/tmd
/opt/IBMtape/tapeutil.c
/opt/IBMtape/tapeutil
/opt/IBMtape/tapelist
/opt/IBMtape/diags_info
/opt/IBMtape/IBMtape.conf
```

```
/opt/IBMtape <non-empty directory not removed>  
## Updating system information.
```

```
Removal of <IBMtape> was successful.
```

3.3.6 Setting up control path failover on Solaris

The Solaris IBMtape device driver alternate pathing support for library control path is called Control Path Failover (CPF), and will configure multiple physical control paths to the same logical library within the device driver and provide automatic failover to an alternate control path when a permanent error occurs on one path. This is transparent to the running application.

For example, consider a simple multipath connection that consists of two Host Bus Adapters (HBAs) that are connected to a library with two drive control ports enabled as in Figure 3-8 on page 113. The first HBA is connected to the first control port drive (Drive 1 in Figure 3-8 on page 113), and the second HBA is connected to the second control port drive (Drive 4 in Figure 3-8 on page 113). This connection provides two physical control paths to the same library for redundancy if one path from an HBA to the library fails.

When the tape library is attached to the two HBAs on the Solaris system, each HBA detects a control port to the same library, and two logical devices will be configured with IBMtape driver (for example, /dev/rmt/0smc and 1smc). Each logical device is a physical path to the same library. An application can open and use only one logical device at a time, either smc0 or smc1, because these represent the same physical device.

Without the IBMtape alternate pathing support, if an application opens 0smc and a permanent path error occurs (because of an HBA, cable, or drive control port failure, for example), the application fails. It is possible to initiate manual failover by restarting the application on the alternate logical device (1smc), but the failing transaction has to be restarted from the beginning.

When the alternate pathing support is enabled, the device driver configures them internally as a single device with multiple paths. The application can still open and use only one logical device at a time (either 0smc or 1smc). If an application opens 0smc and a permanent path error occurs, the device driver initiates failover error recovery automatically on the alternate path (1smc). If successful, the current operation continues on the alternate path without interrupting the application.

Note: The library data path failover feature code 1682 must be installed on the library (TS3200, TS3310 or TS3500 Lx3 frames) in order for the device driver to detect alternate control paths. In addition, you have to enable the control path for additional drives on the library using either the library operator panel or the Tape Library Specialist. To see how to do this, go to “Enabling additional control paths” on page 107.

The IBM TS3400 library or generally the TS1120 tape drive does not need any feature code as the path failover is built-in.

Configuring alternate control path

Alternate pathing support is enabled automatically by default when the IBMtape device driver is installed on a Solaris system. The Solaris IBMtape device driver provides a driver configuration parameter failover for you to enable or disable the library control path failover (CPF) support. To enable the CPF support for all of the paths, no action is required.

When the device driver configures a logical device with alternate pathing support enabled, the first device configured always becomes the primary path. When a second or more logical device is configured with alternate pathing support enabled for the same physical device, it configures as an alternate path. The device driver supports up to 16 physical paths for a single device.

The primary and alternate path information is shown in the Path Type field from the output of the **tapelists** command, as seen in this example from a TS3500 library, Example 3-29.

Example 3-29 Output of Primary and Alternate Control Paths using tapelists command

```
#tapelists -l
```

Inst#	Special	File	Device	Serial	No	TGT/LUN	Ucode	WWNN	WWPN	Device	Physical	Path	Path	Type
686	/dev/rmt/12smc	03584L32	0000000T0039	1/1	402j	N/A	N/A	/devices/pci@1f,2000/QLGC,qla@1/IBMtape@1,1						Primary
688	/dev/rmt/14smc	03584L32	0000000T0039	2/1	402j	N/A	N/A	/devices/pci@1f,2000/QLGC,qla@1/IBMtape@2,1						Alt_path_1
694	/dev/rmt/26smc	03584L32	0000000T0039	5/1	402j	N/A	N/A	/devices/pci@1f,2000/QLGC,qla@1/IBMtape@5,1						Alt_path_2

Another method for viewing the primary and alternate control paths is to run **tapeutil** and select option 54, **Query Device Paths**. See Example 3-30.

Example 3-30 Output of Primary and Alternate Control Paths using tapeutil

```
Path list in the device:
Path 0 Path 1 Path 2
Current active path: Path 0

Enter path number or <enter> for all of the paths:

Instance Number ..... 201
SCSI Target ..... 4
SCSI LUN ..... 1
Serial Number ..... 000001301084
Ucode Level ..... 227B
Path World Wide NN ..... N/A
Path World Wide PN ..... N/A
Path Type ..... Primary
Path ..... Enable
Device Physical Path ..... /devices/pci@1f,2000/scsi@1/IBMtape@4,1

Instance Number ..... 231
SCSI Target ..... 3
SCSI LUN ..... 1
Serial Number ..... 000001301084
Ucode Level ..... 227B
Path World Wide NN ..... N/A
Path World Wide PN ..... N/A
Path Type ..... Alt_path_1
Path ..... Enable
Device Physical Path ..... /devices/pci@4,2000/pci@1/fibre-channel@4/IBMtape@3,1

Instance Number ..... 293
SCSI Target ..... 2
SCSI LUN ..... 1
Serial Number ..... 000001301084
Ucode Level ..... 227B
Path World Wide NN ..... N/A
Path World Wide PN ..... N/A
Path Type ..... Alt_path_2
```



```
Path ..... Enable
Device Physical Path ..... /devices/pci@6,4000/lpfc@4/IBMtape@2,1
```

Disabling and enabling primary and alternate control paths

Once you install the IBMtape device driver, by default, all the available paths for a physical device are enabled. If for some maintenance reason you need to disable a path and do not want to fail over to this path, run the following steps:

1. Turn the failover parameter to *off* in the path entry in the IBMtape.conf file. For example:

```
name="IBMtape" class="scsi" target=3 lun=1 failover=0;
```

2. Stop the TMD (tape monitor daemon) running on the system and unload the IBMtape driver module from the current kernel:

```
# /opt/IBMtape/tmd -s
# /usr/sbin/rem_drv IBMtape
```

3. Reload the IBMtape driver module in the kernel and start the daemon:

```
# /usr/sbin/add_drv -m ' 0666 bin bin' IBMtape
# /opt/IBMtape/tmd
```

To enable a path from a disabled state, run the following steps:

1. Remove the parameter `failover=0` in the path entry in IBMtape.conf file. For example:

```
name="IBMtape" class="scsi" target=3 lun=1"
```

2. Stop the TMD (tape monitor daemon) running on the system and unload the IBMtape driver module from the current kernel:

```
# /opt/IBMtape/tmd -s
# /usr/sbin/rem_drv IBMtape
```

3. Reload the IBMtape driver module in the kernel and start the daemon:

```
# /usr/sbin/add_drv -m ' 0666 bin bin' IBMtape
# /opt/IBMtape/tmd
```

3.3.7 Setting up data path failover on Solaris

The Solaris IBMtape device driver alternate pathing support will configure multiple physical paths to the same device within the device driver to provide Data Path Failover (DPF) and dynamic load balancing for devices using multiple Host Bus Adapters (HBA). See Figure 3-9 on page 114, Figure 3-10 on page 115, and Figure 3-11 on page 116.

Note: These functions are supported only on IBM LTO2, 3, and 4 native Fibre Channel drives and IBM TS1120 Enterprise tape drives.

When the drive is attached on the Solaris system, each HBA detects a tape drive, and two logical devices will be configured (for example, 0st and 1st). Each logical device is a physical path to the same tape drive. A backup and restore application can open and use only one logical device at a time, either 0st or 1st, because they represent the same physical device.

Without the IBMtape alternate pathing support, if an application opens 0st and a permanent path error occurs (because of an HBA or cable failure, for example), the application fails. It is possible to initiate manual failover by restarting the application on the alternate logical device (1st), but the application has to be restarted from the beginning. A long backup or restore operation could have been in progress when the path error occurred. Sometimes manual failover can require operator intervention to reset the drive because a SCSI Reservation could still exist on the failing HBA path.

When the alternate pathing support is enabled on both 0st and 1st, the device driver configures them internally as a single device with multiple paths. The application can still open and use only one logical device at a time (either 0st or 1st). If an application opens 0st and a permanent path error occurs, the device driver initiates failover error recovery automatically on the alternate path (1st). If successful, the current operation continues on the alternate path without interrupting the application. The failover error recovery first restores the previous device state, SCSI Reservation, and tape position, then retries the failing operation.

The dynamic load balancing support optimizes resources for devices that have physical connections to multiple Host Bus Adapters (HBA) in the same machine. When an application opens a device that has multiple HBA paths configured, the device driver determines which path has the HBA with the lowest usage, and assigns that path to the application. When another application opens a different device with multiple HBA paths, the device driver again determines the path with the lowest HBA usage and assigns that path to the second application. The device driver will update the usage on the HBA assigned to the application when the device is closed. Dynamic load balancing will use all Host Bus Adapters whenever possible and balance the load between them to optimize the resources in the machine.

Note: The library data path failover feature code 1682 must be installed on the library (TS3200, TS3310 or TS3500 Lx3 frames) before enabling alternate data path support in the Solaris device driver for IBM LTO3 and 4 drives. The feature code is not required for IBM TS3400 library or generally for the IBM TS1120 drives.

Enabling/disabling alternate data path support

Alternate pathing support for tape drives is not enabled automatically when the device driver is installed. It must be configured initially on each logical device after installation. When alternate pathing support is enabled for a logical device, it remains set until the device is deleted or the support is deconfigured. The alternate pathing setting is retained even if the system is rebooted.

Alternate pathing support can be enabled on all configured devices at one time, or it can be enabled or disabled selectively by logical device. Perform the following steps to enable DPF support:

1. Enter the DPF feature key(s) in the parameter `dpf_keys` at the beginning of the `IBMtape.conf` file in the directory of `/usr/kernel/drv`. The feature key is required for LTO tape drives only. For example, `dpf_keys="A729E60F7B119411, C7A0B9ef2c1a4360, a729e60f7b118460"`. Also see the *IBM Tape Device Drivers Installation and User's Guide*, GC27-2130 for installation details.

Note: The parameter `dpf_keys` is in the format "key1, key2, key3,...". Each key is 16 characters long with a comma separator and a space. IBMtape driver supports up to 36 dpf keys.

2. To enable the support globally on all currently configured devices, add the following to the beginning of `IBMtape.conf`:

```
dpf_support=1
```

3. To enable a particular path, add the flag `dpf_support=1` in the path entry in `IBMtape.conf`. For example, `name="IBMtape" class="scsi" target=3 lun=0 dpf_support=1`

4. Stop the TMD (tape monitor daemon) running on the system and unload the IBMtape driver module from the current kernel:

```
# /opt/IBMtape/tmd -s
# /usr/sbin/rem_drv IBMtape
```

5. Reload the IBMtape driver module in the kernel and start the daemon:

```
# /usr/sbin/add_drv -m ' 0666 bin bin' IBMtape
# /opt/IBMtape/tmd
```

If for some reason you need to disable DPF support for all drives or for a particular path or drive, perform the following steps:

1. Specify what you want to disable.
 - a. To disable DPF support for all tape drives, set the `dpf_support` parameter in the `IBMtape.conf` file to 0.
 - b. To disable DPF support for a particular tape drive or path, do the following:
 - i. To disable a particular path, add the flag entry `dpf_support=0` in the path entry in `IBMtape.conf`. For example: `name="IBMtape" class="scsi" target=3 lun=0 dpf_support=0`
 - ii. To disable DPF support for a physical tape drive, remove the key from the list of `dpf_keys` in `IBMtape.conf`
2. Stop the TMD (tape monitor daemon) running on the system and unload the IBMtape driver module from the current kernel:

```
# /opt/IBMtape/tmd -s
# /usr/sbin/rem_drv IBMtape
```

3. Reload the IBMtape driver module in the kernel and start the daemon:

```
# /usr/sbin/add_drv -m ' 0666 bin bin' IBMtape
# /opt/IBMtape/tmd
```

3.4 Installing IBM tape device driver for HP-UX

The device driver used for HP-UX UNIX platforms is called **atdd** and it includes both the tape drive and medium changer drivers.

To check if your environment has a supported OS level and HP system, look up the interoperability section at:

<http://www.ibm.com/servers/storage/tape/resource-library.html#interoperability>

Or select the tape library, the folder *plan/upgrade* and then *interoperability matrix*. Look for the section **Hewlett-Packard Servers** for information about operating systems and supported HBAs. To directly search for the supported HBA firmware level and SAN fabric components, see:

<http://www-01.ibm.com/systems/support/storage/config/hba/index.wss>

You can download the latest atdd drivers from the *resource-library* entry above, or directly from:

<ftp://ftp.software.ibm.com/storage/devdrv/HPUX/>

To find the right driver, go to the subdirectory according to your HP-UX OS level and system architecture (either Precision or PCI) and OS. In our case, we have an HP Itanium® system with HP-UX V11i, therefore, we need to be in the `11i_PCI` directory. The IBM tape device driver has the format *atdd.5.5.x.x.bin*.

Note: Other bus architectures like PCI bus or PA-RISC use different formats for the device driver file. See the README file in the ftp directory to make sure you download the correct package for your architecture.

We recommend that you also download the **tapeutil** utility from the same location. This file is called *tapeutil.hpux.x.x.x.x.bin* and is packaged separately, unlike for Solaris or AIX. You use **tapeutil** for tape and medium changer commands such as **move media**, **write**, and **read**.

Finally, download the InstallAtdd script in ASCII. This is a script provided to automatically install the device driver. You can either execute this script, or follow the manual steps in the next section.

Be sure to check the readme for updated information on fixes and prerequisites.

The following sections describe installation, configuration, verification, and removal procedures for the atdd device driver exemplified with the IBM TS3400 TS1120 drives for HP-UX V11i.

3.4.1 Atdd driver installation

By default, the atdd device driver automatically configures all supported IBM tape drives that are attached and powered on when the system starts. You have to decide whether to have the driver automatically configure IBM medium changer devices by default, because some backup applications use their own changer drivers or the native schgr or sctl drivers. In our case, we chose to have the medium changer device automatically configured (claimed).

For detailed information, refer to *IBM Tape Device Drivers Installation and User's Guide*, GC27-2130.

We are installing the atdd driver in the following environment:

- ▶ HP Itanium 2 server with HP-UX operating system release 11i
- ▶ IBM System Storage TS3400 Tape Library with two TS1120 drives

You must have *root* authority to proceed with the installation of the driver. The following installation steps assume that the driver atdd.5.5.0.51.bin has been downloaded to the directory /bavaria/atdd.

1. Copy the installation file to the software depot using the command:

```
swcopy -p -s /bavaria/atdd.5.5.0.51.bin atdd
swcopy -s /bavaria/atdd.5.5.0.51.bin atdd
```

The first command performs a preview copy only. Repeat without the **-p** option to actually execute the copy.

Verify that the Atdd software has been copied in the depot:

```
swlist -d atdd
```

You should see these messages:

```
# atdd 5.5.0.51 GES IBM tape and changer device driver for TotalStorage
  atdd.driver                      IBM Advanced Tape Device Driver
```

2. Use the **swlist** command to view the product's readme file:

```
swlist -d -a readme atdd | more
```

3. To install atdd from the depot to the default root file system, use the command:

```
swinstall -x ask=true atdd
```

The **-ask** option means that you will be prompted whether to allow the system to configure automatically (claim) any medium changer devices. You might have to use an alternative method to configure the medium changer; see the *IBM Tape Device Drivers Installation and User's Guide*, GC27-2130 for information.

When the command runs, you will be prompted with the question,

Would you like to activate the Medium Changer support by ACDD (Y/N)

Enter Y to allow the ACDD module to configure all attached IBM medium changer devices, or answer N to allow the HP native changer driver to configure the devices.

Depending on the version of HP-UX installed, the atdd driver might or might not require an automatic reboot of the system. The atdd package starting with version 3.5.x.x on HP-UX 11i and 1.15.x.x on HP-UX 11.0 is a Dynamically Loadable Kernel Module (DLKM) package without the system reboot requirement. The atdd DLKM package consists of two DLKM modules, atdd (Advanced Tape Device Driver) which controls tape drives and ACDD (Advanced Changer Device Driver) which controls media changers.

Note: If an earlier version of atdd is already installed, the existing version will be replaced. This is true even if the version already installed is more recent than the version being installed.

4. To verify correct installation of the package, use the command:

```
swverify atdd
```

You can see the output in Example 3-31.

Example 3-31 Verifying the correct install with swlist atdd

```
# swverify atdd

===== 03/21/07 14:56:43 MST BEGIN swverify SESSION
(non-interactive) (jobid=patti-0429)

* Session started for user "root@patti".

* Beginning Selection
* Target connection succeeded for "patti:/".
* Software selections:
    atdd.driver,l=/opt/atdd,r=5.5.0.51
* Selection succeeded.

* Beginning Analysis
* Session selections have been saved in the file
  "/home/root/.sw/sessions/swverify.last".
* The analysis phase succeeded for "patti:/".
* Verification succeeded.

NOTE: More information may be found in the agent logfile using the
      command "swjob -a log patti-0429 @ patti:".

===== 03/21/07 14:56:53 MST END swverify SESSION (non-interactive)

(jobid=patti-0429)
```

3.4.2 Verifying the atdd driver installation

To verify the atdd device driver has been installed correctly, use the commands:

- ▶ **ioscan -fnkC tape** shows detected (claimed) tape drives.
- ▶ **ioscan -fnkC autoch** shows detected (claimed) autochangers.
- ▶ **ls -la /dev/rmt** shows the special file name.

The output of **ioscan -fnkC tape** is shown in Example 3-32, and the output of **ioscan -fnkC autoch** is in Example 3-33 on page 135; they were captured from an IBM TS3400 with two FC TS1120 drives.

Example 3-32 shows the device special files (/dev/rmt/0m and /dev/rmt/1m) for each tape drive. Both are connected to the same FC HBA with the location code 1/0/14/1/0.105.

Example 3-32 ioscan -fnkC tape output

ioscan -fnkC tape|pg							
Class	I	H/W Path	Driver	S/W State	H/W Type	Description	
=====							
tape	0	1/0/14/1/0.105.2.255.14.8.0	atdd	CLAIMED	DEVICE	IBM	03592E05
		/dev/rmt/0m			/dev/rmt/c8t8d0BEST	/dev/rmt/s1m	
		/dev/rmt/0mb			/dev/rmt/c8t8d0BESTb	/dev/rmt/s1mb	
		/dev/rmt/0mn			/dev/rmt/c8t8d0BESTn	/dev/rmt/s1mn	
		/dev/rmt/0mnb			/dev/rmt/c8t8d0BESTnb	/dev/rmt/s1mnb	
tape	1	1/0/14/1/0.105.3.255.14.15.0	atdd	CLAIMED	DEVICE	IBM	03592E05
		/dev/rmt/1m			/dev/rmt/c9t15d0BEST	/dev/rmt/s2m	
		/dev/rmt/1mb			/dev/rmt/c9t15d0BESTb	/dev/rmt/s2mb	
		/dev/rmt/1mn			/dev/rmt/c9t15d0BESTn	/dev/rmt/s2mn	
		/dev/rmt/1mnb			/dev/rmt/c9t15d0BESTnb	/dev/rmt/s2mnb	

Example 3-33 shows the FC-connected control paths of the IBM TS3400. There is one control path to each drive except that the LUN is actually 1, as indicated by the last digit. We can also see that the second control path has been identified as an alternate path.

Example 3-33 ioscan -fnkC autoch output

# ioscan -fnkC autoch								
Class	I	H/W Path	Driver	S/W State	H/W Type	Description		
=====								
autoch	1	1/0/14/1/0.105.2.255.14.8.1	acdd	CLAIMED	DEVICE	IBM	3577-TL	
		/dev/rac/c8t8d1			/dev/rmt/3chng			
autoch	0	1/0/14/1/0.105.3.255.14.15.1	acdd	CLAIMED	DEVICE	IBM	3577-TL	
		/dev/rac/c9t15d1			/dev/rmt/1003chng.altpath			

To check if all special files were created, issue command **ls -la /dev/rmt** to display all created special files for tapes, as shown in Example 3-34.

Example 3-34 Verifying atdd driver is correctly installed

```
# ls -la /dev/rmt
crw-rw-rw- 1 bin    bin      115 0x088000 Mar 21 09:39 0m
crw-rw-rw- 1 bin    bin      115 0x088080 Mar 21 09:39 0mb
crw-rw-rw- 1 bin    bin      115 0x088040 Mar 21 09:39 0mn
crw-rw-rw- 1 bin    bin      115 0x0880c0 Mar 21 09:39 0mnb
crw-r--r-- 1 bin    bin      117 0x09f200 Mar 21 09:39 1003chng.altpath
crw-rw-rw- 1 bin    bin      115 0x09f000 Mar 21 09:39 1m
crw-rw-rw- 1 bin    bin      115 0x09f080 Mar 21 09:39 1mb
crw-rw-rw- 1 bin    bin      115 0x09f040 Mar 21 09:39 1mn
crw-rw-rw- 1 bin    bin      115 0x09f0c0 Mar 21 09:39 1mnb
```

crw-r--r--	1 bin	bin	117 0x088200	Mar 21 09:39	3chng
crw-rw-rw-	1 bin	bin	117 0xfffffc	Mar 21 09:39	acdd.cfg
crw-rw-rw-	1 bin	bin	117 0xfffffa	Mar 21 09:39	acdd.ctrl
crw-rw-rw-	1 bin	bin	117 0xfffffd	Mar 21 09:39	acdd.dbg
crw-rw-rw-	1 bin	bin	115 0xfffffc	Mar 21 09:39	atdd.cfg
crw-rw-rw-	1 bin	bin	115 0xfffffa	Mar 21 09:39	atdd.ctrl
crw-rw-rw-	1 bin	bin	115 0xfffffd	Mar 21 09:39	atdd.dbg
crw-rw-rw-	1 bin	bin	115 0x088000	Mar 21 09:39	c8t8d0BEST
crw-rw-rw-	1 bin	bin	115 0x088080	Mar 21 09:39	c8t8d0BESTb
crw-rw-rw-	1 bin	bin	115 0x088040	Mar 21 09:39	c8t8d0BESTn
crw-rw-rw-	1 bin	bin	115 0x0880c0	Mar 21 09:39	c8t8d0BESTnb
crw-rw-rw-	1 bin	bin	115 0x09f000	Mar 21 09:39	c9t15d0BEST
crw-rw-rw-	1 bin	bin	115 0x09f080	Mar 21 09:39	c9t15d0BESTb
crw-rw-rw-	1 bin	bin	115 0x09f040	Mar 21 09:39	c9t15d0BESTn
crw-rw-rw-	1 bin	bin	115 0x09f0c0	Mar 21 09:39	c9t15d0BESTnb

The output shows the special files:

0m This is one of the device special file names used for the first 3592E05 tape drive.

1m This is one of the device special file names used for the second 3592E05 tape drive.

3chng This is the device special file name for the TS3400 medium changer

1003chng.. This is the device special file name for the second path TS3400 medium changer identified as an alternate path

See Table 3-1 on page 97 to interpret all the device names.

You can now use the **tapeutil** utility to test the library. If you downloaded the tapeutil installation file as described in 3.4, “Installing IBM tape device driver for HP-UX” on page 132, install the package with the following commands:

```
swcopy /bavaria/tapeutil.hpux.4.3.3.0.bin tapeutil
swinstall tapeutil
```

Then go to 3.5, “Testing the library with tapeutil” on page 141 to learn how to use **tapeutil**.

Open the device, issue inquiry commands **read** and **write**, and move media across the library to check the driver functionality.

3.4.3 Setting up control path failover on HP-UX

The HP-UX atdd device driver alternate pathing support will configure multiple physical control paths to the same logical library within the device driver and provide automatic failover to an alternate control path when a permanent error occurs on one path. This is transparent to the running application.

Note: This function is supported only on IBM LTO2, 3, and 4 drives with native Fibre Channel and IBM TS1120 tape drives.

For example, consider a simple multipath connection that consists of two Host Bus Adapters (HBAs) that are connected to a library with two drive control ports enabled as in Figure 3-8 on page 113. The first HBA is connected to the first control port drive (Drive 1 in Figure 3-8 on page 113), and the second HBA is connected to the second control port drive (Drive 4 in Figure 3-8 on page 113). This connection provides two physical control paths to the same library for redundancy if one path from an HBA to the library fails.

When the host bus adapter device drivers are loaded into the running system, each HBA detects a control port to the same library, and two logical devices can be created (for example, /dev/rmt/0chnng and /dev/rmt/1chnng) by the atdd driver or the atdd_claim script.

Each logical device is a physical path to the same library. An application can open and use only one logical device at a time, either 0chnng or 1chnng, because they represent the same physical device. Without the atdd alternate pathing support, if an application opens 0chnng and a permanent path error occurs (because of an HBA, cable, or drive control port failure, for example), the application fails. It is possible to initiate manual failover by restarting the application on the alternate logical device (1chnng), but the failing transaction has to be restarted from the beginning. When the alternate pathing support is enabled, the device driver configures them internally as a single device with multiple paths. The driver also renames the alternate paths from 1chnng to 1chnng.altpath.

We recommend that applications open the primary path (0chnng). If an application opens 0chnng and a permanent path error occurs, the device driver initiates failover error recovery automatically on the alternate path (1chnng.altpath). If successful, the current operation continues on the alternate path without interrupting the application.

Important: The library path failover feature code 1682 must be installed and enabled on the library (IBM TS3200, TS3310 and TS3500 Lx3 frames) prior to enabling the alternate pathing support in the HP-UX atdd device drive. In addition, you have to enable the control path for additional drives on the library using either the library operator panel or the Tape Storage Specialist. To see how to do this, go to “Enabling additional control paths” on page 107.

The TS3400, and TS3500 with TS1120 tapes have alternate path as a standard feature, and do not need this feature code. For TS3500 with Lx2 frames, the necessary feature code is 1680.

Enabling/disabling alternate control path support

Alternate pathing support is not enabled automatically when the device driver is installed. The atdd driver provides a kernel parameter alternate_pathing for you to enable the library control path failover. To enable the failover support in the atdd driver, you need to perform the following steps after installing the driver (See Example 3-35). This output is based on an IBM System Storage TS3400 Tape Library with two IBM TotalStorage 3592E05 Tape Drives.

1. Set the alternate_pathing parameter:

```
# /opt/atdd/bin/atdd_failover -a 1
```

2. Initiate CPF for the devices:

```
# /opt/atdd/bin/atdd_claim
```

Example 3-35 Enabling alternate pathing in atdd driver

```
# /opt/atdd/bin/atdd_failover -a 1
# /opt/atdd/bin/atdd_claim
tape      0  1/0/14/1/0.105.2.255.14.8.0  atdd      CLAIMED   DEVICE    IBM
03592E05
autoch    1  1/0/14/1/0.105.2.255.14.8.1  acdd      CLAIMED   DEVICE    IBM
3577-TL
tape      1  1/0/14/1/0.105.3.255.14.15.0  atdd      CLAIMED   DEVICE    IBM
03592E05
autoch    0  1/0/14/1/0.105.3.255.14.15.1  acdd      CLAIMED   DEVICE    IBM
3577-TL
Send 1234567890123456; 0987654321123456 to driver
Checking paths /dev/rmt/3chnng /dev/rmt/??chnng /dev/rmt/???chnng /dev/rmt/1003chnng
```


Checking paths /dev/rmt/0mn /dev/rmt/1mn /dev/rmt/[0-9]?mn /dev/rmt/[0-9]??mn
/dev/rmt/[0-9]???mn

You can check if the driver has recognized multiple control paths for your library by running:
ioscan -funC autoch

If you see an “.altpath” next to one of the special files as in Example 3-36, then you have successfully enabled the control path failover feature for your library. When atdd is loaded into the kernel, the first logical medium changer device that it sees in the system will be the primary path for that medium changer. The other logical medium changers that atdd attached for the same medium changer will be configured as alternate paths. The device driver supports up to 16 physical paths for a single device.

Example 3-36 Viewing the primary and alternate paths

# ioscan -funC autoch								
Class	I	H/W Path	Driver	S/W State	H/W Type	Description		
=====								
autoch	1	1/0/14/1/0.105.2.255.14.8.1	acdd	CLAIMED	DEVICE	IBM 3577-TL		
		/dev/rac/c8t8d1	/dev/rmt/3chngr					
autoch	0	1/0/14/1/0.105.3.255.14.15.1	acdd	CLAIMED	DEVICE	IBM 3577-TL		
		/dev/rac/c9t15d1	/dev/rmt/1003chngr.altpath					

In addition to using the **ioscan** command to display the primary and alternate path configuration for all devices, you can also display this information for any device by running the following command:

tapeutil -f /dev/rmt/Xchngr -o phs -v

In this command, Xchngr is the logical name of any device. This command shows specific information for the primary path and all alternate paths, such as the logical name of the device, the attached host bus adapter, the channel ID, the target ID, the logical unit number under the target, the current enabled status, and how many paths are configured for the device. See Example 3-37 on page 138.

Example 3-37 Alternate method to view primary and alternate paths

```
# tapeutil -f /dev/rmt/1chngr -o phs -v
Querying device paths...

Primary Path Number 1
  SCSI Channel..... 8
  Target ID..... 8
  Logical Unit..... 1
  Path Enabled..... Yes
  Path Manually Disabled..... No

Alternate Path Number 2
  Logical Device..... 1003chngr
  Host Bus Adapter.....
  SCSI Channel..... 9
  Target ID..... 15
  Logical Unit..... 1
  Path Enabled..... Yes
  Path Manually Disabled..... No

Total paths configured..... 2
```

After the alternate pathing support is enabled, it remains set until atdd_claim is run with the alternate_pathing driver parameter set to *off*. The alternate pathing setting is retained even if the system is rebooted. If you want to turn off the control path failover feature in the atdd driver, perform the following steps:

1. Set the alternate_pathing parameter:

```
# /opt/atdd/bin/atdd_failover -a 0
```
2. Initiate CPF for the devices:

```
# /opt/atdd/bin/atdd_claim
```

Disabling and enabling primary and alternate paths

When you load the atdd device driver with the alternate_pathing parameter set at *on*, by default, all the available paths for a physical device are enabled. If, for maintenance reasons, you need to disable a path and do not want to fail over to this path, you can run the following commands, where the *-f* flag is for the primary path and the *-p* flag is for the path that you want to enable or disable. Example 3-38 shows the output for disabling and enabling the alternate path.

This command will disable the path:

```
# tapeutil -f /dev/Xchngr -o dis -p /dev/Xchngr -v
```

To enable a path from a disabled state, run the following command:

```
# tapeutil -f /dev/Xchngr -o ena -p /dev/Xchngr -v
```

Example 3-38 Output for disabling and enabling the alternate path

```
*****
*Disabling alternate path*
*****

# tapeutil -f /dev/rmt/3chngr -o dis -p /dev/rmt/1003chngr.altpath -v

SCSI path disabled.

*****
*Verifying alternate path has been disabled*
*****

# tapeutil -f /dev/rmt/3chngr -o phs -v

Querying device paths...

Primary Path Number 1
  SCSI Channel..... 8
  Target ID..... 8
  Logical Unit..... 1
  Path Enabled..... Yes
  Path Manually Disabled..... No

Alternate Path Number 2
  Logical Device..... 1003chngr
  Host Bus Adapter.....
  SCSI Channel..... 9
  Target ID..... 15
  Logical Unit..... 1
  Path Enabled..... No
  Path Manually Disabled..... Yes
```

```

Total paths configured..... 2

*****
*Enabling alternate path *
*****

# tapeutil -f /dev/rmt/3chngr -o ena -p /dev/rmt/1003chngr.altpath -v

SCSI path enabled.

*****
*Verifying alternate path has been enabled*
*****

# tapeutil -f /dev/rmt/1chngr -o phs -v

Querying device paths...

Primary Path Number 1
  SCSI Channel..... 8
  Target ID..... 8
  Logical Unit..... 1
  Path Enabled..... Yes
  Path Manually Disabled..... No

Alternate Path Number 2
  Logical Device..... 1003chngr
  Host Bus Adapter.....
  SCSI Channel..... 9
  Target ID..... 15
  Logical Unit..... 1
  Path Enabled..... Yes
  Path Manually Disabled..... No

Total paths configured..... 2

```

For information about how to set up Data Path Failover for HP-UX, refer to the IBM Tape Device Drivers Installation and User's Guide (GC27-2130), which can be downloaded from:

ftp://ftp.software.ibm.com/storage/devdrv/Doc/IBM_Tape_Driver_IUG.pdf

3.4.4 Configuring tape devices

To change the default configuration parameters for the tape devices, such as compression, block size, and buffering, use the following procedure.

You can examine the current configuration using the **atdd_cfg** program located in **/opt/atdd/bin** directory. Every tape device is associated with a specific instance. To get the instances used in your environment, you first need to know the H/W Path (SCSI path) to the device. Use the H/W Path column of the **ioscan** command as in shown in Example 3-39 to determine the SCSI path of your device.

Example 3-39 ioscan output

tape	0	1/0/14/1/0.105.2.255.14.8.0	atdd	CLAIMED	DEVICE IBM	03592E05
tape	1	1/0/14/1/0.105.3.255.14.15.0	atdd	CLAIMED	DEVICE IBM	03592E05
autoch	1	1/0/14/1/0.105.2.255.14.8.1	acdd	CLAIMED	DEVICE IBM	3577-TL
autoch	0	1/0/14/1/0.105.3.255.14.15.1	acdd	CLAIMED	DEVICE IBM	3577-TL

In our case, the two drives are configured at addresses 2.255.14.8 and 3.255.14.15. Issue the command shown in Example 3-40.

Example 3-40 atdd_cfg command to get the instance number

```
/opt/atdd/bin/atdd_cfg -g INSTANCE 1/0/14/1/0.105.2.255.14.8.0
INSTANCE: 1
/opt/atdd/bin/atdd_cfg -g INSTANCE 1/0/14/1/0.105.3.255.14.15.0
INSTANCE: 2
```

Our two devices correspond to instance number 1 and 2. Having the instance number of the device, you can query the device parameters (Example 3-41).

Example 3-41 Querying the device parameters

```
/opt/atdd/bin/atdd_cfg -g SILI <instance>
/opt/atdd/bin/atdd_cfg -g DEVICES
/opt/atdd/bin/atdd_cfg -g BLOCKSIZE <instance>
/opt/atdd/bin/atdd_cfg -g COMPRESSION <instance>
/opt/atdd/bin/atdd_cfg -g BUFFERING <instance>
/opt/atdd/bin/atdd_cfg -g IMMEDIATE <instance>
/opt/atdd/bin/atdd_cfg -g TRAILER <instance>
/opt/atdd/bin/atdd_cfg -g ERRNO_LEOT <instance>
```

If needed, you can change the device parameters as in Example 3-42.

Example 3-42 Changing the device parameters

```
/opt/atdd/bin/atdd_cfg -s SILI <sili> <instance>
/opt/atdd/bin/atdd_cfg -s BLOCKSIZE <block size> <instance>
/opt/atdd/bin/atdd_cfg -s COMPRESSION <compression> <instance>
/opt/atdd/bin/atdd_cfg -s BUFFERING <buffering> <instance>
/opt/atdd/bin/atdd_cfg -s IMMEDIATE <immediate> <instance>
/opt/atdd/bin/atdd_cfg -s TRAILER <trailer> <instance>
/opt/atdd/bin/atdd_cfg -s ERRNO_LEOT <errno_leot> <instance>
```

For example, to change COMPRESSION to 1 (On) for the device with instance 1:

```
/opt/atdd/bin/atdd_cfg -s COMPRESSION 1 1
```

Any changes made here will be lost when the server is rebooted. To make the changes permanent, add entries in the Configuring Parameters section of the file `/sbin/init.d/atdd`, as shown in Example 3-43.

Example 3-43 Configuring Parameters section of atdd configuration file

```
# Configuring Parameters Section
#
# modify the configuration parameters here, for example:
# /opt/atdd/bin/atdd_cfg -s COMPRESSION 0 2
```

3.5 Testing the library with tapeutil

The **tapeutil** tape utility is installed with the IBM tape device drivers on Solaris and AIX, or as a separate package for HP-UX. This utility exercises or tests the functions of the tape device and the device driver. It also performs basic tape and medium changer operations. The tape utility program provides two user interfaces: the interactive menu and UNIX command line.

Start the tapeutil interactive menu by typing **tapeutil** without any parameters. On AIX, this displays the menu shown in Figure 3-12. For Solaris and HP-UX, it has a different format, but the functionality is the same.

```

General Commands:
  1. Open a Device
  2. Close a Device
  3. Device Info
  4. Tape Drive Service Aids
  5. Inquiry
  6. Test Unit Ready
  7. Reserve Device
  8. Request Sense
  9. Log Sense Page
 10. Mode Sense Page
 11. Release Device
  Q. Quit Program

Medium Changer Commands:
 12. Element Information
 13. Position To Element
 14. Element Inventory
 15. Exchange Medium
 16. Move Medium
 17. Load/Unload Medium
 18. Initialize Element Status
 19. Prevent/Allow Medium Removal

Tape Commands:
 20. Query/Set Parameters
 21. Prevent/Allow Medium Removal
 22. Rewind
 23. Erase Gap
 24. Forward Space Filemarks
 25. Forward Space Records
 26. Space to End of Data
 27. Log Sense
 28. Display Message
 29. Synchronize Buffers
 30. Read and Write Tests
 31. Unload/Load Tape
 32. Erase
 33. Write Filemarks
 34. Backward Space Filemarks
 35. Backward Space Records
 36. Query/Set Tape Position
 37. Read or Write Files
 38. Get Drive Encryption Settings
 39. Report Density Support
 40. Test Encryption Key Path/Setup

Enter Selection:

```

Figure 3-12 *Tapeutil main menu - AIX*

A list of general subcommands, medium changer subcommands, and tape subcommands are displayed. You must open a device before using these commands and operations. To open a device:

1. Select 1: **Open a Device** from General Commands.
2. Enter the name of the device special file. Use any special file that exists for the device using your OS conventions, for example, `/dev/rmt0`, `/dev/rmt0.1`, `/dev/rmt1.smc`, or `/dev/smc0`. See Table 3-1 on page 97 for the device special file names.
3. Enter the Read/Write, Read Only, Write Only, or Append mode to open a device. These modes apply to the tape devices only, not for the medium changer.

After you open a device, select a command by using the appropriate number for the command from the menu. Some commands require additional information after they are selected from the menu.

You can also use the **tapeutil** command line interface by entering commands in the format:

```
tapeutil -f DeviceName Subcommand [Subcommand ...]
```

We give more examples of using **tapeutil** in “Verifying proper device attachment with tapeutil” on page 256. Detailed **tapeutil** reference information is in the manual *IBM Tape Device Drivers Installation and User's Guide*, GC27-2130.

3.6 Creating a library device table

Operating system device names might not necessarily reflect the same order as the devices are physically installed in the library. Therefore, check your drive configuration carefully. We recommend creating a table as in Table 3-3.

Table 3-3 Library device table

Device name	WWN/serial number	Tape drive in the library	SCSI element address
rmt0	5005076300410801	drive 1	257
rmt1	5005076300410802	drive 2	258
rmt2	5005076300410803	drive 3	259

Here are some ways to create this table:

- ▶ FC-attached drives in AIX using WWN match.
If you have FC-attached tape drives, you can use **lsattr -El rmtx** to read the WWN.
- ▶ Using serial number match for AIX.
The serial number of the tape drive that a particular device file represents can be checked by using the command **lscfg -v1 rmtx**.
- ▶ Using **tape1ist** for Solaris. Your output can vary, but will contain this information.

Example 3-44 Tape entries in the server using *tape1ist*

Inst #	Special File	Device	Serial No	TGT/LUN	Ucode	World Wide NN	World Wide PN
Device	Physical Path			Path	Type		
3682	/dev/rmt/10st	03592J1A	000001300280	8/0	04B8	5005076300010811	5005076300410811
	/devices/pci@1f,4000/fibre-channel@2/IBMtape@8,0:st			N/A			
3683	/dev/rmt/13smc	03584L22	000001310008	8/1	404e	N/A	N/A
	/devices/pci@1f,4000/fibre-channel@2/IBMtape@8,1:smc			N/A			
3715	/dev/rmt/12st	03592J1A	000001300178	9/0	04B8	5005076300010812	5005076300410812
	/devices/pci@1f,4000/fibre-channel@2/IBMtape@9,0:st			N/A			

Example 3-44 shows that device special file `/dev/rmt/10st` is the 3592J1A tape drive with assigned SCSI target ID of 8 and LUN of 0, serial number of 1300280, and WWNN of 5005076300010811.

- ▶ Using serial number match in AIX, Solaris, and HP-UX platforms.
List the serial numbers of every created tape drive file name. Use **tapeutil** and **inquiry** option with page x80 as seen in Example 3-46, or use the command form directly as in Example 3-45:

```
tapeutil -f device_name inqpage 80
```

Example 3-45 *tapeutil* - reading serial numbers, command line inquiry

```
tapeutil -f /dev/rmt2 inqpage 80
Issuing inquiry for page 0x80...
```

Inquiry Page 0x80, Length 16

```
0 1 2 3 4 5 6 7 8 9 A B C D E F 0123456789ABCDEF
0000 - 0180 000C 3030 3030 3031 3336 3532 3538 [...000001365258]
```

For *device_name*, use the special file name from your OS, such as:

- */dev/rmt0* - for AIX
- */dev/rmt/0st* - for Sun
- */dev/rmt/0m* - for HP

Example 3-46 tapeutil - reading serial number with inquiry

Enter Selection for */dev/rmt2*: 5

Enter page code in hex or <enter> for standard inquiry: 80
Issuing inquiry for page 0x80...

Inquiry Page 0x80, Length 16

```
      0 1 2 3 4 5 6 7 8 9 A B C D E F 0123456789ABCDEF
0000 - 0180 000C 3030 3030 3031 3336 3532 3538 [...000001365258]
```

Compare this serial number to the number written on the drives in the library. You can also determine the serial by correlating the SCSI element address on the medium changer (Example 3-47) using the following commands:

For AIX and Solaris:

```
tapeutil -f device_name devids
```

For HP-UX:

```
tapeutil -f device_name -o dvc
```

For *device_name*, use the medium changer special file name from your OS, such as:

- */dev/smc0* - for AIX
- */dev/rmt/0smc*- for Sun
- */dev/rmt/0chn*g - for HP

Example 3-47 tapeutil - reading serial number with inquiry

```
tapeutil -f /dev/smc2 devids
Reading element device ids...
```

Drive Address 256

```
Drive State ..... Normal
ASC/ASCQ ..... 0000
Media Present ..... Yes
Robot Access Allowed ..... No
Source Element Address Valid ... No
Media Inverted ..... No
Same Bus as Medium Changer ..... Yes
SCSI Bus Address Vaild ..... No
Logical Unit Number Valid ..... No
Device ID ..... IBM      03592E05      000001365258
```

Using this output, we can complete Table 3-4.

Table 3-4 Library device table

Device name	Serial number	Tape drive in the library	SCSI element address
rmt2	000001365258	drive 2	258

3.7 Fibre Channel HBA driver implementation comments

Previously direct SCSI attachment was a very common tape library attachment. More and more, Open Systems Tape libraries and drives are connected on a SAN using direct Fibre Channel attach. Also recently a new interface, the Serially Attached SCSI (SAS), has been introduced with tape libraries. For more information about SAS, see the *IBM System Storage Tape Library Guide for Open Systems*, SG24-5946.

The tape device driver installation process (already described) is the same for the different attachments. You need a Fibre Channel Host Bus Adapter (HBA) on the host server to connect it to a SAN fabric or with a point-to-point connection.

The FC HBA must be supported for the IBM tape model being connected. Check these Web sites to verify that your HBA is supported, selecting the appropriate server:

<http://www-01.ibm.com/systems/support/storage/config/hba/index.wss>

Once you have verified your HBA is supported, check the driver level and firmware/fcode, and if necessary, download and install the latest driver and firmware. There is a multitude of supported HBA devices, and you should follow the implementation documentation for the relevant HBA.

3.7.1 IBM System p FC HBA installation

The AIX CDs provided with your System p hosts include the necessary packages to support the Fibre Channel HBA. Check in the documentation to determine the filesets that are required, and install them if they are not present.

You should also make sure the FC device filesets shown in Table 3-5 to enable support of FC-attached tape drives, are installed.

Table 3-5 AIX software for FC devices

Fileset name	Function
devices.common.IBM.fc.rte	Common IBM FC Software
devices.fcp.tape.rte	FC SCSI Tape Device Software

Once the base filesets are installed, check for any recent fixes (PTFs) to the filesets at:

<http://www14.software.ibm.com/Webapp/set2/sas/f/genunix3/aixfixes.html>

Select your AIX version under Specific fixes, then enter the fileset name for your adapter (for example, devices.pci.df1080f9*) and click **Search**. Download and install any required fixes. Assuming your HBAs are installed, they should be visible as shown in Example 3-48. In this example, there is one Fibre HBA.

Example 3-48 Displaying AIX FC adapters

```
# lsdev -C|grep fc
fcnet0    Defined  1V-08-02    Fibre Channel Network Protocol Device
fcs0      Available 1V-08      FC Adapter
fcs0i0    Available 1V-08-01    FC SCSI I/O Controller Protocol Device
```

Next, check and download the microcode levels for your AIX system HBA at the following link:

<http://www14.software.ibm.com/Webapp/set2/firmware/gjsn>

Once you have identified the feature code and the related adapter to use, check if your adapter has the latest microcode level. There are two methods to check the microcode level of the installed HBA.

- The first method uses the **lscfg** command; it will return much of the information in the adapter VPD. The Z9 field will have the firmware level. This method will also display the FRU part number and Assembly part number. To view the microcode installed for your HBA, use the command:

```
lscfg -vl fcs0
```

where `fcs0` is the adapter device name. Example 3-49 shows sample output.

Example 3-49 Output of lscfg command on AIX HBA

```
# lscfg -vl fcs0
fcs0          U0.1-P2-I1/Q1  FC Adapter

Part Number.....00P4295
EC Level.....A
Serial Number.....1F411092C9
Manufacturer.....001F
Feature Code/Marketing ID...5704
FRU Number.....00P4297
Device Specific.(ZM).....3
Network Address.....10000000C93F2243
ROS Level and ID.....02E01035
Device Specific.(Z0).....2003806D
Device Specific.(Z1).....00000000
Device Specific.(Z2).....00000000
Device Specific.(Z3).....03000909
Device Specific.(Z4).....FF601032
Device Specific.(Z5).....02E01035
Device Specific.(Z6).....06631035
Device Specific.(Z7).....07631035
Device Specific.(Z8).....20000000C93F2243
Device Specific.(Z9).....HS1.00X5
Device Specific.(ZA).....H1D1.00X5
Device Specific.(ZB).....H2D1.00X5
Device Specific.(YL).....U0.1-P2-I1/Q1
```

In this example, the HBA microcode level is 1.00X5 as shown in the Z9 field.

- The second method uses the **lsmcode** command, which returns the extension of the firmware image file that is installed.

