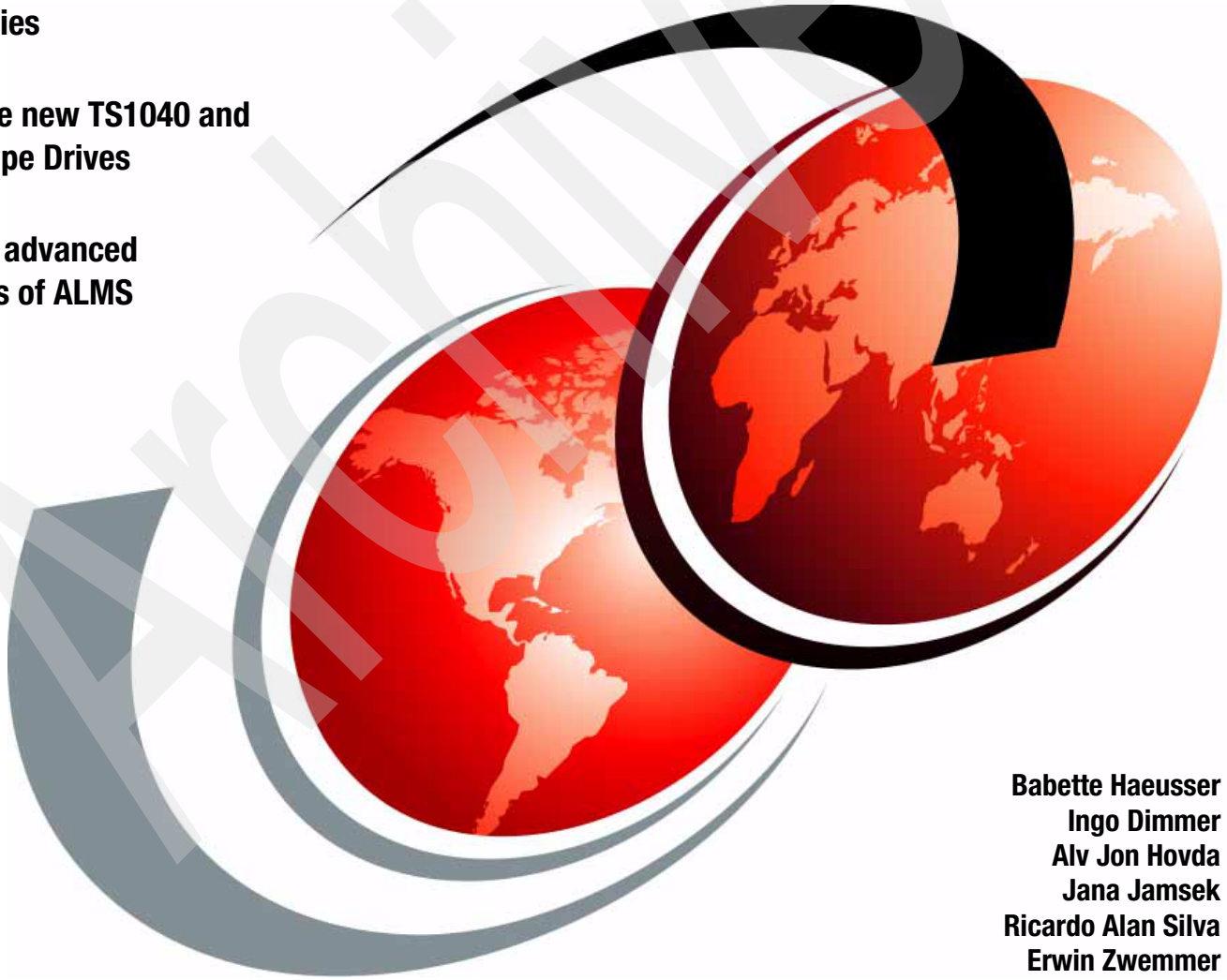
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Implementing IBM Tape in Linux and Windows

- Learn how to set up IBM Tape Drives and Libraries
- Explore the new TS1040 and TS1120 Tape Drives
- Utilize the advanced capabilites of ALMS



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Babette Haeusser
Ingo Dimmer
Alv Jon Hovda
Jana Jamsek
Ricardo Alan Silva
Erwin Zwemmer

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Implementing IBM Tape in Linux and Windows

October 2007

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SG24-6268-04

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

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Fifth Edition (October 2007)

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

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Preface

This IBM® Redbooks® publication follows *IBM TotalStorageIBM System Storage Tape Library Guide for Open Systems*, SG24-5946, and will help you plan, install, and configure IBM Ultrium LTO tape drives, as well as the IBM TS1120 and 3592 tape drive and libraries with servers running Linux® and Windows®. This book focuses on the setup and customization of these drives and libraries in both direct-attached SCSI and SAN configurations.

Part 1 describes how to attach and configure the drives and libraries, and covers basic installation and administration. It also covers the sharing and partitioning of libraries and explains the concept and usage of the Advanced Library Management System (ALMS) and virtual I/O with the IBM TotalStorage® 3584 Tape Library.

Part 2 documents how to use these products with popular data backup applications, including IBM Tivoli® Storage Manager, BakBone NetVault, Arkeia, and EMC Legato NetWorker.

This book will help IBM personnel, Business Partners, and clients to better understand and implement the IBM Ultrium LTO product line and also the IBM TS1120 and 3592 tape drives in Windows and Linux environments.

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.

Babette Haeusser is an IBM Certified IT Specialist at the International Technical Support Organization, San Jose Center. She writes extensively and teaches IBM classes worldwide on all areas of Enterprise and Open Systems Tape Drives (including Tape Encryption), Tape Libraries, and Tape Virtualization. Babette joined IBM in 1973 as an application programmer. In 1987, she became an MVS™ Systems Engineer and specialized in IBM Storage Hardware and Software, which she has supported in various job roles since then. Before joining the ITSO in early 2005, Babette worked in the Advanced Technical Sales Support EMEA. She led a team of specialists for Enterprise Storage, while she focused on Enterprise Tape including tape libraries and Virtual Tape Servers.

Ingo Dimmer is an IBM Advisory IT Specialist for System i™ and a PMI Project Management Professional working in the IBM STG Europe storage support organization in Mainz, Germany. He has eight years of experience in enterprise storage support from working in IBM post-sales and pre-sales support. He holds a degree in Electrical Engineering from the Gerhard-Mercator University Duisburg. His areas of expertise include IBM System i external disk storage solutions, I/O performance, and tape encryption, for which he has been an author of several white paper and IBM Redbooks publications.

Alv Jon Hovda is a Senior IT Specialist in Norway. He has 12 years of experience in the Tivoli Storage Manager field, working with a number of different tape libraries. He has worked at IBM for 37 years. His areas of expertise include Tivoli Storage Manager and AIX®. He has been the author of several IBM Redbooks publications on Tivoli Storage Manager and IBM Open Systems tape.

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Jana Jamsek is an IT Specialist in IBM Slovenia. She works in Storage Advanced Technical Support for EMEA as a specialist for Storage and IBM eServer™ iSeries®. Jana has eight years of experience in the System i, iSeries, and IBM AS/400® area, and five years of experience in Storage. She holds a Master's degree in Computer Science and a degree in mathematics from the University of Ljubljana, Slovenia. She has co-authored several IBM Redbooks publications and IBM Redpapers.

Ricardo Alan Silva is an IT Specialist for IBM GTS Brazil, working in the Tivoli Storage Manager team supporting Tivoli Storage Manager and all its complementary products. He has been working at IBM for five years. His areas of expertise include System Storage™ Disk and Tape solutions, Tivoli Storage products implementation and TPC. He is an IBM Certified Deployment Professional: Tivoli Storage Manager V5.3 and IBM Certified Storage Administrator: Tivoli Storage Manager V5.

Erwin Zwemmer is a Certified High End Tape Solution Specialist working at the Tape Support Centre in Mainz, Germany, since 2001. In his current job, Erwin provides EMEA support to colleagues for the complete spectrum of IBM TotalStorage and System Storage tape and optical products. Prior to his position with IBM Germany, he worked as an AS/400 Technical Support Member. He joined IBM Holland in 1995 as an IBM Customer Engineer for AS/400 systems and multivendor products.

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Figure 1 The team: Ingo, Jana, Erwin, Babette, Ricardo Alan, and Alv Jon

Thanks to the following people for their contributions to this project:

Leslie Parham and Emma Jacobs,
International Technical Support Organization, San Jose Center

Wade Wallace
International Technical Support Organization, Austin Center

Jennifer Bappert, Dan Watanabe, Linda Muller, Tommy de Jesus, Alan Ishikawa, Stefan Lehmann, Jeffrey Li, Kai Asher, Lee Jesionowski, Alain Taku, Carla Ruhl, Roy Tritch,
IBM Tucson Development and Marketing

Thanks to the authors of the previous editions of this book:

Charlotte Brooks, Bertrand Dufrasne, Thomas Gaines, Alv Jon Hovda, Carsten Krax, Michael Lohr, Takashi Makino, Reena Masters, Tony Rynan, Abbe Woodcock, Josef Weingand, and Erwin Zwemmer.

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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 SG24-6268-04
for Implementing IBM Tape in Linux and Windows
as created or updated on October 4, 2007.

August 2007, Fifth Edition

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

New information

- Ultrium 4 drives and libraries
- TS1120 Tape Drive
- TS3400 Tape Library
- 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 tape in Linux and Windows

In this part, we introduce the IBM System Storage tape products (IBM LTO Ultrium products and TS1120 Tape Drive) and describe how to set them up in Windows 2000, Windows 2003, and Linux environments. Both native SCSI and SAN (Fibre Channel) attachments are presented. We also show how to use the administration tools, such as the IBM System Storage Tape Library Specialist.

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1

Introduction to IBM Open System Tape on Linux and Windows

This chapter provides 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:
  - 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
- HBAs and drivers discussion
- LVD and SAS
- HD68 versus VHDCI discussion

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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 LLC[1]) 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 Library 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 on page 5) 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

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These models are shown in Figure 1-2.



Figure 1-2 The LTO product family

We describe these models in more detail starting in 1.1.3, “IBM System Storage TS2230 Tape Drive” on page 8.

Some existing models have two drive options: IBM LTO3 and LTO4.

LTO1 was the first generation of the LTO technology with a tape capacity of 100 GB per cartridge in a native format, and a 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 a 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 a 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 a capacity of 1600 GB using 2:1 compression. A WORM (write-once, read-many) version of the LTO4 cartridge is also available.

1.1.2 Media compatibility

Figure 1-3 on page 7 depicts the media compatibility characteristics for the last three generations of LTO tape.

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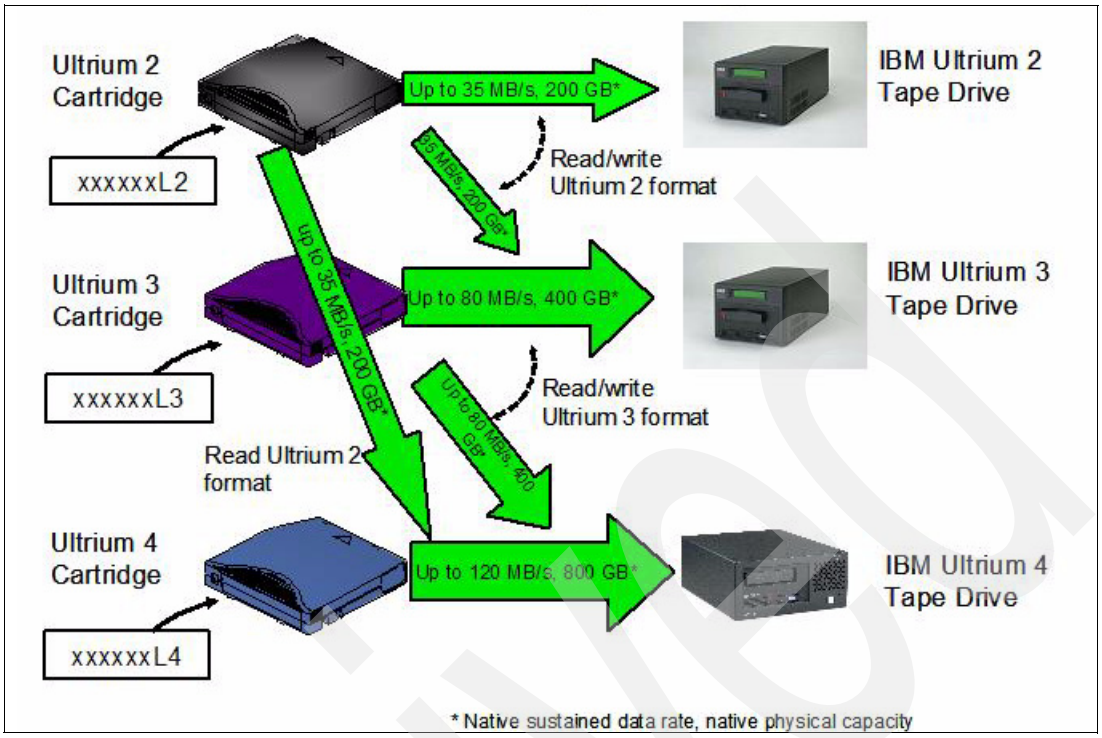


Figure 1-3 LTO Generation 1 - 4 media compatibility

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.

1.1.3 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 400 GB, or 800 GB 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 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 IBM TS2230 Tape Drive, see *IBM System Storage Tape Library Guide for Open Systems*, SG24-5946.

1.1.4 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, 4 mm, or 8 mm tape drives.

IBM TS2340 is an LTO tape drive designed to increase maximum tape drive throughput native data rate performance up to 120 MB/s. 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 system 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 IBM TS2340 Tape Drive, see *IBM System Storage Tape Library Guide for Open Systems*, SG24-5946.

1.1.5 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 Serial Attached SCSI (SAS) 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.

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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 (through a Web browser) to the library for a 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 IBM TS3100 Tape Library, see *IBM System Storage Tape Library Guide for Open Systems*, SG24-5946.

1.1.6 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 IBM LTO4 tape drive, the IBM TS3200 also has 3 GB Serial Attached SCSI (SAS) 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 ensure 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 (through a 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 IBM TS3200 Tape Library, see *IBM System Storage Tape Library Guide for Open Systems*, SG24-5946.

1.1.7 IBM System Storage TS3310 Tape Library

The TS3310 Tape Library is a highly expandable IBM LTO library that allows you to start small with a 5U base unit available in desktop or rack-mounted configurations. Over time, as your need 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 six 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.

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It provides 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. The 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 (through a 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 IBM TS3310 Tape Library, see *IBM System Storage Tape Library Guide for Open Systems*, SG24-5946.

1.1.8 IBM System Storage TS3500 Tape Library

The IBM System Storage TS3500 Tape Library 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) environment. 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 *IBM TS3500 Tape Library with System z Attachment: A Practical Guide to TS1120 Tape Drives and TS3500 Tape Automation*, 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 may now be upgraded nondisruptively, that is, without interrupting the normal operations of the library.

The TS3500 supports Tape Encryption on the following tape drives: IBM System StorageTS1040 Tape Drive, and the IBM System StorageTS1120 Tape Drive. The three

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different Encryption methods are supported: Application-Managed Encryption (AME), System-Managed Encryption (SME), and Library-Managed Encryption (LME) by the TS3500.

Figure 1-9 shows the IBM System Storage TS3500 Tape Library.



Figure 1-9 IBM System Storage TS3500 Tape Library

1.1.9 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 D23 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

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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 the 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 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 through feature FC1658 if attaching a D53 expansion frame to an L23 base frame.

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An additional 4 I/O station door can be installed in a Dx3 frame. This requires FC1451, and up to three Dx3 frames may be installed with this feature. Figure 1-10 shows the 4 I/O Station D-Frame. There is a LED status panel located on the right upper corner. 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 D53 I/O frames in a sixteen frame library. The 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 will show you the volume label.



Figure 1-10 A graphical overview of the 4 I/0 door using the Web user interface

1.1.10 IBM TS3500 Tape Library frames L23 and D23

The Model L23 and D23 frames integrate the IBM TotalStorage 3592 Tape Drive with a 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.

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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 needs.

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 D23 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 newly installed frame.

If a D23 is being added to an installed L32 or D32 frame, 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 through 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 FC1451, and up to three Dx3 frames may be installed with this feature. Figure 1-10 on page 15 shows the 4 I/O Station D-Frame. There is a LED status panel located on the right upper corner. 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 D53 I/O frames in a sixteen frame library. The D23 models are compatible with existing models L22, L32, L52, D22, D32, and D52.

1.1.11 IBM TS3500 High Availability Unit HA1

The IBM TS3500 High Availability Frame Model HA1 may 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 nondisruptively 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 may have 3592, LTO1, LTO2, LTO3, and LTO4 media installed and configured. The Advanced Library Management Systems (ALMS) (see 1.1.16, “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 need 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.

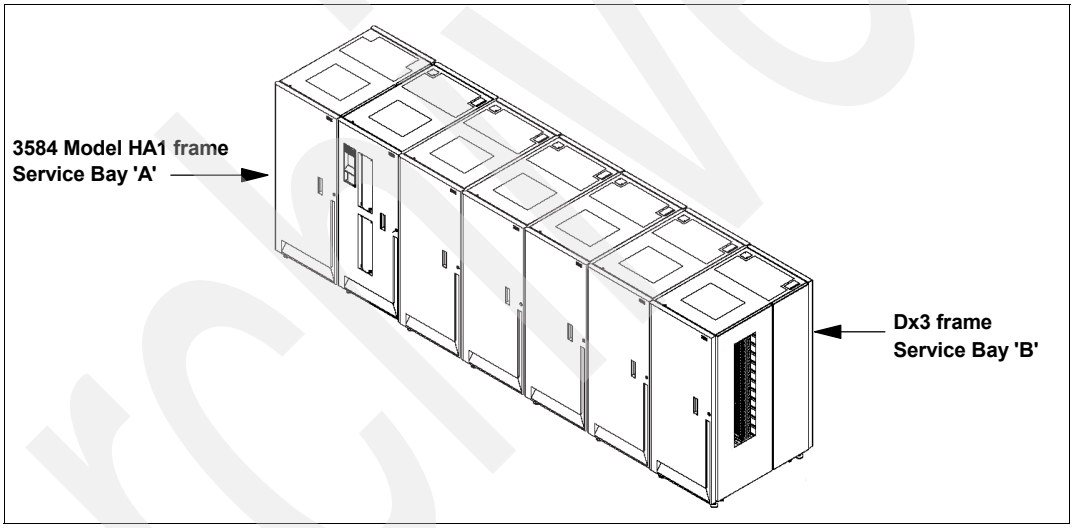


Figure 1-11 Location of service bays in the IBM TS3500 Tape Library

To summarize, to implement nondisruptive accessor failover, the following is 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)

1.1.12 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 is transparent to the running application.

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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).

1.1.13 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. Data path failover is now supported 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' 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 may 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 IBM 3592 tape drives do not require this feature.

1.1.14 SNMP

Occasionally, the IBM TS3500 Tape Library may 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 B, “SNMP setup” on page 271.

1.1.15 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 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 info
  - Use IBMTSSML3584_TapeLibrary PrimaryOwnerName and PrimaryOwnerContact.

There is no support for Service Location Protocol (SLP) and Secure Socket Layer (SSL) at the time of the writing of 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 embedded SMI-S will have the same functions as the external LINUX PC.

Note: The embedded SMI-S function requires a Lx3 Frame and a library firmware level that supports SMI-S.

1.1.16 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 SCSI 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 77.