```
lsmcode -d fcs0
```

where `fcs0` is the adapter device name. Example 3-50 shows sample output.

Example 3-50 Output of lsmcode command on AIX HBA

```
DISPLAY MICROCODE LEVEL
fcs0    FC Adapter
```

```
The current microcode level for fcs0 is 100305.
```

```
Use Enter to continue.
```

In this example, 100305 is the extension of the firmware image (df1080f9.100305) that was last loaded on the adapter.

If the adapter microcode is not at the level as listed on the Web site, download the file from the Web site with either the AIX (.bin file) or RPM format package, and follow the installation instructions.

HBA configuration

The HBA does not need to be configured in most cases. Nevertheless, we recommend that you verify that your HBA connection is set to point-to-point (such as switched fabric) mode.

To check if this parameter is set correctly, use the command:

```
lsattr -El adapter_name
```

The output is in Example 3-51. The init_link parameter shows the connection type. In our example it is a1, which means it is set to FC_AL.

Example 3-51 HBA parameters

# lsattr -El fcs0			
bus_intr_lvl	89	Bus interrupt level	False
bus_io_addr	0x4ec00	Bus I/O address	False
bus_mem_addr	0xd0040000	Bus memory address	False
init_link	a1	INIT Link flags	True
intr_priority	3	Interrupt priority	False
lg_term_dma	0x800000	Long term DMA	True
max_xfer_size	0x100000	Maximum Transfer Size	True
num_cmd_elems	200	Maximum number of COMMANDS to queue to the adapter	True
pref_alpa	0x1	Preferred AL_PA	True
sw_fc_class	2	FC Class for Fabric	True

To change this parameter, use the command:

```
chdev -l adapter_name -a init_link=pt2pt -P
```

This is shown in Example 3-52.

Example 3-52 Change connection type

# chdev -l fcs0 -a init_link=pt2pt -P	
fcs1	changed

The system must be rebooted for this change to take effect.

You can also change this using **SMIT Devices → FC Adapter → FC Adapter → Change/Show Characteristics of a FC Adapter**. Select the adapter to be changed (such as fcs0). Change the INIT Link flags value from a1 to pt2pt if necessary, as shown in Example 3-54. Also, set Apply change to DATABASE only to yes.

Example 3-53 SMIT change connection type

Change / Show Characteristics of a FC Adapter		
Type or select values in entry fields. Press Enter AFTER making all desired changes.		
FC Adapter	[Entry Fields]	
Description	fcs0	
Status	FC Adapter	
Location	Available	
Maximum number of COMMANDS to queue to the adapter	1V-08	
	[200]	+#

Maximum Transfer Size	[0x100000]	+
Preferred AL_PA	[0x1]	+
INIT Link flags	[pt2pt]	+
Apply change to DATABASE only	yes	+

After rebooting, re-issue **lsattr** to check for the correct setting, as shown in Example 3-54.

Example 3-54 Connection type is Point to Point

# lsattr -El fcs0			
bus_intr_lvl	89	Bus interrupt level	False
bus_io_addr	0x4ec00	Bus I/O address	False
bus_mem_addr	0xd0040000	Bus memory address	False
init_link	pt2pt	INIT Link flags	True
intr_priority	3	Interrupt priority	False
lg_term_dma	0x800000	Long term DMA	True
max_xfer_size	0x100000	Maximum Transfer Size	True
num_cmd_elems	200	Maximum number of COMMANDS to queue to the adapter	True
pref_alpa	0x1	Preferred AL_PA	True
sw_fc_class	2	FC Class for Fabric	True

3.7.2 Solaris Fibre Channel HBA driver installation

For Solaris servers, you need a supported HBA adapter as listed in the HBA matrix, and as described in 3.7, “Fibre Channel HBA driver implementation comments” on page 145.

We recommend checking the IBMtape.README file for the latest configuration settings. The Readme file can be found at:

<ftp://ftp.software.ibm.com/storage/devdrv/Solaris/IBMtape.README>

There are several HBA adapters supported for Open Systems Tape libraries and tape drives. Select the appropriate device and operating system environment, and follow the driver installation and update documentation.

To download the driver, or to check if there is a later update available, go to this Web site:

<http://www-01.ibm.com/systems/support/storage/config/ssic/index.jsp>

This indicates tested and verified microcode levels, and links to the appropriate vendor sites. If necessary, download the installation file and the readme instructions. Be sure to read the instructions file before continuing with the adapter driver installation or update.

3.8 Updating library and drive firmware

It is a good habit to check periodically for available updates on the IBM Web site; newer code can provide additional support functions or fix problems. To upgrade the installed microcode level of the library, refer to the Operator Guide for your library or drive. In our example, we describe the procedures to check and update the library and drive microcode for various IBM tape libraries.

3.8.1 Using My Support to stay up-to-date with your drivers and firmware

My Support provides e-mail notification when firmware is updated and becomes available for download and installation.

To register for My Support:

1. Visit the Web at:

<http://www.ibm.com/support>

2. Under Personalized support, click **My support**.

3. If this is your first access, under Sign in, click **Register**; otherwise, go to step 5.

4. Fill in the information required for registration. Items with an asterisk (*) are required fields.

5. Enter your user ID and password and click **Submit** to access My Support.

6. Enter the information required for your **My personalized page**.

a. Select **Add products**.

b. From the **Products** drop-down, select **Storage**.

c. In the next drop-down, select **Computer Storage**.

d. In the next drop-down, select **Computer Tape Storage**.

e. In the next drop-down, select **Computer Tape Libraries**.

f. Click the checkboxes for the appropriate products.

g. Click **Add products** at the bottom of the page.

h. Review your profile for correctness.

i. Under **Subscribe to email**, select **Storage** and then check the boxes labeled **Flashes and Downloads** and **Drivers**, and click **Update**.

j. Under Welcome, (*your name*), click **Sign out** to end your session.

You will be notified whenever there is new firmware available for the products you selected during registration.

3.8.2 Check the installed firmware

To check for microcode updates, use one of the following links:

<http://www-1.ibm.com/servers/storage/support/lto/>
<ftp://ftp.software.ibm.com/storage/>

Here you can find the latest microcode releases for the LTO library and drives. Download the required microcode to a disk file on your system, and then you can later upload to the tape library.

How to update the firmware

For the library microcode, use the compressed file appcode.zip for Windows systems, or appcode.tar for UNIX systems. It contains the Vn_n_n.lif file that is the microcode image file to upload in the library. For the drive code, download the latest .ro file.

You can use several methods to update the firmware. However we recommend using one of these two:

- ▶ IBM Tape Library Specialist
- ▶ ITDT Tool for tape drive update

Use the following Web site to find and download necessary firmware updates:

<http://www-1.ibm.com/servers/storage/support/lto/>

Select the appropriate tape library model, select download, and firmware.

3.8.3 Upgrading the drive firmware using ITDT

IBM Total Storage Tape Diagnostic Tool - ITDT offers multiple functional capabilities that simplify the task of updating tape drive firmware. It is available for most major platforms and requires no special device drivers. In addition to the executable file, a README file is provided which describes the features and capabilities of the ITDT tool, provides downloading instructions, and gives detailed information on how to use the tool. Look up the Web page:

http://www-1.ibm.com/support/docview.wss?rs=1139&context=STCXRL&dc=D400&uid=ssg1S4000338&oc=en_US&cs=utf-8&lang=en

It is important that you read the README file first, as it contains all of the instructions needed to run the program.

- Update microcode to all supported IBM LTO Tape Drives and Tape Library products (non-IBM devices cannot be selected), as well as IBM 3592/TS1120 Tape Drives.
- Upload IBM LTO and 3592/TS1120 Tape Drive and Tape Library dump files used by support personnel to help troubleshoot a problem

The README file will provide all necessary operational procedures for this tool.

3.8.4 Updating firmware using the IBM Tape Library Specialist

The Tape Library Specialist will for most libraries have facilities to display firmware level, and to update both library and drives. Remember that the library must be offline to update any firmware. Similarly, the drive that is being updated will be taken offline, however, the library can still work with the other drive(s).

You must have downloaded the firmware updates to a file on your computer, and can then use the **Browse** button to identify the file. This procedure will be similar for most libraries.

Log in to the Tape Library Specialist and identify the present installed firmware level. This will normally be shown in the Home menu, or by selecting the *Service Library* and *Update Firmware* menu. For the TS3500 look for Library or Drive VPD (Vital Product Data).

IBM TS3100/TS3200

From the TS3100/TS3200 Home menu, select the functions you want to apply. To update firmware, select **Service Library** → **Upgrade Firmware**, to get this screen, Figure 3-13. You can then upload the firmware to the library from a file.

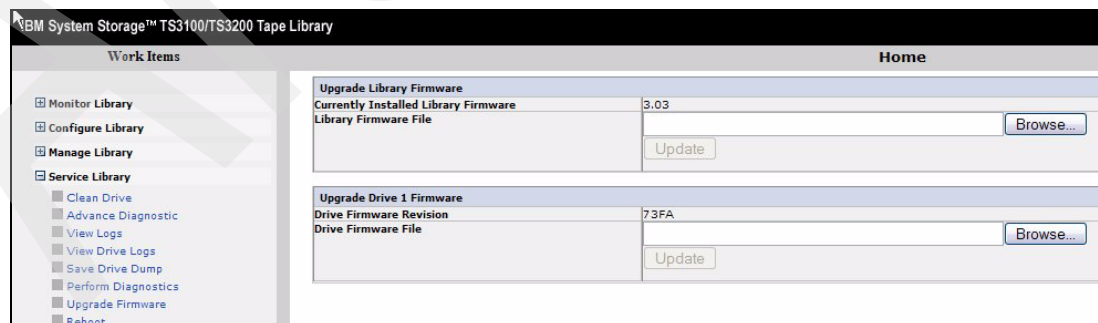


Figure 3-13 Firmware update screen

You can download the latest firmware from one of the following sites:

<ftp://index.storsys.ibm.com/TS3200/>

<http://www-304.ibm.com/jct01004c/systems/support/supportsite.wss/allproducts?brandind=5000034&taskind=1>

IBM TS3310

To look at or update the firmware levels for TS3310, you have separate selections for library and drives. Select **Service Library**, and then for the drives **View/Update Drive Firmware levels**, see the example in Figure 3-14 on page 151. In this example we see there is a warning about different firmware levels already installed.

To update the firmware level of the library, there is a similar selection as seen in the selections for **Service Library**.

IBM System Storage™ TS3310 Tape Library

Library Tasks

- IBM Total Storage
- Welcome Page
- Monitor System
- Manage Cartridges
- Manage Drives
- Manage Library
- Manage Access
- Service Library
 - Operator Interventions
 - Capture Library Log
 - Capture Drive Log
 - View/Update Library Firmware Level
 - View/Update Drive Firmware Levels
 - Reset Drive
 - Shutdown/Restart Library

Logout Help

Drives at Different Firmware Levels

Drives running at different firmware levels may impact the library performance. It is recommended that the drives be updated to the same firmware level.

[Close Message](#)

View/Update Drive Firmware Levels

Refresh Last refresh: Friday, April 6, 2007 8:29:40 MST

Select a Drive Media and Interface Type

LTO-4, Fibre

Drives:

Select	Location	Serial Number	Logical Library	Type	Interface	Element Address	Firmware Level	Status
<input type="checkbox"/> *	0,1	1300000975	lib_3	LTO-4	Fibre	256	71G0	Online
<input type="checkbox"/>	0,2	1300000678	lib_3	LTO-4	Fibre	257	73FA	Online
Total: 2		Filtered: 0		Displayed: 2		Selected: 0		

*Cannot be selected for firmware update, because a cartridge is at the drive.

Figure 3-14 IBM TS3310 Update Firmware level

IBM TS3400

From the TS3400 main screen, to look at or update the firmware levels for either the library or the drives, select **Service Library** → **Firmware Update**, see the example in Figure 3-15.

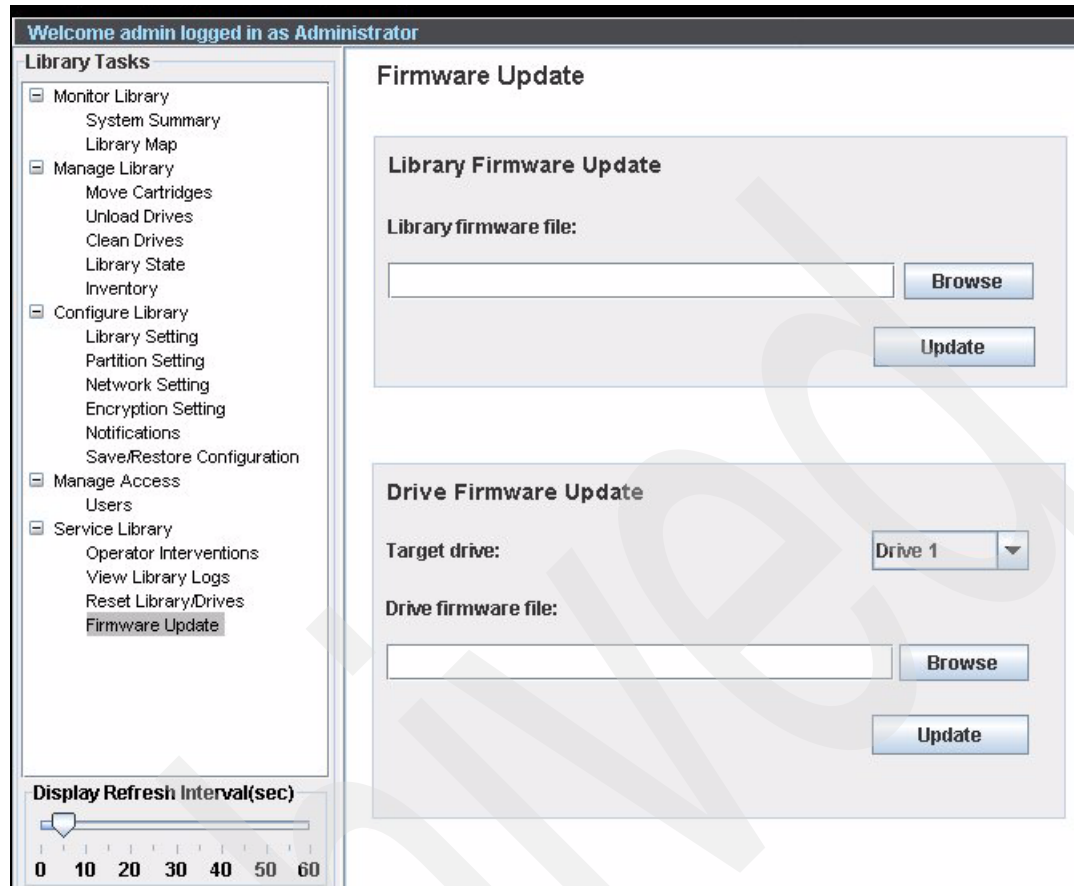


Figure 3-15 IBM TS3400 Firmware Update screen

Use the **Browse** button or enter the firmware update file name, and then the **Update** button to execute the update process. A warning message pops up asking for confirmation. Click **Yes** to start the update. The Specialist does not show any status screen until the update is complete.

For a tape drive update, the library will activate the new firmware automatically. A library reboot is initiated after the library firmware update is finished.

3.8.5 Updating library or drive firmware for IBM TS3500

The IBM TS3500 had additional support for the library and drive firmware update. From the Tape Library Specialist main screen, select **Service** → **Firmware Update** to get to the Firmware Update Wizard screen, see Figure 3-16 on page 153.

Selecting the wizard will guide you through the necessary update routines. You should have downloaded the latest firmware updates, or follow the link to download this before starting the wizard. The wizard will assist you to achieve a nondisruptive update of the different firmware.

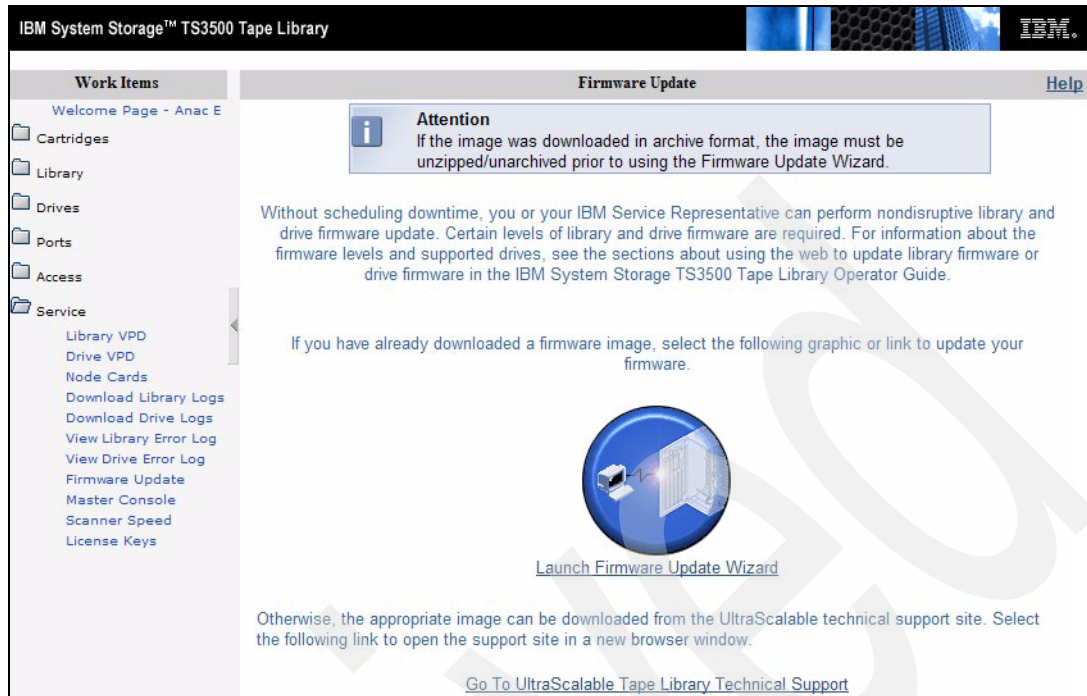


Figure 3-16 IBM TS3500 Tape Library Specialist: Firmware Update

Archived

SAN considerations

In this chapter, we discuss considerations for SAN-attached tapes and libraries. We emphasize issues generally relevant to SAN tape attachment, including:

- ▶ Design considerations for SAN-attached tape libraries
- ▶ Switch fabric zoning
- ▶ Persistent binding

We assume the reader is already familiar with basic SAN concepts. For more information about general SAN concepts and design, refer to these Redbooks publications:

- ▶ *Designing an IBM Storage Area Network*, SG24-5758
- ▶ *Planning and Implementing an IBM SAN*, SG24-6116
- ▶ *IBM SAN Survival Guide*, SG24-6143
- ▶ *Introduction to Storage Area Networks*, SG24-5470
- ▶ *Designing and Optimizing an IBM Storage Area Network*, SG24-6419
- ▶ *IBM Tape Solutions for Storage Area Networks and FICON*, SG24-5474-03

4.1 SAN design considerations for IBM tape libraries

In this section we cover the following IBM tape SAN design considerations:

- ▶ Bandwidth needed for FC Tape
- ▶ How to handle multiple paths to tape drives

The IBM LTO3 and LTO4 tape drives with Fibre Channel interface support either point-to-point or Fibre Channel arbitrated loop attachment. For TS1120 Tape Drive only Fibre Channel attachment is supported.

4.1.1 Bandwidth needed for FC tape

Many SANs are designed for disk I/O, which means they are optimized for high input/output per second (IOPS) and not necessarily for the high bandwidth that is needed for tape and backup I/O. During backup sessions, high volumes of data are generally transferred from disk to tape media. High speed transfer is also a necessity to minimize backup time. Current tape drives, like the IBM LTO4 with 120 MB/sec and the IBM TS1120 with 104 MB/sec, can easily saturate a single FC link if several drives operate concurrently.

Using a SAN fabric configuration, you can potentially attach and access many tape drives through one or more HBAs. But how will this affect performance if several tape drives run concurrently? The theoretical maximum data transfer rate for one FC connection in a 2 Gbit SAN is 200 MB/sec. In reality, we typically see an effective data transfer rate of about 160 MB/sec. In a 1 Gbit SAN we see an effective data transfer rate of just 80 MB/sec.

LTO3 drives have a sustained data transfer rate of 80 MB/second uncompressed, and 160 MB/second using 2:1 compression. In theory, this means you should be able to run two LTO3 uncompressed tape drives or one compressed tape drive concurrently on an HBA without performance degradation.

However, the actual data transfer rates achieved will depend heavily on the type of data.

Typically, most system environments have a mix of data types achieving very different compression rates. If writing very large files with a good compression ratio, you might get a transfer rate of up to 240MB/sec (LTO4) or even more. In that case, you should only run one LTO4 drive on one HBA. On the other hand, if writing small or uncompressible files, then you might see transfer rates of less than 120 MB/sec (LTO4). In this case, more than one LTO4 drives can be run together on one HBA. Nevertheless, we do not recommend that you try to work concurrently with more than two LTO4 drives using a single HBA.

As well as the number of devices per HBA, the overall SAN design must be capable of supporting the volume of data transferred during the backup process (see Figure 4-1 on page 157). The SAN might be able to easily sustain the overall load and normal data traffic, but still have an insufficient bandwidth when backups take place. This is especially true in complex fabrics with multiple switches, where the inter-switch links (ISLs) can become saturated.

As already described, an FC link can sustain about 160 MB/sec. An ISL can handle slightly more, but as already discussed, with one or two (depending on the data and compression) LTO4 tape drives running simultaneously, you can overload one single 2 Gbit ISL.

Overloaded ISLs or HBAs can cause problems, like job aborts, timeouts, tape drives not responding, and bad performance. Therefore, it is essential to provide enough bandwidth for tape operations. You can increase your bandwidth if you install additional HBAs and increase the number of ISLs.

Table 4-1 provides a rule of thumb for how many tape drives per HBA and ISL can run concurrently. Figure 4-1 shows a typical SAN layout with ISL between the servers and tapes.

Table 4-1 Number of tape drives that can run concurrently on HBA or ISL

Drives per HBA / ISL	per Drive	4Gbit	2Gbit
TS1120	104 MB/sec	1 - 2	1
IBM LTO Gen4	120 MB/sec	1 - 2	1
IBM LTO Gen3	80 MB/sec	1 - 2 - 3	1 - 2

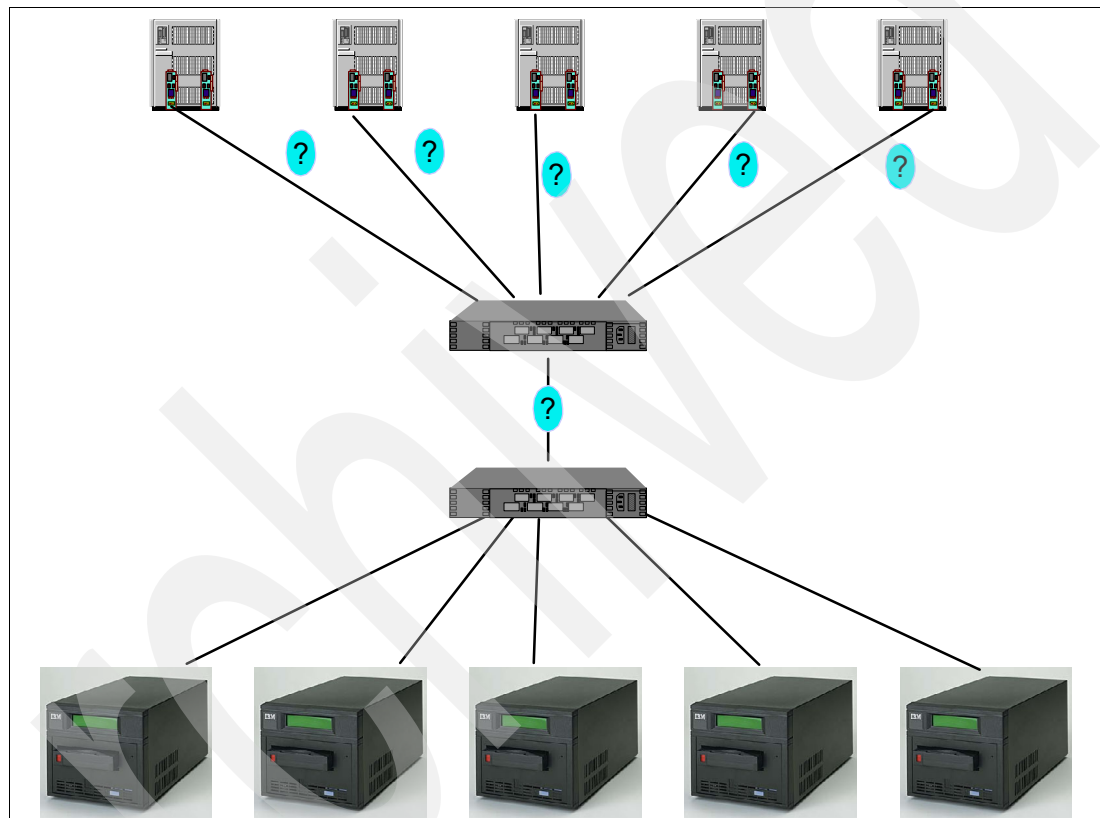


Figure 4-1 SAN Bandwidth for tape

Most SAN fabric hardware provides the ability to measure the real data transfer rate achieved on the SAN. For example, if you have an IBM SAN Fibre Channel Switch you can use the Fibre Channel Switch Specialist to measure data throughput. Enter the IP address of one of the IBM SAN Fibre Channel switches in the browser window, and select the switch to which your HBA is attached (Figure 4-2) to bring up the Switch Management view.

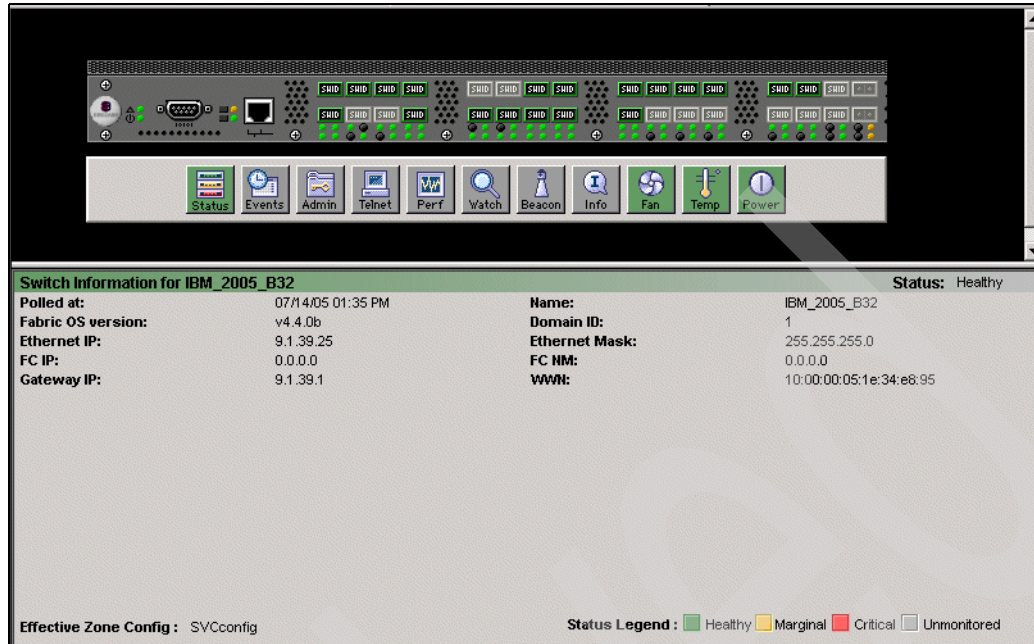


Figure 4-2 Switch Management window

Click the **Performance** icon to display the performance window, as in Figure 4-3. You can see traffic on ports 3 and 25 of around 45-50 MB/sec generated by an LTO 2 drive. If any ports consistently show traffic around 80 MB/sec with 1 Gb FC, or 160 MB/s with 2 Gb FC, you should consider load balancing by adding additional HBAs and ISL, or enabling trunking.

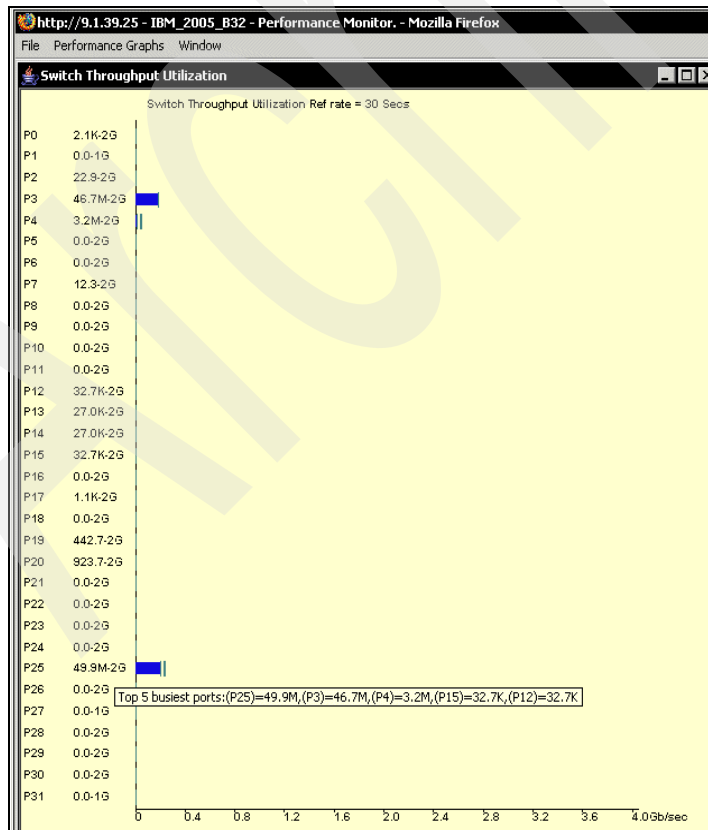


Figure 4-3 Port performance

You can also use the command line interface on the IBM 2109 switches. For example, use the `portperfshow` command to show the data transfer rate on the switch.

4.1.2 Multiple paths to tape drives

We have discussed the reasons for using more than one HBA on the server to give good performance for all drives. However, if you implement this configuration, you will see duplicate tape drive definitions on your server. In this section, we will exemplify this.

We have one System p server with two FC HBAs. These HBAs are connected to a SAN Fabric consisting of IBM 2109 switches. We have an IBM TS3500 with two drives installed (see Figure 4-4).

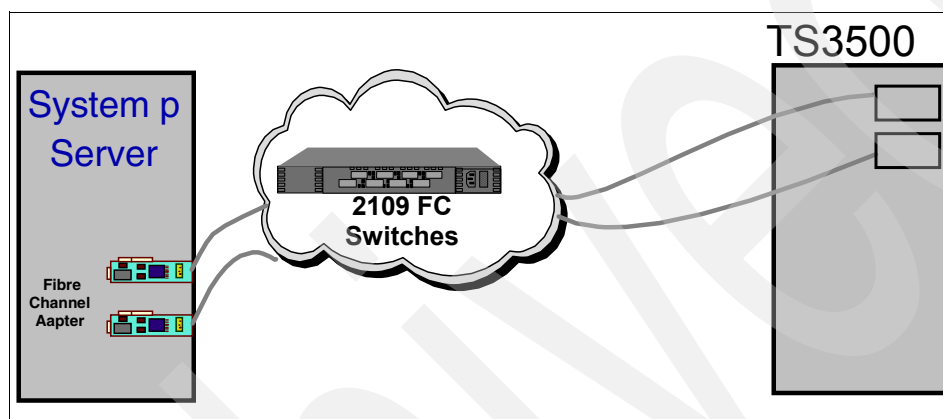


Figure 4-4 Our lab configuration

If we boot the System p server or run `cfgmgr` to detect the new devices, when we list the tapes found (using the `lsdev` command) we get an output as in Example 4-1.

Example 4-1 Duplicate device names because of dual pathing

```
# lsdev -Cc tape
smc0 Available 20-58-01 IBM 3584 Library Medium Changer (FCP)
rmt0 Available 20-58-01 IBM 3580 Ultrium Tape Drive (FCP)
rmt1 Available 20-58-01 IBM 3580 Ultrium Tape Drive (FCP)
smc1 Available 10-68-01 IBM 3584 Library Medium Changer (FCP)
rmt2 Available 10-68-01 IBM 3580 Ultrium Tape Drive (FCP)
rmt3 Available 10-68-01 IBM 3580 Ultrium Tape Drive (FCP)
```

You can see that the medium changer and two tape drives are each detected and defined twice: once on each HBA in the System p server, giving a total of four tape drives and two SCSI Medium Changers. This gives the impression there are more devices available than are actually physically present.

To solve this problem:

- ▶ You can enable *zoning*, which allows one HBA to see only certain tape drives.
- ▶ You can use the *alternate path function* within the IBM Tape Device Driver.
- ▶ You can use *persistent binding* for the HBAs to see only certain WWN.

The different options are described in:

- ▶ 4.2, “Zoning” on page 163
- ▶ 3.2.7, “Data path failover for LTO and TS1120 drives on AIX” on page 113
- ▶ 4.3, “Persistent binding” on page 167.

4.1.3 Tape and disk on the same HBA

Tape and disk I/O are by their nature different. While tape drives use large blocks and *data streaming* to maximize performance, disk drives use smaller block sizes appropriate for random I/O; therefore, mixing disk and tape on a single SCSI bus is not recommended and is rarely done.

Tape drives use large blocks and data streaming that can tie up the SCSI bus for long periods of time, meaning that disk drives get less than their fair share of the SCSI bus. Conversely, tape drives might have difficulty getting access to the bus because disk drives can respond faster. The best practice is thus to keep disk and tape on separate SCSI buses.

With Fibre Channel there is, in principle, less contention. I/O can be multiplexed and small blocks can be interleaved in the middle of large blocks. There is no shared bus to keep a slow device from sending whenever it is ready, so it is certainly possible with Fibre Channel to have both disk and tape sending or receiving with little interference. Indeed in a switched fabric, data is not directly sent to the device, but rather to the Fibre Channel switch.

However, even with FC, for bandwidth reasons disk and tape I/O sharing an HBA is still not recommended (although the bandwidth issue is independent of having mixed device types). For example, during a backup operation your server has to read the data from the disk and write it to a tape drive. With an LTO 3 tape drive, if you write at an average of 80 MB/sec, then you also have to read 80 MB/sec from the disk. With both data streams going through the same HBA, it means that the HBA must handle at least 160 MB/sec (Figure 4-5).

Important: IBM does not recommend sharing of disk and tape I/O on the same HBA.

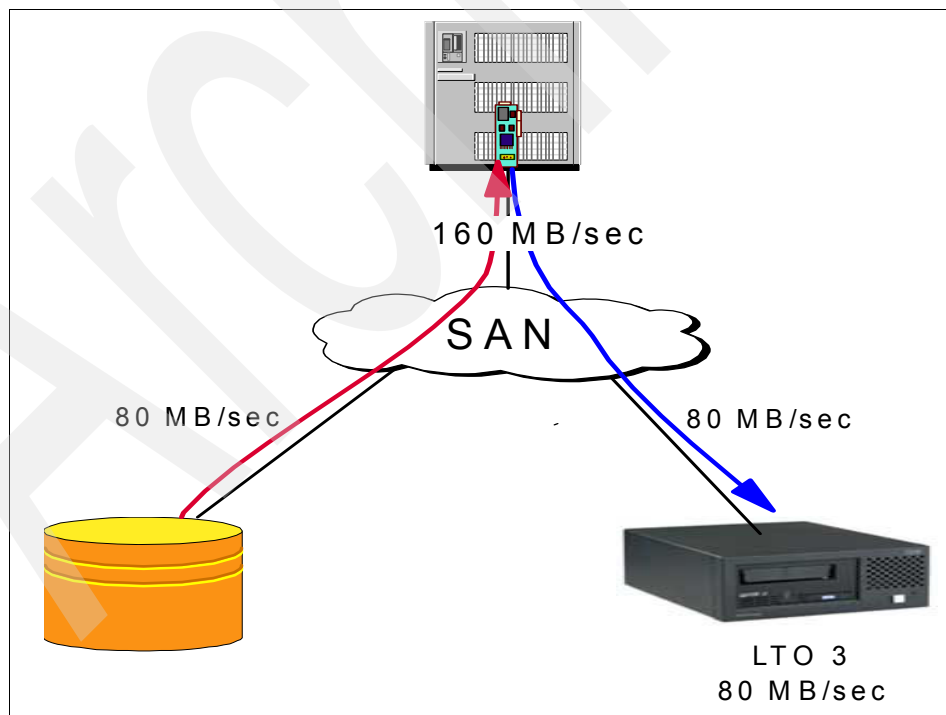


Figure 4-5 Tape and disk on the same HBA

As long as there is no other disk I/O activity during the backup operation, it might work without problems. But if other applications that also access the disk are running during the backup, performance will be impacted. Because disk access uses smaller block size, and is quicker and more frequent, the disk I/O will occupy the FC link, and cause the tape to wait to get on the link, causing backhitches and thus affecting performance. Or even worse, the disk I/O will keep the command queue filled up so that no tape commands can go through.

For a backup server where a high I/O load exists, and for LAN-free clients, where during the backup some other disk I/O occurs, you should use multiple HBAs and separate the disk and tape I/O (see Figure 4-6). This is especially true for backup servers using a disk storage pool (such as with Tivoli Storage Manager) where the backup data is staged to disk and then migrated to tape. If the backup and migration run simultaneously, it will cause a high I/O load.

Keep in mind that your environment will evolve over time, and usually the data traffic will increase. Although it might have been justified (generally from a cost perspective) in a simple installation with low traffic to share the HBA, you must reevaluate the situation on a regular basis. In most cases you will reach a point where it becomes necessary to install additional HBAs.

Tip: Monitor your environment over time and when traffic grows, consider the installation of additional HBAs.

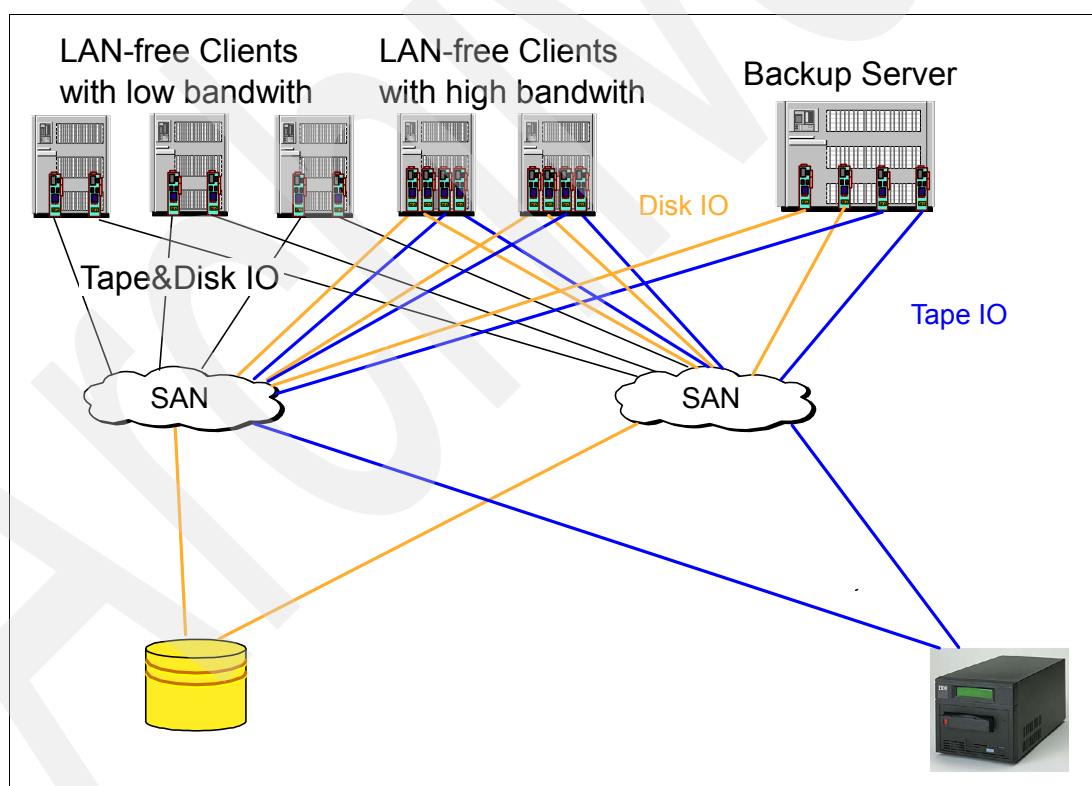


Figure 4-6 SAN example for backup

If you cannot avoid combining disk and tape I/O (for example, when no more PCI slots are available on the host), you should at least implement your SAN in accordance with the following rules and configure your FC HBAs accordingly:

- ▶ Create different zones for disk and tape.
- ▶ Create a different zone for every server.

- ▶ Enable FCP-2 recovery (also called FC Tape Support) on the FC HBA.
- ▶ Set up persistent binding (as described in 4.3, “Persistent binding” on page 167).
- ▶ Disable SCSI Bus Reset to tape devices, if possible.
- ▶ Enable PLOGI instead of PDISC after LIP.
- ▶ Design your SAN for high bandwidth since high bandwidth is needed for tape I/O.
- ▶ Do not overload the HBA. Provide enough HBAs as described in 4.1.1, “Bandwidth needed for FC tape” on page 156.
- ▶ Pay attention also to the PCI Bus performance (see Table 3-2 on page 118).
- ▶ Provide enough bandwidth between the switches (ISLs); consider enabling trunking for the ISL.

Most SANs are designed for disk I/O (high IOPS) rather than high bandwidth (such as tape), which means there might not be enough ISLs for high bandwidth. As discussed previously, you need at least one ISL for every two to three tape drives. If you have more than one ISL between two switches, you should also consider enabling trunking. This is because there is no load balancing on the basis of real I/O over several ISLs if trunking is not enabled.

Many switches (for example, IBM 2109 and IBM 2005) have dls (dynamic load balancing on the basis of the routing table) disabled, which means that load balancing is done during startup of the switch only; you should check periodically if all ISLs are working. After installing an additional ISL, you should run the dynamic load balancing at least once by setting `dlisset`. When done, remember to disable it again as recommended by IBM.

Another potential issue is the device driver level. IBM attempts to be on the same supported FC HBA device driver levels for tape and disk, but it is possible that because of a temporary issue, a given tape device will require a different device driver level than disk or vice-versa.

For all of these reasons, the general IBM recommendation is that, wherever possible, a single HBA should *not* be shared for concurrent disk and tape operation. IBM will support mixing disk and tape on a HBA, and the IBM Support Center will accept problems reported on these configurations. However, if the problem determination process reveals that the cause is the mixing of tape and disk traffic, IBM might choose to tell the customer that the only fix is to separate the traffic.

Important: IBM does not recommend sharing of disk and tape I/O on the same HBA.

4.1.4 Different SAN fabrics for disk and tape

To guarantee the availability of your SAN, either during necessary maintenance or to protect against human error, the best practice is to build redundancy through independent SAN fabrics, thus avoiding any single point of failure. Some large installations also separate disk and tape into different SANs. There are some advantages for separating SAN into storage (disk) and backup (tape):

- ▶ Backup and storage teams can manage their SANs separately and independently.
- ▶ Backup and storage teams can design their SANs for their specific needs and requirements.
- ▶ If there are different vendors for storage and backup, then service and maintenance will likely be simpler since each vendor will be responsible for its own SAN.

Therefore, separating disk and tape into different SANs is principally useful for:

- ▶ A large environments with a need for high availability
- ▶ An environment with different vendors for disk and tape

4.2 Zoning

Zoning allows you to partition your SAN into logical groupings of devices so that each group is isolated from each other, and can only access the devices in their own group. Using zoning, you can arrange fabric-connected devices into logical groups, or zones, over the physical configuration of the fabric. Zones can be configured dynamically. They can vary in size depending on the number of fabric-connected devices, and devices can belong to more than one zone. Because zone members can access only other members of the same zone, a device not included in a zone is not available to members of that zone. Therefore, you can use zones to:

- ▶ Create closed user groups, for example, between test and development environments
- ▶ Create a barrier between different environments, such as Windows and UNIX operating systems
- ▶ Secure fabric areas

Figure 4-7 shows two slightly overlapping zones, represented by the Zone green (solid lines) and the Zone red (dotted lines).

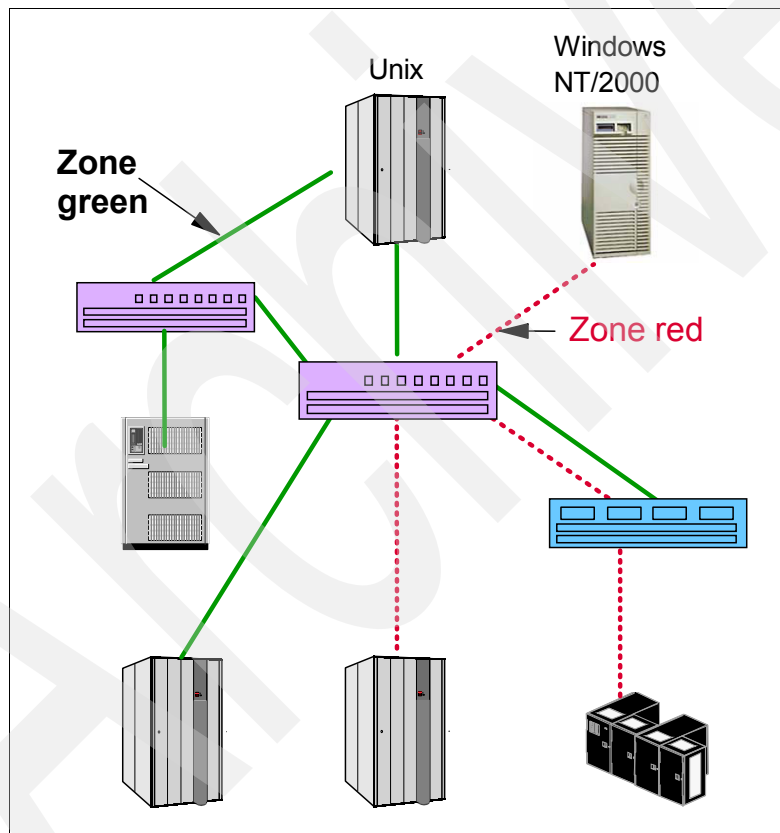


Figure 4-7 Zoning

IBM Tape Device Driver for AIX, Windows, Linux, HP-UX, and Sun Solaris supports multiple paths to the same tape. It provides automatic control path and automatic data path failover to pre configured redundant paths in the event of a loss of an HBA, drive, or control path, without aborting the current jobs in progress.

Other drivers do not support these features. Servers using other drivers can also use multiple HBAs and multiple connections to the SAN fabric, but there is no automatic failover to an individual tape device. What generally occurs is that the physical device is represented twice

by the operating system. To solve this, we must *hide* the additional paths to the library and tapes using zoning, persistent binding, or software.

Figure 4-8 shows how we can set up a zone to eliminate dual pathing so that there is only one connection from the host to the tape devices. The physical FC connections enclosed in the circled zone can be zoned by WWN or physical port connection on the FC switch, creating a single path between host and tape drive.

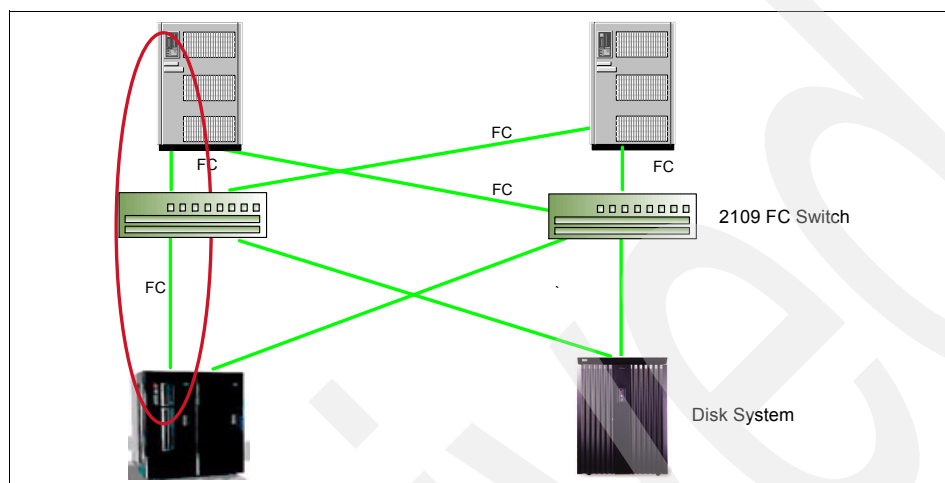


Figure 4-8 Zone to restrict the tapes to one HBA only

In the example shown in Figure 4-9, there are multiple tape drives and HBAs. You might use zones as shown so that the drives are split between the HBAs for performance reasons. Without zoning or other configurations, you will see the same dual pathing issue as described in 4.1.2, “Multiple paths to tape drives” on page 159.

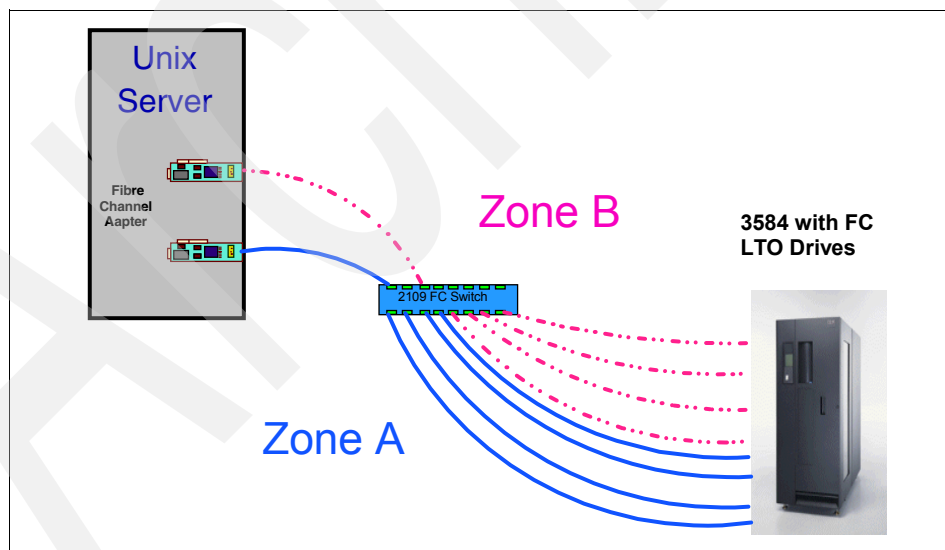


Figure 4-9 TS3500 with 8 FC LTO drives, one server with two HBA and two zones

You can also manage this scenario by using persistent binding as described in 4.3, “Persistent binding” on page 167.

4.2.1 Basic information on zoning

Here we provide some basic information on the use of zoning:

- ▶ Zones can be configured dynamically.
- ▶ Configuring new zones does not interrupt traffic on unaffected ports or devices. Also, new zones do not affect data traffic across interswitch links (ISLs) in cascaded switch configurations. However, zone changes interrupt traffic on affected ports and devices and should be made with care!
- ▶ Zoning configuration is generally a function of the switch devices. For an IBM 2109/2005, zoning can be configured and administered by Telnetting to the switch, or using the Web browser based IBM TotalStorage Specialist.
- ▶ Devices can belong to more than one zone.
- ▶ Zoning can be administered from any switch in the fabric.
- ▶ Changes that are configured to one switch automatically replicate to all switches in the fabric; if a new switch is added to an existing fabric, all zone characteristics are automatically applied to the new switch. Because each switch stores zoning information, zoning ensures a high level of reliability and redundancy.

For detailed information about setting up zoning, refer to the SAN Redbooks publications cited in the introduction to this chapter, or to your switch documentation.

4.2.2 Types of zoning

There are two types of zoning used: hardware zoning and software zoning.

Hardware zoning

Hardware zoning is based on the physical fabric port number. It can be implemented in the following configurations:

- ▶ One-to-one
- ▶ One-to-many
- ▶ Many-to-many

Disadvantage

Zoning configuration can become unusable if the device is connected to a different port, since hardware zoning relies on each device being connected to a specific port.

Advantage

Hardware zoning works independently of influence from other sources such as HBA firmware. The switch hardware ensures that there is no data transfer between unauthorized zone members. However, devices can transfer data between ports within the same zone. Consequently, hardware zoning provides the greatest security possible. Use it where security must be rigidly enforced. Hardware zoning also has a very low impact on the routing performance.

If you use hardware zoning, you must carefully document and update your SAN fabric.

Note: Careful documentation is always a necessary task for managing a SAN.

Software zoning

Software zoning (soft zone) is implemented within the Simple Name Server (SNS) running inside the fabric switch. In a soft zone, at least one zone member is specified by WWN, which is a globally unique 8-byte number. When a device logs in, it queries the name server for devices within the fabric. If zoning is in effect, only the devices in the same zones are returned. Other devices are hidden from the name server query reply.

The members of a zone can be defined with:

- ▶ Node WWN (WWNN)
- ▶ Port WWN (WWPN)

Advantage

Software zoning is not affected by moving devices to different physical switch ports. If you use WWNs for the zone members, even if a device is connected to another physical port, it will still remain in the same zoning definition because the device's WWN remains the same.

Disadvantage

Each component of the SAN fabric must support soft zoning.

The switch does not control data transfer, so there is no guarantee against data transfer from unauthorized zone members.

You can intermix hardware and software zoning.

4.2.3 Suggestion on zoning for tapes

Consider the following recommendations as you plan your zone configuration:

- ▶ Create different zones for disk and tape.
- ▶ Create a zone for every server or for every HBA.
- ▶ Adopt a meaningful naming convention for your zones, like ServerA_Tape1.

4.2.4 World Wide Names of FC Host Bus Adapter

To set up software zoning and eliminate the dual pathing issue, you need to know the World Wide Names of your installed FC HBAs. Each HBA vendor offers its own software products to gather this information on the different systems.

You can also use the Operating Systems commands to find this information, as for example for AIX and HP-UX.

Get WWN of HBA on AIX and HP-UX

Log in as root and type `lsdev -Cc adapter|grep fcs` (Example 4-2) to see the installed Fibre Channel cards. For each Fibre Channel card, there will be a device of type fcsx.

Example 4-2 FC HBA on AIX

```
lsdev -Cc adapter | grep fcs
fcs0    Available 14-08    FC Adapter
fcs1    Available 34-08    FC Adapter
```

Type `lscfg -v1 fcsx`, where x is the adapter number (Example 4-3).

The network address value is the adapter WWN.

Example 4-3 WWN of HBA on AIX

```
lscfg -vl fcs0
fcs0          P1-I5/Q1  FC Adapter

Part Number.....03N2452
EC Level.....B
Serial Number.....MI12313291
Feature Code.....2765
Manufacturer.....0010
FRU Number.....09P0102
Network Address.....10000000C928CEAF
ROS Level and ID.....02C03891
Device Specific.(Z0).....1002606D
Device Specific.(Z1).....00000000
Device Specific.(Z2).....00000000
Device Specific.(Z3).....02000909
Device Specific.(Z4).....FF401050
Device Specific.(Z5).....02C03891
Device Specific.(Z6).....06433891
Device Specific.(Z7).....07433891
Device Specific.(Z8).....20000000C928CEAF
Device Specific.(Z9).....CS3.82A1
Device Specific.(ZA).....C1D3.82A1
Device Specific.(ZB).....C2D3.82A1
Device Specific.(YL).....P1-I5/Q1
```

The similar commands for HP-UX are `ioscan -funC fc` to see the installed Fibre Channel cards. Then use `fcmsutil /dev/tdx` where `x` is the adapter number. The WWN of the adapter is the value of the `N_Port Port World Wide Name` parameter.

4.3 Persistent binding

This function allows a subset of discovered targets to be bound to an HBA. Some operating systems do not guarantee that devices will always be allocated the same SCSI target and LUN IDs after a reboot. This can cause problems for application software that expects tape devices always to have the same SCSI target ID/LUN. Persistent binding allows a tape device's WWN to be bound to a specific SCSI LUN.

Another reason to use persistent binding is to ensure that the operating system drive names are configured in their physically installed order. Many backup applications (for example, EMC Legato NetWorker and VERITAS NetBackup DataCenter) will assume that the devices have been assigned their drive names in the same order as the element numbers. If the drives were configured in a different order, then the application will not correctly access the drives, and for example they will wait indefinitely for a media mount or until the request is manually killed. We show how to display element addresses (element inventory) for drives as well as the cartridge slots in Appendix B, "LTO tips and troubleshooting" on page 251.

Once a configuration has been set, it will survive reboots and any hardware configuration changes. Binding also solves the dual pathing problem. Binding can be implemented by WWNN or WWPN. By using persistent binding, the drives will always use the bound target ID even if we power off one drive, or if we add additional devices to the SAN.

Persistent binding is mainly useful in a Solaris environment, and we highly recommend that you use it there. As is explained in 4.3.2, "Persistent binding for HP-UX or AIX" on page 169, persistent binding is not an issue for HP-UX or AIX.

Note for IBM Tivoli Storage Manager users: Recent releases of Tivoli Storage Manager eliminate the need for persistent binding with the SAN discovery feature. For more information, see 5.12, “Tivoli Storage Manager V5.2 SAN device mapping” on page 222.

4.3.1 Persistent binding with Solaris 10

Device detection has improved considerably from earlier versions to Solaris 10. Persistent binding is however, still useful and recommended for tape devices. In this chapter we identify how you can implement Persistent Binding in Solaris 10. For further details you should look up the Solaris documentation for Fibre Channel and Persistent Binding.

Solaris 10 dynamically detects devices in a SAN without the need to edit configuration files. However, for tape devices it is useful to explicitly specify how `/dev` entries are created, and ensure that they are identical across multiple servers on the SAN. This tape binding can be achieved concurrently with automatic discovery for disk devices.

In `/dev/rmt` directory there are links for physical devices under `/devices` for tape devices. Each tape LUN is represented by a number of minor nodes in the form `/dev/rmt/Nst`, `/dev/rmt/Nstb` and so on, where `N` is an integer starting from 0. For details, refer to Table 3-1 on page 97. This number is assigned by the operating system routine `devfsadm`, and each LUN found gets the next available number. Accordingly, the `/dev/rmt` name will vary from host to host.

Note: Every drive has a unique WWN. Therefore, every drive gets a separate SCSI ID. Without persistent binding, if drives are missing at server boot time or new drives are added, the SCSI IDs will probably change. Therefore, you should always implement persisting binding for native FC tape drives.

Note: If you install native FC tape drives then you cannot expect that the drives defined on the server will show up in the same order as they are installed in the library. Persistent binding will solve this problem too.

Setting up persistent binding for Solaris 10

The file `/etc/devlink.tab` work as a *default device table*. It specifies the rules used by `devfsadm` to create links in the `/dev` directory. Use the `man devlinks` command for more information. Initially there are no entries for tape in this file since `devfsadm` anyway is able to create links for tape devices, but you can add rules to modify the default behavior for creating those tape links.

A sample entry for a tape in the `devlink.tab` file will be of the form:

```
type=ddi_byte:tape;addr=w<PWWN>,<LUN>; rmt/<rmt #>\M0
```

Here you change `<rmt #>` to the specific device number you want to use, and the `<PWWN>` and `<LUN>` to match the specific tape device. This information you can find from the `/dev/rmt` link. Use command `ls -l` as shown in Example 4-4.

Example 4-4 /dev/rmt listing for tape device 1

```
# ls -l /dev/rmt/1st
lrwxrwxrwx 1 root sys          77 Mar 21 16:19 /dev/rmt/1st ->
../../devices/pci@7c0/pci@0/pci@9/SUNW,qlc@0/fp@0,0/st@w5003013d38317011,0:st#
```

If you want to set a fixed device number `/dev/rmt` as device 25, you will add an entry in `/etc/devlink.tab` as shown in Example 4-5.

Example 4-5 /etc/devlink.tab example for tape device 10

```
Top of file removed.....
# All fields must be present (even if blank)
#
# devfs-spec    Dev-Namespec    Extra-Link
#
type=ddi_byte:tape;addr=w5003013d38317011,0; rmt/25\M0
```

If you add this line to the `devlink.tab` file of every Solaris server on the SAN that is using this drive, then it will always appear as minor node (device) 25.

When you have created the necessary entries, run `devfsadm` to rediscover the devices.

Setup comments

Here are some considerations regarding the setup:

- ▶ Any tape drive seen by Solaris, but not defined in the `/etc/devlink.tab` file, will have an automatic device numbering starting from 0. These device numbers might potentially conflict with the settings in `devlink.tab`, so make sure to assign numbers that are high enough to avoid such conflicts.
- ▶ This approach to persistent binding might lead to duplicate links in the `/dev/rmt.` Tapes discovered before any entries were specified in `devlink.tab` have already been assigned, and this assignment will remain after a new discovery is made. Thus there will be duplicate links to the tape drive. To avoid this, delete the original links *before* running device discovery. Run the command `rm /dev/rmt/*`.
- ▶ This method cannot be used for tape drives with multiple attachments connected to multiple HBA ports. In that case Solaris will detect two tape drives, and the last one detected will be given the link as of `devlink.tab`.

4.3.2 Persistent binding for HP-UX or AIX

Persistent binding is not applicable to HP-UX or AIX, as explained in the following sections.

Persistent binding not applicable to HP-UX

With HP-UX it is not necessary to use persistent binding. After a reboot or an `ioscan`, the server automatically detects new Fibre Channel devices and maps them into the UNIX kernel structure. Thereby, the device file name is dependent on the H/W Path. The H/W Path is derived from the port ID, which is based on the domain number and port number of the FC switch.

If you want to see the FC tape devices on your HP system in the physically installed order, you have to hook up your first FC tape drive to the switch port with the lowest port number, and the second tape drive to the second lowest port number, and so on. Do not forget that if you use more than one switch, you also need to note the domain number of the FC switches.

Persistent binding not applicable to AIX

Unlike Solaris, AIX does not communicate with the devices over the SCSI ID and LUN. AIX talks to the devices using the WWN. See Example 4-6, which shows you the result of `lsattr -E1` with a FC connected tape in the IBM TS3500. You can recognize the WWN of the drive in the `ww_name` field, with the value 5005076300410803. You can also identify on the basis of the second to last digit the frame number, which here is 0 (frames are numbered upwards from 0 to F), and on the basis of the last digit the drive slot number, which here is three (drives are numbered upwards from 1 to C). This corresponds with the data transfer element (DTE) address number 259.

The World Wide Names of the drives are assigned by the tape library. This technique is referred to as *library-centric World Wide Names*. Potential drive slots are each assigned a WWN, which does not change when a drive is swapped or replaced.

Example 4-6 List of FC attached tape drives

# lsattr -El rmt0			
autoload	no	Use Autoloading Feature at End-of-Tape	True
block_size	0	Block Size (0=Variable Length)	True
compress	yes	Use Hardware Compression on Tape	True
debug_trace	no	Debug Trace Logging Enabled	True
devtype	ULTRIUM-	Device Type	False
location		Location	True
logging	no	Activate volume information logging	True
lun_id	0x0	Logical Unit Number	True
max_log_size	500	Maximum size of log file (in # of entries)	True
new_name		New Logical Name	True
node_name	0x5005076300010803	World Wide Node Name	False
retain_reserve	no	Retain Reservation	False
rew_immediate	no	Use Immediate Bit in Rewind Commands	True
scsi_id	0x60c79	SCSI Target ID	True
space_mode	SCSI	Backward Space/Forward Space Record Mode	True
trace_logging	no	Trace Logging Enabled	True
trailer_labels	no	Trailer Label Processing	True
ww_name	0x5005076300410803	World Wide Port Name	False

If the SAN configuration was changed before rebooting the AIX server or running **cfgmgr**, the device-to-target/LUN mapping will be preserved because of this connection to the WWN. New devices will get any free device names. Therefore, it is not relevant or necessary to use persistent binding with AIX.

In this example, you can see that the rmt0 is not the first drive in the library. As we described in 4.3, “Persistent binding” on page 167, this can cause problems with many backup applications. Therefore, we have to rename the device names. First, we list all currently configured tape devices with the **lsdev** command (Example 4-7). In this example, we have one LTO1 drive (rmt0) and two LTO2 drives (rmt1 and rmt2).

Example 4-7 List of FC attached tape drives

# lsdev -Cc tape		
rmt0	Available 30-68-01	LTO Ultrium Tape Drive (FCP)
rmt1	Available 30-68-01	IBM 3580 Ultrium Tape Drive (FCP)
rmt2	Available 30-68-01	IBM 3580 Ultrium Tape Drive (FCP)
smc0	Available 30-68-01	IBM 3584 Library Medium Changer (FCP)

Next, we can determine the physically installed order of the tape drives with the **lsattr -El rmtx** command, where x is the adapter number, as specified in Example 4-8 on page 171. Finally, we use **smit devices** to rename the device names to reflect our configuration. Go to **Tape drives** → **Change/Show Characteristics of a Tape Drive** and select the tape drives you want change. Select the name you want to use in the line New Logical Name.

In our case, we have to change rmt0 to rmt2, and vice versa. This cannot be done in one step, because the rmt2 device name is used by another tape device. First, we change the name from rmt0 to rmt3 as shown in Example 4-8. Then we can change rmt2 to rmt0, and finally rmt3 (the original rmt0) to rmt2.

Example 4-8 SMIT change/show characteristics of a tape drive

Change / Show Characteristics of a Tape Drive

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

	[Entry Fields]
[TOP]	
Tape Drive	rmt0
Tape Drive type	LTO
Tape Drive interface	fc
Description	LTO Ultrium Tape Drive (FCP)
Status	Available
Location	30-68-01
Parent adapter	fscsi0
Connection address	1
SCSI ID	0x213ca
Logical Unit ID	0x0
World Wide Port Name	0x5005076300410803
World Wide Node Name	0x5005076300010803
New Logical Name	[rmt3]
Enable Alternate Pathing Support	yes +
Block Size (0=Variable Length)	[0] + #
Use Hardware Compression on Tape	yes +
Use Autoloading Feature at End-of-Tape	no +
(IBM 3581 and IBM 3583 with single drive only)	
Activate volume information logging	no +
Maximum size of log file (in # of entries)	[500] + #
Backward Space/Forward Space Record Mode	SCSI +
Use Immediate Bit in Rewind Commands	no +
Trailer Label Processing	no +

F1=Help	F2=Refresh	F3=Cancel	F4=List
F5=Reset	F6=Command	F7=Edit	F8=Image
F9=Shell	F10=Exit	Enter=Do	

If you have natively attached FC Drives, you will find that normally the drives on AIX are not configured in the same order as they are physically in the library. This SMIT option allows you to easily change the order to reflect your configuration. If you do this, you must update your library device table, as described in 3.6, "Creating a library device table" on page 143.

Archived



Part 2

IBM Open Systems Tape libraries and backup software

In this part of the book, we describe how to implement the IBM Open Systems Tape libraries with the IBM Tivoli Storage Manager backup system. We also provide recommendations for implementing with EMC Legato NetWorker, and Symantec Veritas NetBackup.

Archived

Implementing IBM Tivoli Storage Manager

This chapter describes the installation and implementation of IBM tape devices with IBM Tivoli Storage Manager in AIX, Sun Solaris, and HP-UX environments. In particular, we review Tivoli Storage Manager's ability to:

- ▶ Be used for normal backup/restore processing
- ▶ Allow multiple servers to share the library
- ▶ Provide LAN-free backup services

We also provide information on migrating between the generations of LTO technology with IBM Tivoli Storage Manager, how to define various 3592 media types to Tivoli Storage Manager, and discuss some features available with Tivoli Storage Manager V5.3 and V5.4 that are useful for IBM tape devices.

We begin with a brief overview of Tivoli Storage Manager. For more in-depth information about this product, refer to these Redbooks publications:

- ▶ *IBM Tivoli Storage Management Concepts*, SG24-4877
- ▶ *IBM Tivoli Storage Manager Implementation Guide*, SG24-5416
- ▶ *Get More Out of Your SAN with IBM Tivoli Storage Manager*, SG24-6687
- ▶ *IBM Tivoli Storage Manager Version 5.3 Technical Guide*, SG24-6638
- ▶ *Deployment Guide Series: IBM Tivoli Storage Manager Version 5.4*, SG24-7379

5.1 IBM Tivoli Storage Manager overview

As part of the IBM System Storage Open Software Family, IBM Tivoli Storage Manager protects data from hardware failures, errors, and unforeseen disasters by storing backup and archive copies on offline and off-site storage. It scales to protect hundreds to thousands of computers running more than a dozen operating systems, ranging from laptops to mainframes and connected together via the Internet, WANs, LANs or SANs. Tivoli Storage Manager Extended Edition's centralized Web-based management, intelligent data move and store techniques, and comprehensive policy-based automation all work together to minimize administration costs and the impact to both computers and networks.

Optional software modules allow business-critical applications that must run 24x365 to utilize Tivoli Storage Manager's centralized data protection with no interruption to their service. Optional software extensions also allow SAN-connected computers to use the SAN for data protection data movements, and provide Hierarchical Storage Management to automatically move unused data files from online disk storage to offline tape storage. Tivoli Storage Manager Extended Edition provides disaster planning capability, NDMP control for NAS files, and support for large tape libraries.

Tivoli Storage Manager is ideal for heterogeneous, data-intensive environments, supporting over 40 platforms and over 250 storage devices across LANs, WANs, and SANs, plus providing protection for leading databases and e-mail applications. See Figure 5-1.

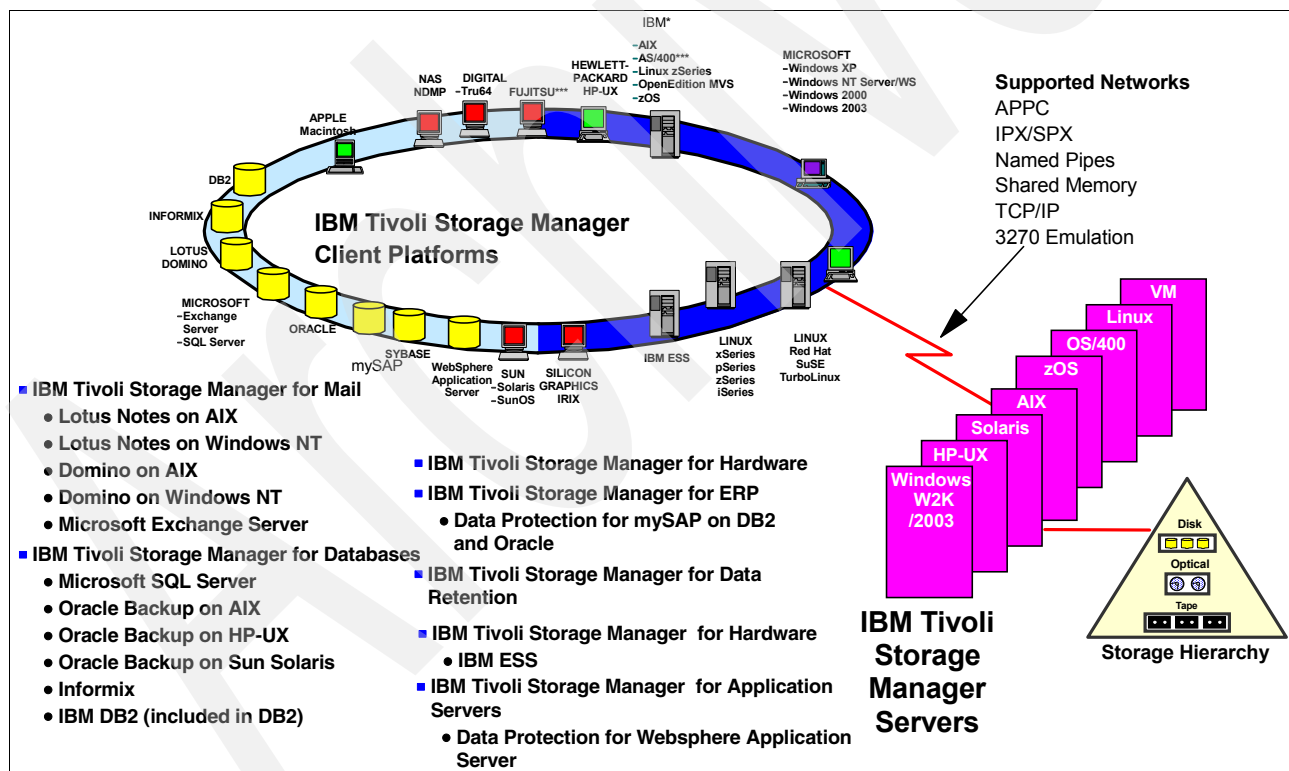


Figure 5-1 IBM Tivoli Storage Manager supported platforms

Tivoli Storage Manager allows users to confidently protect and manage information; it integrates unattended network backup and archive capabilities with centralized storage management and powerful disaster recovery functions. Tivoli Storage Manager is intended for companies with homogeneous or heterogeneous platforms and complex environments that include traditional LANs as well as SANs. It is a best-of-breed, scalable storage management solution that helps provide consistent and reliable protection and management

of mission-critical data that is spread across your company's enterprise. Tivoli Storage Manager is an industrial-strength centralized storage management product for your enterprise.

Tivoli Storage Manager can protect almost any backup-archive client as exemplified in Figure 5-1 on page 176. The Tivoli Storage Manager V5.4 server is provided for different Linux based servers from Linux zSeries® to Linux x86, Windows 2003, AIX, Solaris, and HP-UX. This breadth of platform coverage affords you the choice in selecting the storage management platform that suits your environment and leverages your hardware and software investments. Tivoli Storage Manager can help control the cost of distributed storage management by leveraging storage resources, helping to reduce the cost of downtime and lost data, and helping to increase the productivity of storage administrators and end users.

Tivoli Storage Manager exploits the numerous advantages of SANs with its LAN-free, server-free, and library sharing functions. These help to remove traffic from the LAN, allow for multiple Tivoli Storage Manager servers to share a library, and offload backup processing from mission-critical servers.

Tivoli Storage Manager includes LAN-free backup/restore functionality for many databases and applications, as well as the file-based backup/archive clients. I

For more information about IBM Tivoli Storage Management, visit:

<http://www-306.ibm.com/software/tivoli/products/storage-mgr/>

For the list of currently available storage management products, and supported servers and clients, see:

<http://www-306.ibm.com/software/tivoli/products/storage-mgr/product-links.html>

5.1.1 Tivoli Storage Manager commonly used terms

Here are a few basic Tivoli Storage Manager terms:

► **Server:**

A server is a computer system that provides services to one or more clients, or other devices over a network. A Tivoli Storage Manager server is the repository and manager of all the backed up client data. Administrative policies defined at the server control the types of backup performed and retention policies for the data. The server also manages the physical media and devices where the backed up data is stored.

► **Client:**

A client is a computer system that requests a service of another computer system that is typically referred to as a server. Multiple clients can share access to a common server. In Tivoli Storage Manager terms, a client is a computer system that has data assets requiring protection by the Tivoli Storage Manager server. The client decides what data will be backed up, and is subject to the server's defined administrative policies for data retention. Typically, a client's data is backed up automatically by a server-scheduled operation.

► **Tape library:**

A tape library consists of the physical robotics that move cartridges, one or more tape drives, and slots for tape storage. It must also have a mechanism for controlling the robotics (a library controller), and can also have a library manager that maintains inventory and mediates sharing. In most cases, a library does not have a built-in library manager, so server-based software has to provide the library management function. As an example, the IBM 3494 has a built-in library manager, whereas the IBM TS3xxx libraries does not.

► **Tape library partitioning:**

Some tape libraries (for example, the IBM TS3200, TS3310, TS3400 and TS3500) have the ability to be physically partitioned into multiple logical libraries. Each logical library will have its own storage slots and tape devices, but will share the robotics and Import/Export station with other logical libraries in the same physical library. Each library partition can be managed by a backup application (such as Tivoli Storage Manager).

► **Tape library sharing:**

Tape library sharing is two or more servers sharing the robotics of a tape library. The tape drives and slots within the library might or might not be shared among the attached servers.

5.1.2 Tivoli Storage Manager and tape library sharing

In this section we describe the Tivoli Storage Manager implementation of tape library sharing. This feature allows multiple Tivoli Storage Manager servers to use the same tape library and drives on a SAN to improve both tape hardware asset utilization and potentially backup/restore performance. When two or more Tivoli Storage Manager servers share a library, one server is defined as the *Library Manager*, and controls the library operations. Other servers, known as *library clients*, use server-to-server communications to contact the Library Manager and request library services. This process is shown in Figure 5-2.

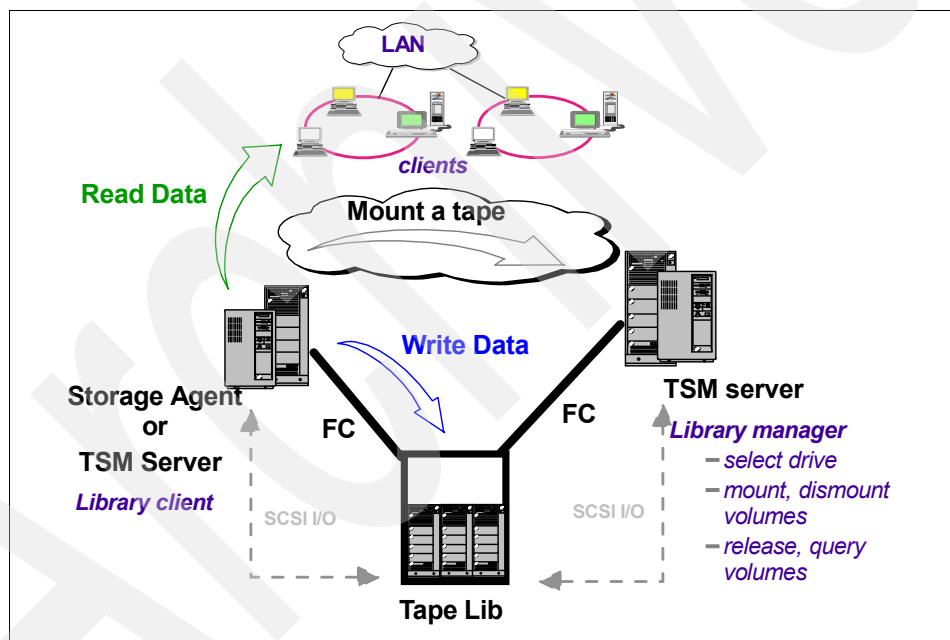


Figure 5-2 Tivoli Storage Manager library sharing overview

Library Manager

The Library Manager physically controls the library. All the communication with the library is done by this server. The Library Manager also serializes access to the tape drives, so that only one server uses a tape drive at any one time. The check-in and check-out of volumes also is performed by the Library Manager.

This Tivoli Storage Manager server is the only server with a library inventory table for that library. The ownership is added to the inventory table to keep track of which tape belongs to a certain library client. This is the only server in the environment that knows all the volumes.

The Library Manager can also use the library for its own purposes, without being a library client at the same time (that is, no library client configuration is necessary on the manager).

Library client

The library client uses server-to-server communications to contact the Library Manager for the handling of the physical hardware. The client sends the requests to the Library Manager, and afterwards reads or writes to the tape drive it was given access to. Server-to-server communication protocol is used to send requests from the library client to the Library Manager, and to send the response from the manager to the client.

LAN-free data transfer

LAN-free data transfer with Tivoli Storage Manager allows the SAN to be used as an alternative path for moving data between the Tivoli Storage Manager clients and the server. LAN-free data transfer exploits this SAN path by enabling the Tivoli Storage Manager client to back up and restore data directly to and from SAN-attached storage (disk and tape), which is shared between the Tivoli Storage Manager server and client, and managed by the client. This means that the data is not transferred over the LAN to the server as in traditional Tivoli Storage Manager backup, but transfers directly from the client to the SAN-attached storage devices.

Tivoli Storage Manager provides LAN-free data transfer for normal files as well as database applications through specialized products like Tivoli Storage Manager for Mail, Tivoli Storage Manager for Databases, and Tivoli Storage Manager for ERP products. These clients require an additional storage agent (Tivoli Storage Manager for SAN) to be installed that directs the movement of the data from the client disk to the SAN-attached storage. This process is shown in Figure 5-3. For a complete list of operating systems and applications supported in a LAN-free environment, refer to:

<http://www-306.ibm.com/software/tivoli/products/storage-mgr-san/>

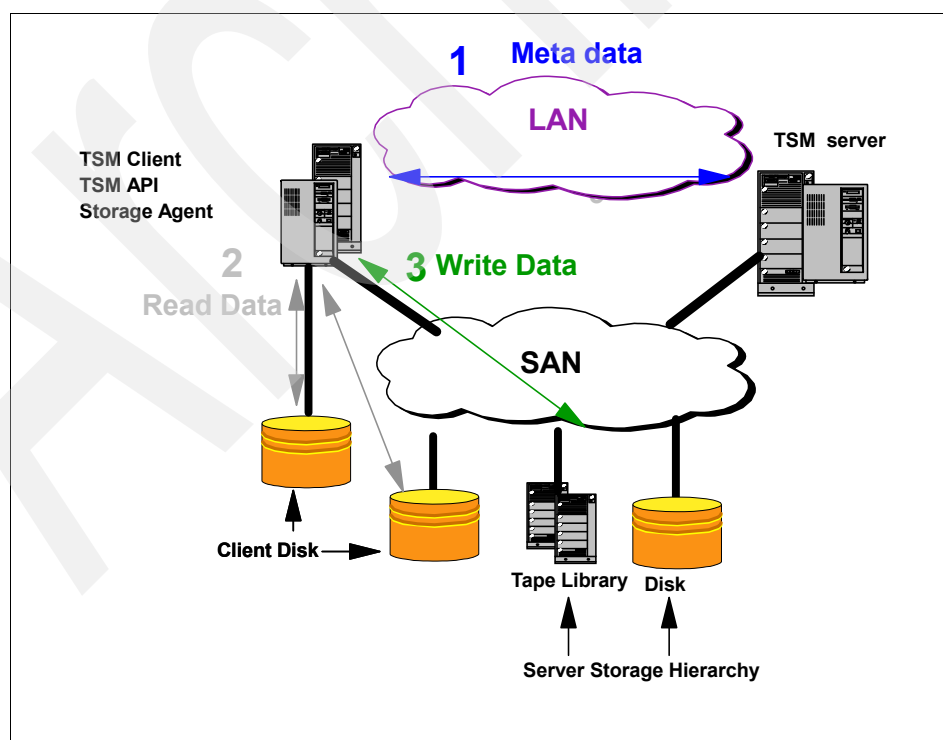


Figure 5-3 Tivoli Storage Manager LAN-free data transfer overview

5.2 Non-shared tape device with Tivoli Storage Manager

In this section we discuss configuring the IBM LTO tape libraries with Tivoli Storage Manager in AIX, Solaris, and HP-UX environments. We used both an FC-connected IBM TS3100 LTO tape library, and a TS3400 3592 tape library.

The lab environment for the Tivoli Storage Manager installation with FC-connected tape devices was as follows:

- ▶ IBM Series p server, AIX Release 5.3.0, and FC adapter
- ▶ IBM System Storage TS3100 Tape Library with FC LTO4 drive
- ▶ IBM System Storage TS3400 Tape Library with IBM TS1120 drives

The following discussion is valid for all generations of LTO. Some parameters might be specific for the different LTO generations (for example, device formats or encryption); they are clearly noted in the text. Similarly, the Tivoli Storage Manager Version 5.3 and 5.4 are only slightly different from the earlier Version 5.2 with respect to the Command Line Interface used throughout this discussion.

All discussions on the setup of Tivoli Storage Manager, except what is specifically device dependent, are the same for all the general IBM LTO libraries, IBM TS3200, TS3310, and TS3500. Also, the setup for 3592 libraries, the IBM TS3400, and the TS3500, will follow this discussion.

5.2.1 Installing Tivoli Storage Manager

To install Tivoli Storage Manager Version 5.4, use the Tivoli Storage Manager manuals for the relevant operating system. For AIX, this is the *IBM Tivoli Storage Manager for AIX Installation Guide*, SC32-0134. This manual can be found at:

<http://publib.boulder.ibm.com/infocenter/tivihelp/v1r1/index.jsp>

To install Tivoli Storage Manager Version 5.3, also use the Tivoli Storage Manager Installation Guide manuals for the relevant operating system. For AIX, this is the *IBM Tivoli Storage Manager for AIX Installation Guide*, GC32-1597. You can find these manuals at the aforementioned Web site; select the path for *Storage Manager previous versions*.

Support for new tape devices and tape functionality has been introduced in different versions and maintenance releases of TSM, to provide the necessary support as soon as the functionality is available.

Notes:

- ▶ Tivoli Storage Manager V5.1.6 supports LTO2 drives.
- ▶ Tivoli Storage Manager V5.2 supports mixing LTO1 and 2 in the same logical library.
- ▶ Tivoli Storage Manager V5.2.3 or V5.3 support IBM 3592 tape drives, including WORM.
- ▶ Tivoli Storage Manager V5.2.4 or V5.3.1 supports LTO3 tape drives, and a mix of LTO1, 2 and 3 in the same logical library
- ▶ Tivoli Storage Manager V5.2.5 or V5.3.1.2 supports the LTO3 WORM
- ▶ Tivoli Storage Manager V5.2.7 or V5.3.3 supports the 3592-2 drives (500GB)
- ▶ Tivoli Storage Manager V5.3.4 or V5.4 supports encryption (AME) with the IBM 3592 drives
- ▶ Tivoli Storage Manager V5.3.4.1 supports the 3592-2 drives (JB/JX 700GB)
- ▶ Tivoli Storage Manager V5.3.5 or V5.4.1 supports the TS3400 library and LTO4 tape drives
- ▶ Tivoli Storage Manager V5.3.5.1 or V5.4.1 supports encryption with LTO4 drives

Installation summary

When installing Tivoli Storage Manager, the default configuration sets up a disk storage pool for storing backup data. Before you can begin using tape devices as a backup destination, you must do the following tasks:

1. Attach the devices to your system, which includes physically attaching the devices, configuring the device drivers, and determining the device names.
2. Define the library and the drives in the library with their connection paths, a device class using the library, and a storage pool associated with the device class.
3. Include the storage pool in your storage hierarchy.

To perform these tasks, you can use either the administrative client command line or Web interface. Our examples use the command line interface. This interface is the same across all present Tivoli Storage Manager versions, while the Web-based administrative command interface has changed completely between the previous Tivoli Storage Manager Versions 5.2 and 5.3, with the introduction of the Administrative Console in V5.3. Refer to the Tivoli Storage Manager manuals and Redbooks publications for details using the Web interface.

The next three sections show how to define IBM tape devices in each of the specific AIX, Solaris, and HP-UX standalone (non-shared) environments.

Refer to the following Web site for Tivoli product requirements, supported devices, and code levels:

<http://www-306.ibm.com/software/sysmgmt/products/support/IBMTivoliStorageManager.html>

5.2.2 Configuring non-shared tape library and drives for AIX

You should have already installed your tape drives and library (including the Atape device driver) according to Chapter 3, “Basic IBM Open Systems Tape setup for UNIX systems” on page 95, and Chapter 4, “SAN considerations” on page 155. Now determine the names of your devices (see Example 5-1).

Example 5-1 Installed and available drives and media changer on AIX

```
# lsdev -Cc tape
rmt0 Available 34-08-02      IBM 3580 LTO Tape Drive (FCP)
rmt1 Available 14-08-02      IBM 3592 Tape Drive (FCP)
rmt2 Available 14-08-02-PRI  IBM 3592 Tape Drive (FCP)
smc0 Available 34-08-02      IBM 3573 Tape Medium Changer (FCP)
smc1 Available 14-08-02-PRI  IBM 3577 Library Medium Changer (FCP)
smc2 Available 14-08-02-PRI  IBM 3577 Library Medium Changer (FCP)
```

For performance reasons, we suggest that you use a variable block size length and have hardware compression turned on.

To display or change this setting, use **SMIT** → **Devices** → **Tape Drive** → **Change/Show Characteristics of a Tape Drive**.

Example 5-2 reflects a tape drive configured with Block Size = 0, which means variable length blocks, and Hardware Compression on Tape = yes. The exact content of this example might change with different tape drives and AIX versions. Note that Tivoli Storage Manager can override the device settings for hardware compression by use of the **FORMAT** parameter in the **DEFINE DEVCLASS** command (see 5.2.5, “Defining device class and storage pool” on page 189).

Example 5-2 Change/show characteristics of a tape drive

Change/Show Characteristics of a Tape Drive

Type or select values in entry fields.
Press Enter AFTER making all desired changes.

	[Entry Fields]	
Tape Drive	rmt0	
Tape Drive type	3580	
Tape Drive interface	fc	
Description	IBM 3580 Ultrium Tape Drive (FCP)	
Status	Available	
Location	34-08-02	
Parent adapter	fscsi1	
Connection address	1	
SCSI ID	0xb1e26	
Logical Unit ID	0x0	
World Wide Port Name	0x2002000e11105b14	
World Wide Node Name	0x2001000e11105b14	
New Logical Name	[]	
Enable Alternate Pathing Support	no	+
Block size (0=variable length)	[0]	+#
Use Hardware Compression on Tape	yes	+
Use Autoloading Feature at End-of-Tape	no	+
Activate volume information logging	no	+
Maximum size of log file (in # of entries)	[500]	+#
Backward Space/Forward Space Record Mode	SCSI	+
Use Immediate Bit in Rewind Commands	no	+
Trailer Label Processing	no	+
	no	+
	custom	+

Define the library and tape drives

Use the following commands to define the library, the library path, the drives, and the drive paths to Tivoli Storage Manager using the administrative command line. When there are multiple choices, the default setting is listed last.