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

1.1.17 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 needing 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 82.

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1.1.18 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 System Storage TS3500 Tape Library Operator Guide*, GA32-0560 for further information.

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 will describe the two models of IBM Open System Tape that belong 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 (100 GB) for fast access to data, standard capacity (500 GB), or extended capacity (700 GB). 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, System x, 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 MB/s. In open system environments where data typically compresses at 2:1, the TS1120 tape drive can transfer data up to 200 MB/s. In a mainframe environment where data typically compresses at 3:1, a single tape drive can transfer data up to 260 MB/s. This high transfer rate helps 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 IBM TS1120 Tape Drive, see *IBM System Storage Tape Library 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 system environment. The IBM System Storage TS3400 Tape Library is a five unit (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.

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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 are 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 IBM TS3400 Tape Library, see *IBM System Storage Tape Library 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 needs.

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 then 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, FC1900 or, for the TS3500, FC1604, to support Transparent LTO Encryption. FC1900 (Encryption Configuration) should also be ordered. Supported Tape Libraries for the TS1040 Tape Drive are TS3100, TS3200, TS3310, and TS3500.

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Encryption adds a strong measurement of security to stored data without the processing impact 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 a 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 is communicating 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. EKM is capable of serving numerous IBM encrypting tape drives, regardless of where those tape drives reside.

EKM is part of the IBM Java™ environment and uses the IBM Java Security components for its cryptographic capabilities. 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 EKM to perform cryptographic operations. EKM supports several types of Java keystores offering different operational characteristics to meet your needs.

- Configuration file

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

- Tape drive table

  The tape drive table is used by EKM to keep track of the tape devices it supports. The tape drive table is non-editable, binary file whose location is specified in the configuration file (see Figure 1-14 on page 27).

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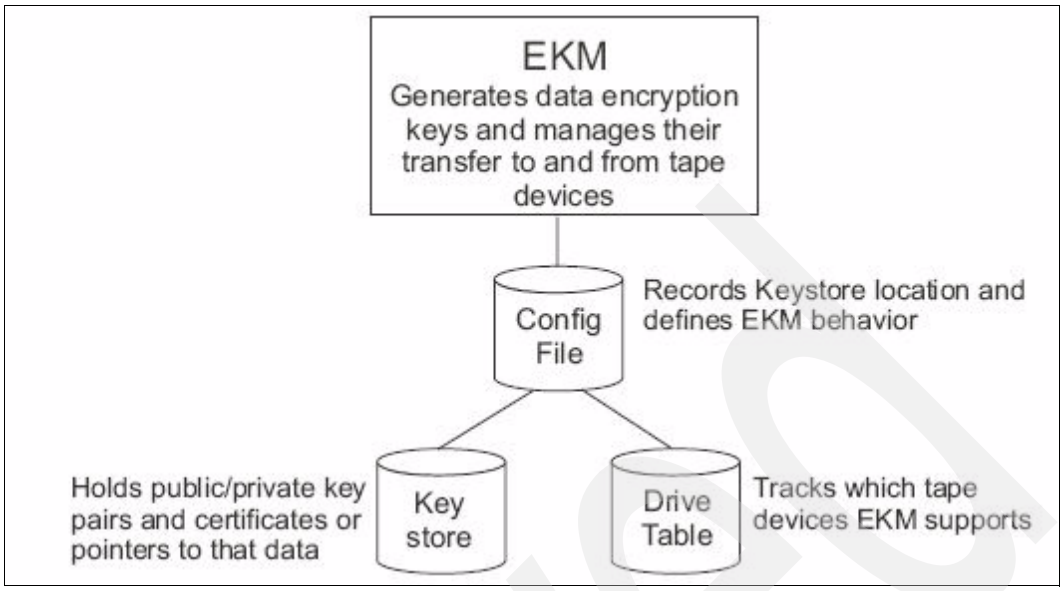


Figure 1-14 Three main components of EKM

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 needed and be able to read the data cartridges that were encrypted using the certificate with that drive or library. Do *not* encrypt your backups!

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 a encryption key from the EKM. Upon receipt of the request, EKM generates an Advanced Encryption Standard (AES) key and sends it to the tape drive. The AES uses a 256-bit encryption as set by 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 is 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 support.

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.

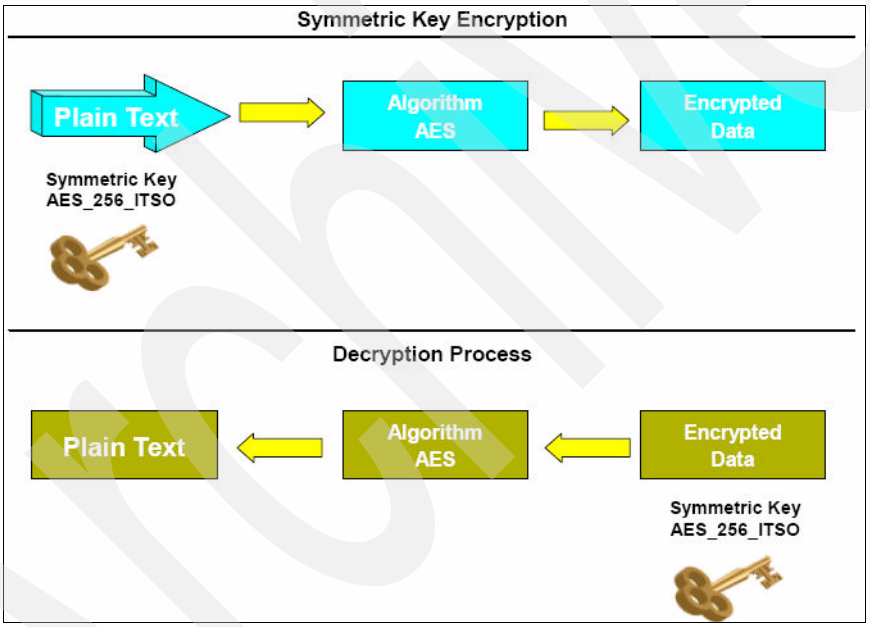


Figure 1-15 Symmetric key encryption data flow

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.The 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.

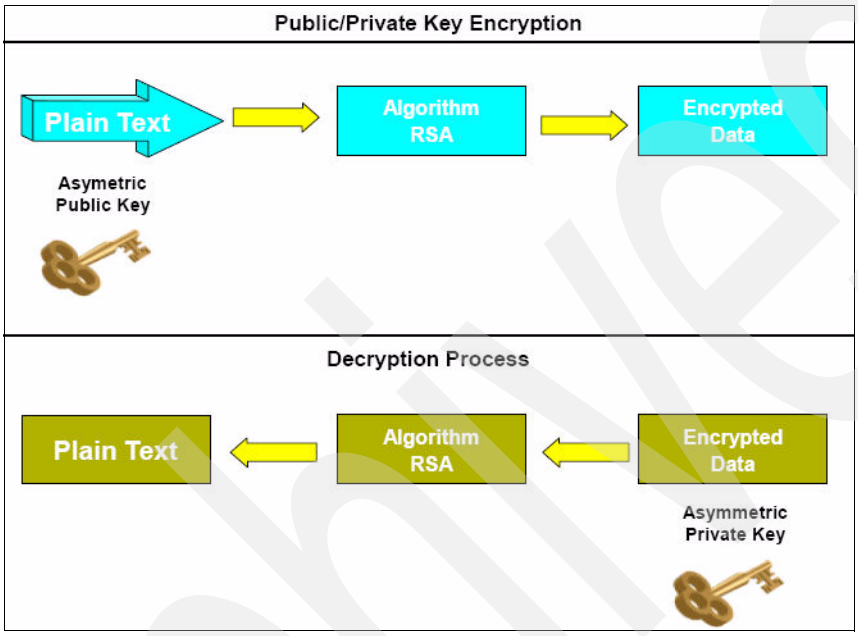


Figure 1-16 Asymmetric key encryption data flow

Managing encryption

There are three methods of encryption management to choose from. This 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 may be located in any one of the following environmental layers.

Application-Managed Tape Encryption

This method is best where operating environments run 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.

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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 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 may 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 support 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 EKM, a Java application running on a library-attached host. The keys pass through the library-to-drive interface, so 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 derive 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 may 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 may not be feasible.

1.3.2 TS1120 tape encryption

The TS1120 Tape Drive uses 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 Tape Drive encryption uses 256-bit AES algorithm keys to encrypt data.

Two types of encryption algorithms are used by 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).

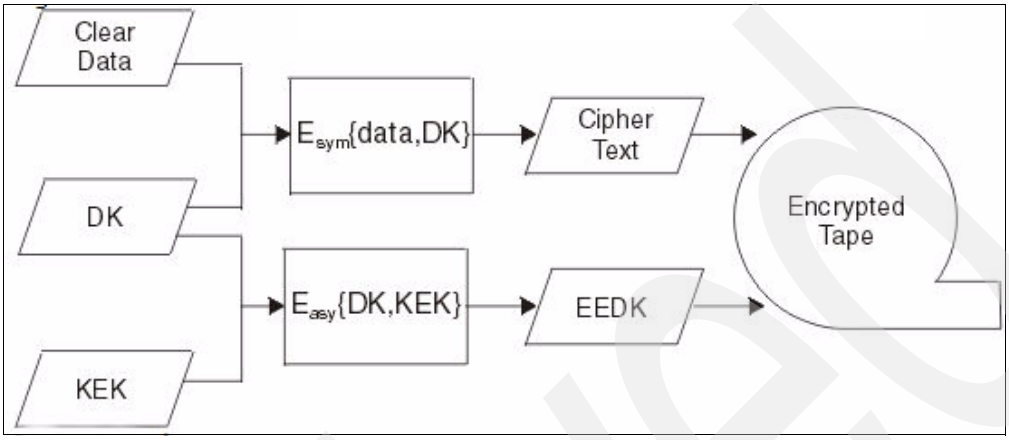


Figure 1-17 Tape Encryption process flow of the TS1120 Tape Drive

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 Encrypting 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 may 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 IBM 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 explain the Tape Encryption and Decryption process in a more detailed way. 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.

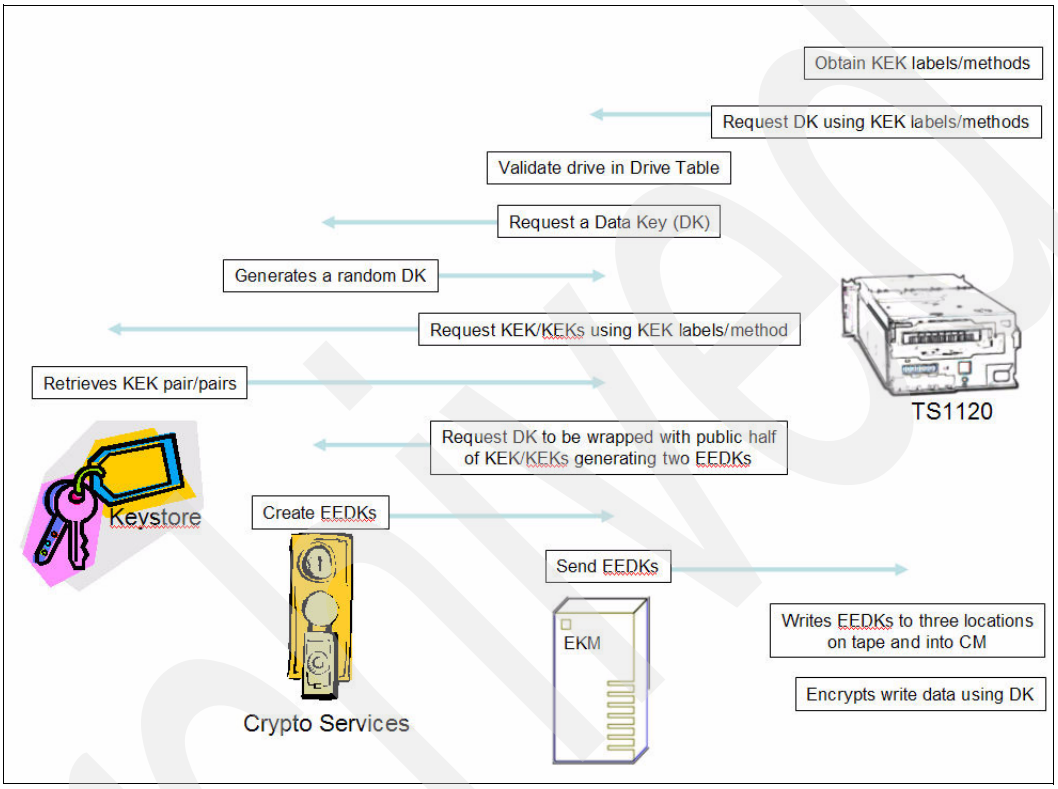


Figure 1-18 Encryption process TS1120

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 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. 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 on page 33 is the decryption data path. In this example, we decrypt data that was encrypted at another site, as outlined in Figure 1-19 on page 33. For the decryption process, the tape has two EEDKs stored in its cartridge memory. We call these EEDK1 and EEDK2.

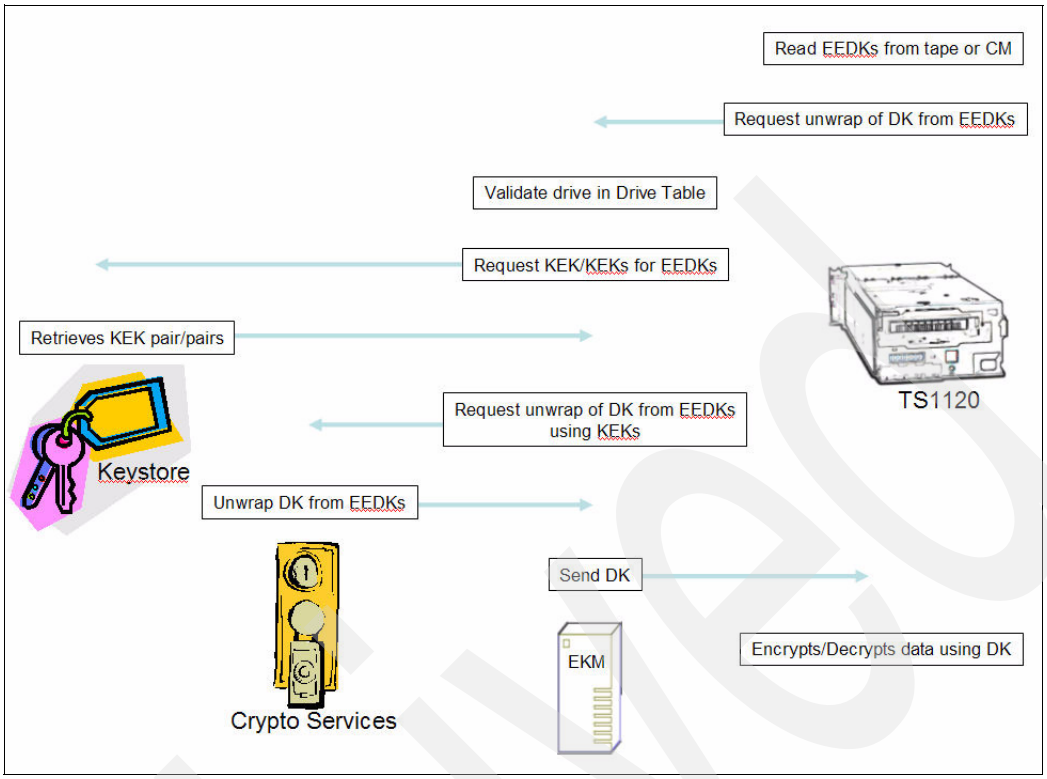


Figure 1-19 Decryption process TS1120

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 may coexist on same medium. The tape drive must a data key for each unique Key Identifier encountered during read operations.

Archive

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 his 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 mounted request, the following steps are taken:

1. The TS1040 receives a mount request for the read or append operation.
2. The TS1040 begins reading and finds an 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 System Tape.

1.4.1 Hardware server platforms

The IBM Open System 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

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Note that 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 following 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, “LTO libraries and backup software” on page 197.

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 Windows 2000/2003 connectivity

In this section, we show examples of connecting LTO models to Windows 2000/2003.

1.5.1 Windows 2000/2003 SCSI direct attach

Figure 1-20 has been extracted from the IBM Web site that details server, operating system levels, Host Bus Adapters, and fabric support for the IBM TS3310 library in the Windows 2000/2003 environment (correct at the time of writing). We listed the Web pages for each LTO model in 1.4.1, “Hardware server platforms” on page 34.

Click the **Details** button (on the Web site) to read the readme file.

SCSI LTO Ultrium 3 LVD Drive Feature (#8037)		
Servers	**Operating Systems** [1]	**Host Adapters**
Microsoft™ Windows™ Servers	**Windows Server 2003** details Build 3790 or later **Windows 2000 Server** details Build 2195 or later	**LVD** Adaptec 29160, 39160 Adaptec 29320, 29320ALP, 39320, 39320D-R, 39320-R Adaptec AHA-29940U2W LSI Logic SYM 22910 Netfinity Adapter #33L5000 IBM #39R8743, #13N2249 (Adaptec 29320ALP), #33L5000, #19K4646, #17P8594
Notes		
1. Certain restrictions may apply. See the details above for your operating system		

Figure 1-20 LTO Windows 2000/2003 attachment summary

From the figure, we can see that in order to attach an IBM TS3310 library to a Windows 2000 Server, build 2195 or higher of the operating system is required, and for a Windows 2003 Server, build 3790 or higher is required.

IBM LTO 3 does not support HVD SCSI interfaces. Only LVD SCSI interfaces are supported.

1.5.2 Windows 2000/2003 Fibre Channel attachment

If you want to use a Fibre Channel attachment, you will use Fibre Channel LTO3 and LTO4 drives.To determine the supported adapters for the IBM TS3500 library, look at the following Web site for the LTO product and operating system of choice (for example, IBM TS3500 with LTO3 FCP drives and Windows 2003):

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

Note: This URL is case sensitive.

The search results are returned, as shown in Figure 1-21 (excerpt only).

Emulex LP10000 Fibre Channel				→ View details
Microsoft Windows Server 2003 R2	TS3500 (6480) with Ultrium 3 Drives (rf060927a_69U1)	1.20a7	1.91a1	
Microsoft Windows Server 2003 SP1	TS3500 (6480) with Ultrium 3 Drives (rf060927a_69U1)	1.20a7	1.91a1	
Emulex LP1050 Fibre Channel				→ View details
Microsoft Windows Server 2003 R2	TS3500 (6480) with Ultrium 3 Drives (rf060927a_69U1)	1.20a7	1.91a5	
Microsoft Windows Server 2003 SP1	TS3500 (6480) with Ultrium 3 Drives (rf060927a_69U1)	1.20a7	1.91a5	
Emulex LP11000 Fibre Channel				→ View details
Microsoft Windows Server 2003 R2	TS3500 (6480) with Ultrium 3 Drives (rf060927a_69U1)	1.20a7	2.10a7	
Microsoft Windows Server 2003 SP1	TS3500 (6480) with Ultrium 3 Drives (rf060927a_69U1)	1.20a7	2.10a7	
Emulex LP11002 Fibre Channel				→ View details
Microsoft Windows Server 2003 R2	TS3500 (6480) with Ultrium 3 Drives (rf060927a_69U1)	1.20a7	2.10a7	

Figure 1-21 Supported HBA and microcode (excerpt)

This excerpt from the output shows that you can attach the Fibre Channel LTO3 FCP drives with the Emulex adapters.