```
DEFINE LIBRARY library_name LIBTYPE=SCSI AUTOLABEL=yes/no
DEFINE PATH server_name library_name SRCTYPE=SERVER DESTTYPE=LIBRARY DEVICE=dev_name
```

For *library_name*, enter a user-specified name of the library to be defined:

```
DEFINE LIBRARY lib3400 LIBTYPE=SCSI
```

For *server_name*, enter the name of your Tivoli Storage Manager server, and for *dev_name*, enter the full device name of library, like /dev/smc0:

```
DEFINE PATH tsm lib3400 SRCTYPE=SERVER DESTTYPE=LIBRARY DEVICE=/dev/smc1
```

Next, define each of the library's drives and drive paths with:

```
DEFINE DRIVE library_name drive_name ELEMENT=element_number/AUTODETECT \
CLEANFREQUENCY=Gigabytes/ASNEEDED/NONE
```

```
DEFINE PATH server_name drive_name SRCTYPE=SERVER DESTTYPE=DRIVE LIBRARY=library_name \
DEVICE=dev_name
```

For *library_name*, enter the name of your already defined library (lib3400 in our example). Use the operating system device name of the tape drive being defined for *dev_name*. Enter the full device name for *dev_name*, like /dev/rmt0. The *element_address* is a number that indicates

the physical location of a drive within an automated library. Tivoli Storage Manager needs the element address to connect the physical location of the drive to the drive's SCSI address. Starting with V5.2 you can specify autodetect for *element_number*. When specified as autodetect (default) the element number will automatically be detected by Tivoli Storage Manager when the path to the drive is defined.

For your reference, for the TS3500 you can get the SCSI *element_number* of your drives from the Operator Guide manual, refer to *IBM SystemStorage TS3500 Tape Library Operator Guide*, GA32-0560. Generally you can get this information from the Tivoli Storage Manager device support Web page:

http://www-306.ibm.com/software/sysmgmt/products/support/IBM_TSM_Supported_Devices_for_AIXHPSUNWIN.html

Under Supported Devices, select the relevant Tape Libraries. Click the appropriate device to obtain the element addresses.

To use **tapeutil** (the utility program installed together with the tape drivers), open one device and select option **14: Element Inventory**. Search for Drive Address and make sure it shows the correct SCSI bus address matching your operating system device driver. The *drive address* is the element address of a tape drive. Example 5-3 shows you one drive with element addresses of 257.

Example 5-3 Element information returned by tapeutil

```

Drive Address 257
Drive State ..... Normal
ASC/ASCQ ..... 0000
Media Present ..... No
Robot Access Allowed ..... Yes
Source Element Address Valid ... No
Media Inverted ..... No
Same Bus as Medium Changer ..... Yes
SCSI Bus Address Vaild ..... No
Logical Unit Number Valid ..... No
Volume Tag .....
  
```

Keep in mind that your drives are not necessarily configured by the operating system in the same order as they are installed physically in the library, as described in 4.3, “Persistent binding” on page 167. Therefore, check carefully that the element address maps with your drive configuration.

Note: The CLEANFREQUENCY parameter in the DEFINE DRIVE command is optional. Tivoli Storage Manager-managed cleaning is intended for drives and libraries that do not have an automatic cleaning function. The IBM TS3310, TS3400, and TS3500 have an automatic cleaning function, which means they take care of drive cleaning. Therefore, it is not necessary to specify the CLEANFREQUENCY parameter since the default value is NONE.

If you want Tivoli Storage Manager to control drive cleaning, you should use the option ASNEEDED. Change the *auto cleaning* function setting to the *host cleaning* function on the library. Also, if you use a physically partitioned IBM TS3500, then every logical partition needs its own cleaner cartridge.

There is no need to clean LTO drives on a periodic basis (that is, after a set number of gigabytes has been processed by the drive), and additional manual cleanings are discouraged.

Our TS3400 has been partitioned into two logical libraries with one drive each. We configured our drives in the IBM TS3400 with:

```
DEFINE DRIVE lib3400 drive1
```

```
DEFINE DRIVE lib3400-2 drive2
```

```
DEFINE PATH tsm drive1 SRCTYPE=SERVER DESTTYPE=DRIVE LIBRARY=lib3400 DEVICE=/dev/rmt1
```

```
DEFINE PATH tsm drive2 SRCTYPE=SERVER DESTTYPE=DRIVE LIBRARY=lib3400-2 DEVICE=/dev/rmt2
```

Tip: Before defining the drives and libraries, make sure that your library is online and your drives are available to AIX. Also, there should not be any cartridge loaded in the drive being defined.

Continue the implementation with 5.2.5, “Defining device class and storage pool” on page 189.

5.2.3 Configuring non-shared tape library and drives for Solaris

You should have already installed your tape drives and library according to Chapter 3, “Basic IBM Open Systems Tape setup for UNIX systems” on page 95, and Chapter 4, “SAN considerations” on page 155. Now determine the names of your devices; you will see a listing similar to the one in Example 5-4.

Example 5-4 Installed and available drives and media changer on SUN Solaris

```
# ls -la /dev/rmt
total 52
drwxrwxr-x  2 root  sys   512 Mar 30 10:35 .
drwxrwxr-x 13 root  sys  9216 Apr  3 15:07 ..
lrwxrwxrwx  1 root  root   47 Mar 27 11:34 0st -> ../../devices/pci@1f,4000/scsi@2/IBMtape@8,0:st
lrwxrwxrwx  1 root  root   48 Mar 27 11:34 0stb -> ../../devices/pci@1f,4000/scsi@2/IBMtape@8,0:stb
lrwxrwxrwx  1 root  root   49 Mar 27 11:34 0stbn -> ../../devices/pci@1f,4000/scsi@2/IBMtape@8,0:stbn
lrwxrwxrwx  1 root  root   48 Mar 27 11:34 0stc -> ../../devices/pci@1f,4000/scsi@2/IBMtape@8,0:stc
lrwxrwxrwx  1 root  root   49 Mar 27 11:34 0stcb -> ../../devices/pci@1f,4000/scsi@2/IBMtape@8,0:stcb
lrwxrwxrwx  1 root  root   50 Mar 27 11:34 0stcbn -> ../../devices/pci@1f,4000/scsi@2/IBMtape@8,0:stcbn
lrwxrwxrwx  1 root  root   49 Mar 27 11:34 0stcn -> ../../devices/pci@1f,4000/scsi@2/IBMtape@8,0:stcn
lrwxrwxrwx  1 root  root   48 Mar 27 11:34 0stn -> ../../devices/pci@1f,4000/scsi@2/IBMtape@8,0:stn
lrwxrwxrwx  1 root  root   48 Mar 27 11:34 1smc -> ../../devices/pci@1f,4000/scsi@2/IBMtape@8,1:smc
lrwxrwxrwx  1 root  root   47 Mar 27 11:34 2st -> ../../devices/pci@1f,4000/scsi@2/IBMtape@9,0:st
lrwxrwxrwx  1 root  root   48 Mar 27 11:34 2stb -> ../../devices/pci@1f,4000/scsi@2/IBMtape@9,0:stb
lrwxrwxrwx  1 root  root   49 Mar 27 11:34 2stbn -> ../../devices/pci@1f,4000/scsi@2/IBMtape@9,0:stbn
lrwxrwxrwx  1 root  root   48 Mar 27 11:34 2stc -> ../../devices/pci@1f,4000/scsi@2/IBMtape@9,0:stc
lrwxrwxrwx  1 root  root   49 Mar 27 11:34 2stcb -> ../../devices/pci@1f,4000/scsi@2/IBMtape@9,0:stcb
lrwxrwxrwx  1 root  root   50 Mar 27 11:34 2stcbn -> ../../devices/pci@1f,4000/scsi@2/IBMtape@9,0:stcbn
lrwxrwxrwx  1 root  root   49 Mar 27 11:34 2stcn -> ../../devices/pci@1f,4000/scsi@2/IBMtape@9,0:stcn
lrwxrwxrwx  1 root  root   48 Mar 27 11:34 2stn -> ../../devices/pci@1f,4000/scsi@2/IBMtape@9,0:stn
```

Refer to Table 3-1 on page 97 for the special device file names to be used with the Solaris operating system. The recommendation for Tivoli Storage Manager is to use *xst* or *xstc*, which is No BSD-compatibility and rewind on close. Therefore, we can use either */dev/rmt/xst* or */dev/rmt/xstc* (compression on).

For performance reasons we suggest that you use a variable length block and hardware compression from the LTO drives. The block size length is configured in the *IBMtape.conf* file, as described in 3.3.2, “Configuring tape and medium changer devices” on page 124. For variable block size, set the *block_size=0*, as shown in Example 5-5.

Example 5-5 IBMtape.conf excerpt

```
name="IBMtape"
  class="scsi"
  target=0 lun=2
  block_size=0
  buffering=1
  immediate=0
  trailer=0
  sili=0;
```

To enable hardware compression you can specify the `/dev/rmt/xstc` device file when defining the tape drive. Note that Tivoli Storage Manager can also override the device settings for hardware compression by use of the `FORMAT` parameter in the `DEFINE DEVCLASS` command (see 5.2.5, “Defining device class and storage pool” on page 189).

Define the library and tape drives

Use the following commands to define the library, the library path, the drives, and the drive paths to Tivoli Storage Manager using the administrative command line. When there are multiple choices the default setting is listed last.

```
DEFINE LIBRARY library_name LIBTYPE=SCSI AUTOLABEL=yes/no
DEFINE PATH server_name library_name SRCTYPE=SERVER DESTTYPE=LIBRARY DEVICE=dev_name
```

For *library_name*, enter a user-specified name of the library to be defined, for example:

```
DEFINE LIBRARY lib3500 LIBTYPE=SCSI
```

For *server_name*, enter the name of your Tivoli Storage Manager server, and for *dev_name*, enter the full device name of library, like `/dev/rmt/1smc`:

```
DEFINE PATH sol-e lib3500 SRCTYPE=SERVER DESTTYPE=LIBRARY DEVICE=/dev/rmt/1smc
```

Next, define each of the library’s drives and drive paths with:

```
DEFINE DRIVE library_name drive_name ELEMENT=element_number/AUTODETECT \
CLEANFREQUENCY=Gigabytes/ASNEEDED/NONE
```

```
DEFINE PATH server_name drive_name SRCTYPE=SERVER DESTTYPE=DRIVE LIBRARY=library_name \
DEVICE=dev_name
```

For *library_name*, enter the name of your already defined library (lib3500 in this example). Use the operating system device name of the tape drive being defined for *dev_name*. Enter the full device name for *dev_name*, like `/dev/rmt/0st`. The *element_address* is a number that indicates the physical location of a drive within an automated library. Tivoli Storage Manager needs the element address to connect the physical location of the drive to the drive’s SCSI address. From V5.2 onwards, you can specify autodetect as *element_number*. When specified as autodetect (the default for V5.2), the element number will automatically be detected by Tivoli Storage Manager when the path to the drive is defined.

For your reference, for the TS3500 you can get the SCSI *element_number* of your drives from the Operator Guide manual, refer to *IBM SystemStorage TS3500 Tape Library Operator Guide*, GA32-0560. Generally you can get this information from the Tivoli Storage Manager device support Web page:

http://www-306.ibm.com/software/sysmgmt/products/support/IBM_TSM_Supported_Devices_for_AIXHPSUNWIN.html

Under Supported Devices, select the relevant Tape Libraries. Click the appropriate device to obtain the element addresses.

To use **tapeutil** (the utility program installed together with the tape drivers), open the media changer device and use option **17: Inventory**. Search for the drive address. The drive address is the element address of a tape drive, see Example 5-6.

Example 5-6 Element information returned by tapeutil

```
Tape Drive Address 257
Tape Drive State ..... Normal
ASC/ASCQ ..... 0000
Media Present ..... No
Robot Access Allowed ..... Yes
Source Element Address Valid ... No
Media Inverted ..... No
Same Bus as Medium Changer ..... Yes
SCSI Bus Address ..... 35
Logical Unit Number ..... 0
Volume Tag .....
```

--- more ---

```
Tape Drive Address 258
Tape Drive State ..... Normal
ASC/ASCQ ..... 0000
Media Present ..... No
Robot Access Allowed ..... Yes
Source Element Address Valid ... No
Media Inverted ..... No
Same Bus as Medium Changer ..... Yes
SCSI Bus Address ..... 36
Logical Unit Number ..... 0
Volume Tag .....
```

Remember that your drives are not necessarily configured by the operating system in the same order as they are installed physically in the library, as described in 4.3, “Persistent binding” on page 167. Therefore, check carefully that the element address maps with your drive configuration.

Note: The **CLEANFREQUENCY** parameter in the **DEFINE DRIVE** command is optional. Tivoli Storage Manager-managed cleaning is intended for drives and libraries that do not have an automatic cleaning function. The IBM tape libraries have an automatic cleaning function, which means they take care of drive cleaning. Therefore, it is not necessary to specify the **CLEANFREQUENCY** parameter since the default value is **NONE**.

The IBM 3581 2U does not have an automatic cleaning function; therefore, it is recommended to let Tivoli Storage Manager manage the cleaning of this device.

If you want Tivoli Storage Manager to control drive cleaning, you should use the option **ASNEEDED**. Change the *auto cleaning* function setting to the *host cleaning* function on the autoloader or library. Also, if you use a partitioned IBM TS3500, then every logical partition needs its own cleaner cartridge.

There is no need to clean LTO drives on a periodic basis (that is, after a set number of gigabytes have been processed by the drive), and additional manual cleanings are discouraged.

Continue the implementation with 5.2.5, “Defining device class and storage pool” on page 189.

5.2.4 Configuring non-shared tape library and drives for HP-UX

You should have already installed your tape drives and library according to Chapter 3, “Basic IBM Open Systems Tape setup for UNIX systems” on page 95, and Chapter 4, “SAN considerations” on page 155. Now determine the names of your devices; you should see a listing similar to Example 5-7.

Example 5-7 Installed and available drives and media changer on HP-UX

```
# ls -la /dev/rmt
crw-rw-rw- 1 bin      bin      245 0x050000 Mar 16 11:13 Om
crw-rw-rw- 1 bin      bin      245 0x050080 Mar 16 11:13 Omb
crw-rw-rw- 1 bin      bin      245 0x050040 Mar 16 11:13 Omn
crw-rw-rw- 1 bin      bin      245 0x0500c0 Mar 17 17:14 Ombn
crw-rw-rw- 1 bin      bin      245 0x051000 Mar 16 11:28 lm
crw-rw-rw- 1 bin      bin      245 0x051080 Mar 16 11:13 lmb
crw-rw-rw- 1 bin      bin      245 0x051040 Mar 16 11:13 lmn
crw-rw-rw- 1 bin      bin      245 0x0510c0 Mar 17 17:51 lmbn
crw-rw-rw- 1 bin      bin      245 0x056000 Mar 16 11:14 2chng
crw-rw-rw- 1 bin      bin      245 0xfffffc Mar 16 11:13 atdd.cfg
crw-rw-rw- 1 bin      bin      245 0xfffffd Mar 16 11:13 atdd.dbg
crw-r--r-- 1 root     root     245 0xfffffe Mar 15 11:24 atdd_config
crw-rw-rw- 1 bin      bin      245 0x050000 Mar 16 11:13 c5t0d0BEST
crw-rw-rw- 1 bin      bin      245 0x050080 Mar 16 11:13 c5t0d0BESTb
crw-rw-rw- 1 bin      bin      245 0x050040 Mar 16 11:13 c5t0d0BESTn
crw-rw-rw- 1 bin      bin      245 0x0500c0 Mar 16 11:13 c5t0d0BESTnb
crw-rw-rw- 1 bin      bin      245 0x051000 Mar 16 11:14 c5t1d0BEST
crw-rw-rw- 1 bin      bin      245 0x051080 Mar 16 11:14 c5t1d0BESTb
crw-rw-rw- 1 bin      bin      245 0x051040 Mar 16 11:14 c5t1d0BESTn
crw-rw-rw- 1 bin      bin      245 0x0510c0 Mar 16 11:14 c5t1d0BESTnb
```

For performance reasons we suggest that you use hardware compression. Recording format ultrium2c (LTO2), ultrium3c (LTO3), or ultrium4c (LTO4), which are configured when the device class is defined, use hardware compression. More information on how to configure the device class is in 5.2.5, “Defining device class and storage pool” on page 189.

Define the library and tape drives

Use the following commands to define the library, the library path, the drives, and the drive paths to Tivoli Storage Manager using the administrative command line. When there are multiple choices, the default setting is listed last.

```
DEFINE LIBRARY library_name LIBTYPE=SCSI AUTOLABEL=yes/no
EFINE PATH server_name library_name SRCTYPE=SERVER DESTTYPE=LIBRARY DEVICE=dev_name
```

For *library_name*, enter a user-specified name of the library to be defined, for example:

```
DEFINE LIBRARY lto3500 LIBTYPE=SCSI
```

For *server_name*, enter the name of your Tivoli Storage Manager server, and for *dev_name*, enter the full device name of the library, such as `/dev/rmt/2chng`.

```
DEFINE PATH easter lto3500 SRCTYPE=SERVER DESTTYPE=LIBRARY DEVICE=/dev/rmt/2chng
```

Next, define each of the library’s drives and drive paths with:

```
DEFINE DRIVE library_name drive_name ELEMENT=element_number/AUTODETECT \
CLEANFREQUENCY=Gigabytes/ASNEEDED/NONE
```

```
DEFINE PATH server_name drive_name SRCTYPE=SERVER DESTTYPE=DRIVE LIBRARY=library_name \
DEVICE=dev_name
```

For *library_name*, enter the name of your already defined library (lto3500 in this example). Use the operating system device name of the tape drive being defined for *dev_name*. Enter the full device name for *dev_name* such as /dev/rmt/0m. The *element_address* is a number that indicates the physical location of a drive within an automated library. Tivoli Storage Manager needs the element address to connect the physical location of the drive to the drive's SCSI address. From V5.2 onwards, you can specify autodetect as the *element_number*. When specified as autodetect (default in V5.2) the element number will automatically be detected by Tivoli Storage Manager when the path to the drive is defined.

For your reference, for the TS3500 you can get the SCSI *element_number* of your drives from the Operator Guide manual, refer to *IBM SystemStorage TS3500 Tape Library Operator Guide*, GA32-0560. Generally you can get this information from the Tivoli Storage Manager device support Web page:

http://www-306.ibm.com/software/sysmgmt/products/support/IBM_TSM_Supported_Devices_for_AIXHPSUNWIN.html

Under Supported Devices, select the relevant Tape Libraries. Click the appropriate device to obtain the element addresses.

To use **tapeutil** (the utility program installed together with the tape drivers), open one device and use option **14: Element Inventory**. Search for Drive Address. The *drive address* is the element address of a tape drive. Example 5-8 shows you two drives with the element addresses of 256 and 257.

Example 5-8 Element information returned by tapeutil

```
Drive Address 256
Drive State ..... Normal
ASC/ASCQ ..... 0000
Media Present ..... No
Robot Access Allowed ..... Yes
Source Element Address Valid ... No
Media Inverted ..... No
Same Bus as Medium Changer ..... Yes
SCSI Bus Address ..... 0
Logical Unit Number Valid ..... No
Volume Tag .....
```

Hit <enter> to continue...

```
Drive Address 257
Drive State ..... Normal
ASC/ASCQ ..... 0000
Media Present ..... No
Robot Access Allowed ..... Yes
Source Element Address Valid ... No
Media Inverted ..... No
Same Bus as Medium Changer ..... Yes
SCSI Bus Address ..... 1
Logical Unit Number Valid ..... No
Volume Tag .....
```

Keep in mind that your drives are not necessarily configured by the operating system in the same order as they are installed physically in the library, as described in 4.3, “Persistent binding” on page 167. Therefore, check carefully that the element address maps with your drive configuration.

Note: The CLEANFREQUENCY parameter in the DEFINE DRIVE command is optional. Tivoli Storage Manager-managed cleaning is intended for drives and libraries that do not have an automatic cleaning function. The IBM tape libraries have an automatic cleaning function, which means they take care of drive cleaning. Therefore, it is not necessary to specify the CLEANFREQUENCY parameter since the default value is NONE.

The IBM 3581 2U does not have an automatic cleaning function; therefore, it is recommended to let Tivoli Storage Manager manage the cleaning of this device.

If you want Tivoli Storage Manager to control drive cleaning, you should use the option ASNEEDED. Change the *auto cleaning* function setting to the *host cleaning* function on the autoloader or library.

There is no need to clean LTO drives on a periodic basis (that is, after a set number of gigabytes has been processed by the drive), and additional manual cleanings are discouraged.

Continue the implementation with the following section.

5.2.5 Defining device class and storage pool

Configuring the device classes and storage pools is the same for the AIX, Solaris, and HP-UX environments. When there are multiple choices, the default setting is listed last.

LTO4 and LTO3 definitions are similar, except for specifying format=ultrium4c or =ultrium3c.

Define device class

Configure the device class:

For LTO drives use *LTO* as DEVTYPE parameter.

```
DEFINE DEVCLASS devclass_name LIBRARY=library_name DEVTYPE=LTO \  
FORMAT=Ultrium/UltriumC/Ultrium2/Ultrium2C/Ultrium3/Ultrium3C/Ultrium4/Ultrium4C/Drive \  
MOUNTLIMIT=mount_limit/DRIVES
```

If using any 3592 drives, use *3592* as DEVTYPE parameter.

```
DEFINE DEVCLASS devclass_name LIBRARY=library_name DEVTYPE=3592 \  
FORMAT=3592/3592C/3592-2/3592-2c/Drive MOUNTLIMIT=mount_limit/DRIVES
```

The *library_name* will match the name of the library you previously defined.

The FORMAT parameter has the following valid options for LTO:

► drive

The server selects the highest format that can be supported by the drive on which a volume is mounted. This value will use the settings on the tape drive characteristics (device driver) for hardware compression. This is the default.

► ultrium

This specifies that Tivoli Storage Manager writes data using the ULTRIUM recording format. This format results in a cartridge capacity of 100 GB when using an Ultrium 100 GB data cartridge. This value overrides the settings on the tape drive characteristics for hardware compression.

► **ultriumc**

This specifies that Tivoli Storage Manager writes data using the ULTRIUM recording format with compression. This format results in a cartridge capacity of approximately 200 GB when using an Ultrium 100GB data cartridge. This value overrides the settings on the tape drive characteristics for hardware compression.

► **ultrium2**

Specifies that Tivoli Storage Manager writes data using the ULTRIUM2 recording format. This format results in a cartridge capacity of 200 GB when using Ultrium2 200 GB data cartridges. This value overrides the settings on the tape drive characteristics for hardware compression.

► **ultrium2c**

Specifies that Tivoli Storage Manager writes data using the ULTRIUM2 recording format with compression. This format results in a cartridge capacity of approximately 400 GB when using Ultrium2 200 GB data cartridges. This value overrides the settings on the tape drive characteristics for hardware compression.

► **ultrium3**

Specifies that Tivoli Storage Manager writes data using the ULTRIUM3 recording format. This format results in a cartridge capacity of 400 GB when using Ultrium3 400 GB data cartridges. This value overrides the settings on the tape drive characteristics for hardware compression.

► **ultrium3c**

Specifies that Tivoli Storage Manager writes data using the ULTRIUM3 recording format with compression. This format results in a cartridge capacity of approximately 800 GB when using Ultrium3 400 GB data cartridges. This value overrides the settings on the tape drive characteristics for hardware compression.

► **ultrium4**

Specifies that Tivoli Storage Manager writes data using the ULTRIUM4 recording format. This format results in a cartridge capacity of 800 GB when using Ultrium4 800 GB data cartridges. This value overrides the settings on the tape drive characteristics for hardware compression.

► **ultrium4c**

Specifies that Tivoli Storage Manager writes data using the ULTRIUM4 recording format with compression. This format results in a cartridge capacity of approximately 1600 GB when using Ultrium4 800 GB data cartridges. This value overrides the settings on the tape drive characteristics for hardware compression.

The **FORMAT** parameter has the following valid options for the 3592:

► **3592**

Specifies that Tivoli Storage Manager writes data using the 3592 recording format. This format results in a cartridge capacity of 300 GB when using 3592 300GB data cartridges. This value overrides the settings on the tape drive characteristics for hardware compression.

► **3592c**

Specifies that Tivoli Storage Manager writes data using the 3592 recording format with compression. This format results in a cartridge capacity of approximately 900 GB when using 3592 300 GB data cartridges. This value overrides the settings on the tape drive characteristics for hardware compression.

► **3592-2**

Specifies that Tivoli Storage Manager writes data using the 3592-2 recording format. This format results in a cartridge capacity of 500 GB when using 3592 500GB JA/JW data cartridges, and 700 GB using the 700GB JB/JX data cartridges. This value overrides the settings on the tape drive characteristics for hardware compression.

► **3592-2c**

Specifies that Tivoli Storage Manager writes data using the 3592 recording format with compression on TS1120 drives. This format results in a cartridge capacity of approximately 1500 GB when using 3592 500 GB JA/JW data cartridges, and 2100 GB using the 700GB JB/JX data cartridges. This value overrides the settings on the tape drive characteristics for hardware compression.

Compression in general improves backup performance. Therefore, we recommend that you use compression either specifically with

FORMAT=ultriumc/ultrium2c/ultrium3c/ultrium4c/3592c/3592-2c; or with FORMAT=drive, which implies that the server selects the highest format that is supported by the drive on which a volume is mounted. (Do not use FORMAT=drive for a library containing a mix of Ultrium 1, 2, 3, or 4 drives. Use then the specific definitions, as described in detail in 5.11, “Device migration and co-existence” on page 214).

If you use FORMAT=ultriumc/ultrium2c/ultrium3c/ultrium4c/3592c/3592-2c/drive, then your LAN-free clients also use compression regardless of whether hardware compression is enabled.

Note that Tivoli Storage Manager also provides optional client compression. If this is enabled, then clients compress their data before sending it to the storage device. This is particularly useful where the network connection between the client and server is slow and traffic needs to be minimized. With client compression on, using tape drive compression has little effect and is not recommended.

You should evaluate your environment and requirements (probably by performing some appropriate testing) to determine if client compression is of benefit. If so, then enable it, and use the uncompressed (FORMAT=ultrium/ultrium2/ultrium3/ultrium4/3592/3592-2) flag when defining the device class. If not, then tape drive compression should be used.

The option MOUNTLIMIT specifies the maximum number of sequential access volumes that can simultaneously be mounted for the device class. This parameter is optional. The default is drives, which means that the maximum is set to the number of drives installed and available in the library. There are two reasons why you might use a specific value rather than the default:

- If you are going to share the library among multiple servers, you might want to specify a number instead of the default drives to limit the number of drives to which each server has access.
- If you have a mixture of LTO generation drives in the same library, see 5.11, “Device migration and co-existence” on page 214 for more information. It is then recommended that the default value of drives is not used for the older LTOx device classes. For example, when specifying MOUNTLIMIT=drives, the Tivoli Storage Manager server will load LTO2 cartridges into LTO2 drives in preference to LTO3 or 4 drives, but there exists the possibility that all LTO3 or 4 drives could be loaded with LTO2 cartridges and therefore, an LTO3 or 4 cartridge could not be loaded. It might be necessary to set the MOUNTLIMIT parameter to a value that is equal to the number of that version of drives, or certainly to a value less than the total number of drives in the library.

For the following discussion we defined an IBM TS3500 in our UNIX environment, called the device class `dev3500lto4`, pointing to our library `lib3500`, specified `ULTRIUM4C` for the `FORMAT` parameter and set the `MOUNTLIMIT` to 2.

```
DEFINE DEVCLASS dev3500lto4 DEVTYPE=LTO LIBRARY=lib3500 FORMAT=ULTRIUM4C MOUNTLIMIT=2
```

See Example 5-9 for device class definition.

Example 5-9 Query devclass dev3500lto4 f=d

```
Device Class Name: DEV3500LT04
  Device Access Strategy: Sequential
    Storage Pool Count: 1
      Device Type: LTO
        Format: ULTRIUM4C
    Est/Max Capacity (MB):
      Mount Limit: 2
    Mount Wait (min): 60
  Mount Retention (min): 60
    Label Prefix: ADSM
      Library: lib3500
        Directory:
          Server Name:
            Retry Period:
              Retry Interval:
                Shared:
          High-level Address:
            Minimum Capacity:
              WORM: No
            Scaled Capacity:
  Last Update by (administrator): ADMIN
    Last Update Date/Time: 04/08/07 20:42:03
```

Define storage pool

Define the storage pool with:

```
DEFINE STGPPOOL stgpool_name devclass_name MAXSCRATCH=number
```

This storage pool will be assigned (written) to the device class we just defined, so we specify the name, `dev3500lto4`. We used `lto4pool` as the `stgpool_name`, and defined a maximum of 200 tapes belonging to this storage pool:

```
DEFINE STGPPOOL lto4pool dev3500lto4 MAXSCRATCH=200
```

Example 5-10 shows you the storage pool we defined.

Example 5-10 q stgpool lto4pool f=d

```
Storage Pool Name: lto4pool
  Storage Pool Type: Primary
    Device Class Name: DEV3500LT04
  Estimated Capacity (MB): 0.0
    Pct Util: 0.0
    Pct Migr: 0.0
    Pct Logical: 100.0
    High Mig Pct: 90
    Low Mig Pct: 70
    Migration Delay: 0
    Migration Continue: Yes
  Migration Processes:
    Next Storage Pool:
```

```
Reclaim Storage Pool:
Maximum Size Threshold: No Limit
Access: Read/Write
Description:
Overflow Location:
Cache Migrated Files?:
Collocate?: No
Reclamation Threshold: 60
Maximum Scratch Volumes Allowed: 200
Delay Period for Volume Reuse: 0 Day(s)
Migration in Progress?: No
Amount Migrated (MB): 0.00
Elapsed Migration Time (seconds): 0
Reclamation in Progress?: No
Volume Being Migrated/Reclaimed:
Last Update by (administrator): ADMIN
Last Update Date/Time: 04/08/07 18:01:50
Storage Pool Data Format: Native
Copy Storage Pool(s):
Continue Copy on Error?:
CRC Data: No
Last Update Date/Time: 04/08/07 20:50:18
```

Now you can use this storage pool in your management class copy groups, so that the device will be used for backups or archives.

5.2.6 Inserting data and cleaning cartridges

Once we have set up our definitions, we need to identify the cartridges that Tivoli Storage Manager will use, either for storing data, or for cleaning the drives. LTO cartridges are identified as IBM machine type 3589. You can find information on how to buy LTO and 3592 cartridges from IBM, both data and cleaning, from the Web site:

<http://www-1.ibm.com/servers/storage/media/>

LTO and 3592 cartridges are also available from several other licensed manufacturers, which vary from country to country. Check your local sources for details.

Labeling data cartridges

Tivoli Storage Manager requires each tape used to have a physical label written on it for identification. You can label volumes individually or process multiple volumes with variations of the label command. Here, we want to perform initial labeling of all the new tapes in our library. Since the IBM TS3500 has a barcode reader, and the tapes already have an external barcode label, this command will cause the matching label to be written onto the tape. It is not necessary that the magnetic label is the same as the barcode label; however, you will avoid a lot of confusion by making them identical. We put the new tapes directly into the library, then used the following command:

```
LABEL LIBVOLUME 1ib3500 SEARCH=yes LABELSOURCE=barcode CHECKIN=scratch
```

The parameter SEARCH=Yes means that Tivoli Storage Manager searches inside the library for any unlabeled volume with a readable barcode. It then mounts each cartridge in turn and writes the label onto the tape.

Note: There should be no cleaning cartridges in the library inventory accessible from the host because Tivoli Storage Manager will try to label and mount them into a drive.

If you have enabled the tape library's autoclean function, and cleaning cartridges were inserted as appropriate, then those cartridges are not accessible from the host, and no labeling operation will occur for them.

After issuing the **LABEL LIBVOLUME** command, you can check on the status of the inserted volumes with the **QUERY LIBVOL** command. Example 5-11 shows all the labeled cartridges with scratch status. The element address is also displayed, so we can tell which physical location contains each volume.

Example 5-11 Tivoli Storage Manager: query libvol

Library Name	Volume Name	Status	Owner	Last Use	Home Element
-----	-----	-----	-----	-----	-----
lib3500	ABA920	Scratch			1,024
lib3500	ABA922	Scratch			1,025
lib3500	ABA923	Scratch			1,026
lib3500	ABA924	Scratch			1,037
lib3500	ABA925	Scratch			1,030
lib3500	ABA926	Scratch			1,031
lib3500	ABA927	Scratch			1,032
lib3500	ABA928	Scratch			1,029
lib3500	ABA929	Scratch			1,028
lib3500	ABA990	Scratch			1,036

Labeling data cartridges using the I/O station

To insert additional data cartridges to the library, use the command:

```
LABEL LIBVOLUME lib_name SEARCH=bulk LABELSOURCE=barcode CHECKIN=scratch
```

If you have only a few cartridges to insert, use the I/O station and use the option **SEARCH=bulk**. You will be prompted on the administrator console to insert all the volumes to be labeled into the I/O station, and to indicate that this has been done by issuing the command (at an administrative command prompt):

```
REPLY request_id
```

The server will then load and label the volumes it finds.

If you do not have an open administrator console, you can issue either the command **QUERY REQUEST** or **QUERY ACTLOG** to display information about pending mount requests.

Example 5-12 shows you an output of the activity log when inserting two cartridges into the IBM TS3500. We used this command:

```
LABEL LIBVOLUME lib3500 SEARCH=bulk LABELSOURCE=barcode CHECKIN=scratch
```

We followed it with this command to continue the operation:

```
REPLY 011
```

Example 5-12 Tivoli Storage Manager: Query actlog, for inserting new cartridges

```
04/09/07 18:49:11 ANR2017I Administrator ADMIN issued command: LABEL LIBVOLUME LIBM3584
SEARCH=BULK LABELSOURCE=BARCODE
CHECKIN=SCRATCH
04/09/07 18:49:11 ANR0984I Process 23 for LABEL LIBVOLUME started in the
```

```

                                BACKGROUND at 18:49:11.
04/09/07 18:49:11    ANR8799I LABEL LIBVOLUME: Operation for library lib3500
                                started as process 23.
04/09/07 18:49:11    ANR0609I LABEL LIBVOLUME started as process 23.
04/09/07 18:49:12    ANR8373I 011: Fill the bulk entry/exit port of library lib3500 with
                                all LTO volumes to be processed within 60 minute(s); issue 'REPLY'
                                along with the request ID when ready.
04/09/07 18:49:44    ANR2017I Administrator ADMIN issued command: REPLY 011
04/09/07 18:49:44    ANR8499I Command accepted.
04/09/07 18:51:00    ANR8810I Volume ABA926 has been labeled in library lib3500.
04/09/07 18:51:42    ANR8427I CHECKIN LIBVOLUME for volume ABA926 in library lib3500
                                completed successfully.
04/09/07 18:52:40    ANR8810I Volume ABA925 has been labeled in library lib3500.
04/09/07 18:53:22    ANR8427I CHECKIN LIBVOLUME for volume ABA925 in library
                                lib3500 completed successfully.

```

Labeling data cartridges without a barcode reader

If your library has a barcode reader (such as the IBM TS3100/TS3200, TS3310, TS3400 or TS3500), you will almost certainly be using this reader to label the cartridges. However, if you have an LTO model (such as the single drive IBM TS2340) without a barcode reader, you will need to manually specify a label. If the media is labeled with a barcode anyway, we strongly recommend that you use this barcode string to label the volume, since this will make it much easier for the operators to distinguish the volumes.

To insert an unlabeled cartridge, specify the volume name you want to use for the cartridge and put the cartridge in the I/O station or drive:

```
LABEL LIBVOLUME lib_name volume_name CHECKIN=scratch
```

You will be prompted to insert the cartridge and to indicate when it is available by issuing the command (at an administrative command prompt):

```
REPLY request_id
```

You can insert only one cartridge for each command. It will then be labeled by the server.

Example 5-13 shows you an output of the activity log for using this method with one unlabeled cartridge in an IBM TS3500. We used this command:

```
LABEL LIBVOLUME lib3500 unlab02 CHECKIN=SCRATCH
```

We followed it with this command to continue the operation:

```
REPLY 013
```

Example 5-13 Tivoli Storage Manager: Query actlog, output for manually labelling a cartridge

```

04/09/07 15:12:04    ANR2017I Administrator ADMIN issued command: LABEL
                                LIBVOLUME lib3500 unlab02 CHECKIN=SCRATCH OVERWRITE=YES
04/09/07 15:12:04    ANR0984I Process 28 for LABEL LIBVOLUME started in the
                                BACKGROUND at 15:12:04.
04/09/07 15:12:04    ANR8799I LABEL LIBVOLUME: Operation for library lib3500
                                started as process 28.
04/09/07 15:12:04    ANR0609I LABEL LIBVOLUME started as process 28.
04/09/07 15:12:06    ANR8323I 013: Insert LTO volume UNLAB02 R/W into
                                entry/exit port of library LIB3854 within 60 minute(s);
                                issue 'REPLY' along with the request ID when ready.
04/09/07 15:12:25    ANR2017I Administrator SERVER_CONSOLE issued command:
                                REPLY 013
04/09/07 15:12:25    ANR8499I Command accepted.
04/09/07 15:15:32    ANR8810I Volume UNLAB02 has been labeled in library lib3500.

```

```

04/09/07 15:16:15 ANR8427I CHECKIN LIBVOLUME for volume UNLAB02 in library lib3500
                  completed successfully.
04/09/07 15:16:16 ANR8800I LABEL LIBVOLUME for volume UNLAB02 in library
                  lib3500 completed successfully.
04/09/07 15:16:16 ANR0985I Process 28 for LABEL LIBVOLUME running in the BACKGROUND
                  completed with completion state SUCCESS at 15:16:16.

```

Inserting cleaner cartridges

If you have chosen to have Tivoli Storage Manager manage library cleaning, you need to insert some cleaning cartridges. Use:

```
CHECKIN LIBVOLUME lib3500 STATUS=cleaner CHECKLABEL=barcode SEARCH=bulk CLEANINGS=50
```

The parameter *SEARCH=bulk* means that Tivoli Storage Manager will search the library I/O station for usable volumes to check-in. Set the *CLEANINGS* parameter to the number of uses specified for your cartridge, for LTO this is 50. Insert one or more cleaner cartridges into the I/O station, and reply to the request issued by the server as shown in Example 5-14.

Example 5-14 Insert cleaner cartridge

```

04/09/07 20:02:56 ANR2017I Administrator ADMIN issued command: CHECKIN
                  LIBVOLUME lib3500 STATUS=CLEANER CHECKLABEL=BARCODE
                  MOUNTWAIT=60 SEARCH=BULK CLEANINGS=50
04/09/07 20:02:56 ANR0984I Process 4 for CHECKIN LIBVOLUME started in the
                  BACKGROUND at 20:02:56.
04/09/07 20:02:56 ANR8422I CHECKIN LIBVOLUME: Operation for library lib3500
                  started as process 4.
04/09/07 20:02:56 ANR0609I CHECKIN LIBVOLUME started as process 4.
04/09/07 20:03:07 ANR8373I 001: Fill the bulk entry/exit port of library lib3500
                  with all LTO volumes to be processed within 60 minute(s); issue
                  'REPLY' along with the request ID when ready.
04/09/07 20:03:09 ANR2017I Administrator ADMIN issued command: QUERY ACTLOG
04/09/07 20:03:21 ANR2017I Administrator ADMIN issued command: REPLY 001
04/09/07 20:03:21 ANR8499I Command accepted.
04/09/07 20:03:46 ANR8430I Volume CLN117 has been checked into library lib3500.
04/09/07 20:03:46 ANR1434W No files have been identified for automatically
                  storing device configuration information.
04/09/07 20:03:46 ANR8431I CHECKIN LIBVOLUME process completed for library
                  lib3500; 1 volume(s) found.
04/09/07 20:03:46 ANR0985I Process 4 for CHECKIN LIBVOLUME running in the
                  BACKGROUND completed with completion state SUCCESS at 20:03:46.

```

5.2.7 Performance hints for Tivoli Storage Manager with LTO or 3592

Since Tivoli Storage Manager writes a record to its database of each file backed up, it will perform better with large file workloads than with small file workloads. This is because of the proportion of time spent doing database writes and updates as a fraction of the total backup time. Therefore, to get the best performance from Tivoli Storage Manager with LTO and IBM 3592 drives, be sure to update the parameter *TXNGROUPMAX* on the server to a higher value than the default 256. This parameter controls how many files are transferred as a group between the client and server. Note that the larger the *txngroupmax* value, the larger the Tivoli Storage Manager database log area must be.

Tip: Tivoli Storage Manager V5.2 increased the maximum size for TXNGroupmax to 8192, and in V5.3 this was further increased to 65000. A value of 4096 or higher is recommended for environments that back up numerous small files such as 10 KB files. With Tivoli Storage Manager V5.3 this parameter can also be defined for the individual clients. Thus an intermediate value, say 2048, can be set for the server, and the high values should then be defined individually when registering the client.

In the client option file, also set the parameter TXNByteLimit to its maximum of 2097152 (2 GB). This parameter specifies the number of kilobytes the client program can buffer together in one transaction before it sends data to the server.

To set TXNGroupmax, edit the dsmserve.opt on the Tivoli Storage Manager server as shown in Example 5-15. If you are using the Storage Agent for LAN-free backup you should also set this parameter to the same value in the options file dsmsta.opt. The restart of the server process is required to enable this change (for Storage Agent, restart of the Storage Agent process is required).

Example 5-15 TXNGroupmax entry in dsmserve.opt and dsmsta.opt

```
*=====
* TXNGROUPMAX
*
* Specifies the maximum number of files transferred as a group between
* the client and storage agent.
*
* Syntax
* +-----+-----+
* | TXNGroupmax | value |
* +-----+-----+
*
* Parameters
* value Specifies the maximum number of files that are
* transferred as a group between the client and
* storage agent. The minimum value is 4 and the maximum
* value is 65000. The default value is 256.
*
* Examples
* TXNGroupmax 4096
```

Alternatively, the parameter can be set online to the server by the command:

```
SETOPT TXNGROUPMAX 4096
```

To set the client parameter TXNByteLimit, edit dsm.sys (for UNIX clients) or dsm.opt (for all other clients). The entry should look like:

```
TXNByteLimit 2097152
```

In general, small file workloads will back up faster if they are staged initially to a disk storage pool, which then migrates to the tape pool. More suggestions on storage pool configuration are in *IBM Tivoli Storage Manager Implementation Guide*, SG24-5416. We also recommended the use of compression on the tape drives as previously discussed in this chapter.

5.3 LTO WORM (Write Once Read Many)

As of the LTO3 tape drive LTO drives now has WORM functionality. Special LTO WORM cartridges (identified as LT cartridges) are designed to provide non-alterable, non-rewritable tape media for long-term records retention.

Tivoli Storage Manager supports IBM LTO3 WORM devices and media at V5.2.4.5 and V.5.3.1.2. IBM LTO WORM devices are only available with LTO3 and LTO4 devices and media. To use LTO WORM, an LTO WORM device class definition is required, and all the drives in this library must be WORM capable. This uses the WORM=YES parameter in the definition.