If you click the **View Details** link for each HBA, this will take you to the vendor's Web site to download device drivers and microcode.

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For more information about using SCSI and SAN HBAs to attach the LTO drives and libraries with Windows 2003, refer to Chapter 3, “Basic IBM tape setup for Windows” on page 101.

1.6 Intel Linux connectivity

In this section, we show an example of a direct SCSI attachment to an Intel Linux server.

1.6.1 Linux SCSI direct attach

Figure 1-22 is an example of the IBM Web site that details server, operating system levels, and SCSI adapters for the IBM TS3310 library in the Linux environment. The Web pages for each LTO model are given in 1.4.1, “Hardware server platforms” on page 34.

In order to attach an IBM TS3310 library to a Linux server, you must ensure that you are running the correct Linux operating system and kernel levels.

SCSI LTO Ultrium 3 LVD Drive Feature (#8037)		
Servers	**Operating Systems** [1]	**Host Adapters**
Linux Servers	**Red Hat Advanced Server Enterprise Linux 4** details **SUSE Linux Enterprise Server 9** details **Asianux 2.0** details **Other versions** details	**LVD (32bit)** Adaptec 29160, 39160 Adaptec 29320, 29320ALP, 39320 Adaptec 2940 U2W IBM #39R8743, #13N2249 (Adaptec 29320ALP), #33L5000, #19K4646, #17P8594 **LVD (64bit)** Adaptec 29320ALP, 39320 IBM #39R8743, #13N2249 (Adaptec 29320ALP), #33L5000, #19K4646, #17P8594
Notes		
1. Certain restrictions may apply. See the details above for your operating system		

Figure 1-22 LTO Linux attachment summary

IBM LTO3 does not support HVD SCSI interfaces. Only LVD SCSI interfaces are supported.

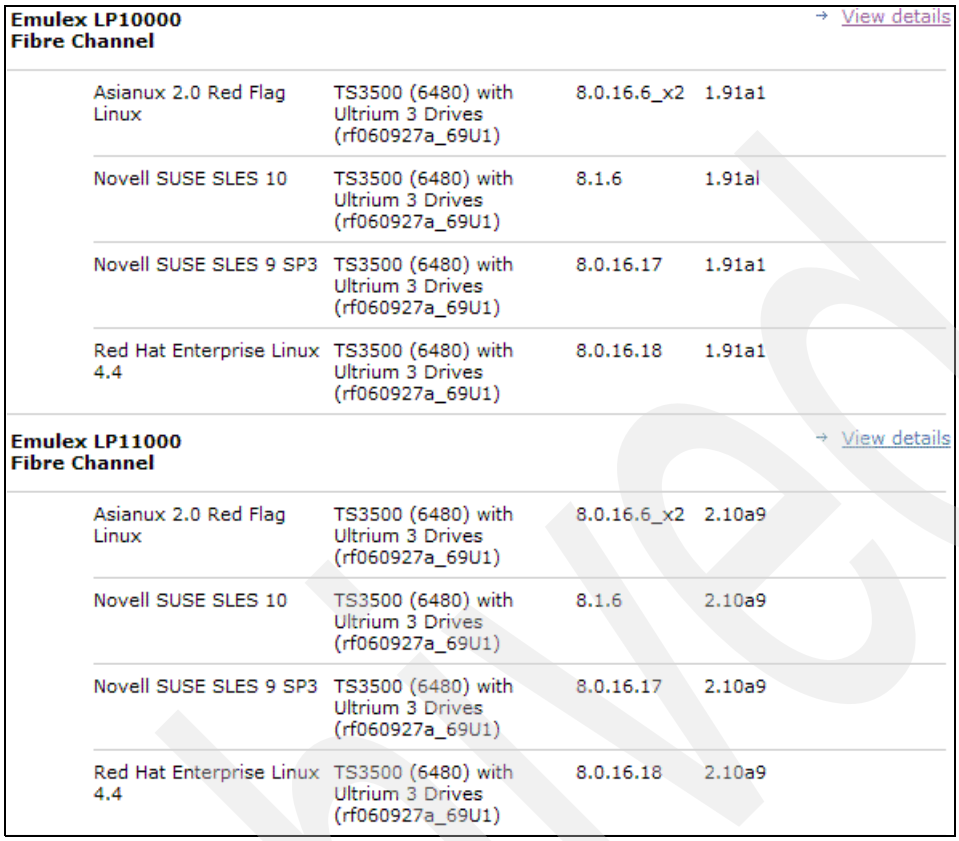
1.6.2 Linux Fibre Channel attachment

If you want to use a Fibre Channel attachment, you will use Fibre Channel LTO3 or LTO4 drives. To determine the supported adapters for the IBM TS3500 library, look up the following Web site for the LTO product and operating system of choice (for example, IBM TS3500 with LTO3 FCP drives and Linux):

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

Note: This URL is case sensitive.

The search results are returned, as shown in Figure 1-23 (excerpt only).



Emulex LP10000 Fibre Channel			→ View details
Asianux 2.0 Red Flag Linux	TS3500 (6480) with Ultrium 3 Drives (rf060927a_69U1)	8.0.16.6_x2	1.91a1
Novell SUSE SLES 10	TS3500 (6480) with Ultrium 3 Drives (rf060927a_69U1)	8.1.6	1.91al
Novell SUSE SLES 9 SP3	TS3500 (6480) with Ultrium 3 Drives (rf060927a_69U1)	8.0.16.17	1.91a1
Red Hat Enterprise Linux 4.4	TS3500 (6480) with Ultrium 3 Drives (rf060927a_69U1)	8.0.16.18	1.91a1
Emulex LP11000 Fibre Channel			→ View details
Asianux 2.0 Red Flag Linux	TS3500 (6480) with Ultrium 3 Drives (rf060927a_69U1)	8.0.16.6_x2	2.10a9
Novell SUSE SLES 10	TS3500 (6480) with Ultrium 3 Drives (rf060927a_69U1)	8.1.6	2.10a9
Novell SUSE SLES 9 SP3	TS3500 (6480) with Ultrium 3 Drives (rf060927a_69U1)	8.0.16.17	2.10a9
Red Hat Enterprise Linux 4.4	TS3500 (6480) with Ultrium 3 Drives (rf060927a_69U1)	8.0.16.18	2.10a9

Figure 1-23 Supported HBA and microcode (excerpt)

This excerpt from the output shows that you can attach the Fibre Channel LTO3 FCP drives with the Emulex adapters.

If you click the **View Details** link for each HBA, this will take you to the vendor's Web site to download device drivers and microcode.

For more information about using SCSI and SAN HBAs to attach the LTO drives and libraries with Linux, refer to Chapter 3, "Basic IBM tape setup for Windows" on page 101.

1.7 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 needs
  - Application characteristics: Read/write mix, amount of data transferred, streaming or stop/start, and 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/s of compressible data, can saturate a SCSI-160 adapter. A SCSI-160 adapter can transfer 160 MB/s, but that does not include SCSI overhead. With overhead, the available bandwidth is approximately 140-150 MB/s. Two LTO3 drives cannot run at their native drive rate of 80 MB/s on a single adapter. If performance is not a primary consideration, it may 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.

1.8 Host Bus Adapters and device drivers

This section will cover the following:

- What are HBAs?
- Why are they needed, and which one do you need?
- Are drivers needed for HBAs?

Note: We recommend that you do not attach both disk and tape devices to the same HBA. See 5.1.3, “Tape and disk on the same HBA” on page 186 for more information.

1.8.1 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.

1.8.2 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 may need 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.

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Figure 1-24 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 need to be installed.

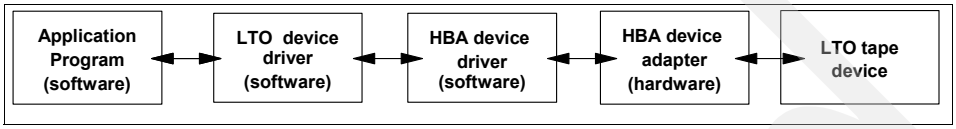


Figure 1-24 Device data flow

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 needed by full tape management systems. Whenever possible, the LTO driver will take advantage of the device features transparently to the application.

1.9 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/s 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 300 MB/s. 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 need external terminators. The I/O bus will be electronically terminated.

The total cable length from the device to the HBA is limited to 6 meters. 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.

1.10 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, 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 you order the correct cable with the right-end plug to attach to your HBA.

Figure 1-25 shows the VHDCI and HD-68 connectors.

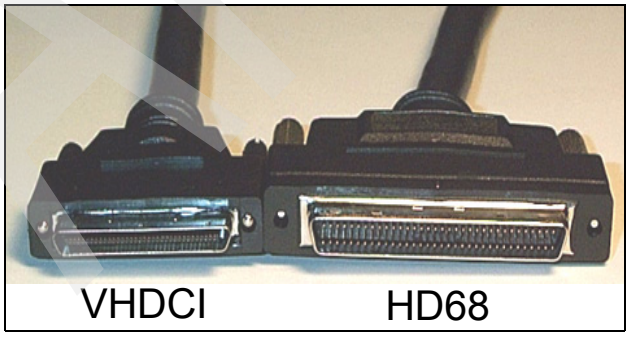


Figure 1-25 SCSI connectors

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2

IBM Open System Tape Library sharing and partitioning

In this chapter we describe the sharing and partitioning of the IBM System Storage TS3100 Tape Library, IBM System Storage TS3200 Tape Library, IBM System Storage TS3310 Tape Library, IBM System Storage TS3400 Tape Library, and IBM System Storage TS3500 Tape Library.

The topics are:

- 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 book:

- *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

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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. 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 may or may 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

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

Some technique is needed 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 45). Other examples are STK with ACSLS, or ADIC with Scalar DLC.

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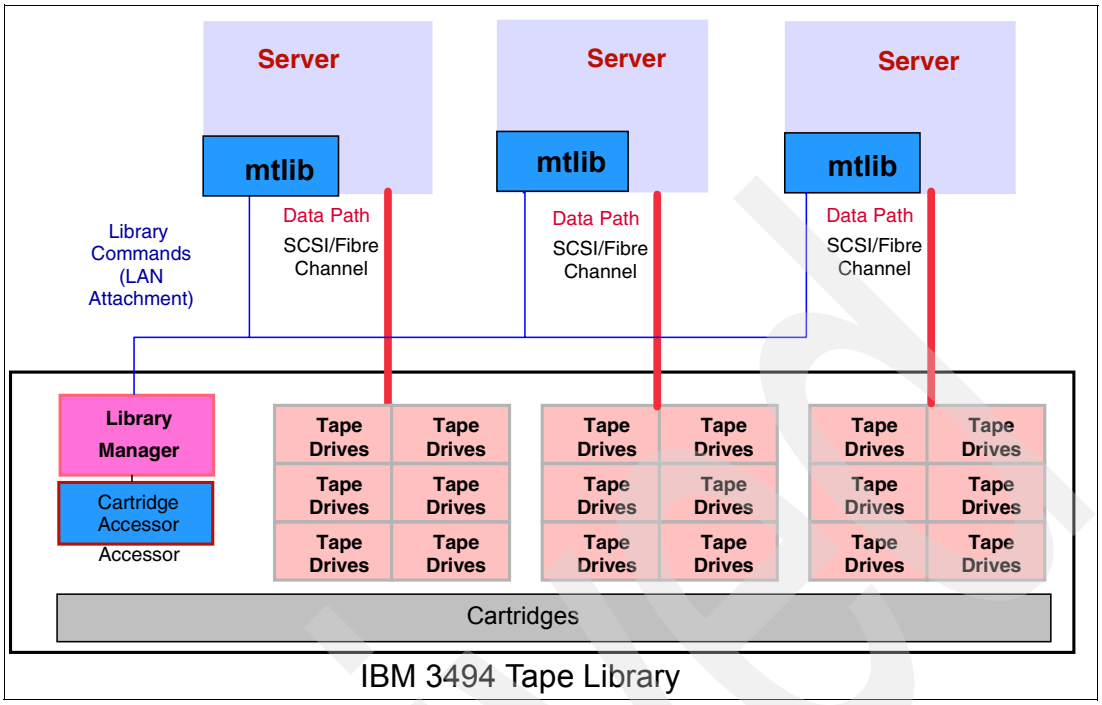


Figure 2-1 IBM 3494 tape library sharing

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 needing 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 is 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.

Archive

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.

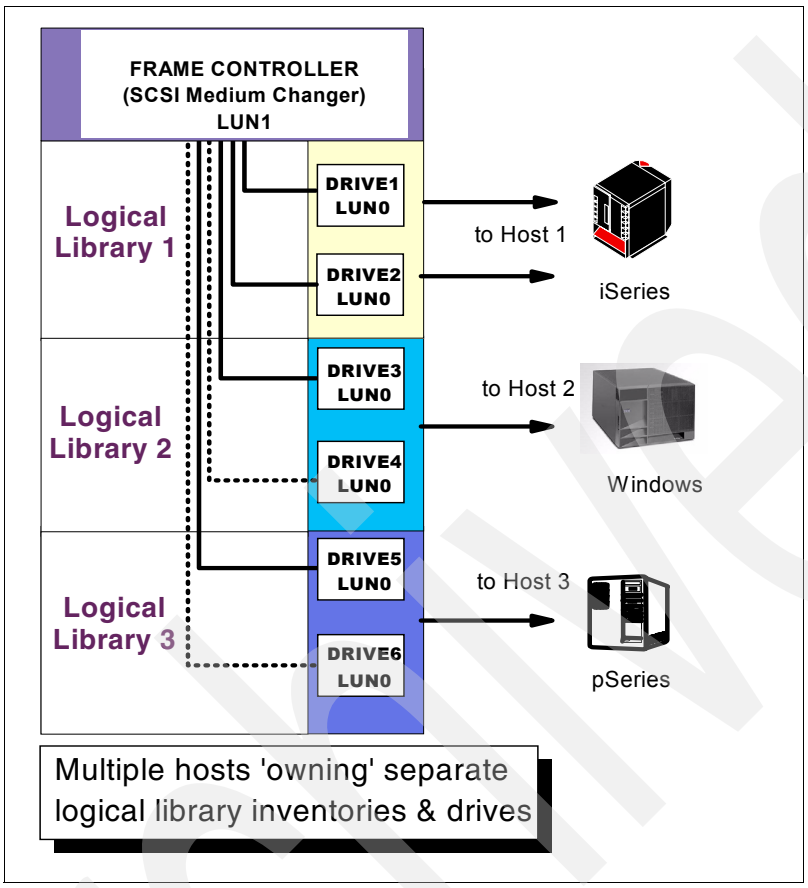


Figure 2-2 IBM multipath architecture and logical partitioning

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 the need 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 77.

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.

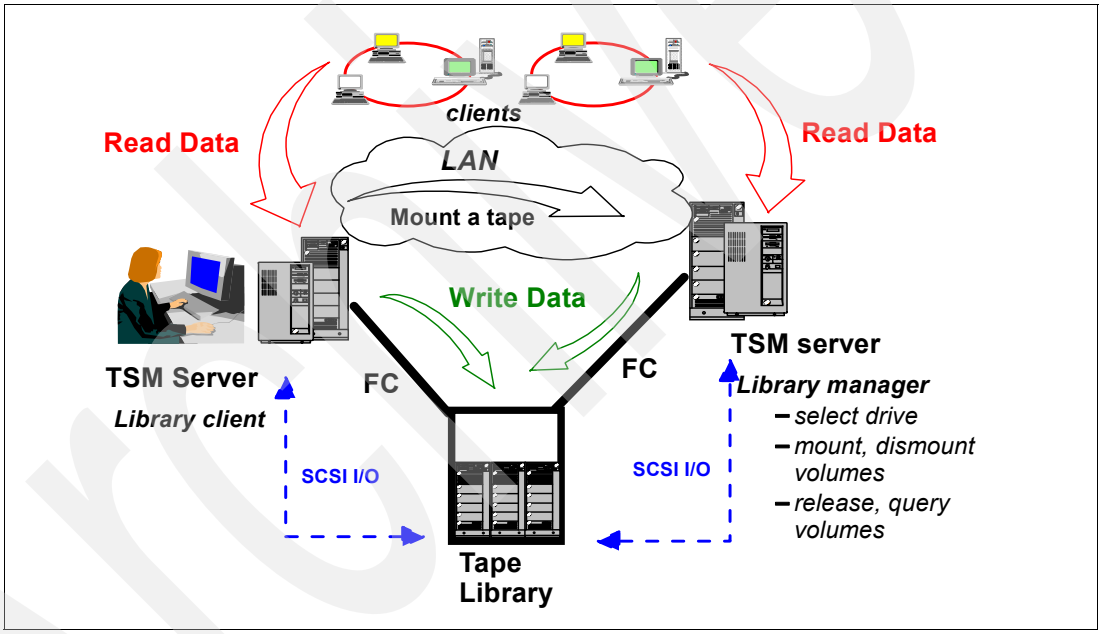


Figure 2-3 Tivoli Storage Manager library sharing

Archive

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

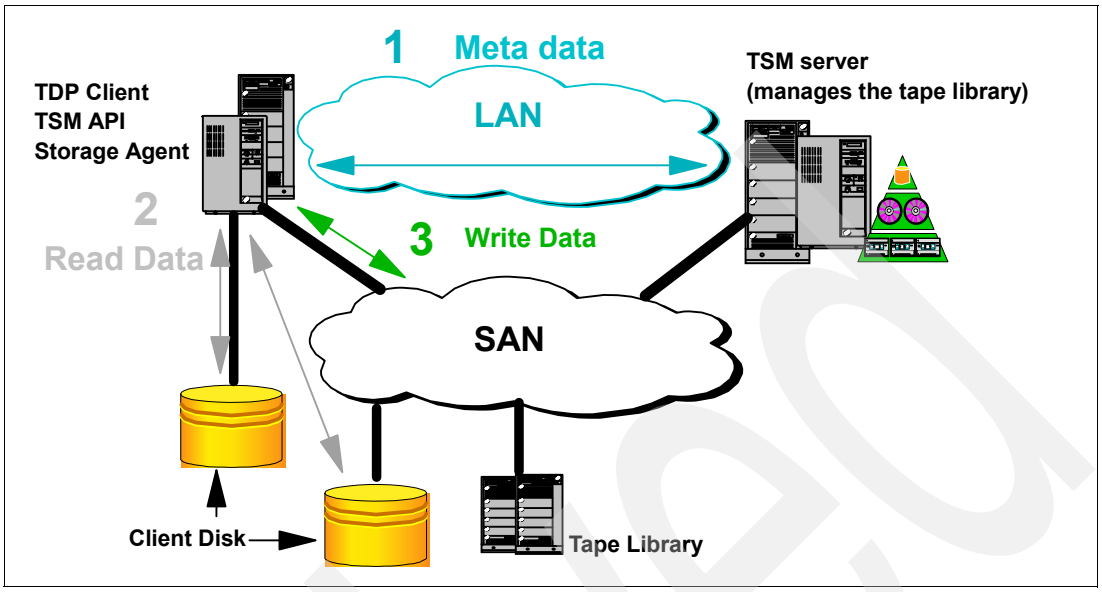


Figure 2-4 LAN-free backup

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 need only one scratch pool, instead of several scratch pools (one for each server).

Figure 2-5 on page 49 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 3, "Basic IBM tape setup for Windows" on page 101 and Chapter 4, "Basic IBM tape setup for Linux" on page 159. For complete details, see *Get More Out of Your SAN with IBM Tivoli Storage Manager*, SG24-6687.

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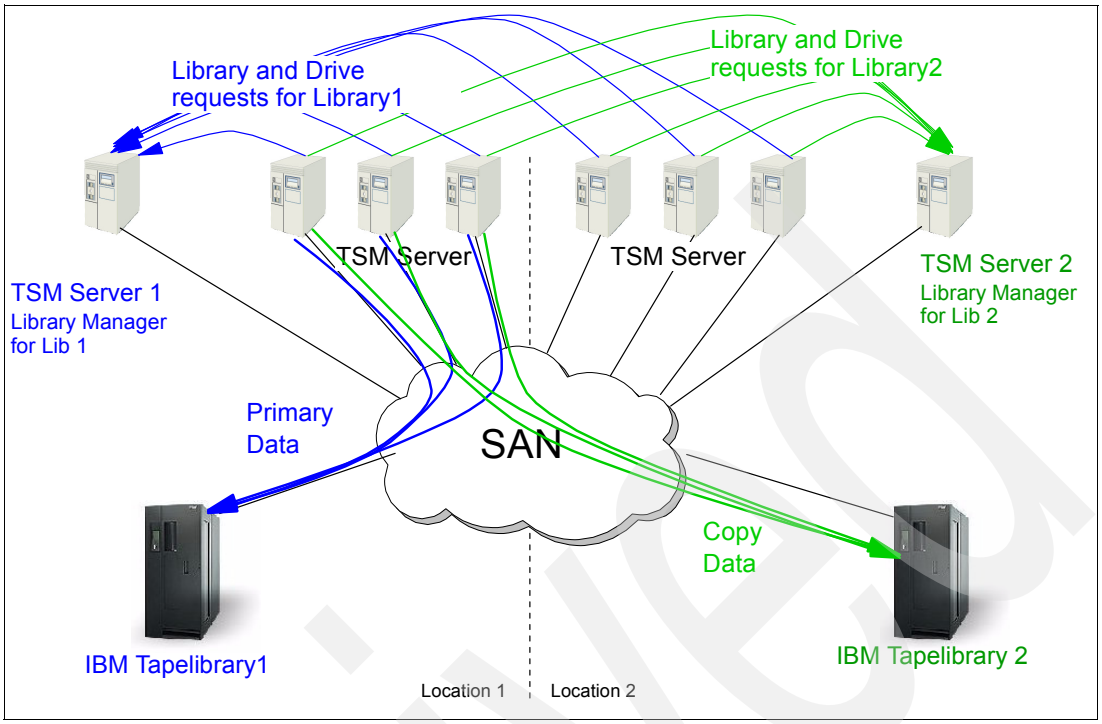


Figure 2-5 Library sharing done by TSM

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 need 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 System 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 10/100 MB 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, which 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.

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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

as exemplified in the library tasks for the TS3400 library (see Figure 2-6).

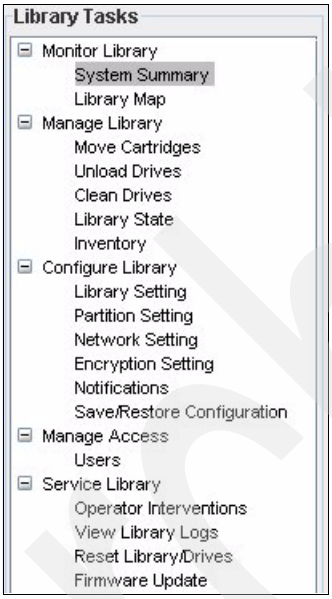


Figure 2-6 TS3400 Tape Library Specialist - Library Tasks

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

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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 Set up and configure 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 I*BM 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 **ENTER** to display.
2. Press **DOWN** to select IP Address.
   a. Click **ENTER** to highlight the IP Address field.
   b. Press **UP** or **DOWN** to select the digit(s) of your library's IP Address.
   c. Click **ENTER** to highlight the next digit(s) in your IP Address.
   d. After entering the final digits, click **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:
   – **Save** to save your network settings.
   – **Cancel** to cancel all of your entries and leave the settings as they are.
6. Click **ENTER** to return to the Configure menu and Cancel twice to return to the home window.

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 window.

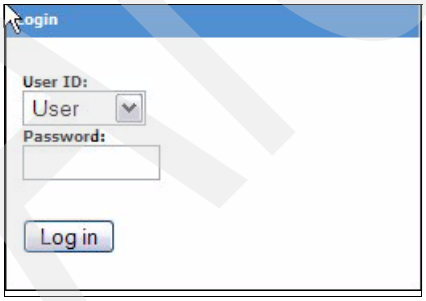


Figure 2-7 IBM TS3200 Tape Library Login window

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.

Archive

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).

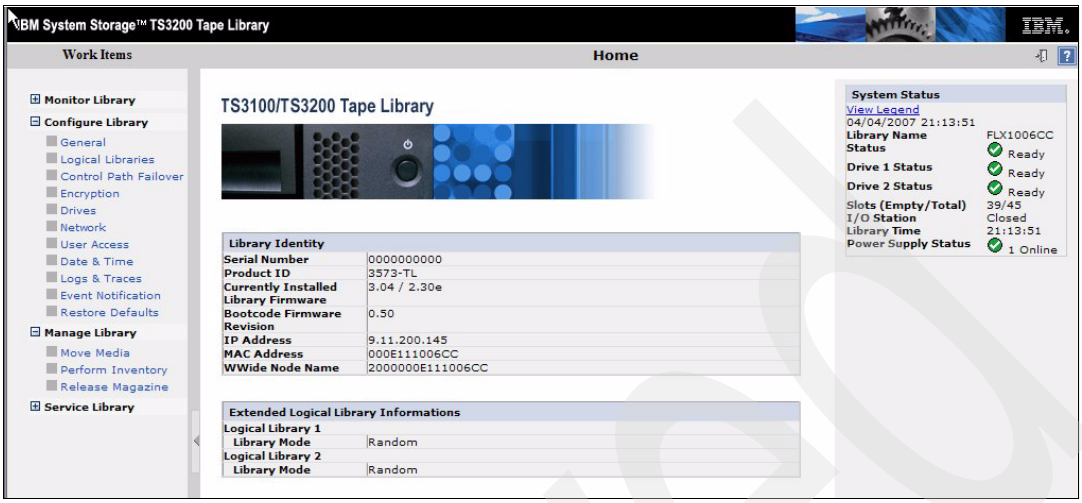


Figure 2-8 IBM TS3200 Home menu

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.

1. Start the Tape Library Specialist.
2. In the Home window (see Figure 2-8), select **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 by selecting **Configure Library** → **General** (see Figure 2-9).

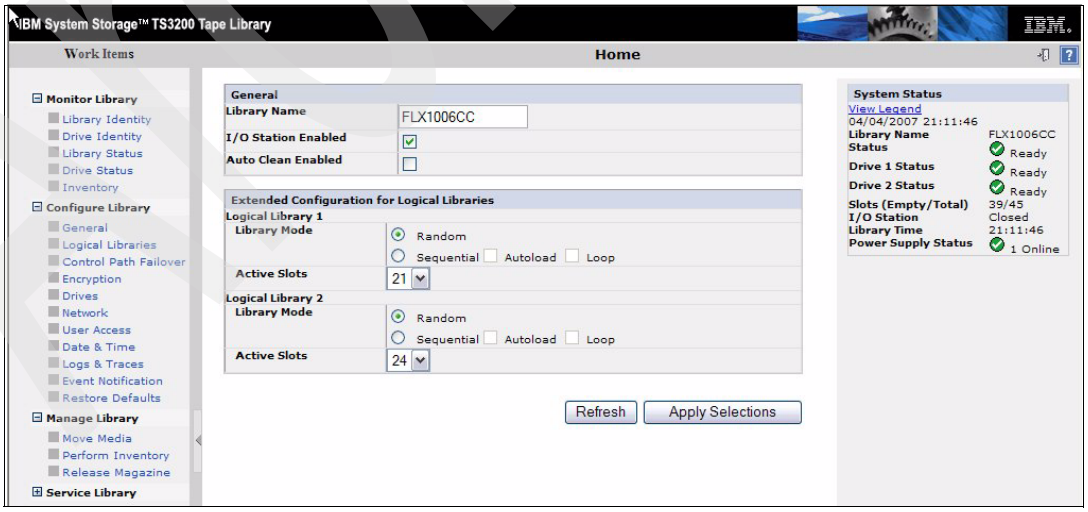


Figure 2-9 IBM TS3200 Partition details

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 Set up and configure 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 log in as the default user admin with the password secure. Remember to change this password, and define your own user IDs and passwords. The main screen will appear, as shown in Figure 2-10.

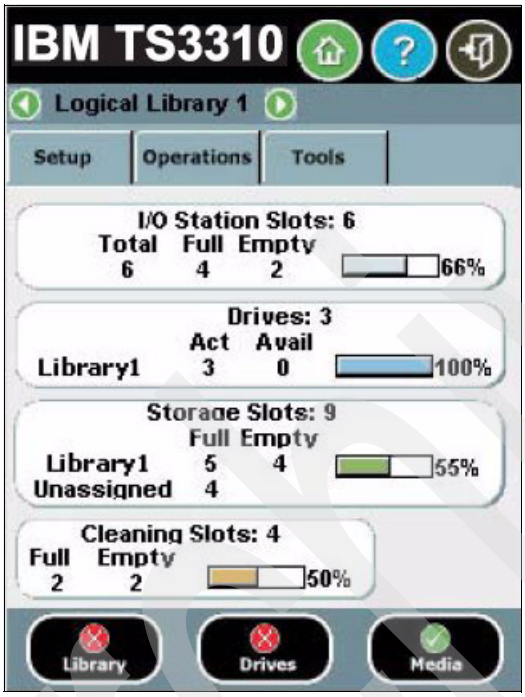


Figure 2-10 TS3310 Home Screen Capacity View

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 the network settings.

You need to 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.
- The 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**.

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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.

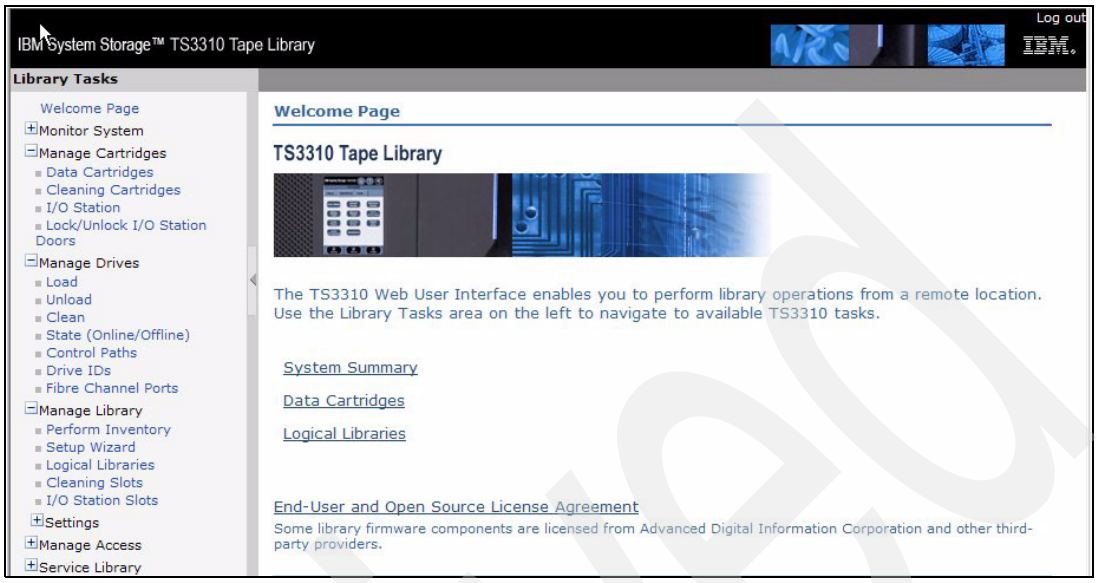


Figure 2-11 TS3310 Tape Library Specialist welcome screen

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 need 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 53, 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 Appendix B, “SNMP setup” on page 271. 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 UIs.

1. Connect to the Tape Library Specialist, and log in with default ID *admin* and the password *secure*. Remember to change the password for security. The welcome screen will display, as shown in Figure 2-12 on page 55.

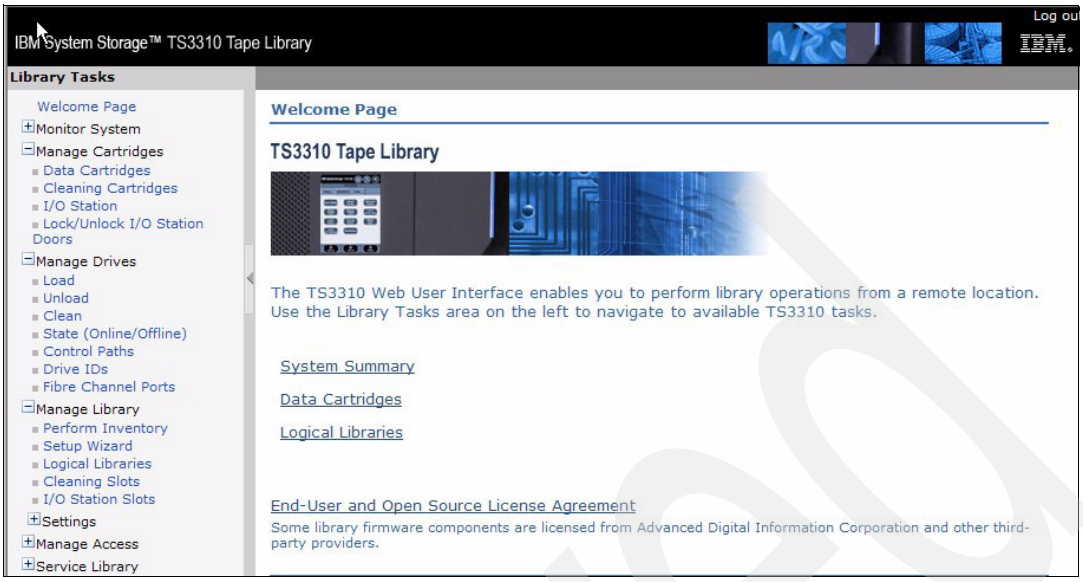


Figure 2-12 IBM TS3310 Welcome page

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

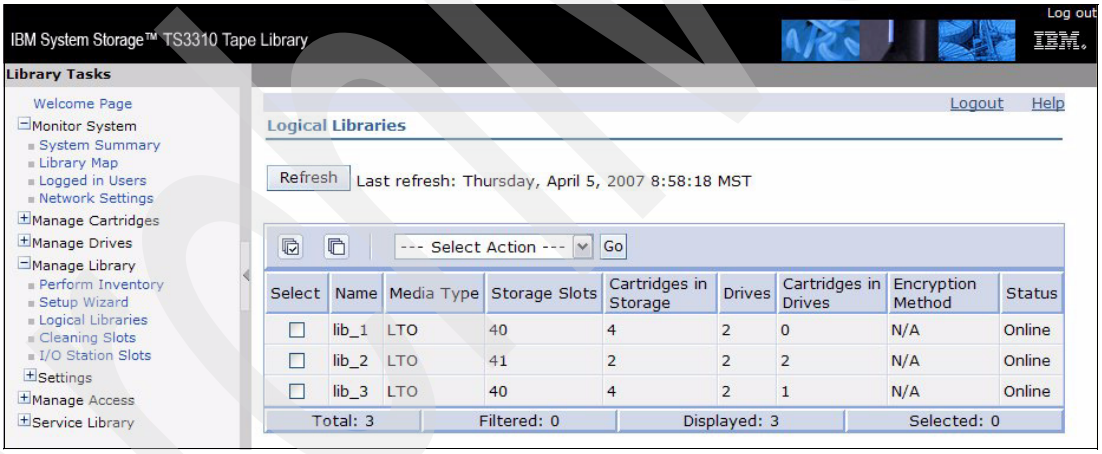


Figure 2-13 IBM TS3310 Logical Libraries

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, as shown in Figure 2-14. You can modify general properties, change storage slots, and assign tapes. Click **Apply** to activate.

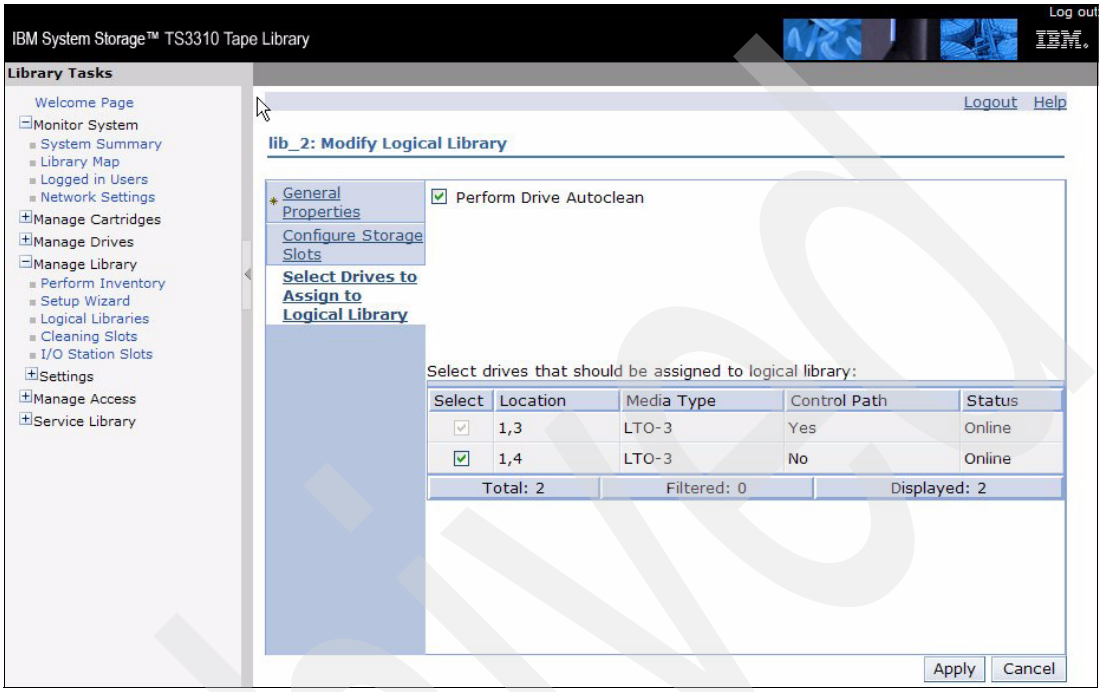


Figure 2-14 Modify a logical library

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

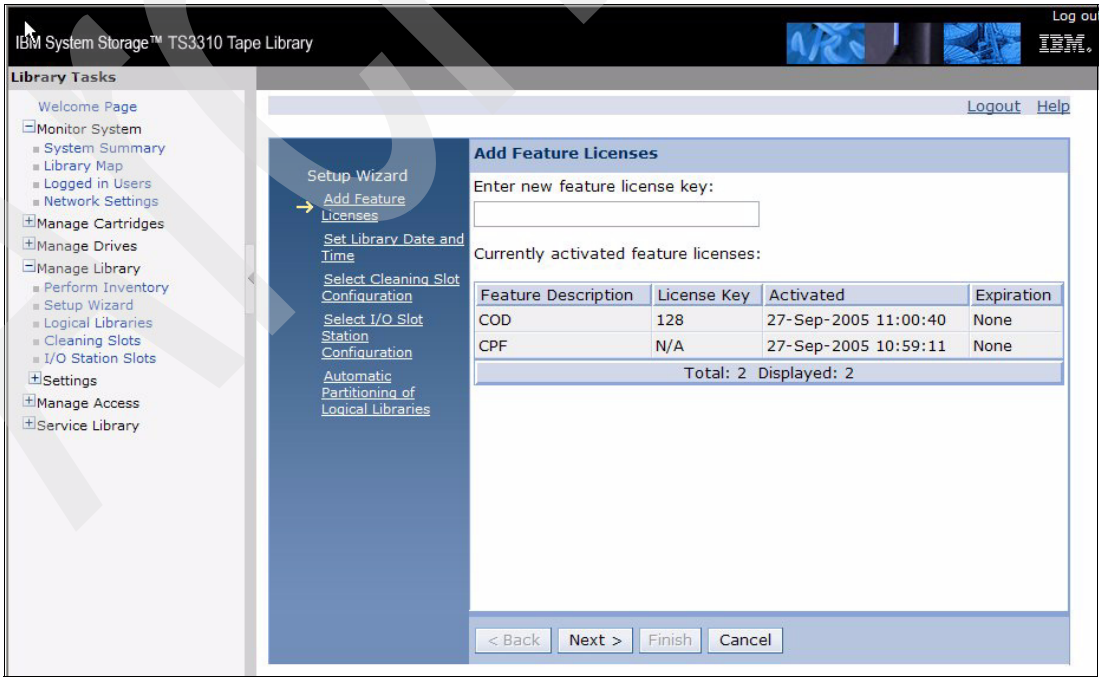


Figure 2-15 IBM TS3310 Setup Wizard

For further description on how to configure the logical partitions, see *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 Set up and configure 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, as shown in Figure 2-16.