```
DEFINE DEVCLASS <class name> LIBRARY=<library name> DEVTYPE=LTO WORM=YES
```

Tivoli Storage Manager can only distinguish LTO WORM media from rewritable media when the media is mounted in a drive. Therefore, all WORM media needs to either be checked in with CHECKLabel=Yes or labeled with the CHECKIN parameter specified. Any media that is checked in without mounting in the drive is considered rewritable by Tivoli Storage Manager. Note that this also means that you cannot make use of the AUTOLABEL attribute of the library for WORM media. Once the media is checked in to Tivoli Storage Manager, Tivoli Storage

Note: This limitation is only for LTO in SCSI libraries, and does not apply to 3592 WORM in either SCSI or 3494 libraries.

5.4 Various 3592 media types and Tivoli Storage Manager

This section describes characteristics of the 3592 cartridges and drive functions, and how to use them with Tivoli Storage Manager. For detailed information on the hardware functions mentioned here, refer to the IBM 3592 product manuals. Although this is not an LTO tape drive, it can coexist with the LTO drives in the same IBM TS3500 library. And the IBM TS3400 library is especially suited in the Open Systems environments. Thus it is part of the Open Systems Tape systems discussed here.

The following cartridges formats are available for the 3592:

- ▶ JA - 609m 300/500 GB Standard R/W Tape
- ▶ JJ - 246m 60/100 GB Short R/W Tape
- ▶ JW - 609m 300/500 GB Standard WORM Tape
- ▶ JR - 246m 60/100 GB Short WORM Tape
- ▶ JB - 825m 700 GB Standard R/W Tape
- ▶ JX - 825m 700 GB Standard WORM Tape

The lower capacity (JA/JJ/JW/JR) cartridge is when the cartridge is used with the 3592 generation 1 tape drive, the 3592-J1A, The new TS1120, will write the same cartridges with the higher density, or use the lower density when operating in 3592-J1A compatibility mode. The JB/JX extended capacity cartridges are for use by the TS1120 only.

Capacity scaling and segmentation

The IBM 3592 supports scaling and segmentation modes on the different 300/500/700 GB R/W cartridges to allow a capacity trade off for improved access times.

Tivoli Storage Manager can utilize these functions by specifying the SCALECAPACITY parameter with the command **DEFINE/UPDATE DEVCLASS**.

A cartridge is initialized according to the SCALECAPACITY parameter when it is first mounted to the drive. It will stay in the SCALECAPACITY setting until it returns to scratch state.

Each of the SCALECAPACITY parameter settings (20/90/100) will initialize the cartridge as shown in Figure 5-4.

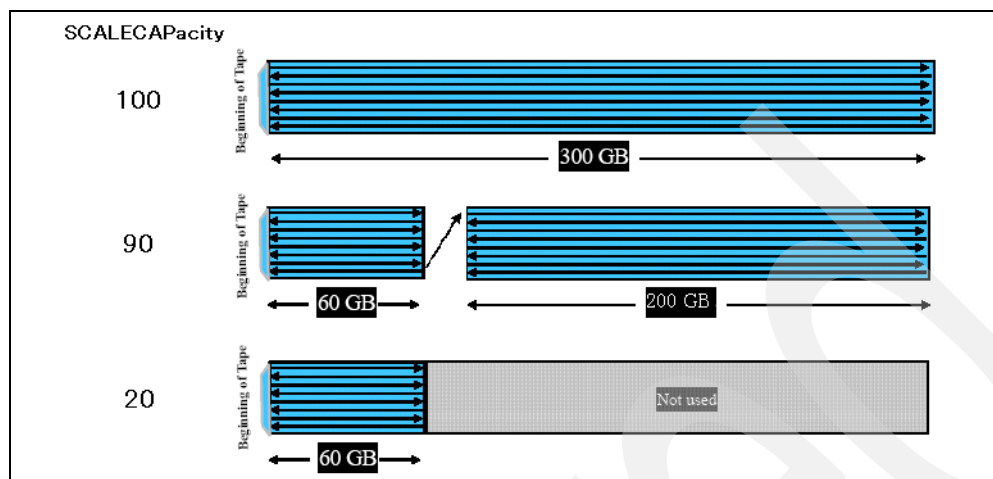


Figure 5-4 How each of the SCALECAPACITY parameter initializes 3592 JA cartridges

When SCALECAPACITY is set to 100 (default), Tivoli Storage Manager will initialize the cartridge as a full size (for example 300 GB) cartridge. When set to 90, it will initialize the cartridge as a segmented tape. When set to 20, it will initialize the cartridge to use only the first one fifth (60 GB) of the cartridge.

Depending on the customer requirements, in most cases you should use either the SCALECAPACITY=100 for capacity-oriented applications (for example, data backup) or SCALECAPACITY=20 for access-oriented applications such as HSM.

There is no practical reason for using SCALECAPACITY=90 because you cannot control where the data is written on the tape. After the first 60 GB segment is filled, the drive will proceed to write on the rest of the (slower access) tape. Each of the segmented parts must be defined to a different storage pool to fully utilize the segmented function, but with the current Tivoli Storage Manager architecture, it is not possible to define two storage pools for one volume.

WORM (Write Once Read Many)

The IBM 3592 WORM data cartridges are designed to provide non-alterable, non-rewritable tape media for long-term records retention. The drive will automatically determine if the mounted volume is a WORM or R/W cartridge.

To use this function, specify the parameter WORM=yes in the command **DEFINE/UPDATE DEVCLASS**. Tivoli Storage Manager V5.2.3 or later is required.

Because Tivoli Storage Manager can distinguish between WORM and R/W cartridges (assigns “media type” of 412 for WORM cartridges and 411 for R/W cartridges at the time of check-in), you can have both WORM and R/W cartridges in a single logical library just by defining device classes, one with WORM=yes and the other with WORM=no.

Note: For the IBM TotalStorage 3494 Tape Library, you would also need to specify WORMSCRATCHCATEGORY with the **DEFINE/UPDATE LIBRARY** command.

Short length (economy) cartridges

Both R/W and WORM cartridges are available with the standard length (300/500 GB) and the short length (60/100 GB) format.

For a JA (standard length) cartridge, define the device class as follows; you have the option to specify the SCALECAPACITY parameter:

```
DEFINE DEVCLASS devclass_name DEVTYPE=3592 FORMAT=3592/3592c/3592-2/3592-2c/drive \
LIBRARY=library_name SCALECAPACITY=20/90/100
```

For JJ (short length) cartridges, define the device class as follows:

```
DEFINE DEVCLASS devclass_name DEVTYPE=3592 FORMAT=3592/3592c/3592-2/3592-2c/drive \
LIBRARY=library_name
```

For JW and JR cartridges, define device class as follows:

```
DEFINE DEVCLASS devclass_name DEVTYPE=3592 FORMAT=3592/3592c/3592-2/3592-2c/drive \
LIBRARY=library_name WORM=yes
```

The SCALECAPACITY parameter with value other than 100 (default) can be specified only with the standard length R/W cartridge.

When the short length cartridges are initially defined to a storage pool, **QUERY VOLUME** and **QUERY STGPPOOL** will show you 300 GB (or 900 GB for compressed) for each of the volumes defined. When the EOVS (end-of-volume) is reached; query commands will show the actual data written for the volume.

Fast access storage pool with IBM 3592 in Tivoli Storage Manager

To configure a fast access storage pool with 3592 drives, you have two options:

1. Define a device class with SCALECAPACITY=20 and use standard length R/W cartridges.
2. Use short length (economy) cartridges.

To set up both the fast access storage pool and the non-fast access (optimized for capacity) storage pool in a single logical library:

1. If using method (1) to configure the fast access storage pool:

Define a separate device class for each storage pool, one with SCALECAPACITY=100 and one with SCALECAPACITY=20. The scratch JA tape will automatically be initialized to the storage pool it is called for.

2. If using method (2) to configure the fast access storage pool:

Since Tivoli Storage Manager does not distinguish between the short length and the standard length cartridges, you would need to define each of the cartridges explicitly to the storage pool.

It is probably a better idea to just logically partition the library into a *short length cartridge only* partition (fast access partition), and a *standard length cartridge only* partition (capacity partition).

5.5 Sharing LTO libraries with Tivoli Storage Manager

The concepts of library sharing were discussed in Chapter 2, "IBM Open Systems Tape Library sharing and partitioning" on page 39. In this section we briefly discuss configuration parameters to consider; for in-depth discussion of Tivoli Storage Manager, library sharing, and the use of SAN, refer to the Redbooks publication, *Get More Out of Your SAN with IBM Tivoli Storage Manager*, SG24-6687.

Several Tivoli Storage Manager servers can share the same tape library using the library sharing feature, as shown in Figure 5-2 on page 178. Tape library sharing is supported between any combination of Windows, AIX, Solaris, Linux, and HP-UX Tivoli Storage Manager servers. We recommend using the latest code level. You can find the link to download the latest code fixes at:

<http://www-306.ibm.com/software/sysmgmt/products/support/IBMTivoliStorageManager.html>

All servers that will share the library need to have an FC/SAN connection to the tape drives in the library. One server will control the library robotics and is designated the *Library Manager*. Other library users are designated *Library Clients*. Services are requested from the Library Manager, rather than the library itself as in non-shared library configurations. For instance, if a library client wants to write data to a tape, then the client has to ask the Library Manager to mount the tape volume. After the tape is mounted by the Library Manager, the library client can write the data directly over the physical SAN path to the tape drive.

5.5.1 Configuring the Library Manager to share libraries

Install and configure your tape library and drives on the Library Manager, as described in 5.2, “Non-shared tape device with Tivoli Storage Manager” on page 180. Library sharing is part of the Extended Edition functionality and does not require any special licensing any more. Define the library with the `shared=yes` parameter, such as:

```
DEFINE LIBRARY lib3500 LIBTYPE=SCSI SHARED=YES
```

Define drives and path information as for the non-shared environment.

Because library sharing uses server-to-server communication for sending and receiving requests, you need to configure server-to-server communications between the Library Manager and the library clients.

Set the following parameters on the Library Manager: `servername`, `password`, `serverhladdress`, `serverlladdress`, and set `crossdefine` to `on`.

```
SET SERVERNAME server_name
SET SERVERPASSWORD server_password
SET CROSSDEFINE on
SET SERVERHLADDRESS server_ip_address
SET SERVERLLADDRESS server_ip_portaddress
```

5.5.2 Configuring the library client

The library client is similarly set up for `crossdefine`. Set the parameters: `servername`, `password`, `serverhladdress`, `serverlladdress`, and set `crossdefine` to `on`.

```
SET SERVERNAME server_name
SET SERVERPASSWORD server_password
SET CROSSDEFINE on
SET SERVERHLADDRESS server_ip_address
SET SERVERLLADDRESS server_ip_portaddress
```

Next, we define the Library Manager server on each of the library clients, so that they will know which system is managing the tape libraries. Use the **DEFINE SERVER** command and match the parameters to the server definitions on the Library Manager (server name, password, IP address, and port number).

```
DEFINE SERVER library_manager_servername SERVERPASSWORD=library_manager_password \
HLADDRESS=library_manager_ip_address LLADDRESS=library_manager_port_number \
COMM=tcpip
```


Since we have set `crossdefine` to on, these commands should automatically create library client definitions on the Library Manager. Check this with the **QUERY SERVER** command.

5.5.3 Define library and drives for library client

See Chapter 3, “Basic IBM Open Systems Tape setup for UNIX systems” on page 95, and Chapter 4, “SAN considerations” on page 155 for basic tape drive installation on the library clients.

You will need to define the library definition at each library client. The drive paths must be defined for each library client drive, but this definition is done at the Library Manager.

```
DEFINE LIBRARY library_name LIBTYPE=shared PRIMARYLIBMANAGER=lib_manager_name
```

Note the use of the `LIBTYPE=shared` parameter. You must use the same `library_name` as was defined on the library server.

On the Library Manager define each of the tape drive paths for each library client as:

```
DEFINE PATH server_name drive_name SRCTYPE=SERVER DESTTYPE=DRIVE LIBRARY=library_name \
DEVICE=device_name
```

For `server_name`, enter the name of the library client, and for `device_name` specify the name of the device special file on the library client machine.

Important: Keep in mind that the drives are not necessarily configured by the operating system in the same order as they are installed physically in the library, as described in 4.3, “Persistent binding” on page 167. Therefore, check carefully that the element address matches your drive configuration.

You can check the result with the command **Q PATH**.

Now you can define the device class and the storage pool using the library definitions as described in 5.2.5, “Defining device class and storage pool” on page 189.

5.5.4 Administering shared libraries

When using a shared LTO library, it is important to remember that the library clients cannot directly access the library robotics (medium changer) themselves. Any requests for tape movement must be made through the Library Manager. While library clients do not directly access the library robotics, once a volume is mounted in a drive, the library clients can read or write data directly to the drive through the SAN data path. This means that certain commands give different output, or are not applicable in some circumstances.

QUERY LIBVOLUME

If you use the **QUERY LIBVOLUME** on the Library Manager, the output will now also display which Tivoli Storage Manager server is the “owner” of each volume, as shown in Example 5-16.

Example 5-16 Q LIBVOL on a Library Manager

Library Name	Volume Name	Status	Owner	Last Use	Home Element
lib3500	ABA920	Private	SICILY	Data	4,114
lib3500	ABA922	Private	SICILY	Data	4,104
lib3500	ABA923	Scratch			4,106
lib3500	ABA924	Scratch			4,107

lib3500	ABA925	Private	SICILY		4,130
lib3500	ABA926	Private	SICILY		4,098
lib3500	ABA927	Private	BRAZIL	Data	4,102
lib3500	ABA928	Private	BRAZIL	Data	4,111
lib3500	ABA929	Private	BRAZIL	Data	4,112
lib3500	ABA990	Private	BRAZIL	Data	4,133

The library client is only using the drives, and has no knowledge of the library contents. Example 5-17 shows executing **QUERY LIBVOLUME** on a library client.

Example 5-17 Q LIBVOL on a library client

```
tsm: BRAZIL> QUERY LIBVOLUME
ANR2017I Administrator ADMIN issued command: QUERY LIBV
ANR2034E QUERY LIBVOLUME: No match found using this criteria.
```

QUERY VOLUME

Querying the volumes (**QUERY VOLUME**) on any attached server will report only those volumes that belong to that server, as shown in Example 5-18.

Example 5-18 QUERY VOLUME on a shared library

```
tsm: SICILY>q volume
```

Volume Name	Storage Pool Name	Device Class Name	Estimated Capacity (MB)	Pct Util	Volume Status
ABA920	LT04POOL	DEV3500LT04	95,367.0	2.4	Filling
ABA922	LT04POOL	DEV3500LT04	190,734.0	0.8	Filling

AUDIT LIBRARY

Performing an **AUDIT LIBRARY** command from a library client does not actually perform a physical audit on the shared library; instead, the library client's database is checked and synchronized against the Library Manager's database. No tape mounts are performed.

Performing this command on the Library Manager mounts or inspects tapes in the library, the same as it does in non-shared configurations.

CHECKIN and CHECKOUT LIBV

Checking a volume in or out of a shared library must be done by the Library Manager. If you try to execute the **CHECKOUT LIBVOLUME** command from a library client, the operation will fail with an error.

LABEL LIBVOLUME

When the IBM tape library is shared, tape labeling must be performed on the Library Manager. If you try to execute the **LABEL LIBVOLUME** command from a library client, the operation will fail with an error.

You can share the scratch volumes between all the library clients because the Library Manager server has a central repository for information about all the volumes contained in the library. Since all media handling requests are handled by the Library Manager, it can keep track of which tape belongs to which library client, and which tapes are unallocated and available for use by any library client. There is no special configuration required to utilize this feature; simply make sure there is an adequate supply of labeled scratch tapes in the library.

The Library Manager will allocate them as needed to the requesting library clients or to itself. Once a particular volume is assigned to a library client, the Library Manager flags that volume as used by that client, and prevents other clients from accessing it.

Note: The Library Manager is itself a fully functional Tivoli Storage Manager server, that is, it typically supports its own backup client workload, and can access and use the volumes just like a library client. However, it also has the particular function of overall management of the devices and tape inventory.

5.6 LAN-free backup with Tivoli Storage Manager

In this section we briefly discuss configuration parameters to consider for LAN-free backup. For in-depth discussion of this topic, see the Redbooks publication, *Get More Out of Your SAN with IBM Tivoli Storage Manager*, SG24-6687.

LAN-free client data transfer is based on library sharing as already discussed in 5.5, “Sharing LTO libraries with Tivoli Storage Manager” on page 200. Clients that will send their data using the LAN-free path need SAN access to the storage devices, for example, the LTO library. The Tivoli Storage Manager server also requires tape library access via the SAN. LAN-free backup is performed by separating the actual application data (the client data written to or read from the storage pools) from the meta or control data (information contained in the Tivoli Storage Manager database). The metadata is transmitted over the LAN from the Tivoli Storage Manager client to the Tivoli Storage Manager server while the application data is moved directly over the SAN from the Tivoli Storage Manager client to the storage device. Figure 5-5 illustrates this process.

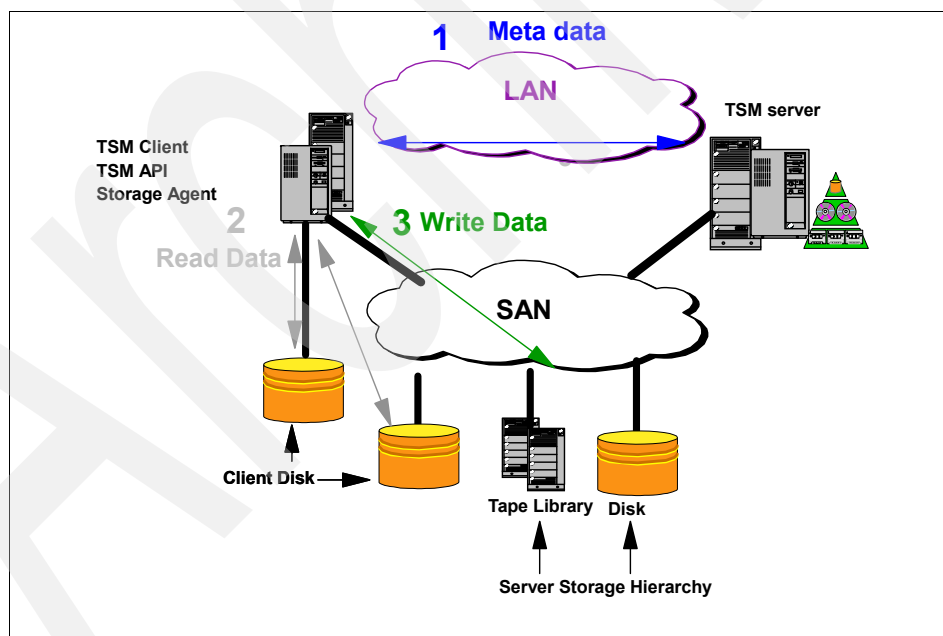


Figure 5-5 LAN-free backup lab example

A core component of LAN-free technology is the Storage Agent, which is a piece of code installed on each LAN-free client. Essentially, the Storage Agent can be viewed as a lightweight Tivoli Storage Manager server that has no database or storage hierarchy of its own. It behaves like a library client, which contacts the Tivoli Storage Manager server for volume access, and reads/writes data directly to SAN-attached devices.

5.6.1 LAN-free configuration setup

Install and configure the LAN-free clients according to the detailed instructions in the Storage Agent's User Guides, for example *IBM Tivoli Storage Manager for AIX Storage Agent User's Guide*, SC32-0129

Before beginning, set up your Tivoli Storage Manager server as a Library Manager as described in 5.5.1, "Configuring the Library Manager to share libraries" on page 201.

Table 5-1 is a summary of the tasks necessary to configure LAN-free backup-archive client data transfer. The detailed instructions are contained in the user's guides.

Table 5-1 Configuring LAN-free backups

Step	On server	On client
1)	.....	Install tape drives according to user's guide.
2)	.....	Install Tivoli Storage Manager client code.
3)	.....	Modify <code>dsm.sys</code> of backup-archive client with: ENABLELANFREE YES LANFREECommethod TCPIP LANFREETCPPort port_number
4)	.....	Install the Storage Agent.
5)	.....	Specify the DEVCONFIG option in the <code>dsmsta.opt</code> of Storage Agent: DEVCONFIG outputfile
6)	Define each LAN-free client Storage Agent as if it was a server. Use the <code>DEFINE SERVER</code> command.	.....
7)	.....	Set the installation data for the Storage Agent with: DSMSTA SETSTORAGESERVER
8)	Register clients for LAN-free backup. If needed, define a separate domain. Also register license for LAN-free nodes.	.....
9)	.....	Obtain Tape Device information (see 5.6.2, "Define path considerations" on page 206).
10)	Use the <code>DEFINE PATH</code> command to define paths from the Storage Agent to the drives that are available to the Tivoli Storage Manager server (see 5.6.2, "Define path considerations" on page 206).	.....
11)	.....	Test if data transfer goes over the SAN

Note: Make sure TXNGROUPMAX in `dsmsta.opt` is set at the same value as that in `dsmserve.opt`. When using LTO or 3592 drives, it is recommended to set this value to 256 or higher for performance reasons. Refer to 5.2.7, "Performance hints for Tivoli Storage Manager with LTO or 3592" on page 196.

5.6.2 Define path considerations

Consider the following guidelines for mapping your SAN drives:

- ▶ Define paths to all drives. Problems can occur if you do not define paths from the server to each drive in a library. For example, during backup operations, all drives that have paths can be used by the Storage Agent in backing up data. Backup operations will fail if you try to use other drives in a library that do not have defined paths. When paths are defined for each drive in a library, backup operations wait until the next drive is available for the transfer of data.
- ▶ If you want to limit the number of drives available to a node, you can use the MAXNUMMP parameter with the **REGISTER NODE** or **UPDATE NODE** command. This will limit the number of drives that are available for the Storage Agent to use on behalf of the client.
- ▶ Review tape device names. For the same tape device, the device name as known to the server will probably not match the device name as known to the Storage Agent, as described in 4.3, “Persistent binding” on page 167.

Define paths on the server using the device names as seen by the Storage Agent on each client system. Use the **DEFINE PATH** command:

```
DEFINE PATH storageagent_name drive_name SRCTYPE=SERVER DESTTYPE=DRIVE \  
LIBRARY=library_name DEVICE=dev_name_on_storageagent
```

Where:

- ▶ storageagent_name is the name of the storage agent.
- ▶ drive_name is the tape drive name defined on the Tivoli Storage Manager server.
- ▶ library_name is the tape library name defined on the server.
- ▶ dev_name_on_storageagent is the device special file name of the tape drive on the storage agent machine (for example, /dev/rmt0).

Important: Remember also that the drives are not necessarily configured by the operating system in the same order as they are installed physically in the library, as described in 4.3, “Persistent binding” on page 167. Therefore, check carefully that the element address matches your drive configuration.

5.7 NDMP backup with Tivoli Storage Manager

Network Data Management Protocol (NDMP) is an open standard protocol developed to eliminate the issues associated with the decentralization of backup standards for file servers, and dedicated Network Attached Storage (NAS) file servers.

NDMP backup is provided with IBM Tivoli Storage Manager Enterprise Edition. This is well documented in the *Administration Guide* for your Tivoli Storage Manager platform, for example, for AIX server:

- ▶ *IBM Tivoli Storage Manager for AIX Administrators Guide*, SC32-0117.

Also see the Redbooks publication:

- ▶ *IBM Tivoli Storage Manager Implementation Guide*, SG24-5416.

5.7.1 Network Attached Storage

Network Attached Storage (NAS) is a way to make large amounts of disk storage available to many clients using standard file sharing protocols. A NAS box (sometimes also called a NAS appliance or file server) consists of a number of standard disks, one or more network

adapters (NICs), and a controller that typically runs an embedded, specialized operating system used to configure and administer the box. The NAS appliance exists as an entity on the network. The disks are divided up into volumes, which can then be accessed by other servers or workstations using standard file sharing protocols like NFS and CIFS. Network Attached Storage is, therefore, easy and relatively cheap to implement, since standard file sharing methods and normal network adapters are used to access the data.

But the question arises, how do you back up the data in the NAS box? One way is to back up the mounted file systems from a client that is accessing it. However, this involves multiple network accesses and might or might not back up metadata, like access control lists, correctly. Or, you could write/modify a backup client to run directly on the NAS appliance itself. The issue here is that vendors use different operating systems (often specialized) for their appliances, which means multiple ports of the backup client would be necessary. A standard is really needed to make NAS backup easier.

The need for NDMP

NDMP is a standard protocol for backup applications to use to back up NAS servers. NDMP provides a high-performance backup solution by separating meta data (control path) transfer over the LAN from raw backup data (data path), which can be transferred locally to a storage device. NDMP also solves the problem of interoperability of various NAS servers and backup software.

NDMP backup with Tivoli Storage Manager is available for the following servers:

- ▶ A Tivoli Storage Manager V5.2 or later server for Windows, AIX, Sun Solaris, HP-UX, or Linux.

For the most up-to-date support details, see:

<http://www-306.ibm.com/software/tivoli/products/storage-mgr/network-data-mgt-protocol.html>

5.7.2 Overview of Tivoli Storage Manager NDMP backup

Tivoli Storage Manager Enterprise Edition provides backup of supported NAS file servers. Tivoli Storage Manager controls the backup operation remotely, but the NAS file server transfers the backup data locally. Typically, this is a direct SCSI-attached configuration between the NAS file server and a tape library. It is possible to configure NDMP operations with Tivoli Storage Manager using a SAN-attached configuration. However, the library robotics must be logically but explicitly controlled by the Tivoli Storage Manager server, and the tape drives must be logically but explicitly controlled by the NAS file server.

Tivoli Storage Manager Enterprise Edition NDMP support backs up and restores complete NAS file systems without having to use file access protocols like Common Internet File System (CIFS) and Network File System (NFS). The first backup performed is a full backup with every backup thereafter being a differential backup by default (a differential backup will back up all file system changes since the last full backup). When a restore is initiated, Tivoli Storage Manager will restore the full backup first, followed by the differential backup.

Note: A Tivoli Storage Manager V5.3 server is required for directory-level backup. See the latest Tivoli Storage Manager manuals, or the Redbooks publication, *IBM Tivoli Storage Manager Implementation Guide*, SG24-5416, for details.

5.7.3 Tivoli Storage Manager NDMP backup configurations

The fundamental physical requirement for Tivoli Storage Manager NDMP backup is to have the tape devices connected to the NAS system. The library robotics can be controlled by either the NAS system or the Tivoli Storage Manager server. If the tape library does not have separate interfaces for the medium changer and tape devices, or if there is a large distance separating the Tivoli Storage Manager server and the NAS system, then the library must be directly connected to the NAS system. The supported configurations are described in the following sections.

Library connected to NAS system

In this configuration, the tape library and drives are directly connected to the NAS file server, as shown in Figure 5-6. The Tivoli Storage Manager server sends commands to the library across the LAN to the NAS file server, which passes the commands on to the tape library. Any generated responses are sent back to the Tivoli Storage Manager server via the NAS file server. In this configuration the NAS file server can be separated from the Tivoli Storage Manager server by a large distance since TCP/IP connectivity is all that is required.

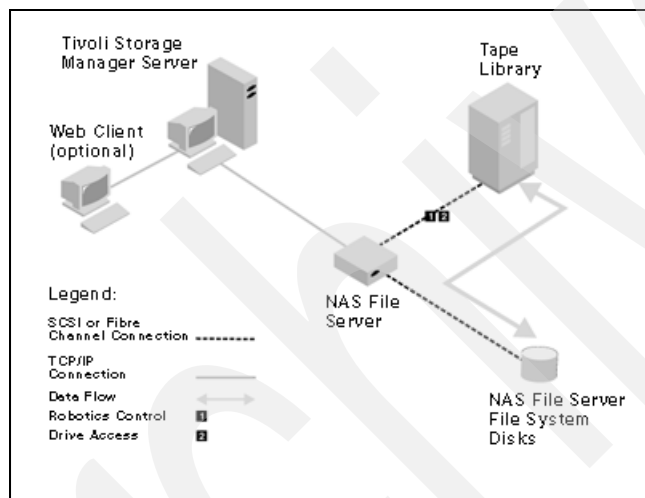


Figure 5-6 Library connected to NAS system

Library connected to Tivoli Storage Manager server

In this configuration the tape library is directly connected to the Tivoli Storage Manager server and the tape drives within the library are directly connected to the NAS file server, as shown in Figure 5-7.

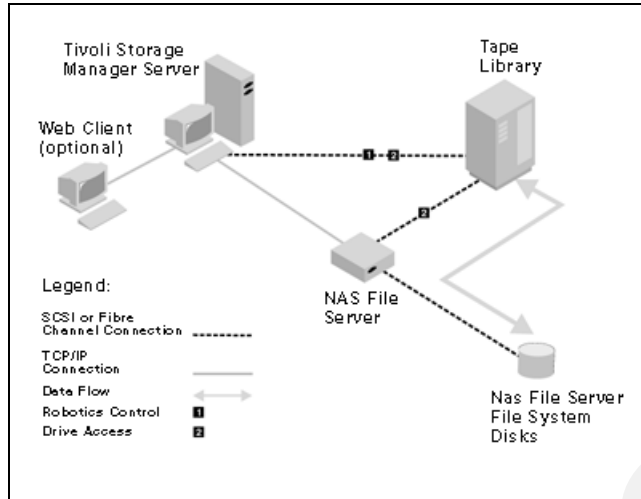


Figure 5-7 Library on Tivoli Storage Manager server; drives on NAS system

The Tivoli Storage Manager server passes commands directly to the tape library, and the NAS file server pushes data directly to the tape devices at the request of the Tivoli Storage Manager server. This configuration is only possible within the physical connectivity limitations of SCSI or Fibre Channel.

Expiration and retention policies for NDMP backup

When an NDMP backup is performed, the Tivoli Storage Manager server checks if a valid full image backup exists. If it does not, a full image backup is performed. The Tivoli Storage Manager server will also identify any older backup versions that exceed the allowed number of versions according to the management class policies. This is done from oldest to most recent without regard to whether the versions represent full or differential images.

Any excess versions are marked for expiration. During expiration processing, if the server detects a full backup that is marked for expiration, it checks to see if that version has any dependent differentials. If so, the full backup version is not deleted even though it has been marked for expiration. An example should make this process clearer (see Figure 5-8).

Suppose that we set VEREXISTS in the backup copy group to 3 and that we run a series of backups as follows:

- ▶ Day 1: Full backup
- ▶ Day 2: Differential backup
- ▶ Day 3: Full backup
- ▶ Day 4: Differential backup
- ▶ Day 5: Differential backup

Each backup operation creates a version in the Tivoli Storage Manager database. After day 4's differential backup, therefore, we have a total of four versions, but the policy settings allow us only three. Therefore, the day 1 backup, being the oldest, will be marked for expiration. However, the first backup cannot be physically expired because the day 2 differential backups depends on it. This is because in order to restore the day 2 backup, we would have to restore the day 1 full and then the day 2 differential. A full backup will never be expired as long as it has dependent differentials.

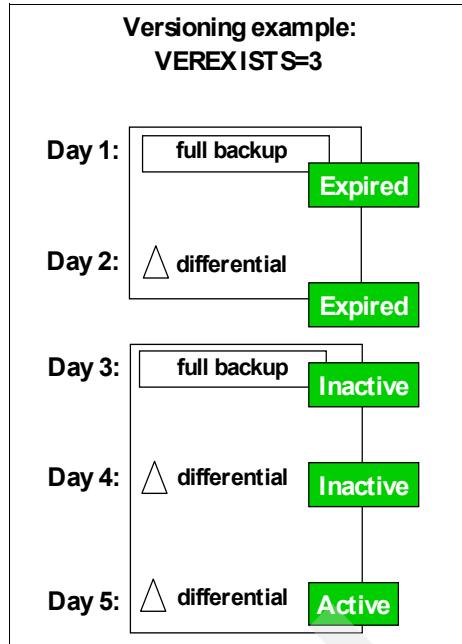


Figure 5-8 How version control works for NDMP backups

However, after day 4 it is no longer possible to restore *just* the day 1 backup. In this case, day 4 represents the ACTIVE backup, with day 2 and day 3 being INACTIVE backup versions. On day 5 when another differential backup is made, both the day 1 and day 2 backups will be marked for expiration. At this stage, shown in Figure 5-8, the day 5 backup represents the ACTIVE backup, day 3 and day 4 backups are INACTIVE and the day 1 and day 2 backups are deleted.

5.8 Tivoli Storage Manager and redundant library control paths

The IBM TS3100/TS3200, TS3310, TS3400, and TS3500 allow you to enable multiple control paths to a single logical library (see 3.2.6, “Setting up control path failover for AIX” on page 106). Support is provided under AIX, Linux, HP-UX, Windows, and Solaris for both SCSI and Fibre Channel attachments when the IBM tape device driver is used. This provides improved redundancy to the libraries. If there is only a single control path available, a failure in this path would result in loss of communication with the library. Therefore, multiple control paths eliminate this single point of failure. See also 3.2.6, “Setting up control path failover for AIX” on page 106 for further details in particular environments.

If you enable multiple control paths on your IBM TS3100/TS3200, TS3310, TS3400 or TS3500, you will see several SCSI media changer devices at the operating system, depending on how many control paths have been enabled.

Figure 5-9 shows an IBM TS3500 with two drives. Both drives have the control path enabled.

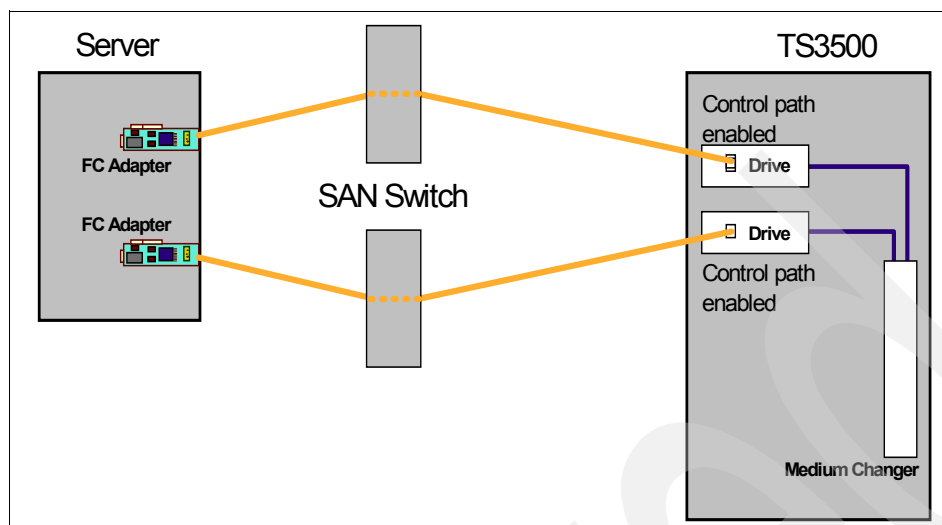


Figure 5-9 IBM TS3500 with multiple control paths enabled

Tivoli Storage Manager cannot automatically handle multiple control paths to one logical library on its own; but it can work with automatic control path failover for AIX. This feature provides an automatic failover to an alternate control path when the primary control path fails. An error on the control path would have no effect to your Tivoli Storage Manager server.

Example 5-19 shows the output of the `lsdev -Cc tape` command with automatic control path failover for this configuration. You can see two tape drives and two smc devices. The `smc0` device is the primary control path and the `smc1` device is the alternate control path.

Example 5-19 TS3500 multi-path architecture with automatic control path failover

```
# lsdev -Cc tape
rmt0 Available 30-68-01 IBM 3580 Ultrium Tape Drive (FCP)
rmt1 Available 30-68-01 IBM 3580 Ultrium Tape Drive (FCP)
smc0 Available 30-68-01-PRI IBM 3584 Library Medium Changer (FCP)
smc1 Available 30-68-01-ALT IBM 3584 Library Medium Changer (FCP)
```

Example 5-20 shows the output of the `lsdev -Cc tape` command if the automatic control path failover for AIX is not installed. You will again see two tape drives and two smc devices, but without a primary or alternate control path.

Example 5-20 TS3500 multi-path architecture without automatic control path failover

```
# lsdev -Cc tape
rmt0 Available 30-68-01 IBM 3580 Ultrium Tape Drive (FCP)
rmt1 Available 30-68-01 IBM 3580 Ultrium Tape Drive (FCP)
smc0 Available 30-68-01 IBM 3584 Library Medium Changer (FCP)
smc1 Available 30-68-01 IBM 3584 Library Medium Changer (FCP)
```

Whether you use automatic control path failover or not, you should only configure one control path to the library in Tivoli Storage Manager. If you configure the second control path, then you will get a second library.

If a failure occurs on the first control path (`smc0`), and we do not use automatic control path failover, we could switch to the second path (`smc1`) with:

```
UPDATE PATH server_name library_name SRCTYPE=SERVER DESTTYPE=LIBRARY DEVICE=/dev/smc1
```

With automatic control path failover enabled, we would not need to perform the **UPDATE PATH** command, since failover happens automatically.

5.9 Tivoli Storage Manager and data path failover

The concept of control and data path failover is further discussed in the Redbooks publication, *Get More Out of Your SAN with IBM Tivoli Storage Manager*, SG24-6687.

The IBM tape device driver for AIX, Linux, and Solaris allows you to configure and automatically failover between multiple data paths (single SAN fabric) to a single FC LTO, or two SAN fabrics to an IBM TS1120 or 3592-J1A drive (see 3.2, “Installing IBM tape device driver for AIX” on page 97, 3.3, “Installing IBM tape device driver for Solaris” on page 121, and 3.4, “Installing IBM tape device driver for HP-UX” on page 132). Note: The LTO drives have only one interface to the fabric, while IBM 3592 has two.

Without the drivers’ alternate pathing support, if an application opens rmt0 and a permanent path error occurs (because of an HBA or cable failure, for example), the application fails. It is possible to initiate manual failover by restarting the application on the alternate logical device (rmt1), but the application has to be restarted from the beginning. A long backup or restore operation might have been in progress when the path error occurred. Sometimes manual failover might require operator intervention to reset the drive because a SCSI Reservation can still exist on the failing HBA path.

When the alternate pathing support is enabled on both rmt0 and rmt1, the device driver configures them internally as a single device with multiple paths. The application can still open and use only one logical device at a time (either rmt0 or rmt1). If an application opens rmt0 and a permanent path error occurs, the device driver initiates failover error recovery automatically on the alternate path (rmt1). If successful, the current operation continues on the alternate path without interrupting the application. The failover error recovery first restores the previous device state, SCSI Reservation, and tape position, then retries the failing operation.

Figure 5-10 shows an IBM TS3500 with 3592 drives.

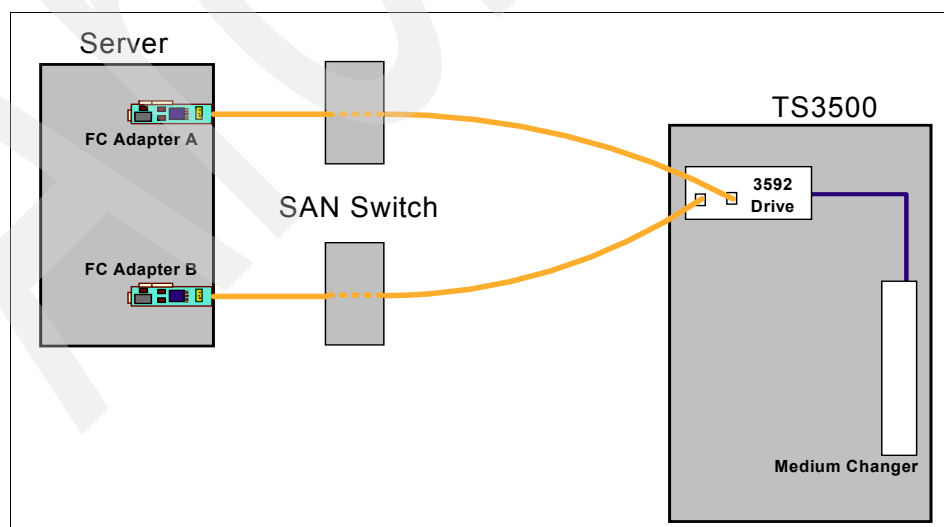


Figure 5-10 3592 drive with multiple data paths configured

Example 5-21 shows the output of the **lsdev -Cc tape** command for this setup with automatic data path failover enabled. You can see two tape drives. The **rmt0** device is the primary data path and the **rmt1** device is the alternate data path.

Example 5-21 3592 drives with automatic data path failover

```
# lsdev -Cc tape
rmt0 Available 20-58-01-PRI IBM 3592 Tape Drive (FCP)
rmt1 Available 30-68-01-ALT IBM 3592 Tape Drive (FCP)
smc0 Available 20-58-01 IBM 3584 Library Medium Changer (FCP)
smc1 Available 30-68-01 IBM 3584 Library Medium Changer (FCP)
```

Example 5-22 shows the output of the **lsdev -Cc tape** command for an LTO setup where automatic data path failover for AIX is not installed. You can again see two tape drives, but without a primary or alternate data path.

Example 5-22 3584 multi-path architecture without automatic control path failover