Figure 2-16 IBM TS3400 Welcome screen

Click **ENTER**, and provide the default password 0000. Remember to change this password from the Configuring Panel. This will display the Top Menu screen, as shown in 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 click **ENTER**.
2. Select **Network Settings**, and click **ENTER**.
3. Press **DOWN** to select **IP Address**, and click **ENTER**.
4. Press **UP** or **DOWN** to select the digit(s) of your library's IP address. Click **ENTER** to select each digit. After the last digit, click **ENTER** to apply.
5. Press **DOWN** to select **Subnet Mask**, and click **ENTER**. Follow the same procedure as for IP Address.
6. Press **DOWN** to select **Gateway**, and click **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 need at least Java 1.5.0 installed on your computer. Log in using the default ID Admin using the

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password secure. Remember to change this password, and establish your own user IDs and passwords. The Welcome screen will display, as shown in Figure 2-18.

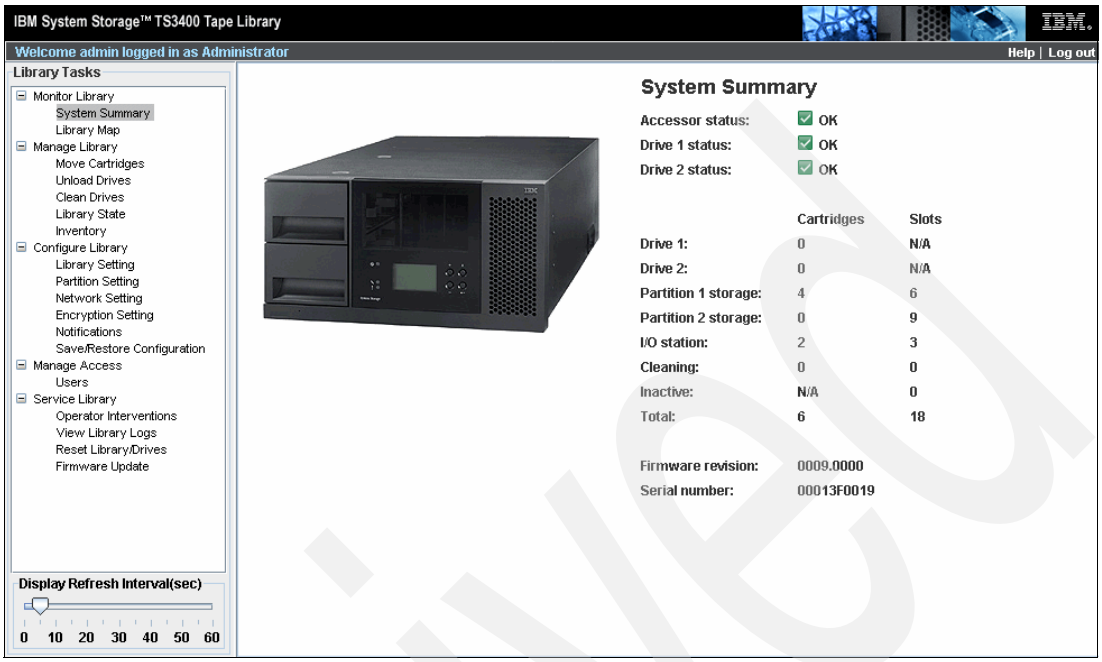


Figure 2-18 TS3400 Welcome screen: System Summary

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 that provide built-in multipathing.

Guidelines for partitioning the IBM TS3400

- 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 will use 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 on page 59.

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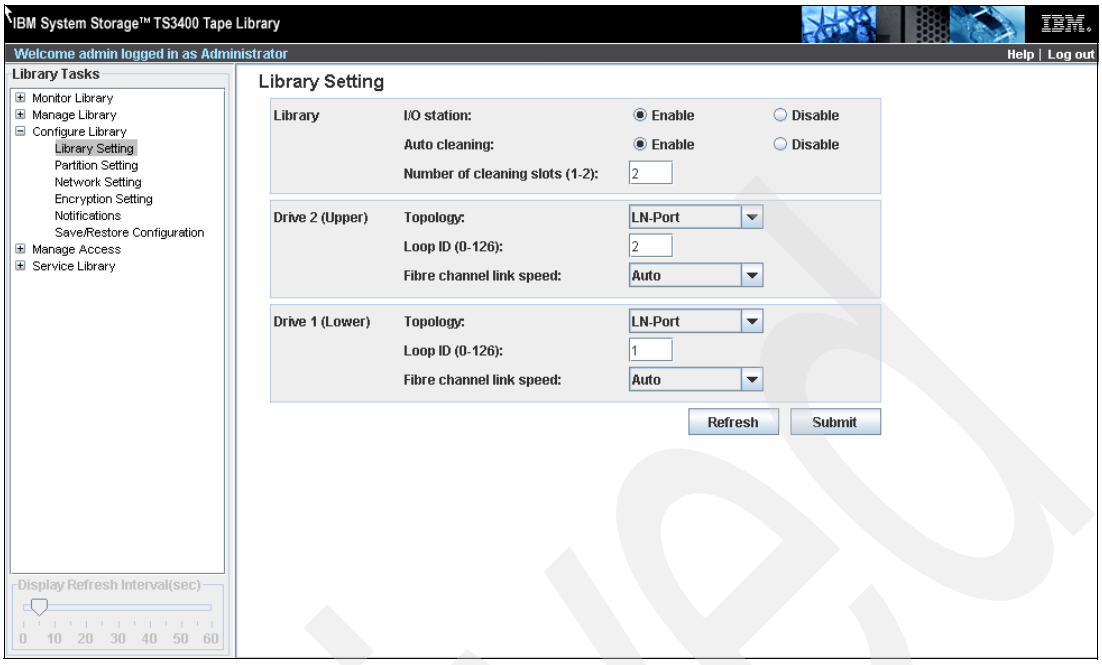


Figure 2-19 IBM TS3400 Library Setting example

Partitioning the IBM TS3400 with the Tape Library Specialist

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

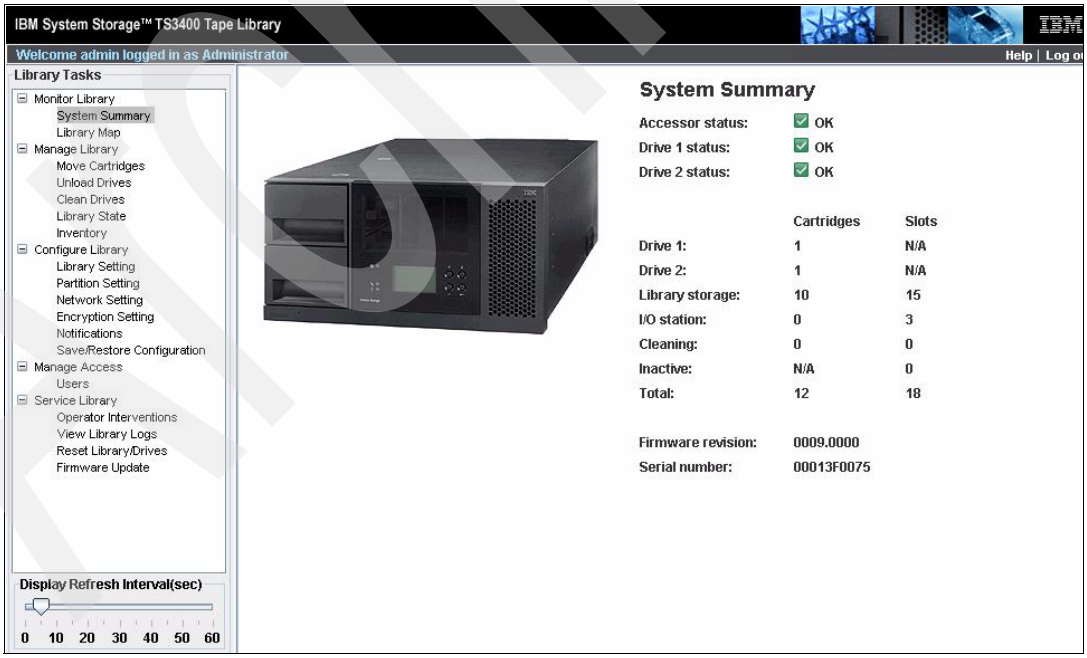


Figure 2-20 IBM TS3400 Tape Library Specialist Summary window

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

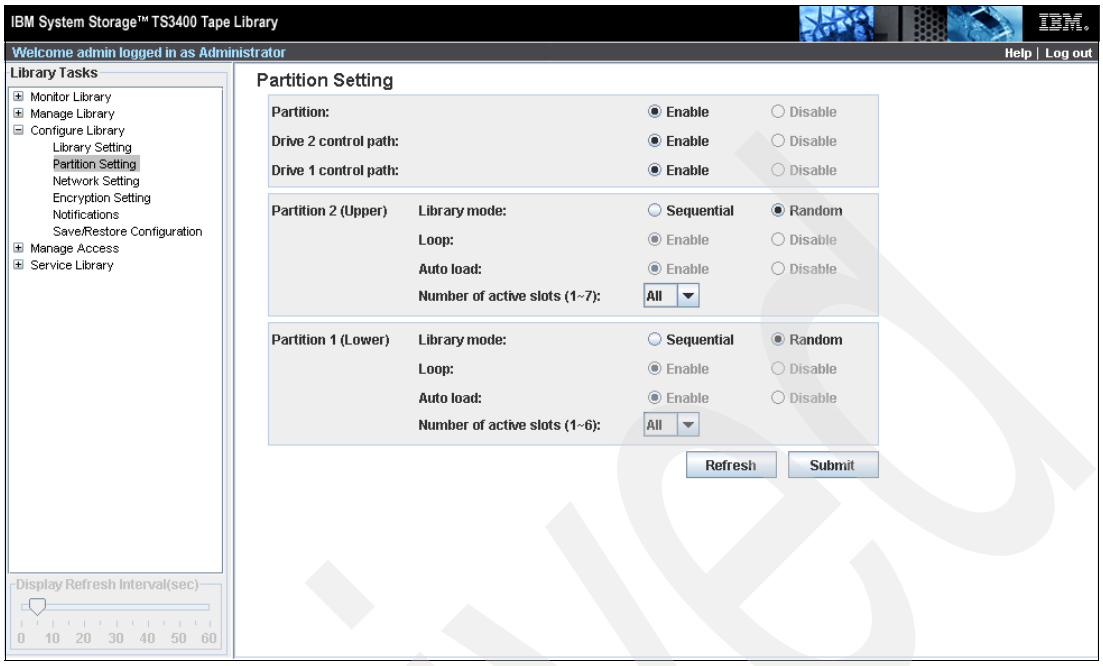


Figure 2-21 IBM TS3400 Partition Setting example

3. To enable partitions, you need 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:

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

2.2.7 Set up and configure 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. Select **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 on page 61.

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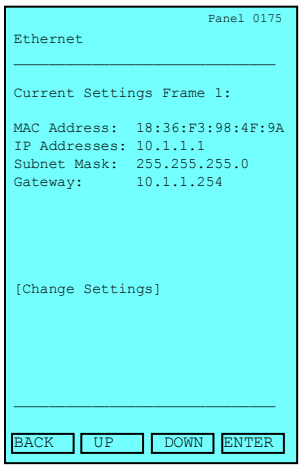


Figure 2-22 Change Ethernet parameters on IBM TS3500

Click **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 now have complete operational control of the TS3500 Tape Library. The library may have implemented the Advanced Library Management Services (ALMS). For more information about ALMS, see 2.3, “ALMS” on page 77.

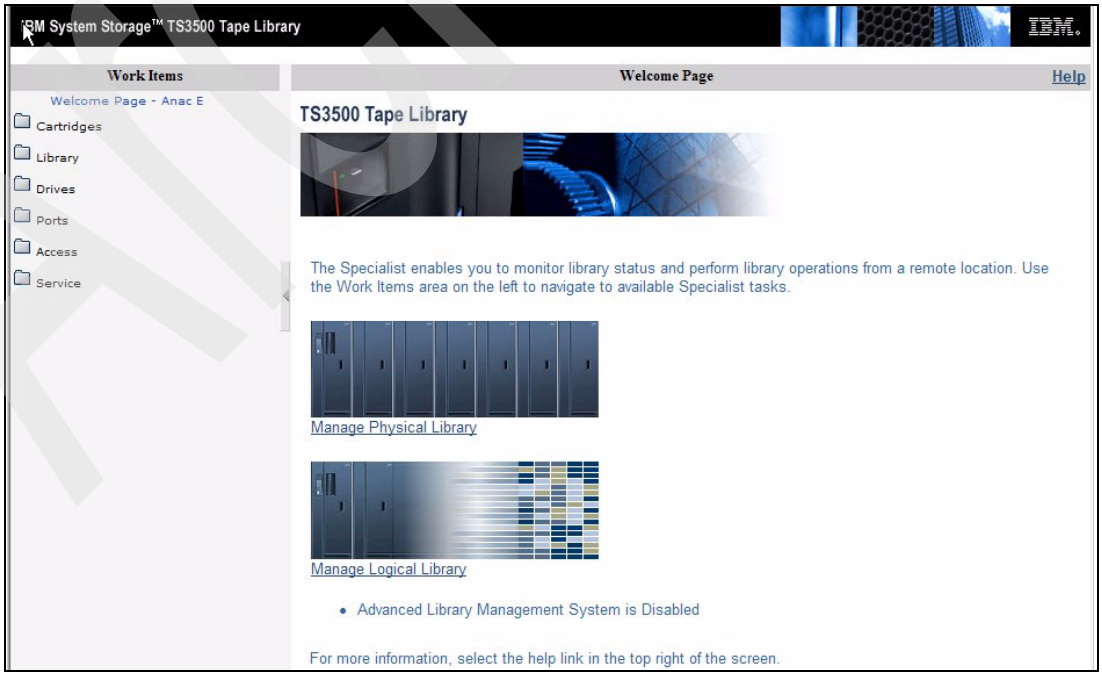


Figure 2-23 IBM TS3500 Tape Library Specialist: Welcome page

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

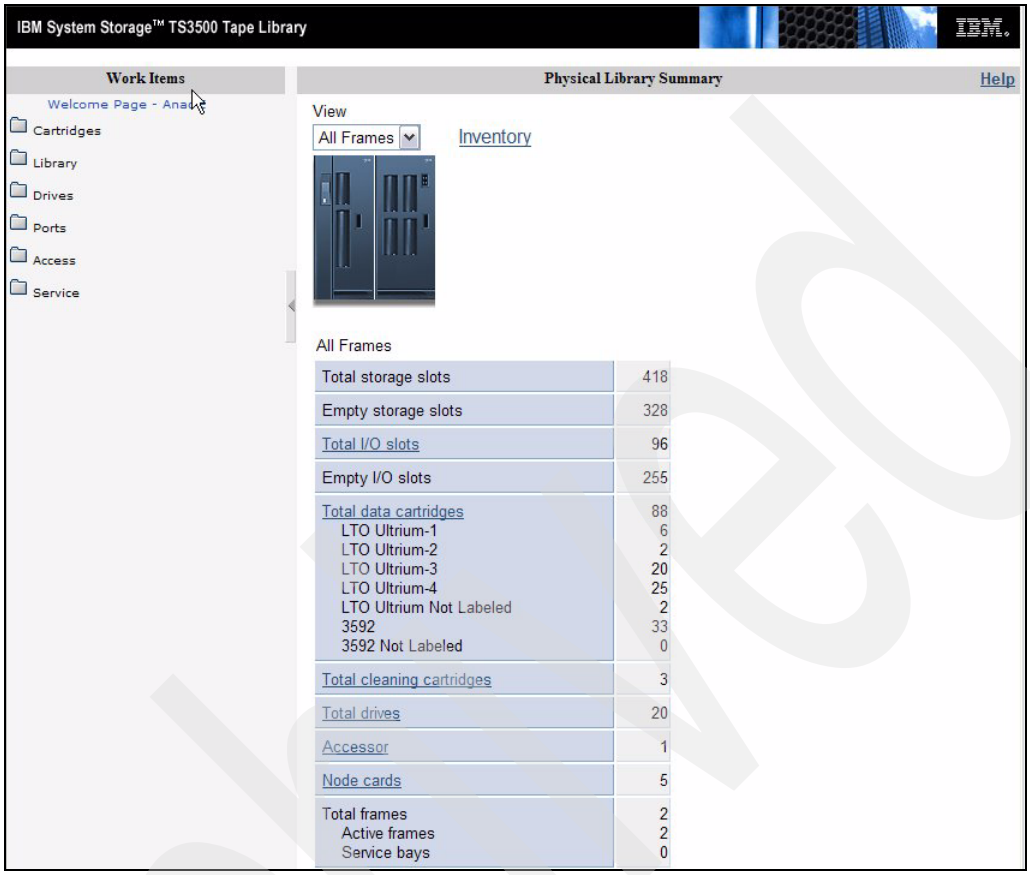


Figure 2-24 IBM TS3500 Physical Library summary window

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 89 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 about Cartridge Assignment Policy, see “Cartridge assignment policy” on page 87.

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 93, 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 this function may interrupt the library activity. Indeed, changing the Drive SCSI/Loop ID will interrupt library and drive activities and may require reconfiguring the host computers.

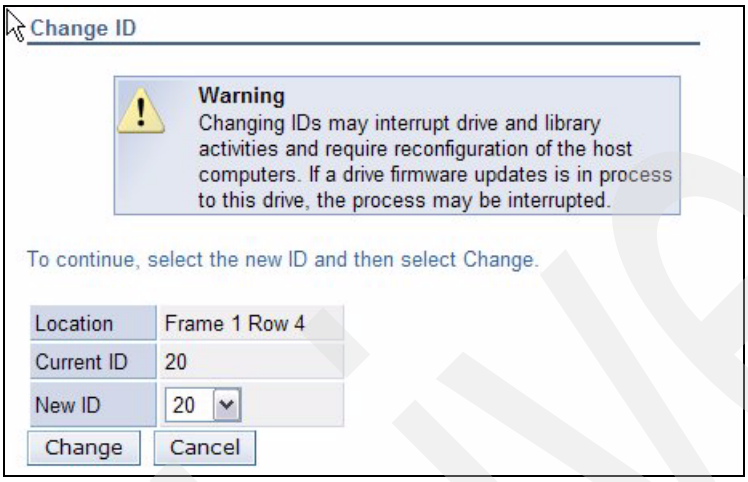


Figure 2-25 IBM TS3500 Tape Library Specialist: ID change warning

Select **Drives** → **Drive Assignment** to display the Drive Assignment Filter window. 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.