```
# lsdev -Cc tape
rmt0 Available 20-58-01 IBM 3580 Ultrium Tape Drive (FCP)
rmt1 Available 30-68-01 IBM 3580 Ultrium Tape Drive (FCP)
smc0 Available 20-58-01 IBM 3584 Library Medium Changer (FCP)
smc1 Available 30-68-01 IBM 3584 Library Medium Changer (FCP)
```

Whether you use automatic data path failover or not, you should only configure one data path to each of the drives defined to the Tivoli Storage Manager server.

Defining a path to **rmt0**, if a failure occurs on this path, the IBM device driver will automatically — and transparently to the application — failover to the alternate path (**/dev/rmt1**) without interrupting the current Tivoli Storage Manager operation.

5.10 Tape alert support

Tape alert messages are generated by tape and library devices to report hardware errors. A log page is created and can be retrieved at any given time or at a specific time, such as when a drive is dismounted. These messages help determine problems that are not related to the Tivoli Storage Manager server.

There are three severity levels of tape alert messages:

- ▶ **Informational:**

For example, you might have tried to load a cartridge type that is not supported. These messages will log in as **ANR8951I** messages.

- ▶ **Warning:**

For example, a hardware failure is predicted. These messages will log in as **ANR8950W** messages.

- ▶ **Critical:**

For example, there is a problem with the tape and your data is at risk. These messages will log in as **ANR8948S** or **ANR8949E** messages.

Tape alert messages are turned off by default. You can set tape alert messages to **ON** or **OFF** using the **SET TAPEALERTMSG** command. The current setting of the tape alert can be checked with the **QUERY TAPEALERTMSG** command. The messages from the device are logged into the actlog, which can be checked with the **QUERY ACTLOG** command.

Example 5-23 and Example 5-24 show the **QUERY TAPEALERTMSG** and **QUERY ACTLOG** commands.

Example 5-23 QUERY TAPEALERTMSG command output

```
tsm: SERVER1>query tapealertmsg
ANR8960I QUERY TAPEALERTMSG: The display of Tape Alerts from SCSI devices is Enabled.
```

Example 5-24 QUERY ACTLOG command output

```
tsm: SERVER1>query actlog begindate=-15 search=TapeAlert
```

Date/Time	Message
-----	-----
04/10/07 18:23:09	ANR8948S Device /dev/rmt/11smc, volume unknown has issued the following Critical TapeAlert: The library mechanism is having difficulty communicating with the drive: 1. Turn the library off then on. 2. Restart the operation. 3. If the problem persists, call the library supplier help line. (SESSION: 9)
04/10/07 18:23:09	ANR8950W Device /dev/rmt/11smc, volume unknown has issued the following Warning TapeAlert: There is a problem with the library mechanism. If problem persists, call the library supplier help line. (SESSION: 9)
04/10/07 18:23:09	ANR8950W Device /dev/rmt/11smc, volume unknown has issued the following Warning TapeAlert: There is a potential problem with the barcode label or the scanner hardware in the library mechanism. 1. No action needs to be taken at this time. 2. If the problem persists, call the library supplier help line. (SESSION: 9)

5.11 Device migration and co-existence

We recommend careful planning when introducing and mixing new generations of media technology with Tivoli Storage Manager. This is because new format generations cannot be read by older drives, and conversely the old formats cannot necessarily be read and written by the new drives. Tivoli Storage Manager controls the media through the library changer by using SCSI commands, and cannot detect the internal format of a cartridge. Tivoli Storage Manager has always taken the position that all media must be at least readable by all the drives in a given library. With Tivoli Storage Manager V5.2 and higher, you can operate with mixed media types when the library is able to distinguish the different media.

This section provides information on migration and co-existence issues for LTO Ultrium 2, 3, and 4 drives in one library, and with Tivoli Storage Manager V5.2 or newer. First, we define a few terms.

Mixed media libraries

Mixed media in a Tivoli Storage Manager server describes devices using different device types (in the devclass) in the same logical library. LTO and 3592 are examples of two devices that need different device classes, but can co-exist in the same library. Mixed media is supported in Tivoli Storage Manager V5.2 and higher.

Mixed generation devices

A mixed generation device in a Tivoli Storage Manager server describes devices that use the same device types (from **DEFINE DEVCLASS**) despite capacity differences. In order to have mixed generation devices in the same device class, the media types must be distinguishable.

Note: In mixed generation environments, the current generation device can generally read and write current and previous generation media. The previous generation device can only read and write previous generation media. LTO Ultrium devices are an example of mixed generation devices.

The design specifications for LTO devices are:

LTO1	Can read and write LTO1 cartridges
LTO2	Can read and write LTO1 and LTO2 cartridges
LTO3	Can read and write LTO2 and 3 cartridges, and can read LTO1 cartridges.
LTO4	Can read and write LTO3 and 4 cartridges, and can read LTO2 cartridges.

Note: Tivoli Storage Manager V5.2.4.0 or higher provides support for the LTO3 drives, while support for LTO4 is available as of V5.3.5.0 or V5.4.1.0.

5.11.1 Scenarios

In the lifetime of a Tivoli Storage Manager server, there will be times when new technology or customer requirements will allow the expansion of storage capacity through new devices. This might occur through the addition of a new library to an existing Tivoli Storage Manager server, or through increased capacity of a new or upgraded tape drive in an existing library.

In both these instances you need to decide whether to install the new technology and retire the old technology, or operate both technologies in parallel.

For LTO2, LTO3, and LTO4 drives, Table 5-2 describes some of the migration and co-existence possibilities in one physical library, and also the migration from an existing library to a new LTO library, relative to the version of Tivoli Storage Manager used. You might need to upgrade the library firmware for LTO3 or LTO4 device support and library partitioning support. We discuss each scenario in more detail in the following sections.

The table and subsequent discussion do not attempt to show all migration possibilities, but cover the most obvious scenarios. For several of the configuration scenarios, there are two identical discussions. In general, whatever applies to coexistence and migration of LTO3 and 4, is also valid for coexistence and migration of the older LTO2 and 3, or even LTO1 and 2.

Table 5-2 LTO migration and co-existence examples

Scenario	Configuration	TSM V5.2.4	TSM 5.3.5 or 5.4.1
1	a) LTO 3 + 4 drives LTO 3 Media -----		1 logical library 1 devclass
	b) LTO 2 + 3 drives, LTO 2 Media	1 logical library 1 devclass	

Scenario	Configuration	TSM V5.2.4	TSM 5.3.5 or 5.4.1
2	a) LTO 3 + 4 drives LTO 3 + 4 Media ----- b) LTO 2 + 3 drives, LTO 2 + 3 Media	----- 1 logical library 2 devclass	1 logical library 2 devclass
3	LTO 2 + 3 + 4 drives LTO 2 + 3 + 4 Media		1 logical library 3 devclass
4	a) Migrate LTO 3 to 4 drives LTO 3 + 4 Media ----- b) Migrate LTO 2 to 3 drives LTO 2 + 3 Media	----- 1 logical library 1 devclass	1 logical library 1 devclass
5	a) Migrate LTO 3 to 4 drives Migrate media LTO 3 to 4 ----- b) Migrate LTO 2 to 3 drives Migrate Media LTO 2 to 3	----- 1 logical library 1 devclass	1 logical library 1 devclass
6	Migrate LTO 2 to 4 drives Migrate media LTO 2 to 4		1 logical library 1 devclass
7	Migrate existing tape storage to LTO	2 libraries 2 devclass	2 libraries 2 devclass

Scenario 1

There are two similar scenarios. Install LTO4 drives in addition to the current LTO3 drives and media, or the equivalent scenario for the older generation: Install LTO3 drives in addition to the current LTO2 drives and media.

We can install the new LTO4 devices with existing LTO3 devices into the same logical library and device class because of mixed generation support. The LTO4 devices will be able to read and write the LTO3 cartridges at the LTO3 speed and capacity.

Similarly, we can install the LTO3 devices with existing LTO2 devices into the same logical library and device class because of mixed generation support. The LTO3 devices will be able to read and write the LTO2 cartridges at the LTO2 speed and capacity.

Scenario 2

Install LTO4 drives and LTO4 media in addition to existing LTO3 drives and LTO3 media.

As of Tivoli Storage Manager V5.2, mixed media types are supported in one library, and thus different generations of tape devices can co-exist in the same logical library. However, two device classes are required because of the two media types.

All of the tape devices are available to the LTO3 device class, but only LTO4 devices are available to the LTO4 device class. Tivoli Storage Manager will ensure that LTO4 media will only be loaded into LTO4 devices for reading and writing. LTO3 media will be read from or written to by all the LTO3 and 4 devices.

Tip:Setting the MOUNTLIMIT parameter:

For read or write tape mounts, Tivoli Storage Manager will select LTO3 drives for LTO3 media first. If no LTO3 devices are available, an available LTO4 drive will be selected for the LTO3 media. To prevent the case where all LTO4 drives are loaded with LTO3 media (leaving no drives available to read/write LTO4 media), set the DEVCLASS parameter MOUNTLIMIT appropriately. For example:

- ▶ MOUNTLIMIT can be set to the number of LTO3 drives in the library for the LTO3 devclass, so it will not use LTO4 drives at all.
- ▶ MOUNTLIMIT can be set to the number of LTO3 drives plus half the number of LTO4 drives. This is a compromise position to allow good drive utilization, but reserves some LTO4 drives for LTO4 media.

You should define a suitable MOUNTLIMIT, which works for your environment.

Scenario 3

As of Tivoli Storage Manager V5.3.5, LTO4 drives are supported, and any combination of LTO 2, 3, and 4 drives and media can be used in one library. As discussed in scenario 2, LTO4 drives can read and write LTO3 media. Similarly the LTO3 drives can read and write LTO2 media.

Although LTO4 drives can read the LTO2 media (but cannot write to it), care should be taken to avoid attempted writing. Set the MOUNTLIMIT option for the LTO2 devclass to less than the sum of LTO2 and 3 drives (see the previous tip), thereby preventing the LTO2 media from being loaded in the LTO4 drives. The LTO2 media will still be available for normal use by the LTO2 and 3 drives.

Alternatively, the migration path will be to have all LTO2 media set to read-only for use by all drives, and the LTO2 drives and media eventually phased out of the library.

Scenario 4

Replace all LTO3 drives with LTO4 drives, using the existing LTO3 media and installing additional LTO4 media:

1. Delete the existing LTO3 device DRIVE and PATH entries and define new DRIVE and PATH entries for the LTO4 devices.
2. The replacement of the LTO3 drives with LTO4 drives will also affect the Tivoli Storage Manager device class parameter format, which should now be set to `ultrium4c`.

Tip: The devclass format parameter is used to pre-determine the capacity value of a storage pool. Because we now have media with varying amounts of capacity (400 GB and 800 GB native), the storage pool values will not be correct. If this is an issue, then use two device classes as described in Scenario 2.

The same discussion applies using the older generation LTO2 and LTO3 media and drives.

Scenario 5

Replace all LTO3 drives with LTO4 drives, and choose to migrate the existing LTO3 media to LTO4 media:

1. Delete the existing LTO3 device DRIVE and PATH entries, and define new DRIVE and PATH entries for the LTO4 devices.
2. Remove empty LTO3 media and install LTO4 media (label 1 in Figure 5-11 on page 219).
3. Over time, update the LTO3 media ACCESS to READONLY. This ensures they will then not be written to any more by any Tivoli Storage Manager client or server operation (label 2 in Figure 5-11 on page 219).
4. You can leave the existing utilized LTO3 cartridges as they are, and over time, expiration of old backups and reclamation will reduce the usage of the old cartridges.
5. However, if you want to drain the existing LTO3 cartridges more quickly, you can execute a **MOVE DATA volume_name LTO_storage_pool_name** command, selecting each individual LTO3 volume and targeting the LTO storage pool.
6. Once the old LTO3 cartridges are emptied, the cartridges can be checked out of the library and new LTO4 cartridges can be checked in to replace them (label 3 in Figure 5-11 on page 219).
7. The replacement of the LTO3 drives and media with LTO4 drives and media will also affect the device class parameter `format`, which should be set to `DRIVE`, `ultrium4`, or `ultrium4C`. If the `format` parameter is left at `ultrium3` or `ultrium3C`, a write will still occur to the end of LTO4 media, but the pre-determined capacity of the storage pool will only show LTO3 capacity on the command **query stgpool**.

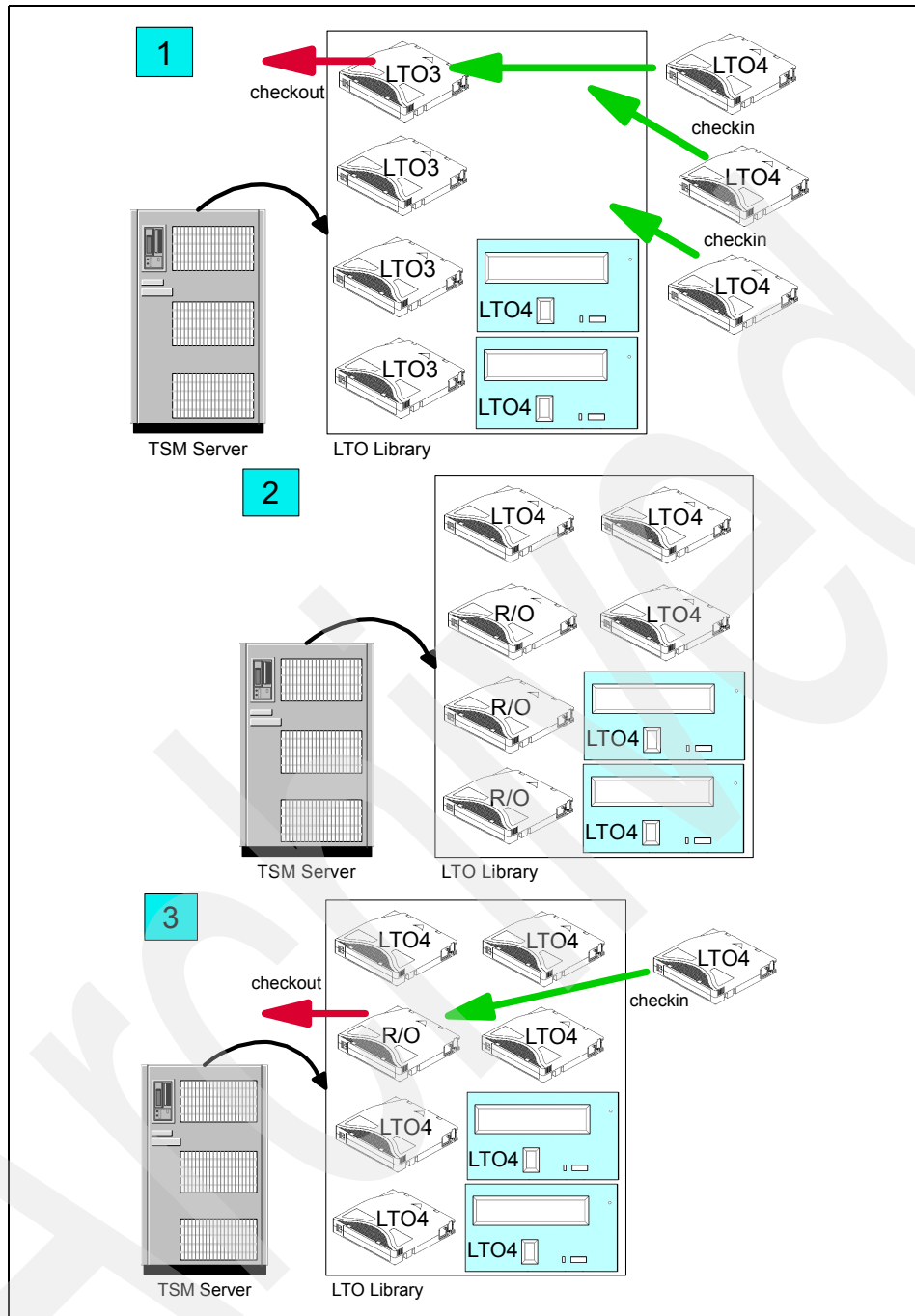


Figure 5-11 Migration scenario 5

The same discussion applies for migrating the older generation LTO2s to LTO3s.

Scenario 6

LTO4 drives can read the LTO2 media. The same discussion as in scenario 5 applies, although in this scenario it is imperative that all LTO2 media are updated to ACCESS of READONLY. All new writes are to the new LTO4 media, and all data on LTO2 media is moved specifically, or phased out over time.

Scenario 7

Replace an existing tape library and migrate the client data to a new LTO tape library. The steps are the same whether migrating to LTO3 or LTO4 drives and media. You are, however, encouraged always to migrate to the newest generation library.

Various techniques can be used. We describe migrating the data by using an existing management class. This only requires modifying the currently used storage pool to cascade to the new LTO storage pool. This has the advantage of being less disruptive, and has no affect on the client option files.

We give two possibilities for storage pools, depending on whether the primary destination is a disk or tape (sequential) pool.

Sequential storage pool as primary copy destination

Your modification affects the storage pools only. Follow these steps:

1. Define the new LTO library, library path, drives, drive paths, and device classes.
2. Create an LTO sequential storage pool and/or copy storage pool using the new LTO device class (label 1 in Figure 5-12 on page 221).
3. Modify the NEXTSTGP00L parameter of the old storage pool to point to the new LTO storage pool (label 2 in Figure 5-12 on page 221).
4. Update the old storage pool ACCESS to READONLY.

Note: This assumes that you want to move the entire storage pool content to the new LTO, since you cannot have the storage pool read-only for certain management classes, and read-write for others.

5. You can leave the old storage pool as it is, and over time, expiration of old backups will reduce the usage of the old storage pool.

However, if you want to drain the old storage pool more quickly, you can simply set HIGHMIG and LOWMIG to zero. This starts a migration process that moves data from the old storage pool to the new LTO storage pool. To speed up the migration, you can increase the MIGPROCESS limit for the old storage pool to use more drives (remember this is a drive-to-drive process).

6. Alternatively, you can execute a **MOVE DATA volume_name LTO_storage_pool_name** command, selecting each individual volume from the old storage pool, and targeting the new LTO storage pool.
7. Once the old storage pool is emptied, modify the BACKUP and ARCHIVE COPY GROUP of each management class to point the DESTINATION to the new LTO Storage pool (label 3 in Figure 5-12).
8. Delete the DRIVE and PATH, and also the LIBRARY and PATH entries for the old library and drives.

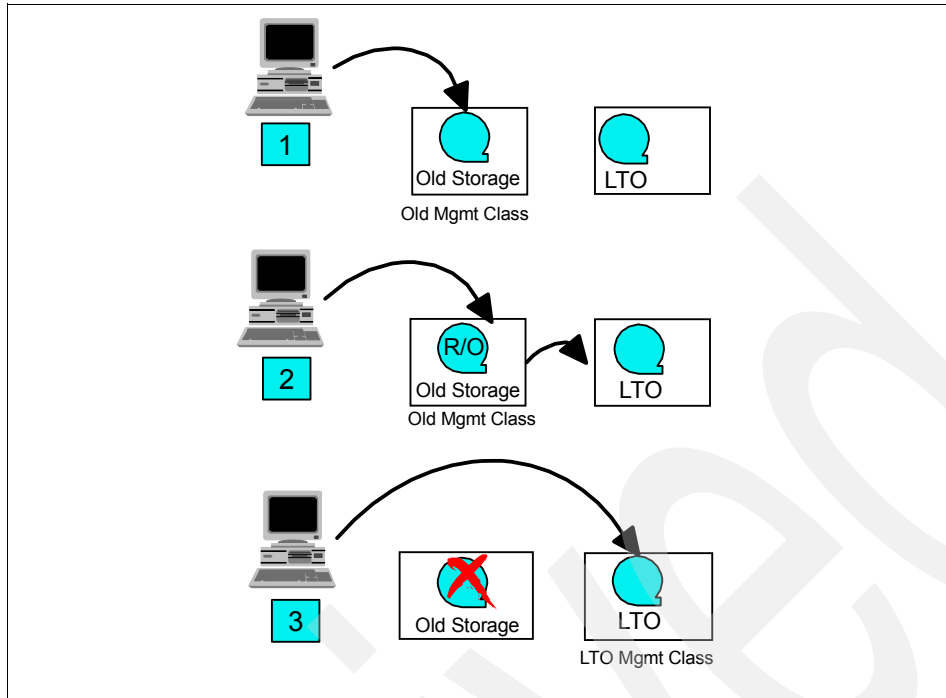


Figure 5-12 Migrating to LTO as sequential primary copy

Disk storage pool as primary copy destination

If you use a disk storage pool as your primary destination which, in turn, is cascaded to the old storage pool, your final modification affects the primary disk storage pool only. Follow these steps:

1. Define the LTO library, library path, drives, drives paths and device classes.
2. Create an LTO sequential storage pool or copy storage pool, or both, using the LTO device class.
3. After creating the new LTO storage pool (label 1 in Figure 5-13 on page 222), modify the NEXTSTGPPOOL parameter of the old storage pool to point to the new LTO storage pool (label 2 in Figure 5-13 on page 222).
4. Update the old sequential storage pool ACCESS to READONLY.

Note: This assumes that you want to move the entire storage pool content to the new LTO, since you cannot have the storage pool read-only for certain management classes and read-write for others.

5. You can leave the old storage pool as it is and, over time, expiration, and migration will reduce the usage of the old storage pool.

However, if you want to drain the old storage pool more quickly, you can simply set HIGHMIG and LOWMIG to zero. This starts a migration process, which moves data from the old storage pool to the new LTO storage pool. To speed up the migration, you can increase the MIGPROCESS limit for the old storage pool to use more drives (remember this is a drive to drive process).

6. You can also run a **MOVE DATA volume_name LTO_storage_pool_name** command, selecting each individual volume from the old sequential storage pool, and targeting the new LTO storage pool.

7. Once the old sequential storage pool is emptied, modify the NEXTSTGP00L parameter of the disk storage pool to point to the new LTO storage pool (label 3 in Figure 5-13).
8. Delete the DRIVE and PATH, and also the LIBRARY and PATH entries for the old library and drives.

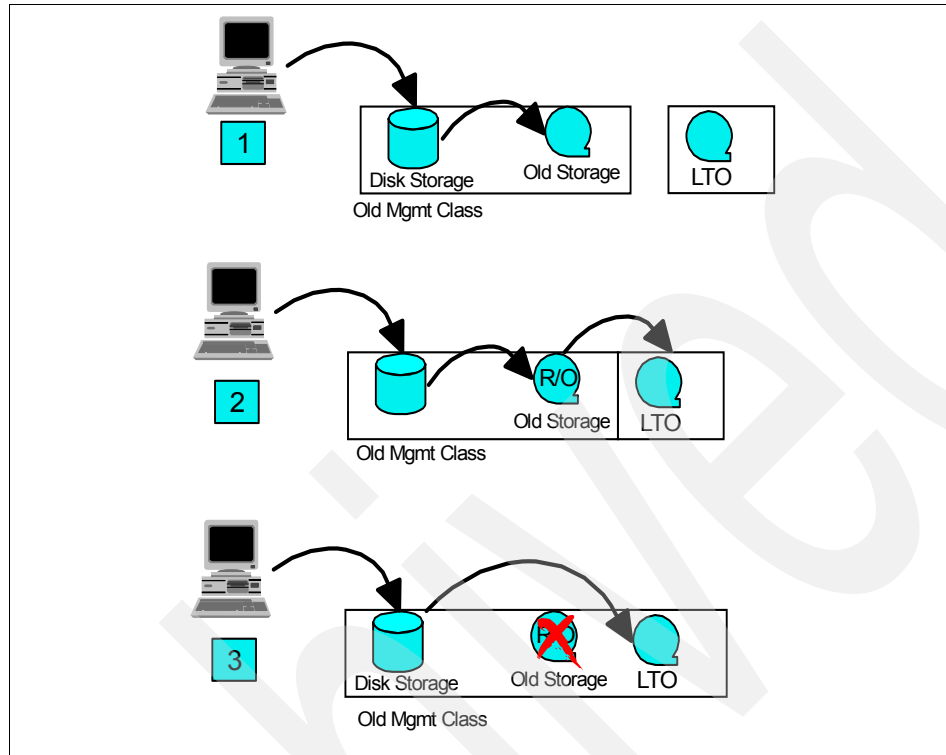


Figure 5-13 Migrating to LTO through disk primary copy

5.12 Tivoli Storage Manager V5.2 SAN device mapping

In a SAN environment, device IDs can change dynamically due to device or cabling changes. Before V5.2, the Tivoli Storage Manager server used statically defined library and tape device IDs. If the device IDs were changed after a reboot or a re-scan of the SCSI bus, Tivoli Storage Manager could access a wrong target device and cause data integrity problems. Tivoli Storage Manager V5.2 introduced a new method to dynamically determine the correct device special file name and make appropriate changes to the Tivoli Storage Manager server database by using the device's serial number. This function can replace persistent binding, which binds a device WWN to a specific target/LUN ID (as described in 4.3, "Persistent binding" on page 167) in certain environments.

SAN Discovery and Device Mapping are discussed in detail for the Tivoli Storage Manager environment in the Redbooks publication, *Get More Out of Your SAN with IBM Tivoli Storage Manager*, SG24-6687.

5.12.1 SAN device mapping functions

SAN device mapping has three basic functions:

- ▶ Serial number autodetection and validation
- ▶ Element number autodetection
- ▶ SAN discovery

To enable these functions, the **DEFINE LIBRARY** and **DEFINE DRIVE** commands have been enhanced to allow manual entry or automatic detection of the serial and element numbers. Also, the **DEFINE PATH** command is enhanced to automatically update the serial number. This new syntax is described in “Define the library and tape drives” on page 182. Refer to the Tivoli Storage Manager documentation for further details.

Serial number autodetection and validation

Serial number autodetection enables Tivoli Storage Manager to automatically obtain a library or drive serial number by issuing a SCSI **Inquiry** command during the **DEFINE PATH** command.

Serial number validation automatically validates the serial number if the serial number is provided with the **DEFINE/UPDATE LIBRARY** and **DEFINE/UPDATE DRIVE** commands by issuing a SCSI **Inquiry** command during the **DEFINE PATH** command. Device serial numbers are also automatically validated during every library or tape drive access.

To avoid potential errors during device definitions or when SAN and device reconfiguration occurs, you can use the **AUTODETECT** function of the **DEFINE PATH** command. This function automatically updates the Tivoli Storage Manager server database with the correct device special file name by using the device's serial number.

Element number autodetection

Element number autodetection enables Tivoli Storage Manager to automatically obtain the drive element address by using the drive's serial number. This function automatically finds the matching element address in the serial number/element number map during the **DEFINE PATH** command.

SAN discovery

To avoid the need for manual modification, there is an accurate SAN device mapping feature available in Tivoli Storage Manager V5.3. This mapping process involves two steps:

1. Detecting that the device has changed.

This detection is accomplished by recording the device's serial number, manufacturer, and World Wide Node Name (WWNN), if it exists, in the Tivoli Storage Manager database. Whenever a device is opened, its identity is verified. This feature is now available on Windows, AIX, Sun, and Linux servers as well as Storage Agents, and was implemented in Tivoli Storage Manager V5.2 for Windows.

2. Reconciling the device definitions (paths) dynamically when changes are detected.

This reconciliation requires Tivoli Storage Manager to discover devices in the SAN environment.

New commands are available in Tivoli Storage Manager V5.3. To activate SAN device mapping, set the **SANDISCOVERY** option to **ON** in the **dsmserv.opt** file:

```
SANDISCOVERY ON
```

This setting is the default for Windows platforms. For all other platforms, you must set this option in the server options file. To activate SAN Discovery in a running Tivoli Storage Manager instance, use the following setting:

```
SETOPT SANDISCOVERY ON
```

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Implementing other backup software with IBM Open Systems Tape

In this chapter we give you pointers to implementing EMC Legato NetWorker and Symantec (Veritas) Netbackup with Open Systems Tape drives and libraries. This includes:

- ▶ Product overview
- ▶ Installation and library definition

For detailed installation procedures and instructions, you should consult the relevant software Web sites and product documentation.

For Legato NetWorker:

<http://software.emc.com/>
http://software.emc.com/products/product_family/networker_family.htm

For Symantec Netbackup:

<http://www.symantec.com/index.jsp>
http://www.symantec.com/enterprise/products/overview.jsp?pcid=1018&pvid=2_1

6.1 EMC Legato NetWorker overview

EMC Legato NetWorker is a suite of storage management software that provides backup, recovery, and other services to computers with a wide variety of operating systems and data types. NetWorker products for different operating systems are interoperable, which provides you flexibility in designing a storage management setup that works best in your current computing environment. For detailed product information, visit the NetWorker Web site:

http://software.emc.com/products/product_family/networker_family.htm

The NetWorker product has four major components: the NetWorker server, client, storage node, and the License Manager:

- ▶ **NetWorker server:** The NetWorker server software provides control and scheduling for NetWorker operations. On the NetWorker server, you can enter the enabler licenses for the NetWorker server, and all the functions the NetWorker server controls such as autochanger modules, additional client connections, and ClientPak licenses. You can also define the clients, devices, and media that the NetWorker server controls, define the schedules for backups and other operations, and monitor all the NetWorker operations.
- ▶ **NetWorker client:** The NetWorker client software provides on-demand backup and recovery functionality, communicating with the NetWorker server. You install the NetWorker client software on all computers that need to back up to the NetWorker server.
- ▶ **NetWorker storage node:** You can back up data directly to devices attached to either a NetWorker server or to a NetWorker storage node. A storage node controls storage devices such as tape drivers, autochangers, and silos.
- ▶ **License Manager:** The License Manager provides a central place for managing the licenses of all your NetWorker clients and servers. Instead of managing licenses separately, you can maintain all your NetWorker licenses from a single computer. Installation of the License Manager is an option when installing the NetWorker software.

6.1.1 NetWorker and IBM LTO interoperability

Be sure that NetWorker is supported in your specific environment. You should cross check on both the IBM and NetWorker Web sites to verify this. Look for interoperability.

http://www-03.ibm.com/servers/storage/tape/lto/lto_isv.html
<http://software.emc.com/support/index.jsp>
ftp://ftp.legato.com/legato/scg/legato_scg.pdf

Note: You can only use non-rewinding devices with the NetWorker server. If you use a rewinding device, the read/write head is repositioned at the beginning of the volume, and the previously backed-up data is overwritten.

6.1.2 NetWorker installation in an AIX environment

In this section, we give you guidelines to NetWorker installation for the IBM AIX platform. For a detailed explanation of the installation process, refer to the *Legato NetWorker Installation Guide - AIX Version*. A version of this book can be downloaded in PDF format from the NetWorker Web site:

<http://web1.legato.com/cgi-bin/catalog?sf=Releases>

Or for up-to date documentation, you should log in with your EMC userid at this Web site:

<https://powerlink.emc.com/nsepn/webapps/btg548664833igtcuup4826/kmlogin/login.jsp?CTAuthMode=BASIC>

You should already have installed and configured the tape drives as described in Chapter 3, “Basic IBM Open Systems Tape setup for UNIX systems” on page 95.

6.1.3 NetWorker installation in a Solaris or HP-UX environment

Install and configure the tape drives as described in Chapter 3, “Basic IBM Open Systems Tape setup for UNIX systems” on page 95.

Then follow the detailed installation process as found in the *Legato NetWorker Installation Guide - Solaris Version*, or similarly *Legato NetWorker Installation Guide - HP-UX Version*. The books can be downloaded in PDF format from the NetWorker Web site at:

<http://web1.legato.com/cgi-bin/catalog?sf=Releases>

6.1.4 Installation comments with NetWorker 7.3

- ▶ For Solaris 10, the NetWorker internal device driver is not supported, and the NetWorker software will use the native Solaris device drivers of **sgen**, **st** and **fp**.
- ▶ On the HP-UX platform, NetWorker internal drivers may be used with IBM tape libraries, but also the IBM Atdd driver can be used.
- ▶ When installing the NetWorker code, at least one storage device must be known. If a tape device is used for backup, ensure it has a valid pathname. For example for AIX a name like `/dev/rmt0.1` Also make sure that the tape device block size is set to variable.
- ▶ Tapes must be nonrewinding, and the pathnames must follow the BSD semantics. For AIX this means that the pathname must be `/dev/rmtx.1` or `/dev/rmtx.5`.
- ▶ In NetWorker 7.3 you should use the Administration Interface to set device parameters.
- ▶ IBM tape libraries using the IBM tape driver must be configured using the **jbconfig** command. The NetWorker device autodetection will use the NetWorker internal driver, thus **jbconfig** must be used.

6.2 Symantec NetBackup overview

Symantec NetBackup was formerly known as Veritas Netbackup, and is a suite of storage management software that provides backup, recovery, and other services to computers for a wide variety of operating systems and data types.

Veritas NetBackup 6.0 delivers high-performance data protection that scales to protect the largest UNIX, Windows, Linux, and NetWare environments. With complete protection from the desktop to the data center, NetBackup offers a single console for management of all backup and recovery operations.¹

- ▶ End-to-End Data Protection — Data protection for all environments, from desktop to data center to vault.
- ▶ Single Solution for All Platforms — NetBackup helps you to consolidate and standardize your backup and recovery operations, protecting all major UNIX variants, Windows, Linux, and NetWare systems.

¹ Copyright (c) 2005 VERITAS Software Corporation. All rights reserved. VERITAS, the VERITAS Logo and NetBackup are trademarks or registered trademarks of VERITAS Software Corporation or its affiliates in the U.S. and other countries. Other names may be trademarks of their respective owners.

- Unlimited Scalability—Centralized management and control, high-performance technology, and a flexible multi-tier architecture enable NetBackup software to adapt to the growing needs of the modern data center.

For detailed product information, visit the Symantec NetBackup Web site:

http://www.symantec.com/enterprise/products/overview.jsp?pcid=1018&pvid=2_1
<http://www.symantec.com/enterprise/support/index.jsp>

Many improvements have been made in V6.0 to the Veritas NetBackup product that make it much more robust to meet the needs of the customers, including several core architecture changes. Because of these changes and the number of new features now offered in NetBackup, Symantec encourages you to upgrade any systems running a pre-6.0 version to the latest version of NetBackup 6.0. Before upgrading, look at:

http://ftp.support.veritas.com/pub/support/products/NetBackup_Enterprise_Server/285590.pdf

6.2.1 NetBackup and IBM LTO interoperability

Be sure that NetWorker is supported in your specific environment. You should cross check on both the IBM and NetWorker Web sites to verify this. Look for interoperability.

http://www-03.ibm.com/servers/storage/tape/lto/lto_isv.html
<http://seer.entsupport.symantec.com/docs/278692.htm>
http://ftp.support.veritas.com/pub/support/products/NetBackup_Enterprise_Server/278064.pdf

And for the interfacing with IBM TS3500 ALMS

http://ftp.support.veritas.com/pub/support/products/NetBackup_Enterprise_Server/284200.pdf

Note: You can only use non rewinding devices with the NetBackup server. If you use a rewinding device, the read/write head is repositioned at the beginning of the volume, and the previously backed-up data is overwritten.

6.2.2 NetBackup installation in a general UNIX environment

For a detailed explanation of the general UNIX installation process, refer to the following manuals for *Veritas NetBackup 6.0*:

- *Installation Guide for Unix and Linux*
- *Media Manager Device Configuration Guide for Unix, Windows and Linux*
- *Media Manager System Administrator Guide for Unix and Linux*

See your installation documentation, or look up the Symantec Veritas support Web site:

<http://seer.entsupport.symantec.com/docs/279261.htm>

You should already have installed and configured the tape drives as described in Chapter 3, “Basic IBM Open Systems Tape setup for UNIX systems” on page 95.

In an AIX or HP-UX installation with the IBM TS3000 family of libraries you are recommended to use the IBM device driver for the tape drives, but to use Veritas passthrough driver for the library. For other libraries use the passthrough driver for both library and drives. If this device driver is installed when configuring the library, you must remove the device definitions (similar to /dev/smc0), and use the standard Veritas passthrough driver `ovpass`.

For other operating systems you are recommended always to use the Veritas passthrough driver.

6.2.3 Installation comments with NetBackup 6.0

Here are some considerations for this product:

- ▶ Before configuring NetBackup, you must have the storage devices attached to the server and perform all configuration steps specified by the device and operating system vendor (including installation of any required device drivers).
- ▶ In an AIX environment, if you are using IBM tape drives, VERITAS recommends that you install the IBM AIX tape driver. Refer to the IBM documentation when using this driver. If you are using other tape drives, VERITAS recommends that you use the IBM AIX OST (other SCSI tape) driver. Refer to the IBM documentation when using this driver.
- ▶ Use the IBM Atdd driver when configuring IBM tape drives on HP-UX. Configure atdd and BEST device paths according to IBM driver documentation. Do not configure atdd for robotic control of IBM robots. Check the VERITAS support web site for the latest recommended atdd driver version from IBM.
- ▶ Use the `/usr/sbin/mknod` command to create the passthru device files for both Media Manger and for the tape drives. Although the passthru device files for tape drives are used during NetBackup operation, they are not specified during configuration.
- ▶ Some recent versions of the IBM device drivers (Atape for AIX, Atdd for HP-UX, and IBMTape for Windows) are tested and may be used with the IBM tape drives. The passthru device files must still be created. For the library generally use the passthru drivers.
- ▶ Follow the documentation mentioned above, and do the necessary configurations according to that documentation.

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Part 3

Appendixes

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SNMP setup

In this appendix we describe setting up SNMP on the different IBM System Storage libraries.

- ▶ IBM System Storage TS3100 Tape Library / IBM System Storage TS3200 Tape Library
- ▶ IBM System Storage TS3310 Tape Library
- ▶ IBM System Storage TS3400 Tape Library
- ▶ IBM System Storage TS3500 Tape Library.

We also show some examples of usage with the IBM Tivoli NetView software.

Simple Network Management Protocol (SNMP) alerts

Occasionally, the LTO library may encounter a situation that you want to know more about, such as an open door that causes the library to stop. The IBM System Storage TS3000 family of tape libraries implement a standard TCP/IP protocol called Simple Network Management Protocol (SNMP) to send alerts about conditions (such as an opened door) over a TCP/IP LAN network to an SNMP manager. These alerts are called SNMP traps. SNMP is a set of protocols for managing complex networks, and works by sending messages, called protocol data units (PDUs), to different parts of a network.

Using the information supplied in each SNMP trap, the monitoring server (together with customer-supplied software) can alert operations staff of possible problems or operator interventions that occur. Many monitoring servers (like Tivoli NetView) can be used to send e-mail or pager notifications when they receive an SNMP alert. (For more information, see your Tivoli NetView documentation or the documentation for your network management application). Some of the libraries can also send such e-mail notifications directly.

Agents, which are SNMP-compliant devices, store data about themselves in Management Information Bases (MIBs) and return this data to the SNMP requesters, such as the host's monitoring application. SNMP traps are alerts or status messages that can be collected, monitored, and used to proactively manage attached libraries using the SNMP protocol with the host server(s).

The tape library supports transmission of SNMP traps and collection of MIB information as an SNMP agent. SNMP traps can be received using an SNMP manager and MIB information can be collected using a MIB browser.

The monitoring server must be loaded with system management software that can receive and process the trap, or the trap is discarded. SNMP supports a get/get-response mechanism for an operator to gather more information about a problem or query the library about its current status. A **get** is a request for information about the library that the operator issues through a monitoring server and which is transmitted by SNMP. A **get-response** is the information that is provided in response to the get. This type of support generally requires an up-to-date library Management Information Base (MIB). The library's MIB contains units of information that specifically describe an aspect of a system such as the system name, hardware number, or communications configuration.

SNMP is itself a sub-protocol of TCP/IP and is based on a hierarchical structure represented by strings of "object identifiers" or OIDs. Much of the data required by network managers is mapped to instances of the OIDs. Standard values are included in higher levels of the structure, providing a standard for identifying those data. Brand-specific extensions are provided by the manufacturers. These standard and proprietary OID collections are called *Management Information Bases* (MIBs). The specification for SNMP, contained in RFC 1157 is available at:

<ftp://ftp.isi.edu/in-notes/rfc1157.txt>

The IBM TS3000 family of tape libraries have the SNMP monitoring function included in the firmware, and supported by the Tape Library Specialist module. The SNMP connection requires an Ethernet port which is included in all the TS3000 family of tape libraries. We described how to configure the LAN connection for these libraries in 2.2.1, "Setting up and configuring the IBM TS3100 / TS3200" on page 47, 2.2.3, "Setting up and configuring the IBM TS3310" on page 49, 2.2.5, "Setting up and configuring the IBM TS3400" on page 53, and 2.2.7, "Setting up and configuring the IBM TS3500" on page 56.

Configuring SNMP for the IBM TS3100/TS3200

The IBM TS3100 and TS3200 use the same technology and the same Tape Library Specialist. The libraries are compatible with TapeAlert technology, which provides error and diagnostic information about the drives and the library to the server.

Select **Configure Library** → **Network** to set up SNMP. Check the **SNMP Enabled** box, and define the SNMP server to receive the predefined traps. You can define 3 different receivers, see Figure A-1.

The screenshot shows the 'Network' configuration page in the IBM System Storage TS3100/TS3200 Tape Library interface. The left sidebar contains a tree view with 'Configure Library' expanded, showing options like General, Logical Libraries, Control Path Failure, Encryption, Drives, Network, User Access, Date & Time, Logs & Traces, Event Notification, and Restore Defaults. The main content area is titled 'Network' and contains the following fields:

DHCP Address	<input type="checkbox"/> On
IP Address	9.11.203.38
Network Mask	255.255.252.0
Gateway Address	9.11.200.1
SNMP Enabled	<input type="checkbox"/>
SNMP Target 1 - IP Address	0.0.0.0
SNMP Target 2 - IP Address	0.0.0.0
SNMP Target 3 - IP Address	0.0.0.0
Community Name	public

Below the fields, there is a message: 'A new login is required if changes are done! If the IP address changes, the new one must be entered in the address bar.' and two buttons: 'Refresh' and 'Submit'.

On the right side, there is a 'System Status' panel with the following information:

- View Legend
- 04/09/2007 14:16:24
- Library Name: FLX105B14
- Status: ☒ Ready
- Drive 1 Status: ☒ Ready
- Slots (Empty/Total): 18/20
- I/O Station: Closed
- Library Time: 14:16:24

Figure A-1 TS3100/TS3200 SNMP Configuration

To set up direct e-mail notification, select **Configure Library** → **Event Notification**, see Figure A-2. This allows you to define a specific e-mail address to receive the trap information, and to select the error level that should be submitted. When you Submit, a test message is sent to this address.

The screenshot shows the 'Event Notification' configuration page in the IBM System Storage TS3100/TS3200 Tape Library interface. The left sidebar is the same as in Figure A-1, with 'Event Notification' selected under 'Configure Library'. The main content area is titled 'Event Notification' and contains the following fields:

Notify Errors	<input type="checkbox"/> On
Notify Warnings	<input type="checkbox"/> On
To Email Address	
Email Domain	
SMTP Server Address	0.0.0.0

Below the fields, there are two buttons: 'Refresh' and 'Submit'.

On the right side, there is a 'System Status' panel with the following information:

- View Legend
- 04/09/2007 13:38:08
- Library Name: FLX105B14
- Status: ☒ Ready
- Drive 1 Status: ☒ Ready
- Slots (Empty/Total): 18/20
- I/O Station: Closed
- Library Time: 13:38:08

Figure A-2 TS3100/TS3200 Event Notification

Configuring SNMP for the TS3310

To configure and activate SNMP event monitoring for the IBM TS3310, you must partly use the TS3310 Operator Panel, and partly the Tape Library Specialist interface. To register traps, you must log in as administrative user at the Operator Panel, and select **Setup** →

Network Management → Trap Registration. Then you can create or change IP addresses for trap receivers. However, we recommend using the easy access of the Web interface.

From the Tape Library Specialist (Figure 2-10 on page 49), from the **Library Tasks** select **Manage Library → Settings → SNMP**, see the SNMP configuration panel Figure A-3.

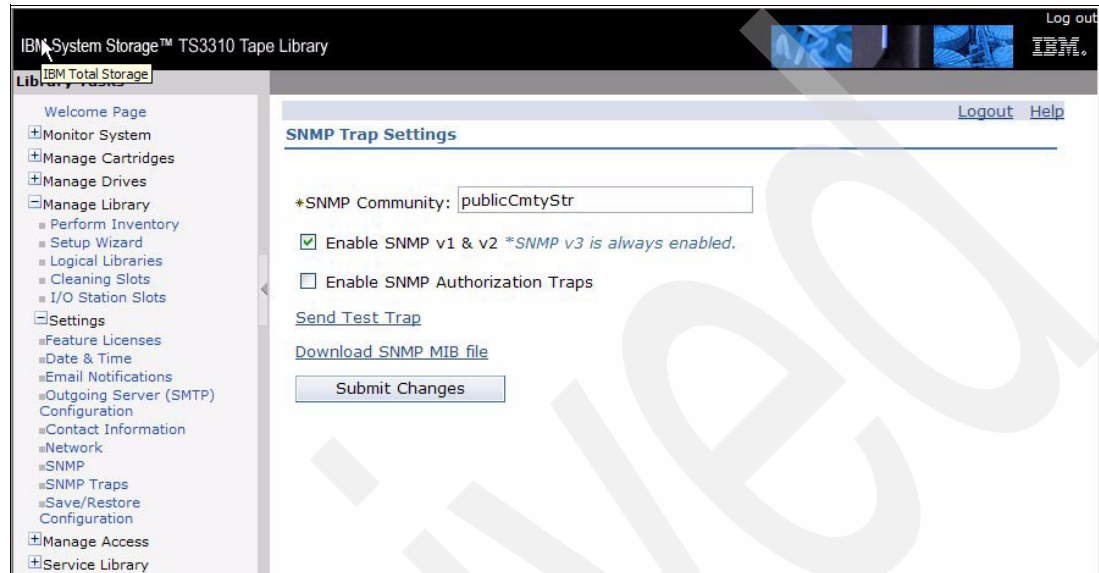


Figure A-3 IBM TS3310 Configure SNMP Trap settings

Click the **Submit** button to apply the changes. A confirmation panel appears. Click **Enter** to confirm the updates. You can select to enable the SNMP version that fits with your SNMP server, however, SNMP V3 is always enabled for this library. Note that if you are using SNMP v3, your login password must be 8 characters long or greater. You will see there is also a selection to download the MIB file to provide it to the SNMP servers.

From the Tape Library Specialist, select **Manage Library → Settings → SNMP Traps** to define your trap settings. This will lead you through a set of panels, the first as in Figure A-4.

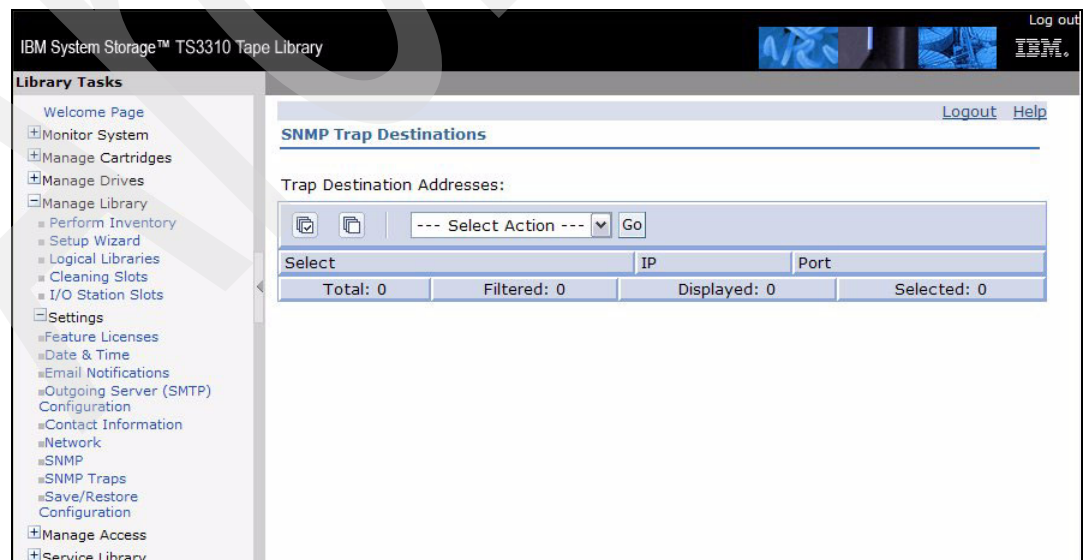


Figure A-4 IBM TS3310 Configure SNMP Trap Destinations

Define your SNMP community, and enable the SNMP level according to the requirements for your SNMP server. The TS3310 cannot receive SNMP requests from the server, but you can define which traps to send where. When you select Add from the drop-down menu in Figure A-4, you get a panel to add SNMP server IP address, see Figure A-5. Default port is 162.

The screenshot shows the 'Add SNMP Trap Destination' dialog box in the IBM System Storage TS3310 Tape Library web interface. The left sidebar contains a 'Library Tasks' menu with options like 'Welcome Page', 'Monitor System', 'Manage Cartridges', 'Manage Drives', 'Manage Library', 'Settings', 'Manage Access', and 'Service Library'. The main panel has a title bar with 'Logout' and 'Help' buttons. Below the title bar, there are two input fields: '*IP Address:' and '*Port:'. The IP address field contains the text '(i.e. 127.1.1.0)'. Below these fields are 'OK' and 'Cancel' buttons.

Figure A-5 IBM TS3310 Add SNMP Trap destination

You may also send e-mail notifications directly from the library. To enable this, and set up a receiving address, select **Manage Library** → **Settings** → **Email Notifications**, see Figure A-6. From the drop-down menu you can enable/disable this functionality, and add or change mail receivers.

The screenshot shows the 'Email Notifications' configuration page in the IBM System Storage TS3310 Tape Library web interface. The left sidebar is the same as in Figure A-5. The main panel has a title bar with 'Logout' and 'Help' buttons. Below the title bar, there is a section titled 'Email Addresses:'. It contains a table with columns: 'Select', 'Email Address', 'Alert Level', and 'Status'. There is a dropdown menu with '--- Select Action ---' and a 'Go' button. The table has one row with a checkbox, the email address 'tdejesus@us.ibm.com', 'Low' alert level, and 'Enabled' status. Below the table, there are summary statistics: 'Total: 1', 'Filtered: 0', 'Displayed:', and 'Selected: 0'.

Select	Email Address	Alert Level	Status
<input type="checkbox"/>	tdejesus@us.ibm.com	Low	Enabled

Total: 1 Filtered: 0 Displayed: Selected: 0

Figure A-6 IBM TS3310 Set Up e-mail notifications

Configuring SNMP for the IBM TS3400

To configure and activate SNMP event monitoring for the IBM TS3400, use the Tape Library Specialist interface. You cannot use the Operator Panel to configure this function.

The TS3400 tape library supports transmission of SNMP traps and collection of MIB information as an SNMP agent. SNMP traps can be received using an SNMP manager and MIB information can be collected using an MIB browser.

The TS3400 library does not accept SNMP Set commands from the applications, but the SNMP Setting tab lets you register traps and SNMP managers.

From the Home panel (Figure 2-6 on page 46), in the **Library Tasks** column select **Configure Library** → **Notifications**, and select the **SNMP Setting** tab, see Figure A-7.

The screenshot shows the IBM System Storage TS3400 Tape Library Specialist web interface. The title bar reads "IBM System Storage™ TS3400 Tape Library". Below the title bar, a message says "Welcome admin logged in as Administrator". The interface is divided into two main sections. On the left is a "Library Tasks" sidebar with a tree view containing categories like "Monitor Library", "Manage Library", "Configure Library", "Manage Access", and "Service Library". The "Configure Library" category is expanded, showing sub-items like "Library Setting", "Partition Setting", "Network Setting", "Encryption Setting", "Notifications", "Save/Restore Configuration", "Users", and "Firmware Update". The "Notifications" item is selected. On the right is the "Notifications" panel, which has two tabs: "Email Setting" and "SNMP Setting". The "SNMP Setting" tab is active. It contains several input fields: "Community:" with the value "public", "Name:", "Location:", and "Contact:". Below these is a "Trap to:" section with four rows, each with a checkbox labeled "Enable" and an IP address field (all showing "0.0.0.0"). To the right of these fields is a "Trap event:" section with four radio button options: "Emergency", "Emergency / Error", "Emergency / Error / Warning" (which is selected), and "Every Event". Below the radio buttons is a "Test" button. At the bottom right of the panel are "Refresh" and "Submit" buttons. At the bottom left of the sidebar, there is a "Display Refresh Interval(sec)" slider ranging from 0 to 60.

Figure A-7 IBM TS3400 Tape Library Specialist: SNMP Setting

To configure SNMP and trap notifications, the network settings for the tape library must be assigned correctly. It is also necessary to set the gateway address if the tape library and the SNMP manager belong to different subnets. Then you need to provide information for the following parameters:

1. Community — SNMP Community name to which the library belongs.
2. Name — Unique SNMP name for the system.
3. Location — Physical location of the system.
4. Contact — Contact person's name.
5. Enter the trap IP addresses to be notified when an event takes place in the **Trap To** fields. Up to four destination addresses can be configured.
6. Select the event level to report in the Trap Event field.
 - Emergency events
 - Emergency and Error events
 - Emergency, Error, and Warning events
 - Every event (default)

7. **Submit** the settings to apply the changes.

To send a test alert, select the **Test** button.

The TS3400 library may also send email traps directly. Selecting the **Email Setting** tab, see Figure A-7 above, you get a very similar panel to define an Email server, and up to four mail receivers.

After you have configured the library to send SNMP alerts to the SNMP server, configure your SNMP monitoring product (like Tivoli NetView) to use the MIB-supplied file and to monitor the events. An example of the Tivoli NetView 6.0.1 panel is shown in Figure A-8, where our tape drive BAVARIA is discovered as a node.

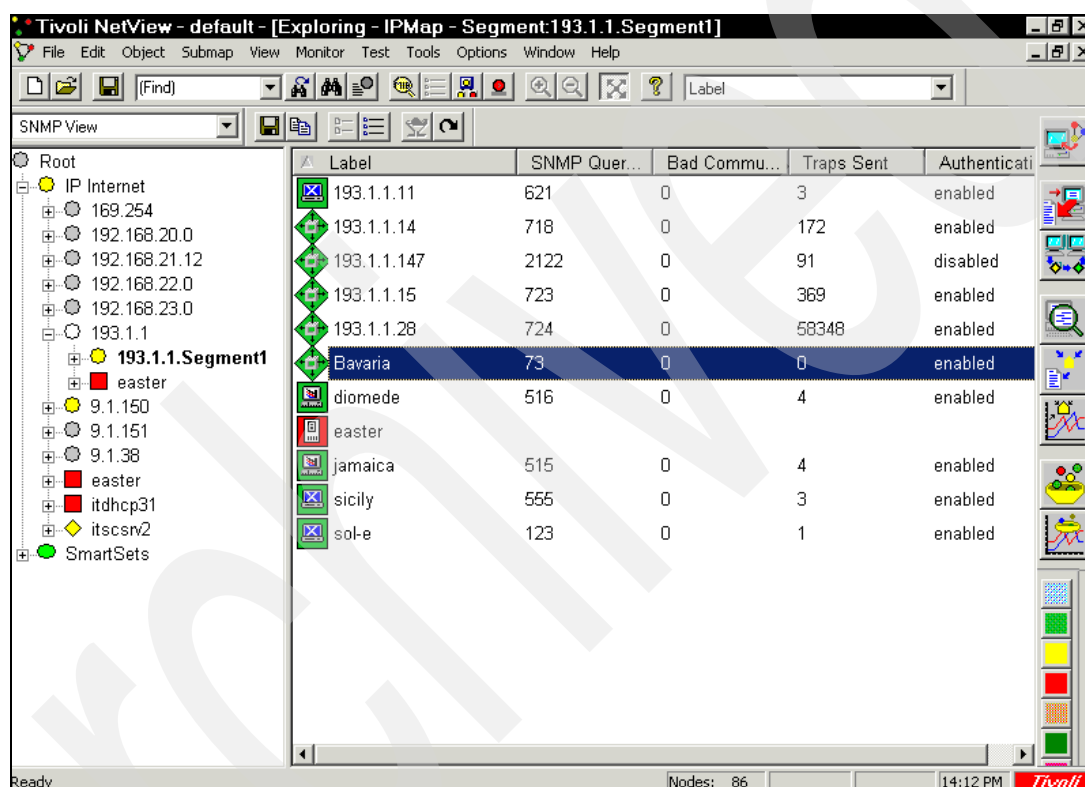


Figure A-8 Tivoli NetView SNMP monitoring

Tip: For more information on NetView, see the Redbooks publication, *Tivoli NetView 6.01 and Friends*, SG24-6019.

Configuring SNMP for the IBM TS3500

In general, the IBM TS3500 library generates SNMP traps when it detects TapeAlert error conditions. Additionally, the library also generates SNMP traps under certain non-error conditions. They are generated under the following non-error conditions:

- ▶ The I/O station has been full for over an hour.
- ▶ The logical library has been full for over an hour and contains no empty storage slots.
- ▶ The I/O station door is open for an extended period of time.

- There are no LTO Ultrium or 3592 cleaning cartridges in the library (0 cleanings remain on the LTO Ultrium cleaning cartridges in library).
- An LTO Ultrium or 3592 cleaning cartridge has expired (the number of cleanings left for the cartridge has decreased to 0).

You can enable SNMP and change settings at the Operator panel dialog or by using the IBM Tape Library Specialist. We recommend using the Specialist.

The IBM TS3500 sends SNMP traps over all configured Ethernet ports. If using more than one Ethernet port, then you will also receive more than one SNMP trap for one single failure. The library acquires TapeAlert 3.0 compatibility information from the drives and sends this information to an SNMP server. In the event of a power loss, the library will detect the loss and generate an SNMP trap for notification. Up to five different SNMP managers can be configured to receive trap events.

The TS3500 library supports SNMP Version 1.0 or 2.0c and can act as an SNMP server, responding to SNMP requests and generating SNMP traps, the get/get-response mechanism. A **get** is a request for information about the library issued from a monitoring server and transmitted by SNMP. A **get-response** is the information provided in response to the get request. This functionality is provided with the TS3500. It generally requires an up-to-date library Management Information Base (MIB). In addition to the IBM TS3500 MIB, you also must load the Storage Networking Industry Association-Storage Media Library (SNIA-SML) MIB into your SNMP monitoring product. You can load the MIB for the IBM TS3500 from:

<ftp://ftp.software.ibm.com/storage/358x/3584/>

Enable SNMP traps using the Operator panel

From the library's Activity Operator panel, click **Menu**, then **Settings** → **Network** → **SNMP**. To enable or disable SNMP, click **Up** or **Down** to highlight **Enable/Disable SNMP** and click **Enter**. The Enable/Disable SNMP panel displays with the current state of SNMP (Figure A-9). Click **Up** or **Down** to specify **Enabled** or **Disabled** for SNMP. The SNMP panel redisplay the new setting. To accept the new setting and return to the previous panel, click **Back**.

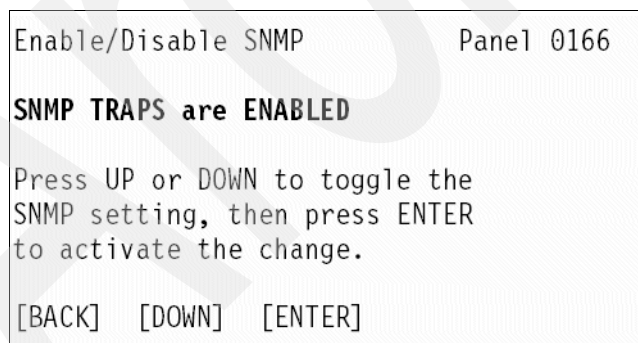


Figure A-9 IBM TS3500 operator panel: Enable/disable SNMP

Some SNMP monitoring applications only support Version 1 SNMP traps, while others only support Version 2 traps. The IBM TS3500 supports both Version 1 and Version 2c.

To send a different version of traps, select on the SNMP Menu **V1/V 2**. The V1/V2 Traps screen displays the version of the traps that were last sent by the SNMP agent. To change the setting, click **Up** or **Down** to specify the version of the trap (Figure A-10), then click **Enter**. The screen redisplay with the new version of the trap. To accept the new setting and return to the previous panel, click **Back**.