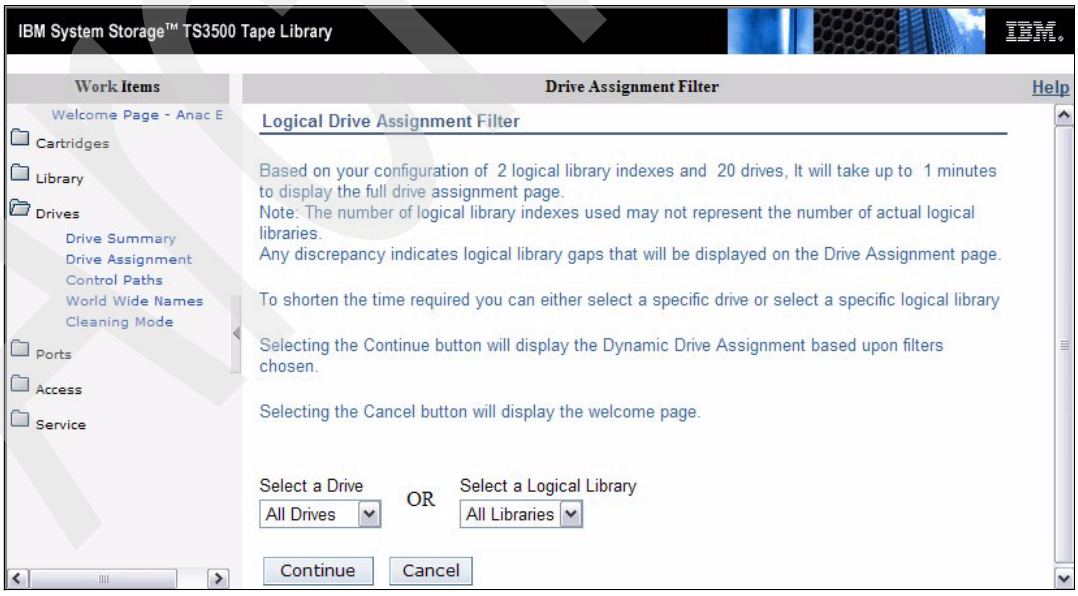


Figure 2-26 IBM TS3500 Tape Library Specialist: Drive Assignment Filter

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 to the left of the check box in the Tucson column.

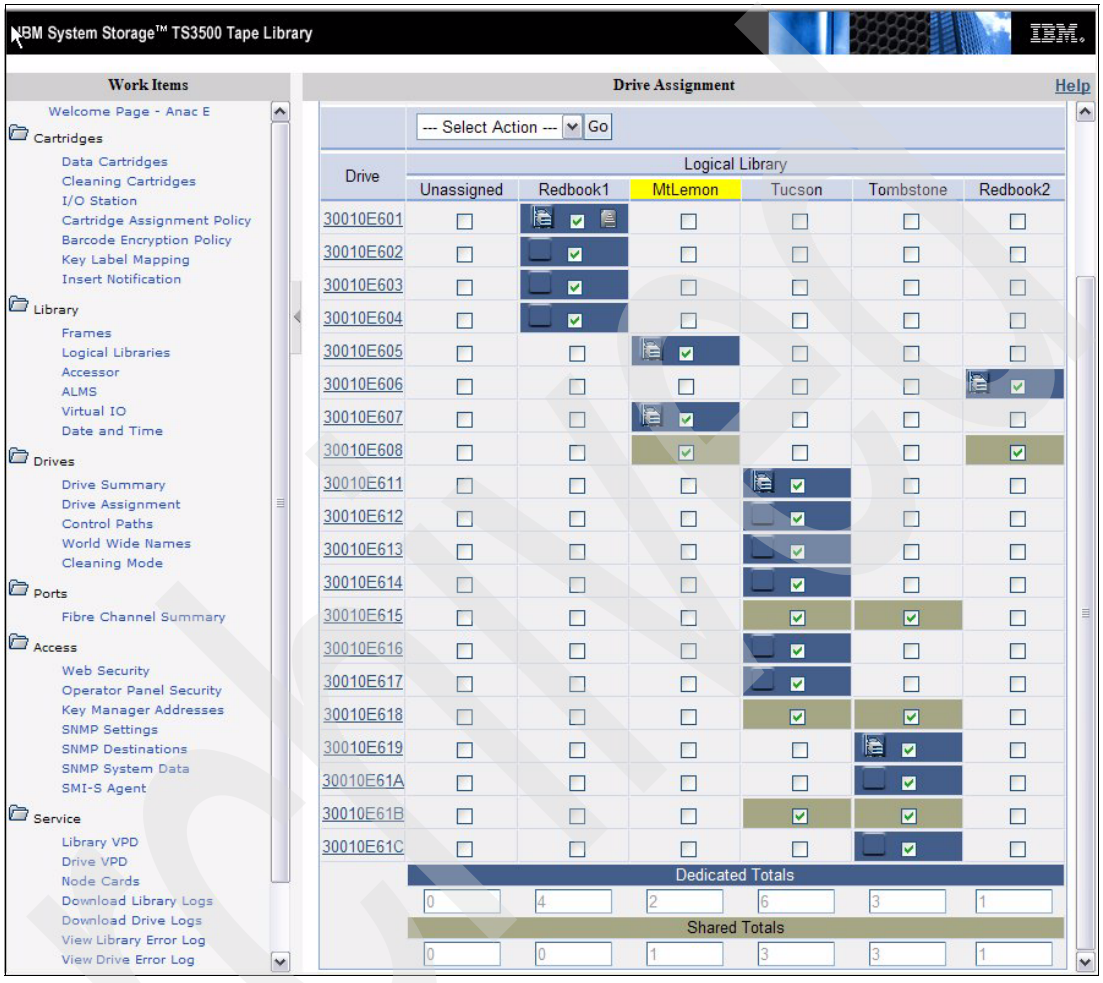


Figure 2-27 Drive Assignment

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

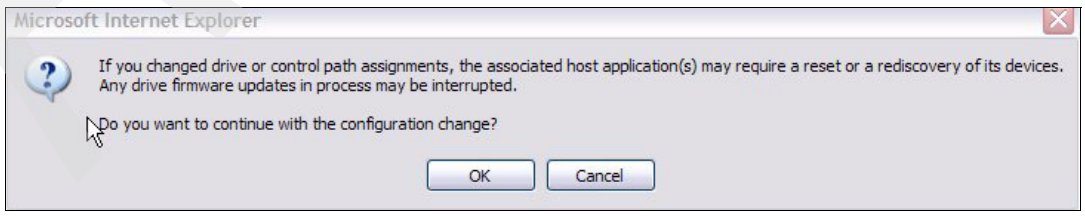


Figure 2-28 IBM TS3500 Tape Library Specialist: Assignment change warning

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**, as shown in Figure 2-29. Once password security is set on, use the same selection to control users and passwords.

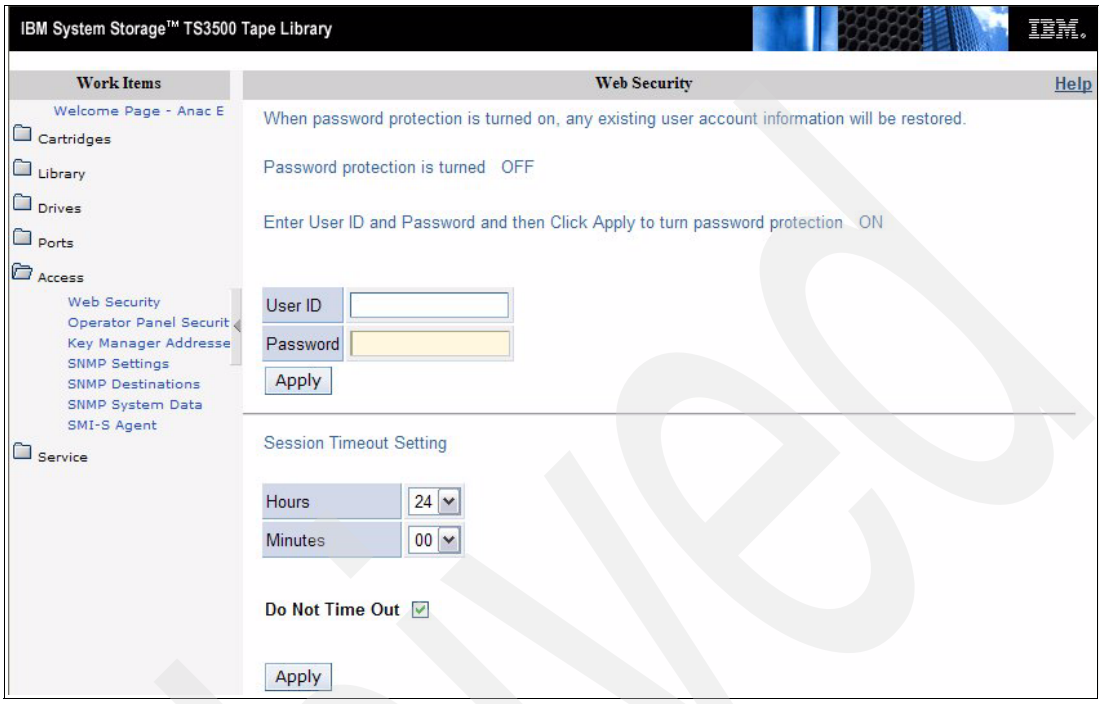


Figure 2-29 Set Password window

For a firmware update of the IBM TS3500 Tape Library, see 3.7, “Updating library, drive, and RMU firmware” on page 149.

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 like 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 77.

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Plan your logical library configuration carefully, because the need for contiguous storage slots and drives makes future changes to the configuration very difficult. For example, 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 as well. 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); instead, 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 needed.

Figure 2-30 on page 67 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 needs 40 slots and two drives; logical library 2 needs 60 slots and two drives; logical library 3 needs 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 ability to install one additional drive in the first logical library if needed.

The library with the highest expected growth was put at the end. If needed, 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.

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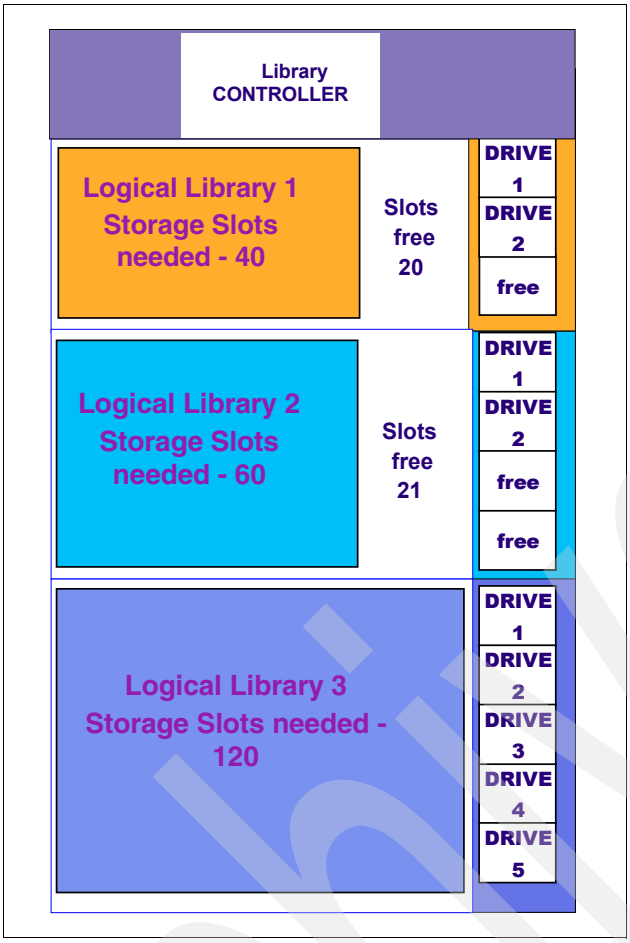


Figure 2-30 IBM TS3500 partitioning example

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 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.

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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 61). 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, as shown in Figure 2-31.

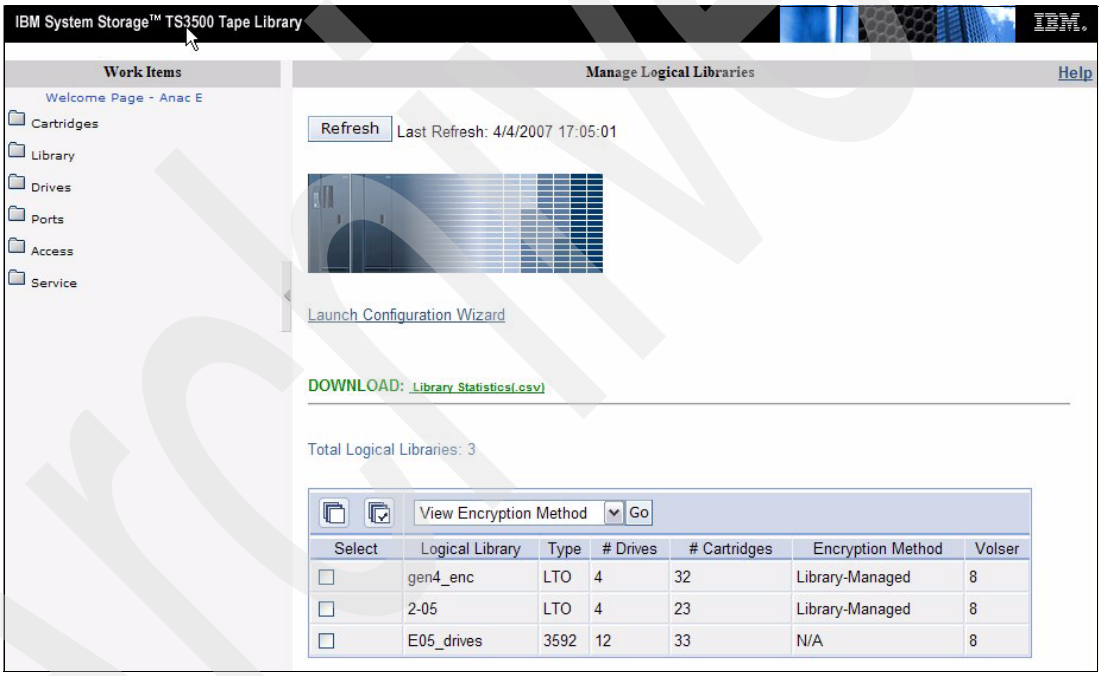


Figure 2-31 IBM TS3500 Tape Library Specialist Logical Libraries entry window

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 may 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 may take less than a minute). Click **Next** to continue.
4. The **Select Configuration Method** window displays (Figure 2-32 on page 69), showing the alternatives: Automated configuration (configuration with barcode labels) or Advanced configuration. Select **Advanced configuration** and click **Next**.

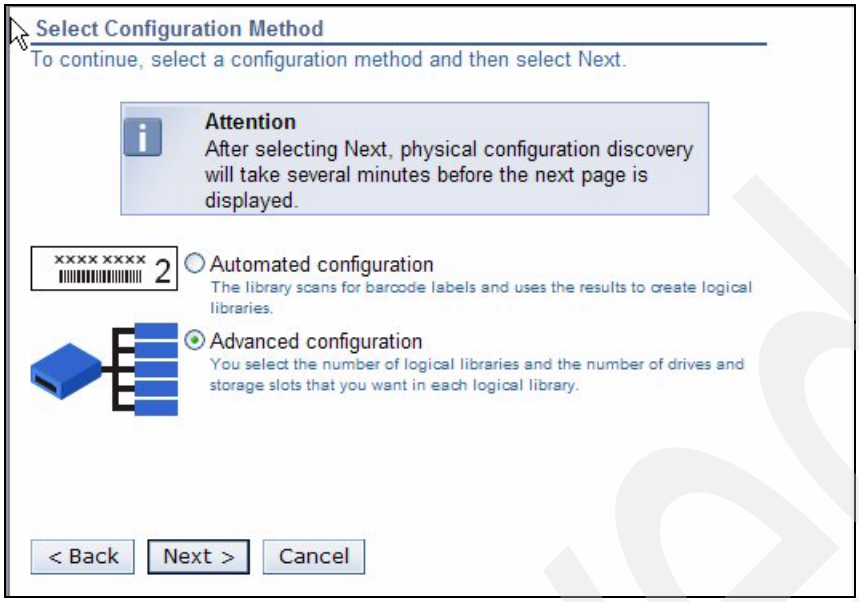


Figure 2-32 IBM TS3500 Tape Library Specialist configuration wizard

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.

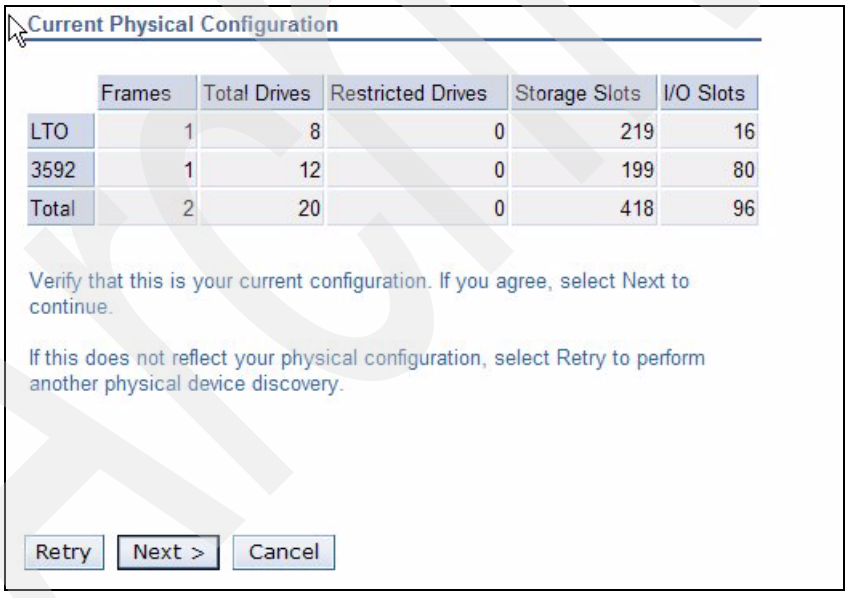


Figure 2-33 Current physical configuration

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

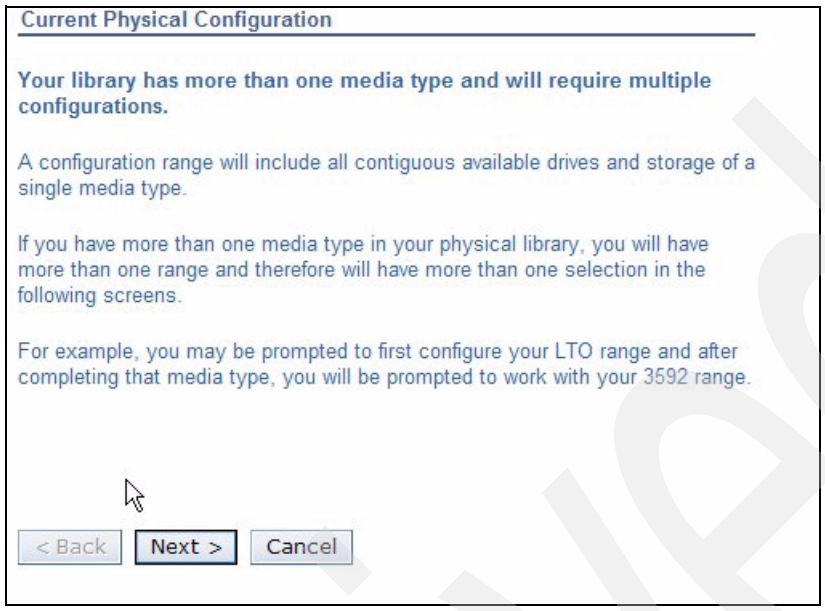


Figure 2-34 Multiple configurations warning

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

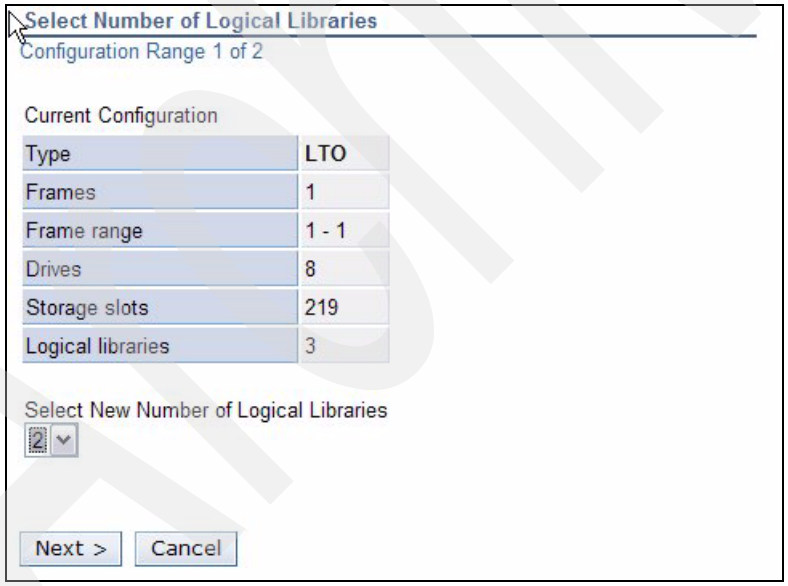


Figure 2-35 IBM TS3500 Tape Library Specialist Logical Libraries

8. Select the number of logical libraries from the drop-down list. Select **Next**. The desired number of drives and slots can now be assigned to each logical library (Figure 2-36 on page 71). 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.

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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 windows. That means you can first configure a range of LTO elements, and then a range of 3592 elements.

Select **Next** when finished.

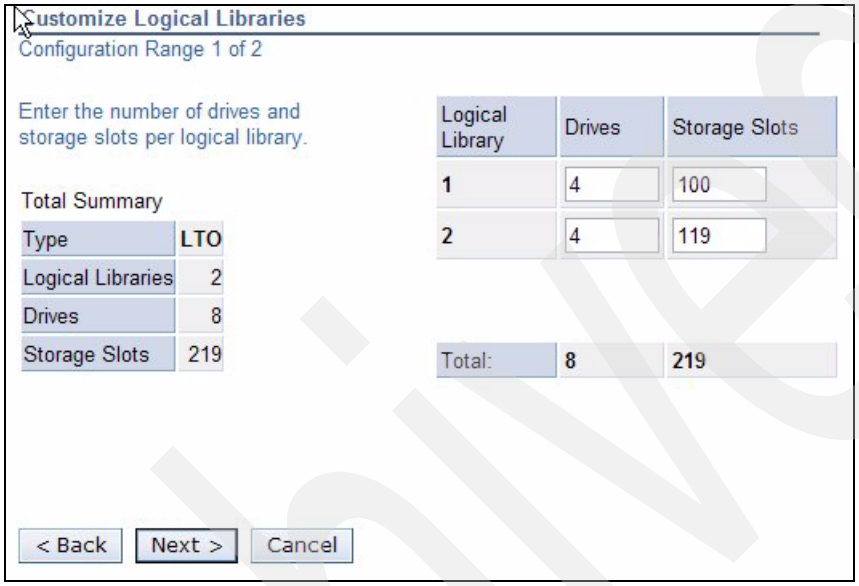


Figure 2-36 IBM TS3500 Tape Library Specialist customize drives and slots - LTO

9. In the same way, select and customize the 3592 libraries, as shown in Figure 2-37.

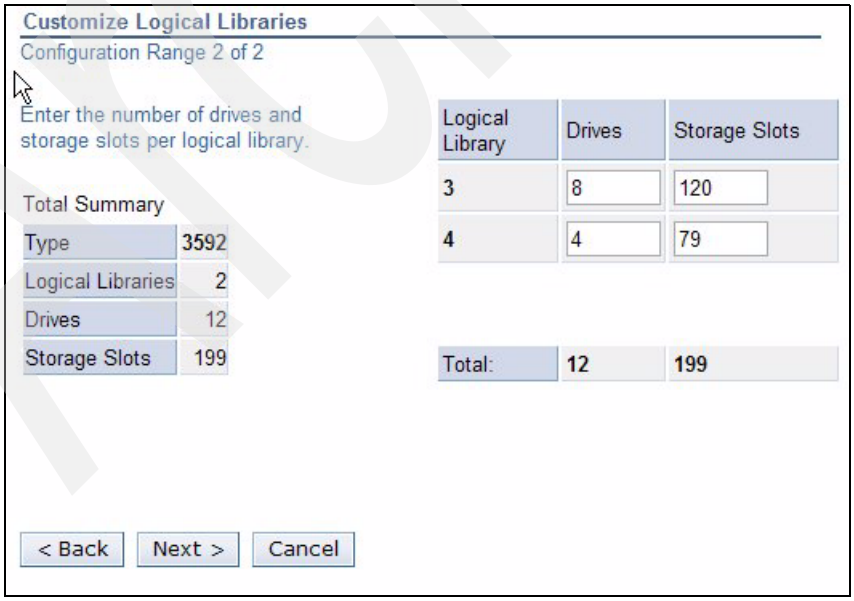


Figure 2-37 Customize drives and slots - 3592

10. A new window shows the selections. The configuration can now be reviewed before being applied, as shown in Figure 2-38.

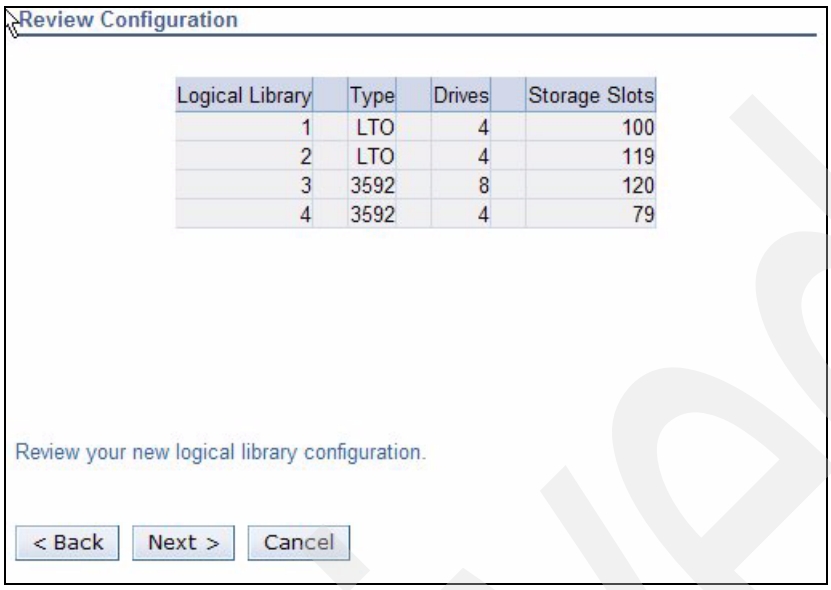


Figure 2-38 Review configuration

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 window (Figure 2-31 on page 68), select the library to be renamed and click **Rename**. On the next window (Figure 2-39), enter a new name. The logical library name is only used by the Library Specialist, and has no effect on the communication with your backup application.

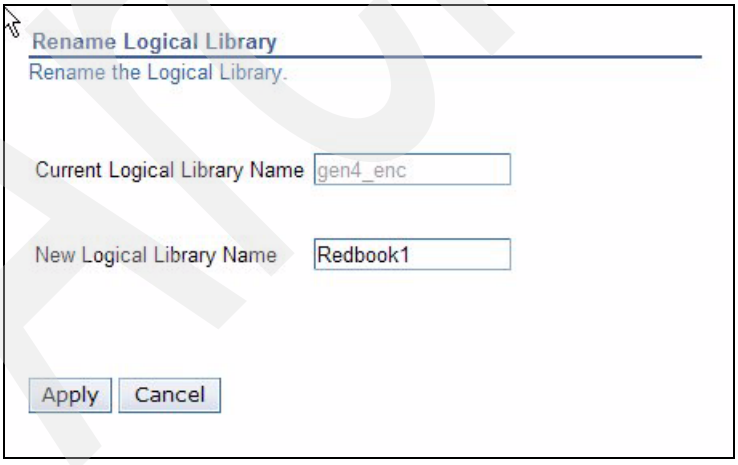


Figure 2-39 Rename logical library

When all logical libraries are renamed, we have our library layout, as shown in Figure 2-40 on page 73.

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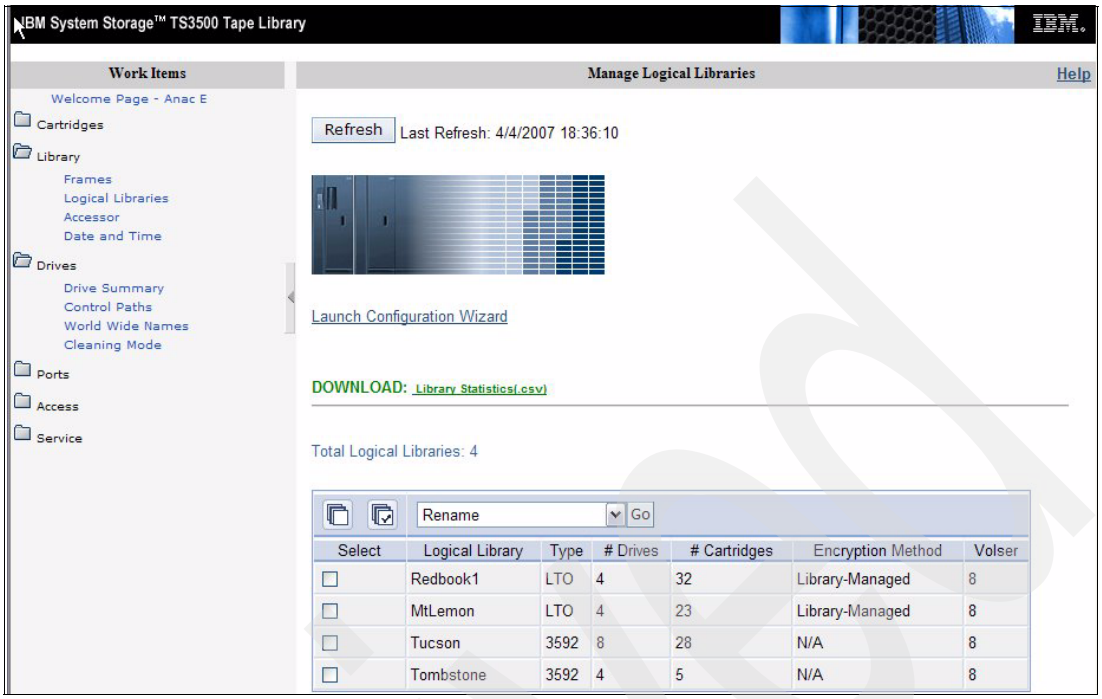


Figure 2-40 IBM TS3500 Logical Library status

Before we can work again with the library, we have to adjust the logical library configuration with the backup application that 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 about how to change an existing library configuration. Some applications like IBM Tivoli Storage Manager handle this easily; other applications like 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.

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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 windows may vary slightly.

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

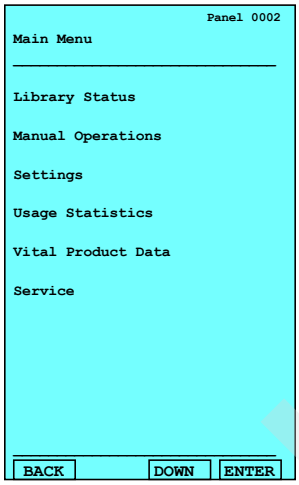


Figure 2-41 IBM TS3500 operator screen: Main Menu

2. Click **UP** or **DOWN** to highlight **Settings** and click **ENTER**. The Settings menu displays.
3. Click **UP** or **DOWN** to highlight **Configuration** and click **ENTER**. The Configuration menu displays.
4. Click **UP** or **DOWN** to highlight **Advanced configuration** and click **ENTER** (Figure 2-42). The library displays the message: `If you continue with configuration the library will go offline.` Click **ENTER** to continue.

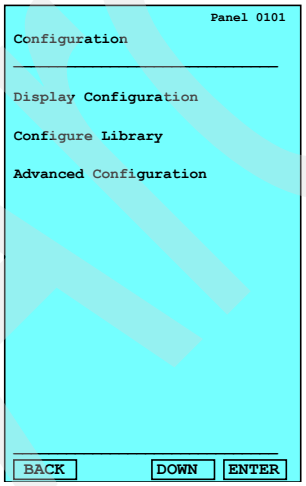


Figure 2-42 IBM TS3500 operator screen: Configuration

5. Click **ENTER** twice. The library displays the message: `Searching for installed devices` and may take several minutes to discover the physical configuration. The Physical Configuration screen displays, identifying the library's existing physical configuration (Figure 2-43 on page 75). The screen shows the total quantity of drives, storage slots, and

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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.

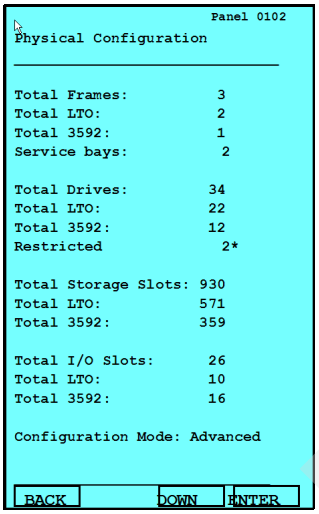


Figure 2-43 IBM TS3500 Configuration display

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

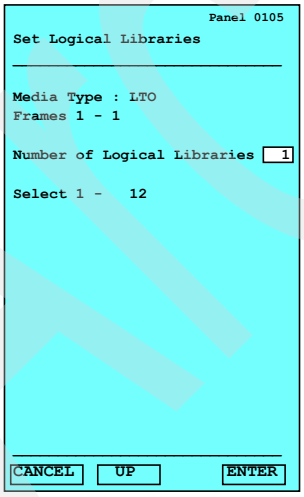


Figure 2-44 IBM TS3500 operator screen: Set Logical Libraries

8. Specify the number of logical libraries that you want by clicking **UP** or **DOWN** to increase or decrease the value.

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9. When the desired quantity of libraries displays, click **ENTER**. The Set Storage Slots screen displays (Figure 2-45).

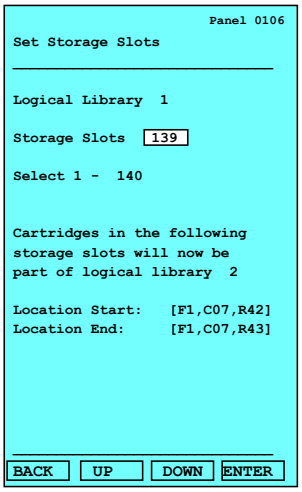


Figure 2-45 IBM TS3500 operator screen: Set Storage Slots

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, click **ENTER**. The Set Drives screen displays (Figure 2-46).

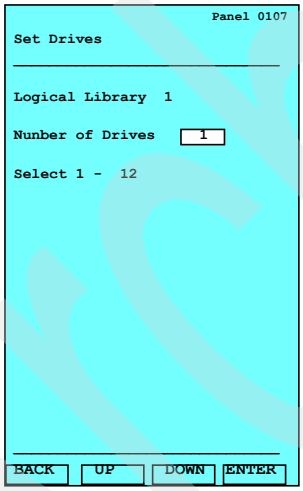


Figure 2-46 IBM TS3500 operator screen: Set Drives

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, click **ENTER**.
12. The Configuration Summary screen for Logical Library 1 is displayed (Figure 2-47 on page 77). The screen contains the range of SCSI element addresses for the cartridge storage slots and the drives.

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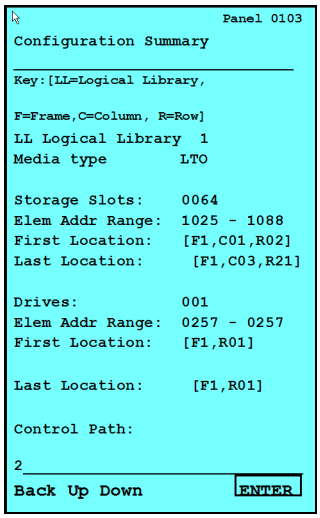


Figure 2-47 IBM TS3500 operator screen: Configuration Summary

13. Click **ENTER** to display the Configuration Summary panel for each logical library. After displaying the screen 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 may 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.

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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.

Consideration: 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 may 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 79). 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 may 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 may 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.

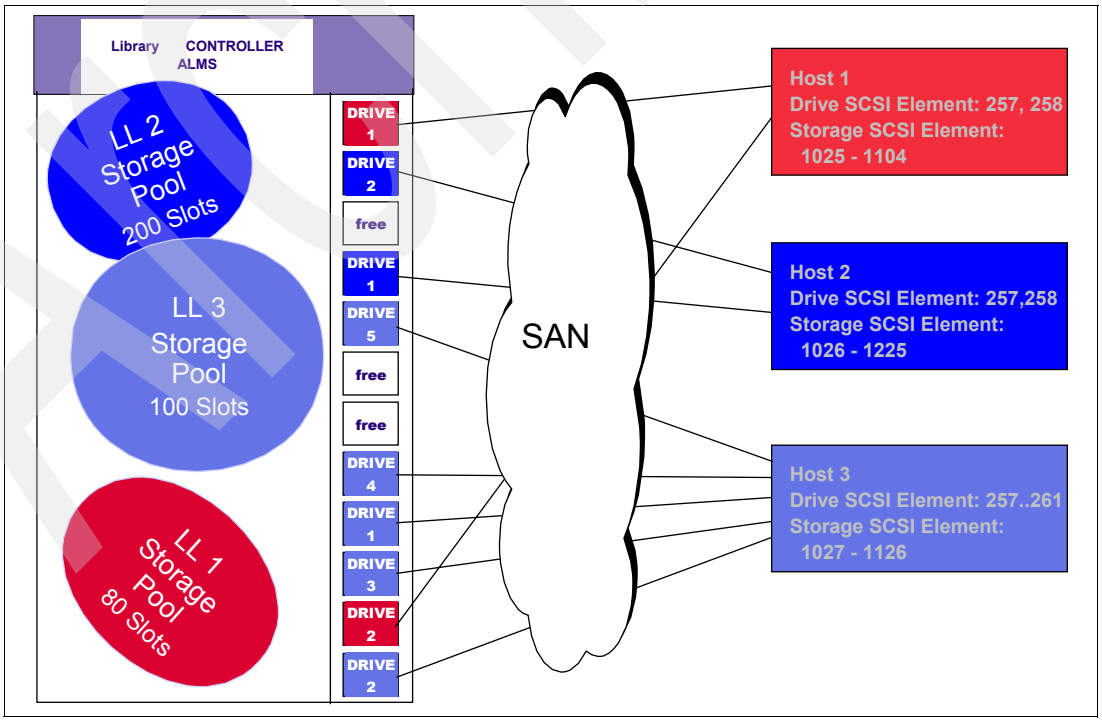


Figure 2-48 IBM TS3500 Tape Library with ALMS

Storage slot pooling

With ALMS, logical libraries can be added or deleted nondisruptively. 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 through 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 it is needed or not.