```

V1/V2 Traps                                Panel 0161

Trap Version is  [V2c]

Version 2 traps are not
supported by some SNMP
management stations.

Press UP or DOWN to toggle the
Trap setting, then press ENTER
to activate the change.

[CANCEL]  [ UP ]  [DOWN]  [ENTER]

```

Figure A-10 IBM TS3500 operator panel: V1/V2 Traps

To view or change the destination IP address of a monitoring station to which SNMP alerts will be sent, choose from the SNMP menu **Destination IP Addresses**. Then click **Up** or **Down** to specify the destination IP address that you want to view or change (Figure A-11), then click **Enter**. You can have the library send the SNMP traps to up to five different monitoring stations.

```

Destination IP Addresses                    Panel 0170

Select Destination IP Address
to view/change.

IP Address:  2

Select 1 - 5

[BACK]  [ UP ]  [DOWN]  [ENTER]

```

Figure A-11 IBM TS3500 operator panel: Destination IP address

The Set Destination IP Address panel displays with the current value of the destination IP address that you specified (Figure A-12). Click **Up** or **Down** to change to the value that you want, then click **Enter**. The panel redisplay with the new destination IP address. To accept the new setting and return to the previous panel, click **Back**.

```

Set Destination IP Address                  Panel 0172

IP Address 2:  10.25.36.1

Use [UP] and [DOWN] to change
highlighted value.

[CANCEL]  [ UP ]  [DOWN]  [ENTER]

```

Figure A-12 IBM TS3500 operator panel: Set destination IP address

To view or change the community name, click **Up** or **Down** to highlight **Community Name** and click **Enter**. The Community Name panel displays with the current password (Figure A-13). To change the password, click **Up** or **Down** to specify the character that you want and click **Enter**. Repeat this operation for the following characters. When you are done, the library displays the message Updating Community Name and the update of the password begins. When the update is finished, Community Name change displays. Click **Enter** to display the new password.

```
Trap Community Name          Panel 0167

Community Name:
public

Press UP/DOWN to change the
current character. ENTER
selects the next character.
ENTER on a blank commits
changes.

[CANCEL]  [ UP ]  [DOWN]  [ENTER]
```

Figure A-13 IBM TS3500 operator panel: Set community name

To use the operator panel to send a test SNMP trap and ensure proper connection of the IBM TS3500, do the following:

From the library's touchscreen, press **Menu** → **Settings** → **Network** → **SNMP** → **Send a Test Trap** → **Enter**. The library displays the message A test trap with the text "This is a test SNMP trap." has been sent to all defined target hosts. Click ENTER to continue.

The library sends an SNMP trap to all SNMP IP addresses at the remote port that you specified. The trap contains the machine type, model number, and serial number of the library, as well as other fields. For more information on SNMP traps, see the *IBM System Storage TS3500 Tape Library Operator Guide*, GA32-0560.

Enable SNMP Traps using Tape Library Specialist

From the Web Tape Library Specialist select **Access** → **SNMP Settings**. Select the trap version, either SNMP V1 or SNMP V2c (see Figure A-14), according to the requirements of your monitoring application. The IBM TS3500 supports both V1 and V2c. You can see there is also a selection to enable SNMP Requests. By enabling this, the SNMP server can request information from the library, the get/get-response mechanism.

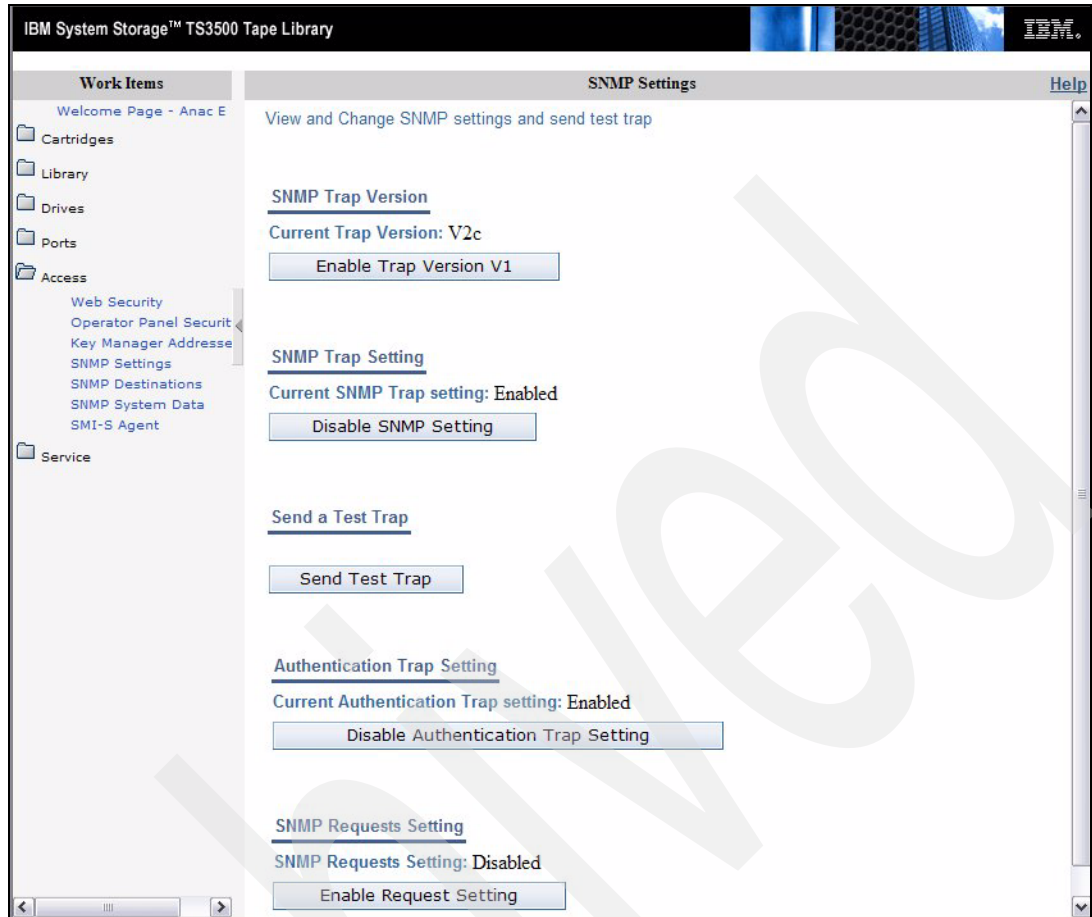


Figure A-14 IBM TS3500 Tape Library Specialist: Enabling SNMP

Next, enter the destination SNMP monitoring server. Up to five SNMP monitoring servers can be defined. Select **SNMP Destinations** at the Specialist and enter the IP address(es) and port(s) of any SNMP monitoring server(s) to which you want to send SNMP alerts. Click **Apply** to accept the information, see Figure A-15.

IBM System Storage™ TS3500 Tape Library

Work Items

- Welcome Page - Anac E
- Cartridges
- Library
- Drives
- Ports
- Access
 - Web Security
 - Operator Panel Security
 - Key Manager Address
 - SNMP Settings
 - SNMP Destinations
 - SNMP System Data
 - SMI-S Agent
- Service

SNMP Destinations

View and set destination IP addresses and ports

IP Address	Port
9.47.81.102	162
9.47.101.20	162
0.0.0.0	162
0.0.0.0	162
0.0.0.0	162

[Apply](#)

Figure A-15 IBM TS3500 Tape Library Specialist: SNMP destinations

You must also establish the SNMP System data, see Figure A-16. Fill in the required information and **Apply**.

IBM System Storage™ TS3500 Tape Library

Work Items

- Welcome Page - Anac E
- Cartridges
- Library
- Drives
- Ports
- Access
 - Web Security
 - Operator Panel Security
 - Key Manager Address
 - SNMP Settings
 - SNMP Destinations
 - SNMP System Data
 - SMI-S Agent
- Service

SNMP System Data [Help](#)

View and Change System data

Community Names

Trap Name	Read Name
anaconda	anaconda

System Group Information

System Name	Anac E
Contact	
Address	
Location	
City	
State	
Country	
Phone	5207994968
Secondary Phone	5207994968

[Apply](#)

Figure A-16 IBM TS3500 SNMP System data

Configure Netview as SNMP monitor

After you have configured the IBM TS3500 to send SNMP alerts to the SNMP server, you must configure your SNMP monitoring product (like Tivoli NetView) to monitor the events. The SNMP monitoring product needs the library Management Information Base (MIB) for interpreting the SNMP traps, otherwise, you have to interpret the SNMP traps manually. Information on how to interpret the SNMP traps manually is in the *IBM System Storage TS3500 Tape Library Operator Guide*, GA32-0560.

The MIB contains units of information that specifically describe an aspect of a system such as the system name, hardware number, or communications configuration. To obtain the MIB for the IBM TS3500/3584, see the Web site:

<ftp://ftp.software.ibm.com/storage/358x/3584/>

For Windows, select **3584mib.zip**, and for UNIX select **3584mib.tar**. Download the MIB and load it into your management application. Follow the information provided by your SNMP monitoring product to receive SNMP traps from the IBM TS3500. As an example, we show you how to configure IBM Tivoli NetView to receive SNMP traps from the IBM TS3500:

1. Create a new object on your NetView console. Enter an Object Name and a Label Name (see Figure A-17).

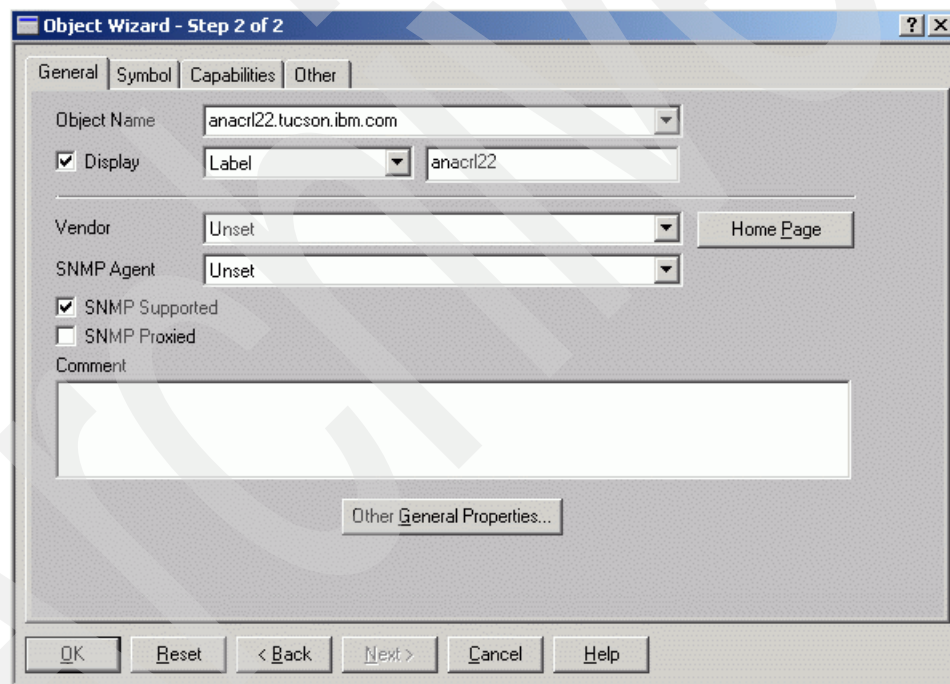


Figure A-17 Tivoli NetView: Create new Object

2. Select the **Other** tab and specify the Hostname, the IP Address of the IBM TS3500, and the Subnet Mask (see Figure A-18). Before you can create this new object, you have to verify the connection. Click the **Verify** icon for that purpose.

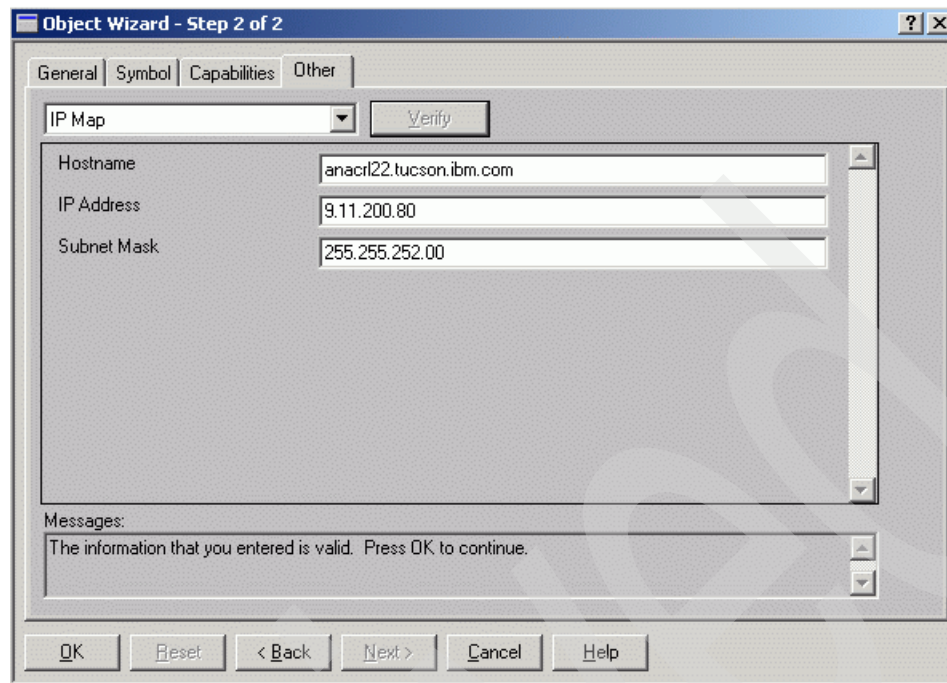


Figure A-18 NetView: Create new object

3. On the NetView console, you can browse the network segment that your library belongs to. The color of the icon indicates the status of the library. See Figure A-19 for an illustration of several libraries with different statuses.

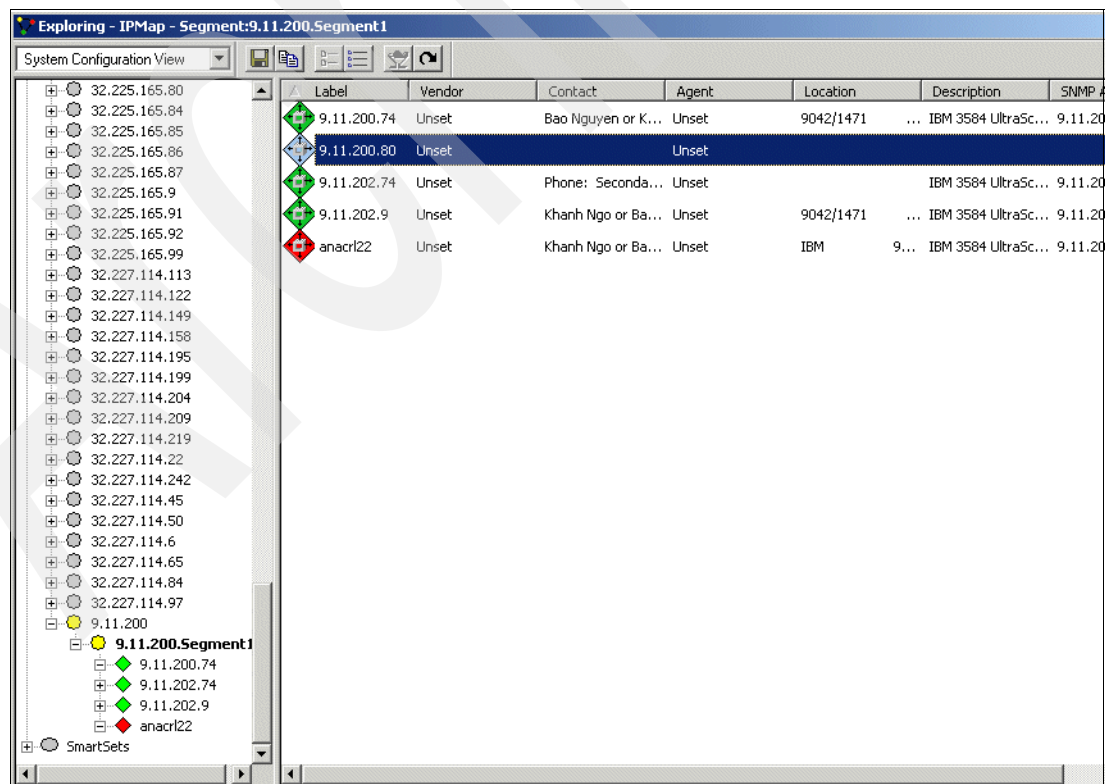


Figure A-19 NetView - Browse network segment

- By choosing the properties of one object (one library) and selecting the event tap, you can see all SNMP traps received by NetView (see Figure A-20).

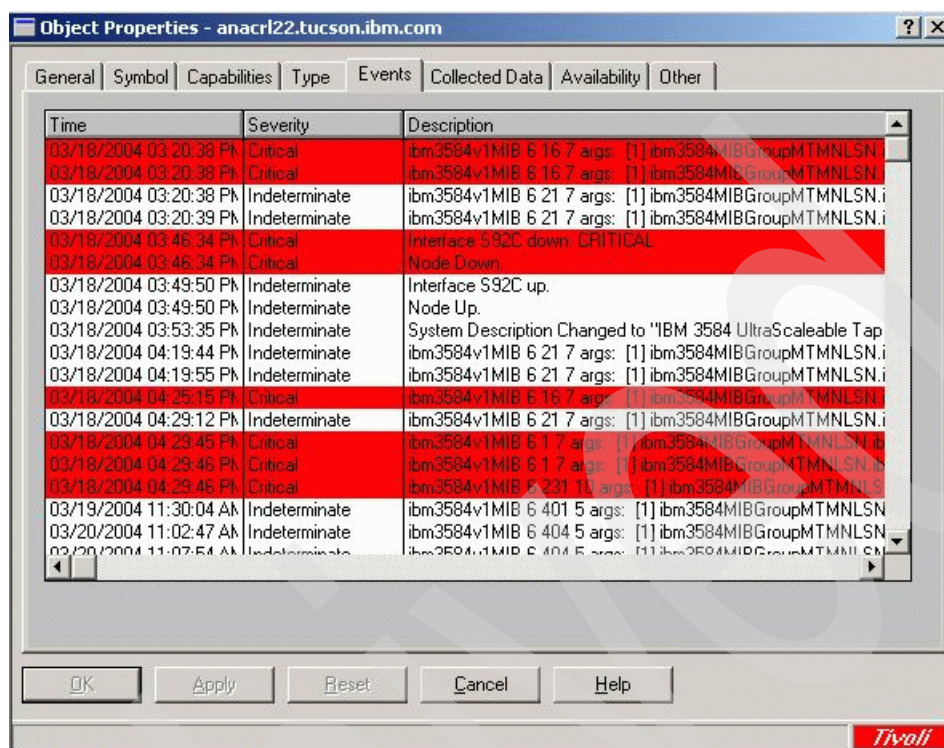


Figure A-20 NetView - SNMP Traps

- If you double click one of these SNMP traps, you will get a detailed description of why the library sent an SNMP trap. In most cases, depending on the failure, you also get suggestions for what to do to resolve the failure (see Figure A-21).

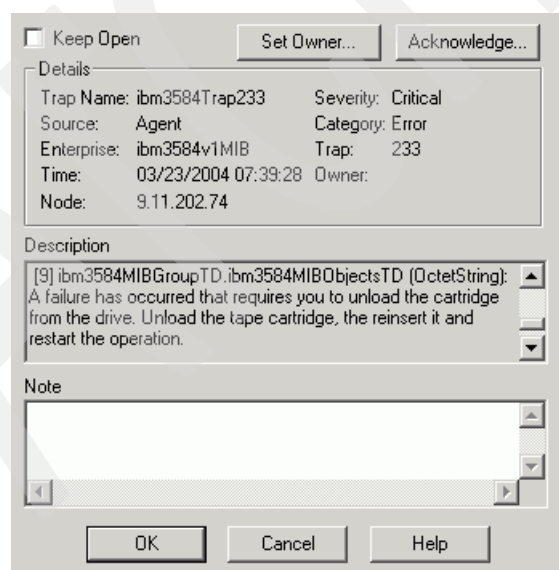


Figure A-21 NetView - Detailed description of TS3500 SNMP Trap

Enabling or disabling SNMP requests

To enable SNMP requests, use the Operator panel or use the IBM TS3500 Tape Library Specialist. From the Web Specialist select **Access** → **SNMP Settings** and enable **SNMP Request settings** as shown in Figure A-14 on page 243.

You can now use SNMP to monitor your library. Here are some examples created with Tivoli NetView:

- ▶ To know how many drives are present in the library, use your monitoring server to issue an SNMP get request on the object `numberOfMediaAccessDevices.0`.
- ▶ For a list showing the status of all of the drives in the library ordered by element address, issue an SNMP get request on the objects `mediaAccessDevice-Availability.1` through `mediaAccessDevice-Availability.n` where *n* is the number returned by `numberOfMediaAccessDevices.0` (see Figure A-22).

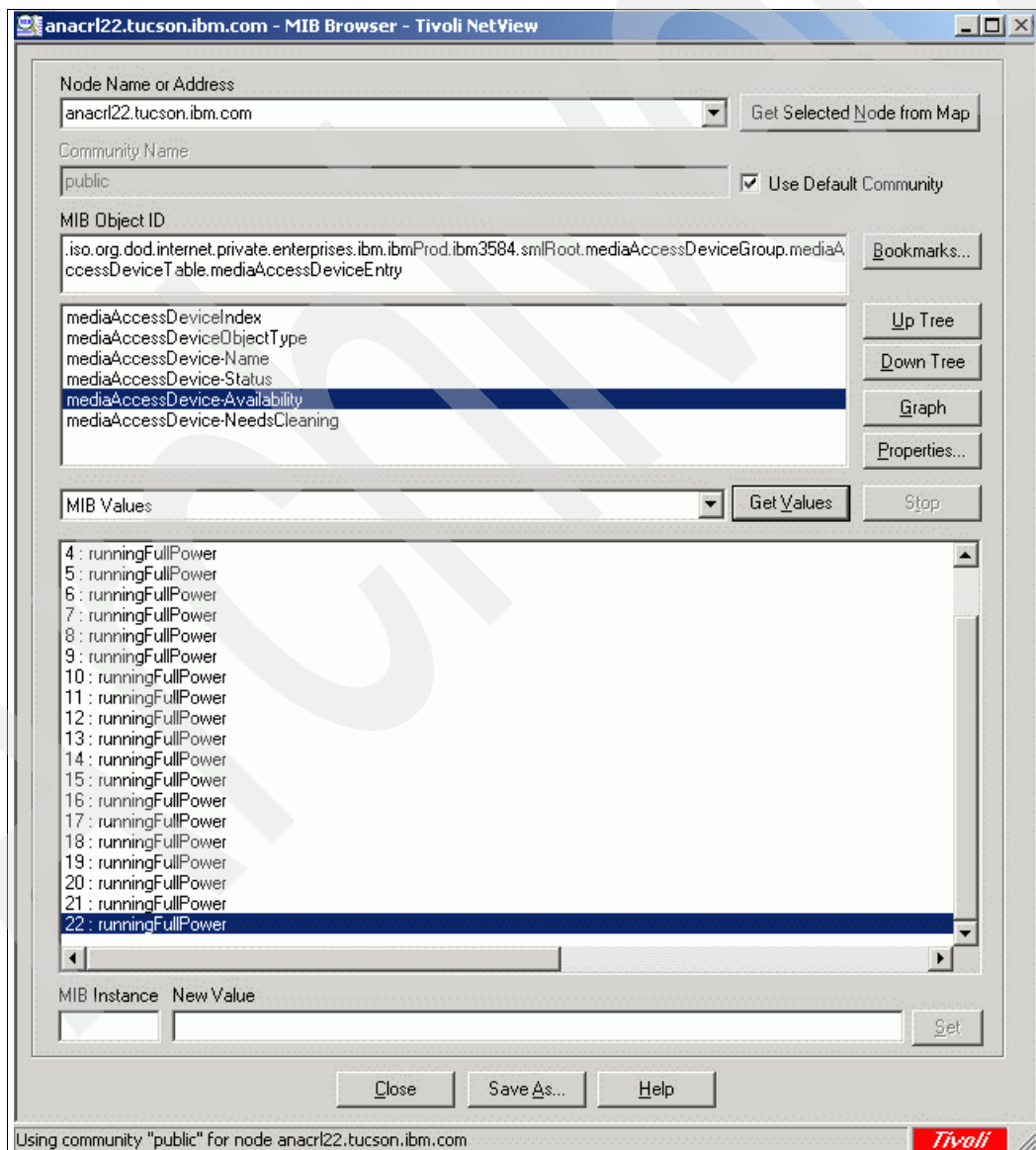


Figure A-22 SNMP Request: Drive status

- To obtain a list of all cartridges in the library, issue an SNMP get request on the object `numberOfPhysicalMedias`. This indicates how many cartridges are present in the library (see Figure A-23).

Issue an SNMP get request on the object `physicalMedia-PhysicalLabel.1` through `physicalMedia-PhysicalLabel.n` where n is the number returned by `numberOfPhysicalMedias`. This gives you a list of the physical label (volser) of all the cartridges in the library. You can also use (depending on your SNMP monitor product) the subtitle `physicalMediaEntry` (see Figure A-24) for the status and the volser of all the cartridges.

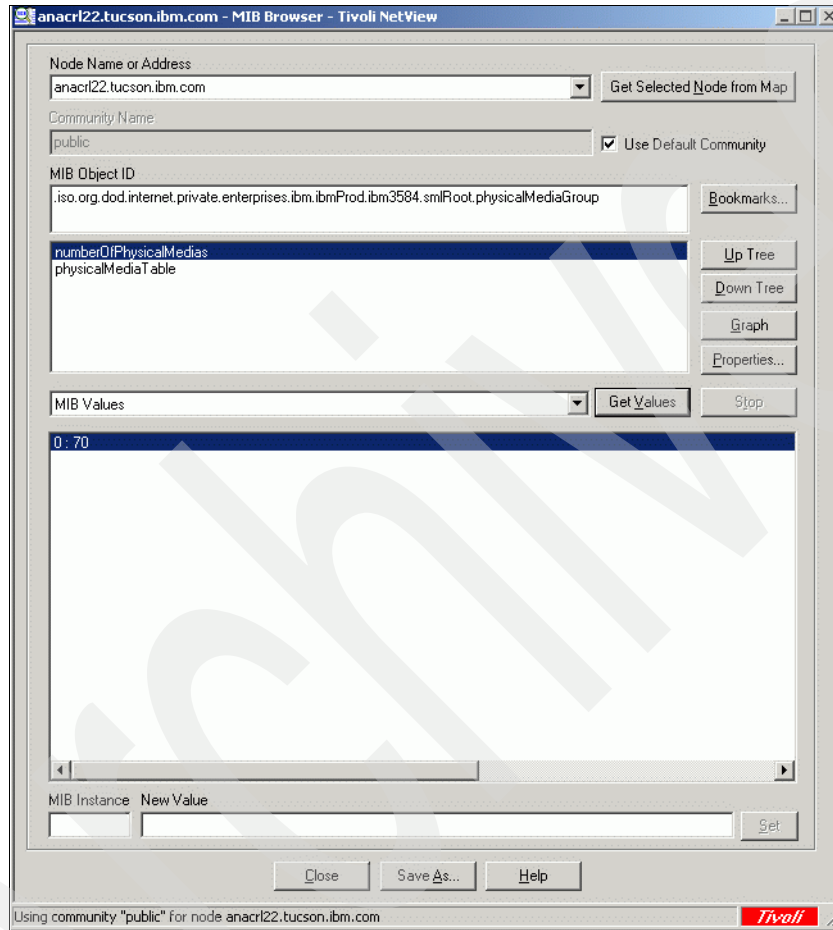


Figure A-23 SNMP Request: Number of all physical cartridges

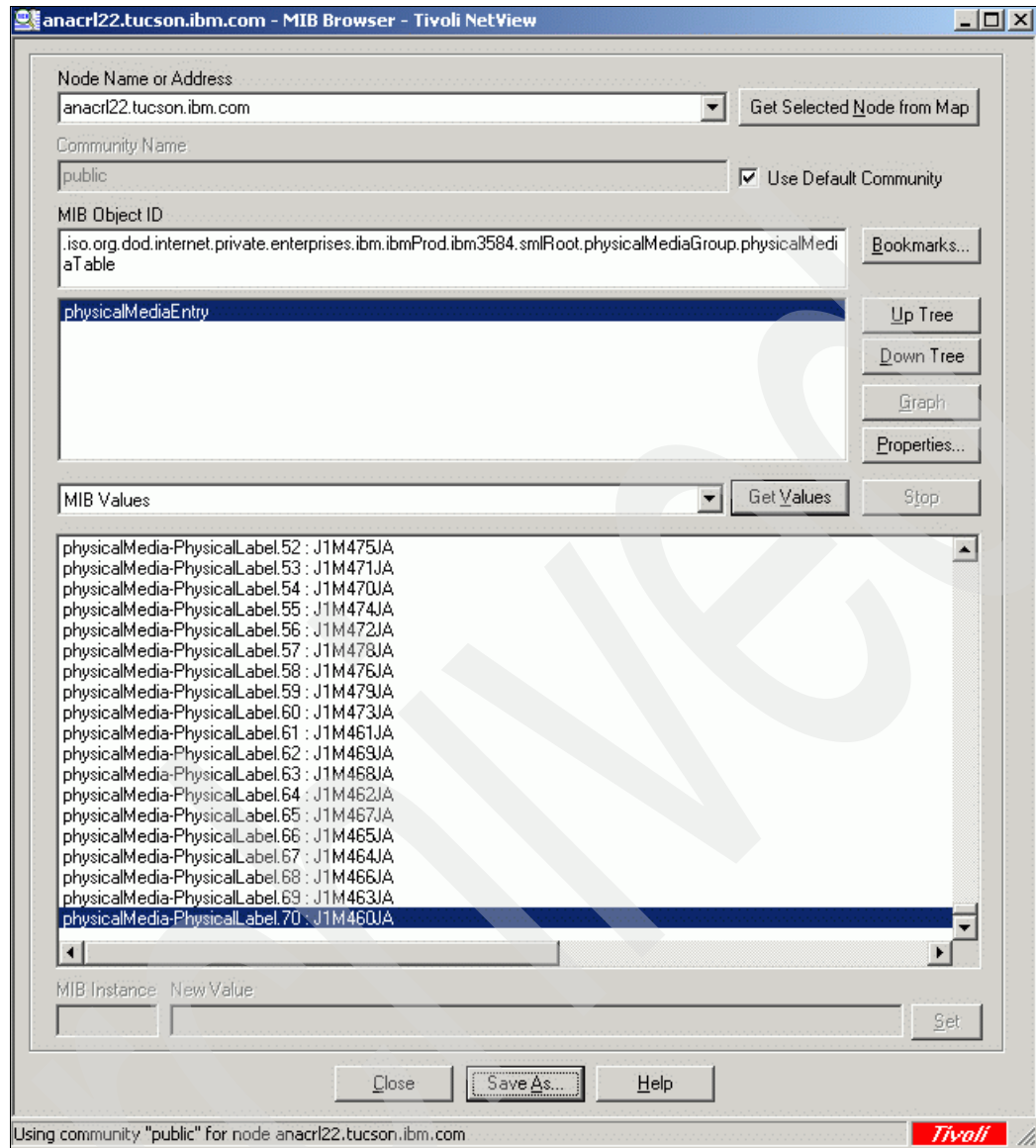


Figure A-24 SNMP Request: List of all physical media

Note: These SNMP requests issued from Tivoli Netview has been included as a sample of how to use SNMP. Configure your monitoring application to take advantage of the SNMP traps and functions provided by the TS3500 library.

LTO tips and troubleshooting

In this appendix we provide some additional information that is useful when implementing IBM Open Systems Tape drives and libraries.

We cover the following topics:

- ▶ Performance considerations for tape devices
- ▶ Commonly used AIX commands
- ▶ Commonly used Solaris commands
- ▶ IBM Tivoli Storage Manager tape drive and library commonly used commands
- ▶ EMC Legato NetWorker autochanger maintenance commands
- ▶ Using **tapeutil** to verify correct device attachment
- ▶ Troubleshooting considerations

Performance considerations

Performance analysis is approached by determining which component of the data path impacts performance. Typically, a performance problem can be isolated by looking at one aspect of the data path at a time. The data path mainly consists of:

- ▶ Client file system
- ▶ Client server hardware
- ▶ Network
- ▶ Application server hardware
- ▶ Application server file system
- ▶ Application itself (for example, database)
- ▶ Connection to the tape drives:
 - Type of HBAs: 1 GBit, 2 Gbit or 4 Gbit
 - What are the HBAs connected to? Which Type of PCI Bus? What else is on the same PCI Bus?
- ▶ Size of files that you are backing up

If you think you have a performance problem, then you have to determine which link of your chain is causing the problem, that is, where does the bottleneck occur? Look at each link separately. The UNIX command **dd** can be used to get a baseline performance level. You can test the performance of your disk subsystem first by writing and reading from the disk to `/dev/null` or `/dev/zero`. Then you might want to test the performance from the server to the tape by writing and reading from tape to `/dev/null` or `/dev/zero`. And finally, you can write files from the disk to the tape.

Attention: The numbers presented here are not intended to reflect any real performance that might be achieved. The tests were run without particular attention to optimizing performance, and are intended to be used for comparative purposes only.

On some UNIX systems you can use `/dev/null` as the destination device, and on others you will use `/dev/zero`.

The **dd** command has the following syntax:

dd *if=input_file/device of=output_file/device bs=blocksize count=amount_of_block_reading/writing*

You can use **dd** in conjunction with **time** to measure the time.

We suggest writing and reading at least 1 GB, hence, use **bs=262144 count=4096**.

These tests were made with LTO1 tape performance on two hosts: BRAZIL and SOL-E. We created a file of 256 MB called `rbs01.dbf`. First, we tested the file system performance with:

```
time dd if=filename of=/dev/null bs=128k
```

Then we tested the tape performance with:

```
time dd if=filename of=/dev/rmt0 bs=128k
```

Example B-1 shows the results obtained on BRAZIL. There is good file system performance (over 74 MB/s) and the tape performance is also in the expected range (nearly 11 MB/s for an LTO1 drive).

Example: B-1 Performance on BRAZIL

```
# ls -l
-rw-r--r-- 1 root sys 268439552 Sep 05 18:21 rbs01.dbf
# time dd if=/software/lto/rbs01.dbf of=/dev/zero bs=128k
2048+1 records in.
2048+1 records out.

real    0m3.43s
user    0m0.02s
sys     0m3.42s
# time dd if=/software/lto/rbs01.dbf of=/dev/rmt0 bs=128k
2048+1 records in.
2048+1 records out.
real    0m23.68s
user    0m0.02s
sys     0m3.95s
```

Example B-2 shows you the result on SOL-E. As you can see, the file system test takes longer than on BRAZIL, which can be attributed to less CPU, disk, or I/O capacity. Therefore, the tape performance is also relatively slower.

Example: B-2 Performance on sol-e

```
# time dd if=/usr/sepp/rbs01.dbf of=/dev/null bs=256k
1024+1 records in
1024+1 records out

real    0m17.43s
user    0m0.02s
sys     0m3.80s
# time dd if=/usr/sepp/rbs01.dbf of=/dev/rmt0st bs=256k
1024+1 records in
1024+1 records out

real    1m19.85s
user    0m0.02s
sys     0m3.77s
# time dd if=/usr/sepp/rbs01.dbf of=/dev/rmt0stc bs=256k
1024+1 records in
1024+1 records out

real    0m33.39s
user    0m0.05s
sys     0m3.53s
```

In addition, you can see in Example B-2 how the performance is different depending on whether hardware compression is used (dev/rmt0st) or not (dev/rmt0stc).

During the tests it might be helpful to monitor the real-time performance values on your SAN switch (if FC drives). You can use either the switch GUI or command line interfaces. For IBM 2109 (Brocade) switches you can use the command **portperfshow** to show the performance of the attached devices. Example B-3 shows the **portperfshow** output from an IBM 2109-F16 Switch. The tape is connected on port 7, and the HBA is connected on port 5. Performance varies between 35 and 36 MB/sec, with the values updated automatically every second.

Example: B-3 IBM 2109 SAN Switch: portperfshow

```
portPerfShow
  0   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15
-----
  0   0   0   0   0 35m 0 35m 0   0   0   0   0   0   0   0
```

0	0	0	0	0	36m	0	36m	0	0	0	0	0	0	0	0
0	0	0	0	0	36m	0	36m	0	0	0	0	0	0	0	0
0	0	0	0	0	36m	0	36m	0	0	0	0	0	0	0	0
0	0	0	0	0	35m	0	35m	0	0	0	0	0	0	0	0
0	0	0	0	0	36m	0	36m	0	0	0	0	0	0	0	0
112	0	0	0	0	35m	0	35m	0	0	0	0	0	0	0	0
0	0	0	0	0	36m	0	36m	0	0	0	0	0	0	0	0
0	0	0	0	0	36m	0	36m	0	0	0	0	0	0	0	0
0	0	0	0	0	36m	0	36m	0	0	0	0	0	0	0	0
0	0	0	0	0	36m	0	36m	0	0	0	0	0	0	0	0
0	0	0	0	0	36m	0	36m	0	0	0	0	0	0	0	0
0	0	0	0	0	35m	0	35m	0	0	0	0	0	0	0	0
0	0	0	0	0	36m	0	36m	0	0	0	0	0	0	0	0
112	0	0	0	0	36m	0	36m	0	0	0	0	0	0	0	0

AIX commands

Table B-1 is a list of useful AIX commands.

Table B-1 AIX commands

Command	Description
lscfg -v	General device configuration
lscfg -vl rmtx	Tape drive configuration
lscfg -vl fcsx	FC HBA configuration
lsattr -E -l rmtx	Device parameters
errpt -a	Error log. Call hardware support if errors are found for TAPE_ERR* or SCSI* error labels.
lspp -l Atape.driver	Driver version
lsdev -Cc tape	Configured tape drives

SUN Solaris commands

Table B-2 is a list of useful Solaris commands.

Table B-2 Commonly used SUN Solaris commands

Command	Description
boot -r	Boot sequence with device scan
catman -w	Format manuals
exec ksh set -o emacs	Use emacs command-line edit in Korn shell
dmesg |more	Show the boot log file
exportfs	Show free NFS volumes
format	Show all hard disks
init 0	OS shutdown
init 6	OS shutdown and reboot

Command	Description
iostat -dnx 2	I/O statistics
kill -9 [processnumber]	Kill specified process number
ps -ef	List of all processes
reboot -- -r	Init 6 and rescan devices
uname -a	Show OS level
eject	Ejects an unmounted CD ROM

Tivoli Storage Manager tape and tape library commands

Table B-3 is a list of commonly used tape commands.

Table B-3 Commonly used Tivoli Storage Manager tape commands

Command	Description
QUERY LIBRARY	Information about the library
QUERY DRIVE	Information about tape drives
QUERY DEVCLASS	Information about device classes
QUERY LIBVOLUME	Find volumes (scratch and private)
QUERY PATH	Information about drive and library paths
QUERY VOLUME	Find private volumes
QUERY VOLUME ACCESS=READONLY	Find volumes in read only status
CHECKIN LIBVOLUME	Check in volumes to the library
CHECKOUT LIBVOLUME	Check out volumes to the library
LABEL LIBVOLUME	Write ITSM labels on cartridges
AUDIT LIBRARY	Check consistency of library inventory
REPLY nnn	Reply to console request

EMC Legato NetWorker autochanger maintenance commands

NetWorker device driver software provides the following maintenance commands for diagnosing problems on tape devices and medium changers (Table B-4).

Table B-4 NetWorker autochangers maintenance commands

Command	Description
lusinfo	Prints out SCSI information
lusdebug	Sets the library debugging level
lrescan	Rescans for devices
lreset	Resets the SCSI bus

Command	Description
changers	Lists the SCSI autochangers attached to the system
inquire	Lists the devices available
ldunld	Loads or unloads a tape device
msense	Retrieves mode sense data
pmode	Prints mode sense data
tur	Tests whether the unit is ready
writebuf	Writes a device buffer
sjirjc	Tests the jukebox

Verifying proper device attachment with tapeutil

Before you start to use your devices for production work with your applications, or if you encounter difficulties with your devices, you might want to verify that the hardware, connections, and device drivers are working together properly. Before you can do this, you should have already installed your LTO according to Chapter 3, “Basic IBM Open Systems Tape setup for UNIX systems” on page 95, and Chapter 4, “SAN considerations” on page 155.

Also, you should have already determined which OS device name corresponds to which tape drive in the library. You could create a list similar to Table B-5.

Table B-5 Library device table

Device name	WWN	Tape drive in the library	SCSI element address
rmt0	5005076300410801	drive 1	257
rmt1	5005076300410802	drive 2	258
rmt2	5005076300410803	drive 3	259

If your list is incorrect, or you have not made one yet, the procedures here will show you how to correct it. You should run this test for every attached tape drive.

AIX tape and medium changer device attachment test

The following example tests the attachment of a medium changer device and a tape drive to an AIX system. The example assumes that the device is attached at /dev/rmt0, and that there is no cartridge in the drive. You also need an unassigned cartridge available for loading in at least one of the slots:

1. List all your tape drives using **lsdev -Cc tape** (Example B-4).

Example: B-4 List tape drives

```
# lsdev -Cc tape
rmt0 Available 1V-08-01 LTO Ultrium Tape Drive (FCP)
rmt1 Available 1V-08-01 LTO Ultrium Tape Drive (FCP)
smc0 Available 1V-08-01 IBM 3584 Library Medium Changer (FCP)
```

2. Start **tapeutil**. The tapeutil menu will be displayed (as in Figure 3-12 on page 142).
3. Enter 1: **Open a Device**.
4. Enter `/dev/rmt0` when prompted for the device name.
5. Enter 1: **Read/Write**.
6. Enter 3: **Device Info**.
7. Enter 5: **Inquiry**. Specify 0 when prompted for an inquiry page. This concludes a very basic test of the device, SCSI connection, and the device driver. You can stop the test here or continue to perform a more complete test.
8. Enter 14: **Element Inventory**.
9. From the output of the previous step, select a writable, scratch cartridge and determine its element ID. Also, select the element ID of the tape drive you are working with; refer to Table B-5.
10. Enter 16: **Move Medium**, then supply the address of the cartridge, followed by the address of the tape drive. Verify that the cartridge moved.
11. Enter 6: **Test Unit Ready** until no error occurs.

If your drive is not ready after 1 minute, then do a visual check to see if the cartridge is loaded on the right drive. If not, your library device table (Table B-5) might be wrong and you will have to figure it out by iteration. Close your device by entering 2, try to open a different device name, and try it again with Test Unit Ready.

Repeat these steps until you find a device which is ready, then update your library device table.
12. Enter 30: **Read and Write Tests**.
13. Enter 1: **Read/Write**. Press Enter three times to accept the defaults and run the test.
14. Enter 31: **Unload Tape**. Wait until the Medium is unloaded.
15. Enter 16: **Move Medium**, then supply the address of the tape drive, followed by the address of the cartridge slot where it was before. Verify that the cartridge moved.
16. Enter 2: **Close a Device**.
17. Enter Q: **Quit Program**.

Solaris and HP tape and medium changer device attachment test

The following example tests the attachment of a medium changer device and a tape device to a Sun or HP system. The example assumes that your media changer is configured at:

- ▶ `/dev/rmt/0smc` - for Sun
- ▶ `/dev/rmt/0chng` - for HP

And, the tape drive is attached at:

- ▶ `/dev/rmt/1st` - for Sun
- ▶ `/dev/rmt/1m` - for HP

And, it assumes that there is no cartridge in any drive.

You also need an unassigned cartridge available for loading in at least one of the slots.

1. Open a terminal session and list all your tape drives with:

```
ls -l /dev/rmt/*stbn - for Sun
ioscan -fnkC tape - for HP
```


2. Enter:

`/opt/IBMtape/tapeutil` - for Solaris

`/opt/tapeutil/tapeutil` - for HP-UX

The tapeutil menu will be displayed (similar to Figure 3-12 on page 142).

3. Enter 1: **Open a Device**. When prompted for the device name:

Enter `/dev/rmt/0smc` - for Sun System

Enter `/dev/rmt/0chnng` - for HP System

4. Enter 3: **Device Info**.

5. Enter 14: **Element Inventory**.

6. From the output of the previous step, select a writable, scratch cartridge, and determine its element ID. Also, select the element ID of the tape drive that you are working with; refer to Table B-5 on page 256.

7. Enter 16: **Move Medium**, then supply the address of the cartridge, followed by the address of the tape drive. Verify that the cartridge moved.

8. Enter 6: **Test Unit Ready** until no error occurs.

If your drive is not ready after 1 minute, check to see if the cartridge actually loaded in the right drive. If not, then your library device table (Table B-5 on page 256) might be wrong, and you will have to figure it out by iteration. Close your device by entering 2; try to open a different device name, and try it again with 6: **Test Unit Ready**.

Repeat these steps until you find a device which is ready, then update your library device table.

9. Enter 30: **Read and Write Tests**.

10. Enter 1: **Read/Write**. Press Enter three times to accept the defaults and run the test.

11. Enter 31: **Unload Tape**. Wait until the tape is unloaded.

12. Enter 16: **Move Medium**, then supply the address of the tape drive, followed by the address of the cartridge slot where it was before. Verify that the cartridge moved.

13. Enter 2: **Close a Device**.

14. Enter Q: **Quit Program**.

Using tapeutil element inventory

When you select option 14: **Element Inventory in tapeutil**, you will receive a list of each element in the library and its status. First, the robot itself is listed, followed by each of the slots in the Import/Export station, as shown in Example B-5.

Example: B-5 Tapeutil element inventory - robot and Import/export station

Reading element status...

Robot Address 1

Robot State Normal

ASC/ASCQ 0000

Media Present No

Source Element Address Valid ... No

Media Inverted No

Volume Tag

..... Some addresses deleted for brevity

Import/Export Station Address 16

Import/Export State Normal

ASC/ASCQ	0000
Media Present	No
Import Enabled	Yes
Export Enabled	Yes
Robot Access Allowed	Yes
Source Element Address Valid ...	No
Media Inverted	No
Volume Tag	

Scroll down to continue the listing of the rest of the Import/Export slots. Next, the drives are listed (Example B-6).

Example: B-6 Tapeutil element inventory - drives

Drive Address 256

Drive State	Normal
ASC/ASCQ	0000
Media Present	No
Robot Access Allowed	Yes
Source Element Address Valid ...	No
Media Inverted	No
Same Bus as Medium Changer	Yes
SCSI Bus Address	0
Logical Unit Number Valid	No
Volume Tag	

Drive Address 257

Drive State	Normal
ASC/ASCQ	0000
Media Present	No
Robot Access Allowed	Yes
Source Element Address Valid ...	No
Media Inverted	No
Same Bus as Medium Changer	Yes
SCSI Bus Address	1
Logical Unit Number Valid	No
Volume Tag.....	

Finally, the individual storage slots are listed (Example B-7).

Example: B-7 Tapeutil element inventory - storage slots

Slot Address 4096

Slot State	Normal
ASC/ASCQ	0000
Media Present	Yes
Robot Access Allowed	Yes
Source Element Address	4096
Media Inverted	No
Volume Tag	ABA920L1

Slot Address 4097

Slot State	Normal
ASC/ASCQ	0000
Media Present	No
Robot Access Allowed	Yes
Source Element Address Valid ...	No
Media Inverted	No
Volume Tag	

You can see that slot 4096 is occupied since Media Present is set to Yes and the Volume Tag (Barcode label) contains ABA920L1, indicating this tape cartridge is located in this slot. Slot 4097 is empty, since Media Present is set to No. Therefore, when selecting option **16: Move Medium** (assuming we knew the tape in slot 4096 was not already used by an application), we can specify source address of 4096 and destination address 256. This loads that tape into the tape drive. To unload the media (after selecting **31: Unload Tape**) move the medium from 256 back to 4096.

Troubleshooting

In this section we present an approach to troubleshooting problems with LTO drives and libraries.

Collecting real-time failure information

If you encounter a problem, it is helpful to save all available error information as soon possible to provide it to the IBM Support Center for failure analysis. The elements to save are listed here, followed by details on how to save each element:

1. Library logs
2. Drive logs (drive dump)
3. Force a drive dump and save the drive dump again
4. Application log
5. Operating system error log

Save the library logs

Follow these steps:

1. Start **tapeutil**.
2. Select option **Tape Drive Service Aids**.
3. Select option **Read Dump**.
4. Select the **medium changer** and save to local disk.

Save the Library logs with IBM System Storage Tape Library Specialist

You can also use the IBM System Storage Tape Library Specialist to download the library logs. If you are using a backup application that uses its own device driver for the medium changer, you cannot use **tapeutil**; you have to use the Tape Library Specialist. Compared to **tapeutil**, where you just download one log for the whole library, if using the Tape Library Specialist, you have to download several logs. The different libraries will all provide similar possibilities as shown in the following figures, see Figure B-1 on page 261 through Figure B-5 on page 263. Generally there are separate selections for drive and library logs.

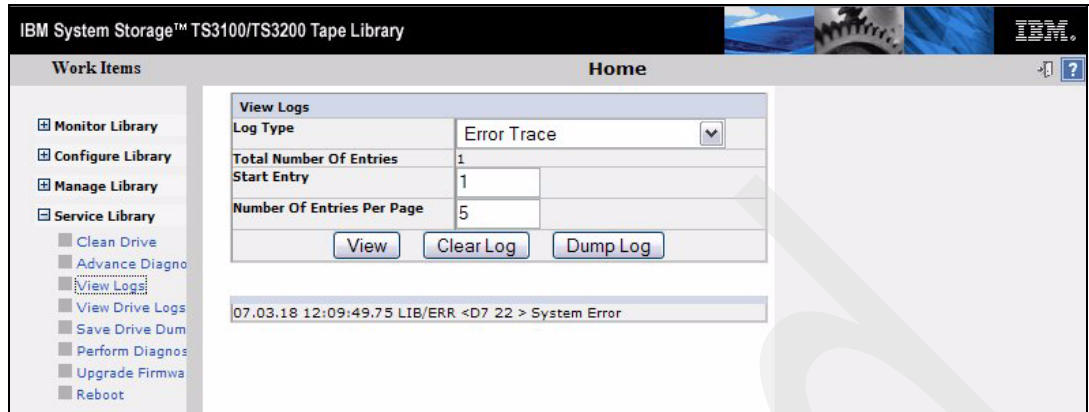


Figure B-1 IBM TS3100/TS3200 Tape Specialist download library logs

We see that we can capture the logs by individual drives or by the different logical libraries.

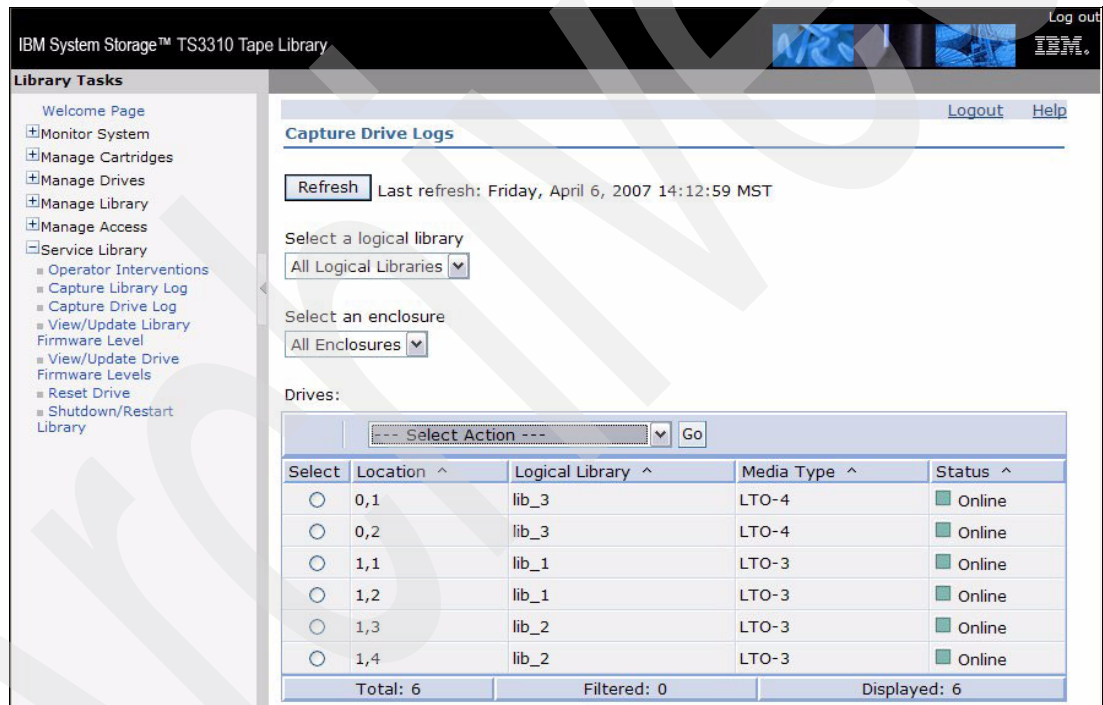


Figure B-2 IBM TS3310 Tape Specialist download drive logs

Some libraries will display the log content directly and give us the option to filter the log according to error codes before downloading. Generally the libraries all provide similar viewing and downloading capabilities, but it might have a slightly different description and selections from the *Library Tasks* menu.

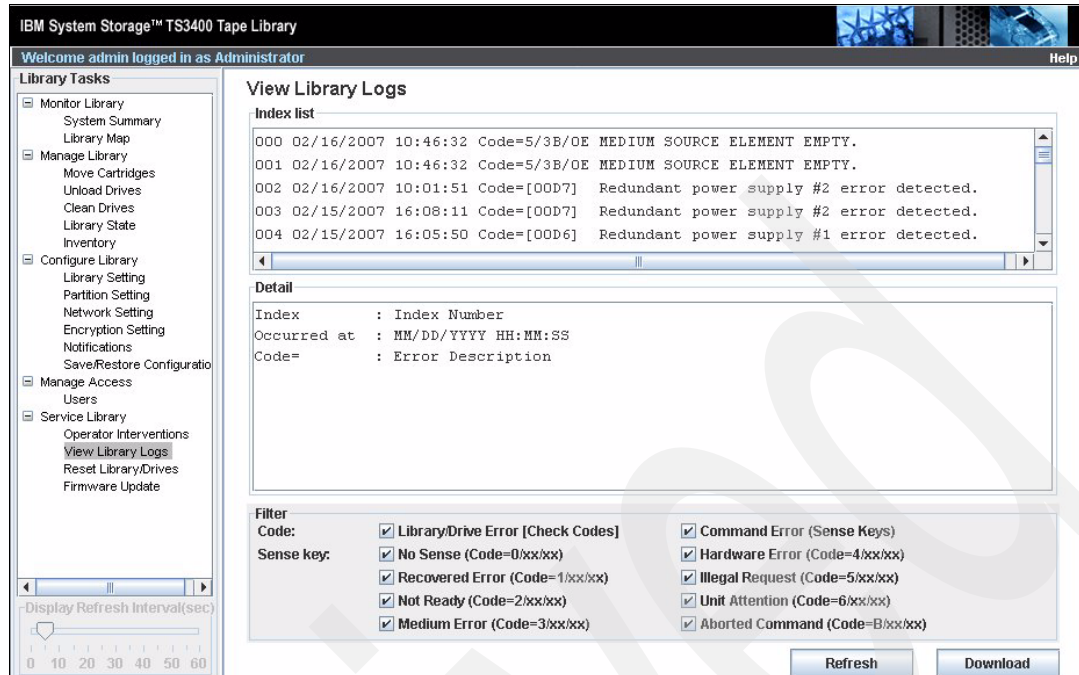


Figure B-3 IBM TS3400 Tape Specialist view and download library logs

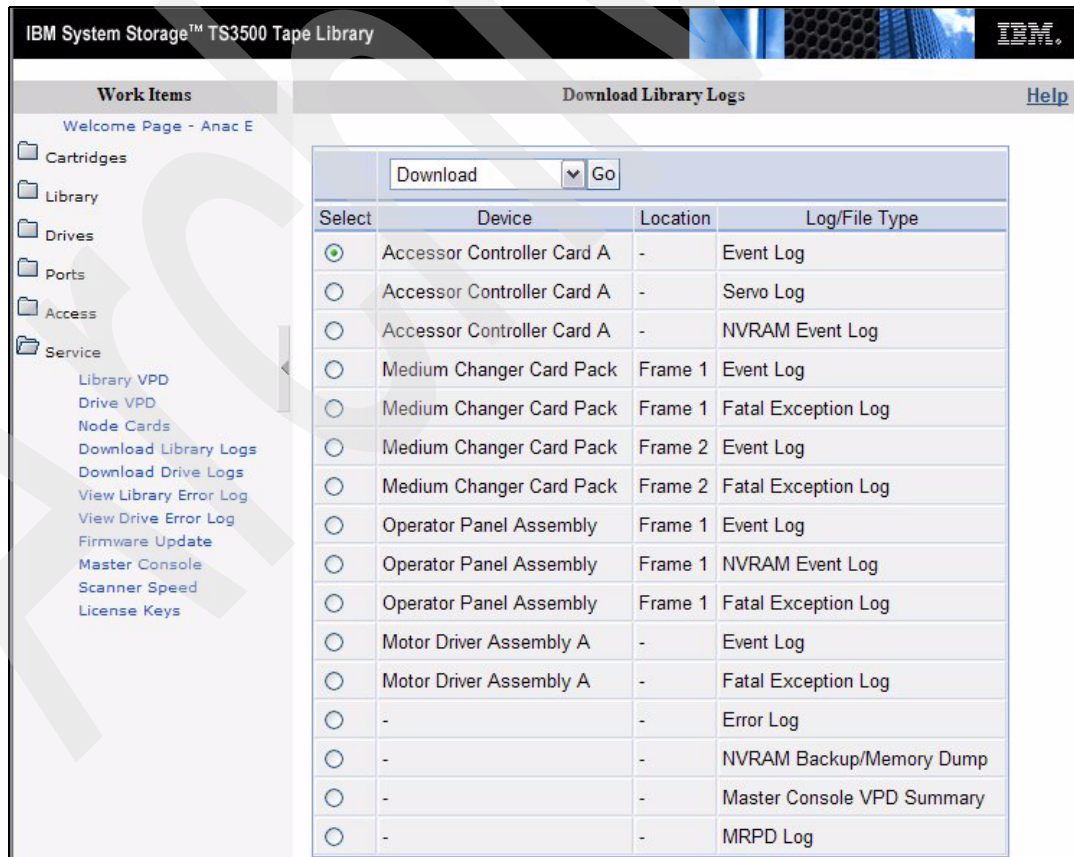


Figure B-4 IBM TS3500 Tape Specialist download library logs

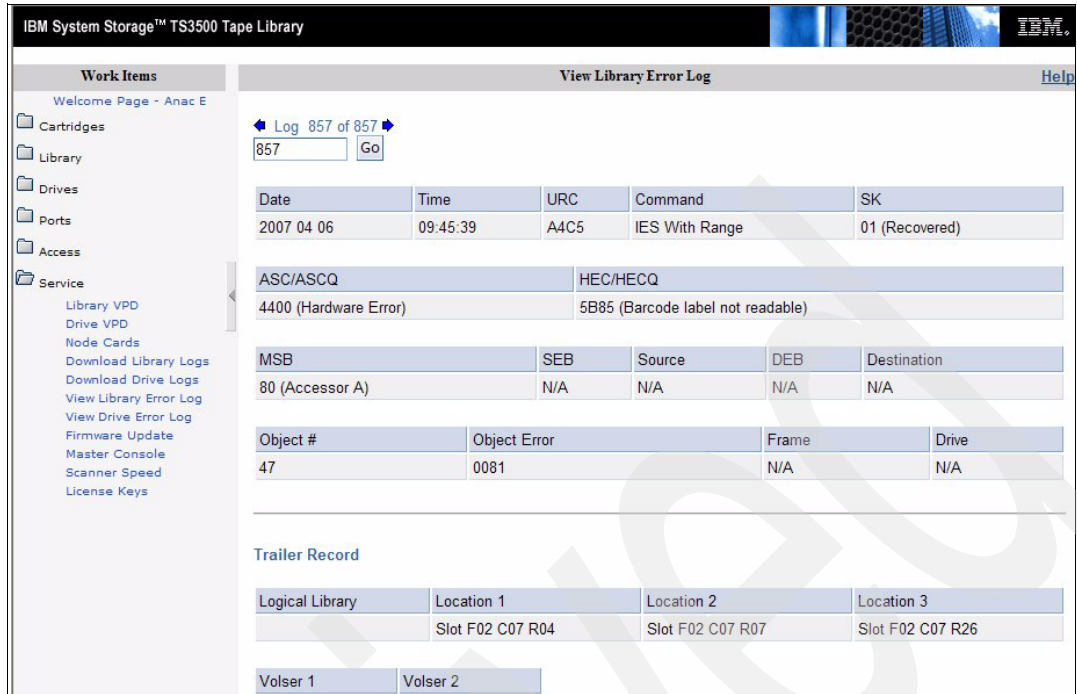


Figure B-5 IBM TS3500 Tape Specialist view library error log

We notice for the TS3500 that the Library has a number of different logs that can be downloaded one by one, as seen in Figure B-4, and that there are selections for just viewing the logs, as shown in Figure B-5.

Save the drive logs

The different logs can also be downloaded by using the **tapeutil** program:

1. Start **tapeutil**
2. Select option **Tape Drive Service Aids** (Example B-8).

Example: B-8 Tape Drive Service Aids Menu

IBM Tape Drive Service Aid Menu 700000

Select One of the Service Aids to be performed

Force Microcode Dump

Perform a microcode dump of the system. The dump is stored in the device.
After the dump is performed it can be transferred using Read Dump.

Read Dump

Transfer a dump from the device to a host file or diskette.

Microcode load

Download microcode from a host file or diskette to tape device through
SCSI bus.

Error Log Analysis

Analyze system error log for a device.

Reset Drive

Issue a SCSI Send Diagnostic command to reset the drive.

Create an FMR Tape

Create an FMR tape cartridge using loaded functional microcode.

F3=Cancel

F10=Exit

3. Select option **Read Dump**.
4. Select the **tape drive** and save the dump to local disk such as before_dump_rmtx_ (Example B-9).

Example: B-9 Saving drive du → mp

```
Prompting for Destination File for Operation on rmt2 located at 30-68-01
B00000
Please enter the following fields...
```

```
Enter Filename:
<ev/before_dump_rmt2] +/
```

F1=Help	F2=Refresh	F3=Cancel	F4=List
F5=Reset	F7=Commit	F10=Exit	

5. Watch for the Operation completed successfully messages (Example B-10).

Example: B-10 Operation completed

```
READ DUMP on rmt2 located at 30-68-01
C00000
```

```
This operation may take a few minutes...
```

```
Operation running, please stand by....
```

```

UAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA;
?                                                                    ?
?                                                                    ?
? Operation completed successfully!                                     ?
?                                                                    ?
?                                                                    ?
? F3=Cancel      F10=Exit      Enter                                     ?
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA0

```

Force a drive dump and save the dump again

Follow these steps:

1. Start **tapeutil**.
2. Select option **Tape Drive Service Aids**.
3. Select option **Force Microcode Dump**.
4. Select the **tape drive**.
5. Select option **Read Dump**.
6. Select the **tape drive** and save the dump to local disk using a different name such as drive_rmtx_after.

Save your application logs

Follow these steps:

- ▶ For Tivoli Storage Manager, save the server activity log.
- ▶ For Legato NetWorker, save the daemon logs.

Save the OS error log

Follow these steps:

1. On AIX save the **errpt -a** output:

```
errpt -a > errpt.det
```

2. On SUN save the messages log:

```
/var/adm/messages
```

3. On HP-UX save the messages:

```
/var/adm/syslog/syslog.log
```

Provide all the logs to the IBM Support Center. You should also provide general information about your system such as:

- ▶ Exact machine type (such as pSeries 7028-H80, HP N-Class Server)
- ▶ Exact OS version (such as AIX 5.1, HP-UX 11.00):
 - For AIX, use **oslevel**
 - For SUN, use **uname -r**
 - For HP, use **uname -r**
- ▶ Installed adapter (SCSI/FC, FC6227/6228, Adaptec, Emulex, and so forth)
- ▶ Adapter microcode, firmware level, bios level, configuration
 - For AIX, use **lscfg -vp > lscfg-vp.out**
 - For SUN, send the conf files, such as:
 - **/kernel/drv/fcaw.conf** for JNI™ - FC adapter
 - **/kernel/drv/q1x.conf** for QLogic – FC adapter
 - **/kernel/drv/lpx.conf** for Emulex – FC adapter
 - For HP, use
 - **fcmsutil /dev/tdx**
- ▶ Installed device driver version and device driver configuration:
 - For AIX, use:
 - Device driver level: **lspp -l Atape.driver**
 - Device parameters: **lsattr -El rmtx**
 - For SUN, use
 - Device driver level: **/usr/bin/pkginfo -l IBMtape**
 - Device parameters: **/kernel/drv/st.conf** and **/usr/kernel/drv/IBMtape.conf**
 - For HP, use:
 - Device driver level: **swverify atdd**
 - Device parameter: **ioscan -fnkC tape**
 - **ioscan -fnkC autoch**

Hints

Finally, here are some miscellaneous operational hints.

Library inventory and application inventory

If you open the library door, the library will automatically update its inventory. But this does not mean that the backup application will also update inventory. If the library has been opened, it is possible that cartridges have been moved, added, or removed. Therefore, you should always have your application audit the library after it has been opened. Refer to your application documentation for details on how to do this. In Tivoli Storage Manager, use the command:

```
AUDIT LIBRARY library_name checklabel=barcode
```


Note: Be sure to specify `checklabel=barcode`, otherwise the library will load and read the physical label on each tape. This will take a long time.

The IBM System Storage Tape Library Specialist

If you have problems connecting to your library using the Tape Library Specialist, verify that your Java version is up to date. We recommend that you upgrade your Java runtime environment to the latest available version, which is available at:

<http://java.com/en/>

Related publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this Redbooks publication.

IBM Redbooks publications

For information on ordering these publications, see “How to get IBM Redbooks” on page 269. Note that some of the documents referenced here may be available in softcopy only.

- ▶ *The IBM TotalStorage Tape Libraries Guide for Open Systems*, SG24-5946
- ▶ *Implementing IBM Tape in Linux and Windows*, SG24-6268
- ▶ *Designing an IBM Storage Area Network*, SG24-5758
- ▶ *IBM Tivoli Storage Manager Version 5.3 Technical Guide*, SG24-6638
- ▶ *IBM Tivoli Storage Management Concepts*, SG24-4877
- ▶ *IBM Tivoli Storage Manager: Implementation Guide*, SG24-5416
- ▶ *Get More out of your SAN with IBM Tivoli Storage Manager*, SG24-6687

Other publications

These publications are also relevant as further information sources:

- ▶ *IBM Tape Device Drivers Installation and User's Guide*, GC27-2130
- ▶ *IBM TotalStorage Tape Device Drivers Programming Reference*, GC35-0346
- ▶ *IBM Ultrium Device Drivers Installation and User's Guide*, GA32-0430
- ▶ *IBM TotalStorage 3580 Tape Drive Setup, Operator, and Service Guide*, GC26-7708
- ▶ *IBM TotalStorage Ultrium Tape Autoloader 3581 Setup, Operator and Service Guide*, GA32-0461
- ▶ *IBM TotalStorage 3581 Tape Autoloader Setup, Operator and Service Guide*, GA32-0470
- ▶ *IBM TotalStorage 3582 Setup, Operator, and Service Guide*, GA32-0458
- ▶ *The IBM TotalStorage 3583 Tape Library 3583 Setup and Operator Guide for Multi-Path Libraries* GA32-0411
- ▶ *IBM TotalStorage 3584 Tape Library Installation and Planning Guide*, GA32-0469
- ▶ *IBM TotalStorage UltraScalable Tape Library 3584 SCSI Reference*, GA32-0454
- ▶ *IBM TotalStorage 3584 Tape Library Operator Guide*, GA32-0468
- ▶ *IBM TotalStorage Enterprise Tape System 3592 Introduction and Planning Guide*, GA32-0464
- ▶ *IBM Storage Area Network Data Gateway Module Setup, Operator, and Service Guide*, GA32-0436
- ▶ *IBM Storage Area Network Data Gateway Installation and User's Guide*, SC26-7304
- ▶ *IBM SAN Data Gateway Router 2108 Model R03 Installation and User's Guide*, SC26-7355

- ▶ *IBM Tivoli Storage Manager for AIX Storage Agent User's Guide*, GC32-0771
- ▶ *IBM Tivoli Storage Manager for Sun Solaris Storage Agent User's Guide*, GC32-0781
- ▶ *Tivoli Storage Manager for AIX Quick Start*, GC32-0770
- ▶ *Tivoli Storage Manager for Sun Solaris Quick Start*, GC32-0780
- ▶ *Tivoli Storage Manager for HP-UX Quick Start*, GC32-0774

Online resources

These Web sites and URLs are also relevant as further information sources:

- ▶ This is the main Web site for information about IBM LTO products:
<http://www.ibm.com/storage/lto>
- ▶ The Linear Tape-Open Technology Organization Web site provides information about the technology, formats and licensing:
<http://www.lto-technology.com/>
- ▶ This Web site describes the media available from IBM:
<http://www.ibm.com/storage/media>
- ▶ Ultrium device driver downloads:
<ftp://ftp.software.ibm.com/storage/devdrv>
- ▶ ISV Support Matrix for LTO:
http://www.storage.ibm.com/hardsoft/tape/conntrix/pdf/lto_isv_matrix.pdf
- ▶ Ultrium 3580 Drive firmware information:
<http://www-1.ibm.com/support/docview.wss?rs=543&org=ssg&doc=S4000055&loc=en-us>
- ▶ IBM 3582 Interoperability Matrix:
<http://www.storage.ibm.com/tape/lto/3582/3582opn.pdf>
- ▶ IBM 3583 Interoperability Matrix:
<http://www.storage.ibm.com/tape/lto/3583/3583opn.pdf>
- ▶ IBM TS3500 Interoperability Matrix:
<http://www.storage.ibm.com/tape/lto/3584/3584opn.pdf>
- ▶ IBM TS3500 drive and library firmware:
<ftp://ftp.software.ibm.com/storage/358x/3584>
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http://ssddom02.storage.ibm.com/hba/hba_support.pdf
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- ▶ HP-UX documentation:
<http://docs.hp.com/>
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Abbreviations and acronyms

AC	Alternating Current	IDRC	Improved Data Recording Capability
AIM	Automatic Identification Manufacturers	IOP	Input/output processor
AIT	Advanced Intelligent Tape	ISV	Industry solution provider
AIX	Advanced Interactive Executive	ITSO	International Technical Support Organization
ALDC	Adaptive Lossless Data Compression	LAN	Local area network
ALMS	Advanced Library Management System	LGMR	Laser Guided Magnetic Recording
AME	Advanced Metal Evaporative	LIP	Loop initialization protocol
AMP	Advanced Metal Evaporative	LPAR	Logical partition
ANSI	American National Standards Institute	LPOS	Longitudinal Positioning
API	Application Programming Interface	LTO	Linear Tape-Open
ATF	Auto Tracking Following	LTO-CM	Linear Tape-Open-cartridge memory
BRMS	Business Recovery and Management Services	LTO-DC	Linear Tape-Open Data Cartridge
CM	Cartridge Memory	LUN	Logical unit number
CRC	Cyclic Redundancy Check	LVD	Low voltage differential
CVE	Compliance Verification Entity	MCC	Medium changer controller
DAT	Digital Audio Tape	MES	Machine equipment specification
DC	Direct Current	MFM	Modified Frequency Modulation
DDS	Digital Data Standard	MIB	Management information block
DLT	Digital Linear Tape	MRC	Magneto-Resistive Cluster
DTE	Data Transfer Element	MTBF	Mean time between failures
ECC	Error checking and correction	OEM	Original equipment manufacture
ECMA	European Computer Manufacturer's Association	P/N	Part number
EEPROM	Electrically Erasable Programmable Read-Only Memory	PCBA	Printed circuit board assembly
EOT	End of tape	PCI	PC Connect interface
EOV	End of volume	POS	Pivoting Optical Servo
ESCON	Enterprise Systems Connection	PRML	Partial Response Maximum Likelihood
FC	Fibre channel/feature code	PTF	Program temporary fix
FC-AL	Fibre channel arbitrated loop	QIC	Quarter inch cartridge
FCP	Fibre channel protocol	RF	Radio frequency
FICON	Fiber Connectivity	RLL	Run Length Limited
FRU	Field replaceable unit	RMU	Remote Management Unit
HBA	Host bus adapter	SAN	Storage Area Network
HSM	Hierarchical storage management	SARS	Statistical Analysis and Reporting System
HVD	High voltage differential	SCSI	Small computer systems interface
IBM	International Business Machines	SDG	SAN Data Gateway
		SDLT	SuperDLT

SLDC	Streaming lossless data compression
SMIT	Systems Management Interface Tool
SNIA	Storage Networking Industry Association
SNMP	Simple Network Management Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
VHDCI	Very High Density Cable Interconnect
VPD	Vital Product Data
WWN	World Wide Name
WORM	Write Once Read Many
WWN	World Wide Name

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