The Drive Assignment Web window supports the following point-and-click capabilities, which are nondisruptive 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 through the source logical library; any de-mount command requested through 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 through 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 it.

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

Archived

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 needed 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 require 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 “Insert notification” on page 82) 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 that 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 you 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 timeout 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 64 slot 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 needing 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, three 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 needed 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, where 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 the TS3500 with 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:

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 click **ENTER**.
2. For each character of the license key, press **UP** or **DOWN** to select the value you want, and click **ENTER** to move to the next digit. If you enter an incorrect number, press **Back** to return to the previous digit.
3. Click **ENTER**. The Features screen now indicates `Advanced Library Management Feature Is Installed.`

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

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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 window with the message that ALMS is disabled at the bottom, as shown in Figure 2-49.

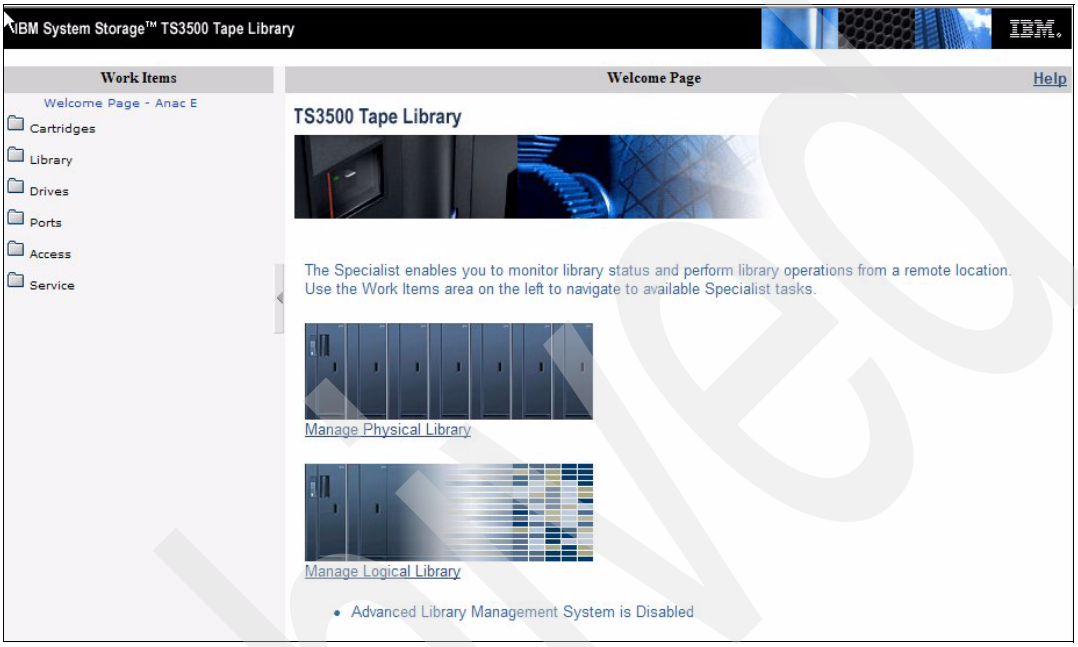


Figure 2-49 Welcome window before enabling ALMS

2. On the left side of the window, 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.

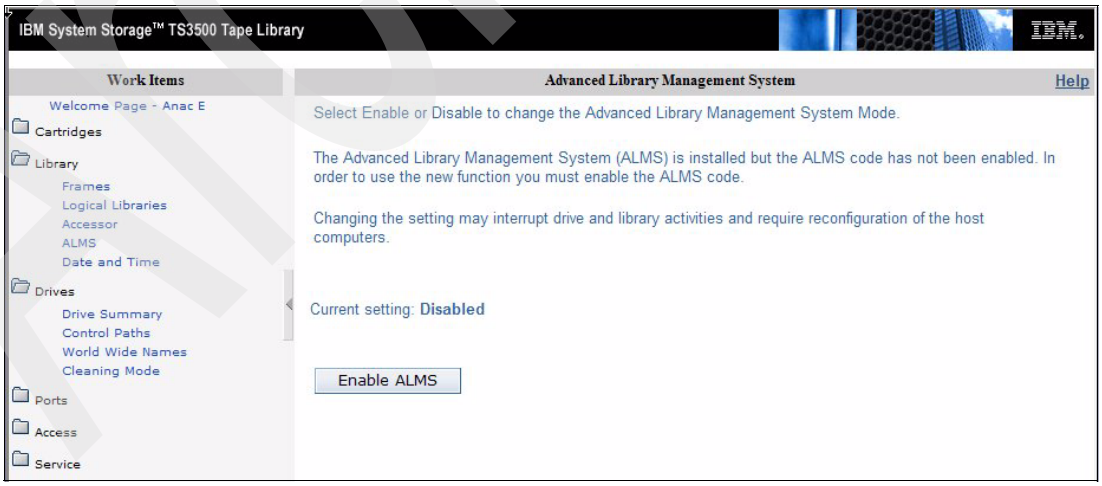


Figure 2-50 Enable ALMS

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 done with care. After ALMS is enabled, the window shown in Figure 2-50 on page 84 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 may 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 on page 86).

Archived

Create and manage logical libraries

1. From the Tape Library Specialist (Figure 2-49 on page 84), select **Library** → **Logical Library** and on the next window, Figure 2-51, click **Create**.

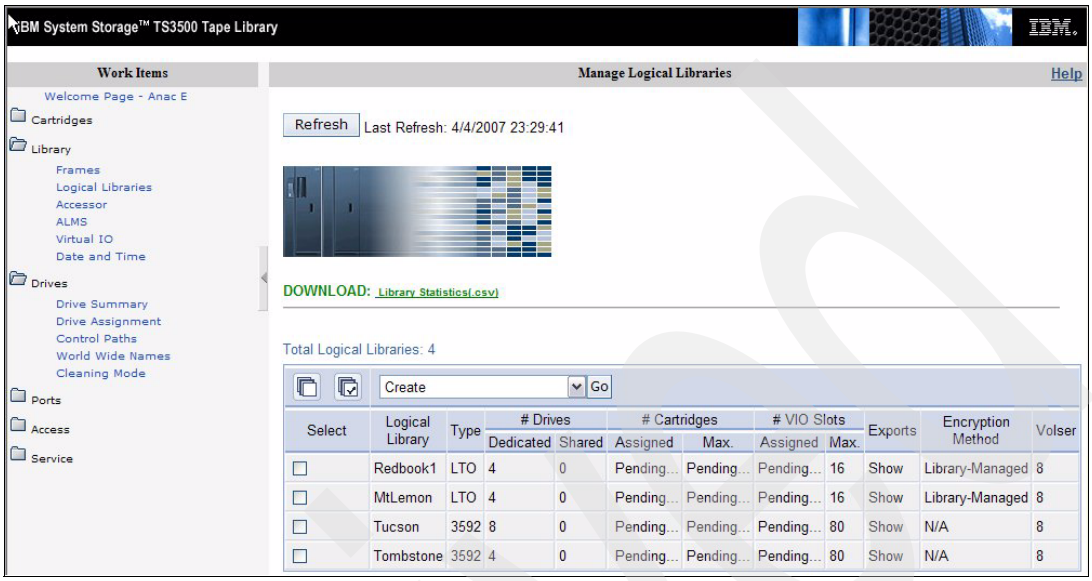


Figure 2-51 Create Logical Library

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.

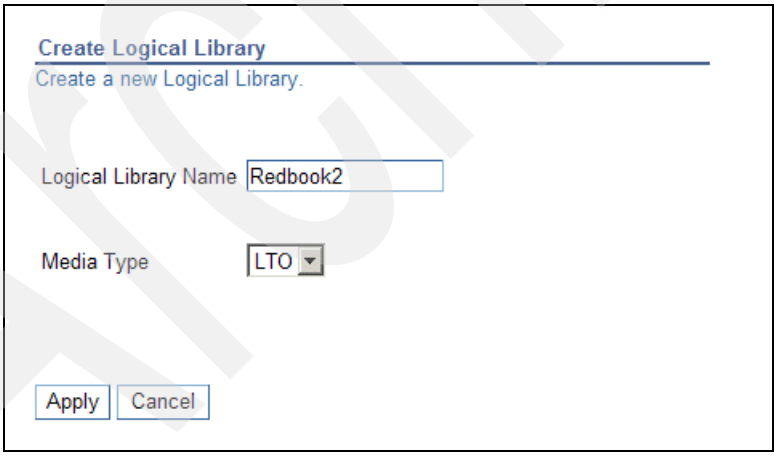


Figure 2-52 Create Logical Library

3. The library created will appear in the Manage Logical Library display, as in Figure 2-53 on page 87, but with no cartridges or drives assigned; these columns show a zero count. Therefore, after creating a new logical library, you need to add cartridge pools and tape drives.

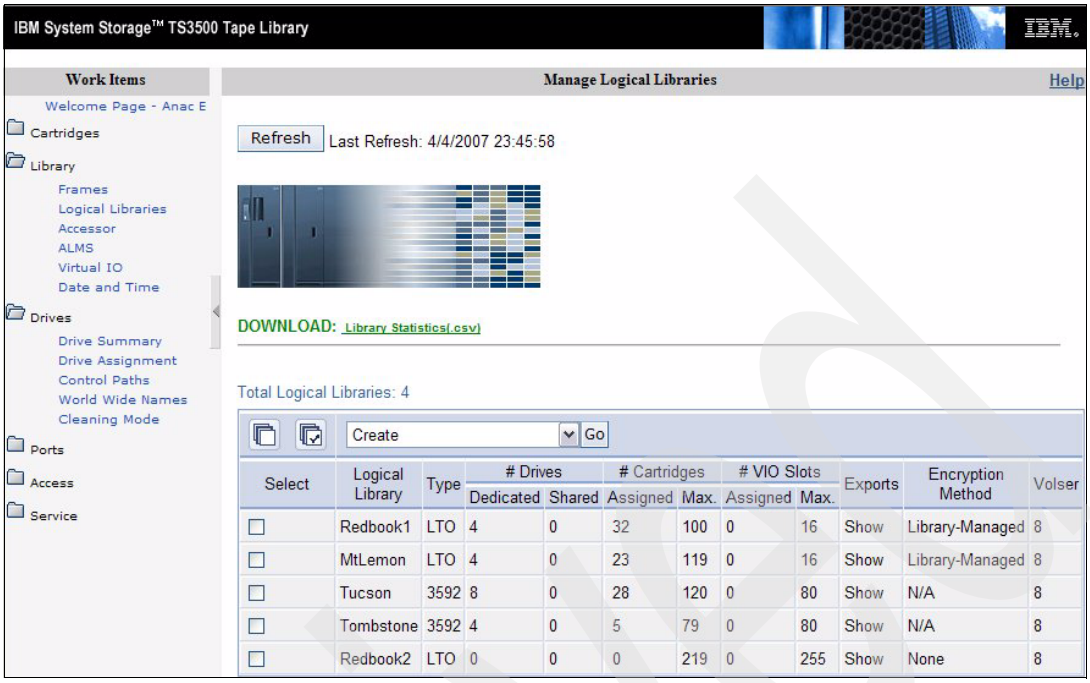


Figure 2-53 Added new logical library

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).

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

Archived

1. 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).

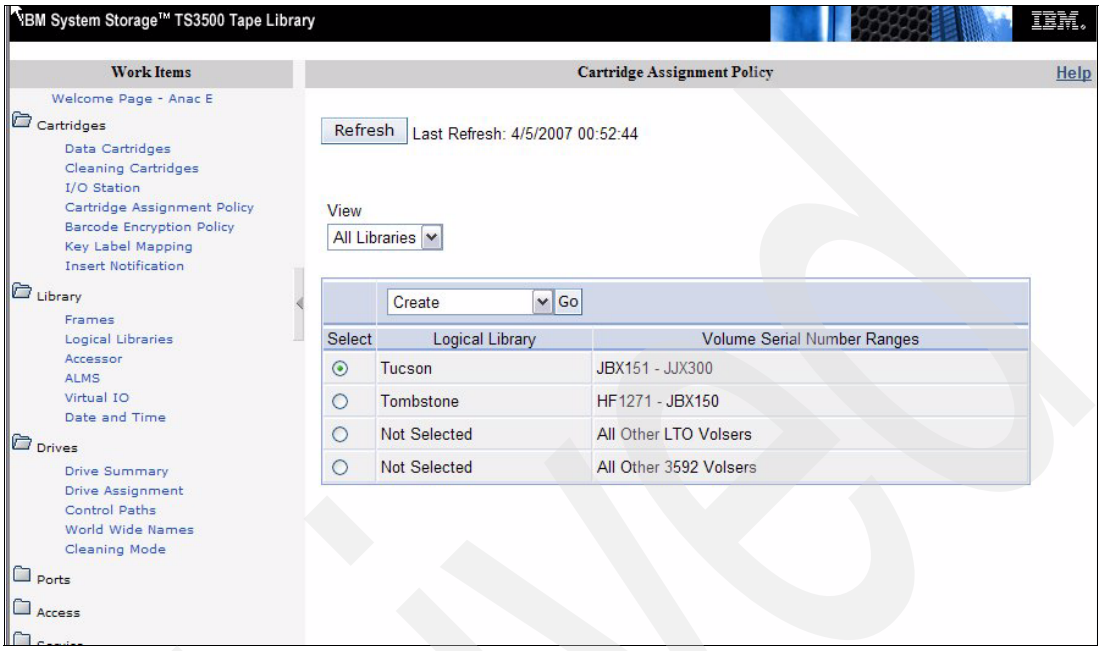


Figure 2-54 Cartridge assignment policy main window

2. 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, as shown in Figure 2-55, and click **Apply**.

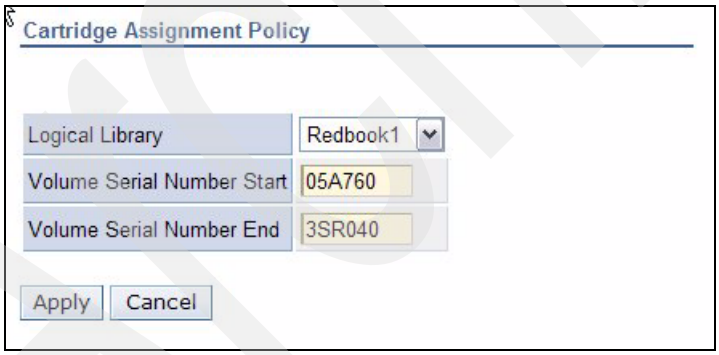


Figure 2-55 Cartridge Assignment Policy assignments

3. All unassigned cartridges and all new inserted cartridges within the specified range 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.

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

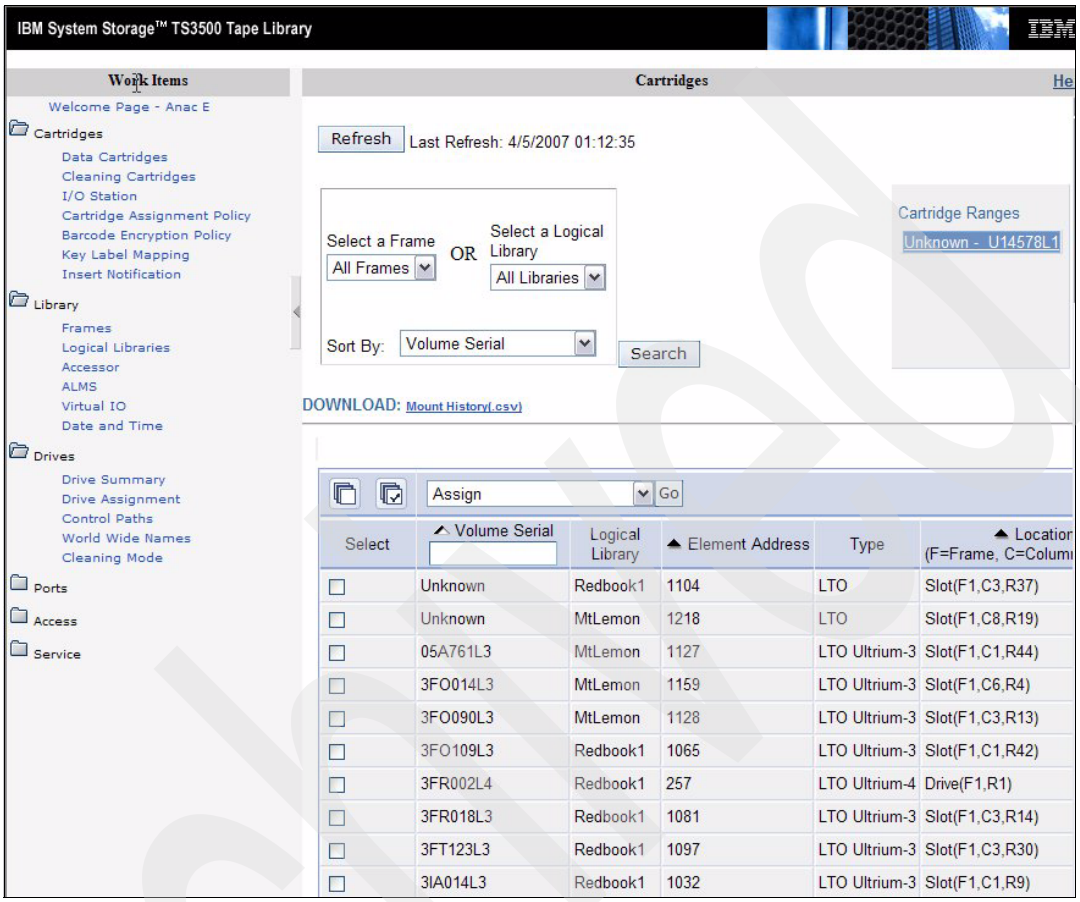


Figure 2-56 Assign Data Cartridge menu

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.

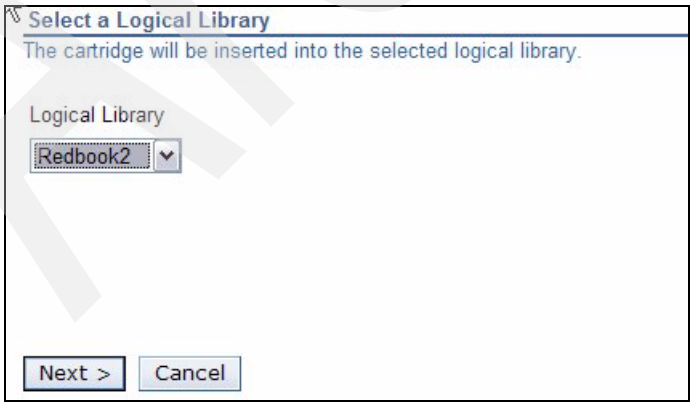


Figure 2-57 Assign cartridge to a logical library

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.

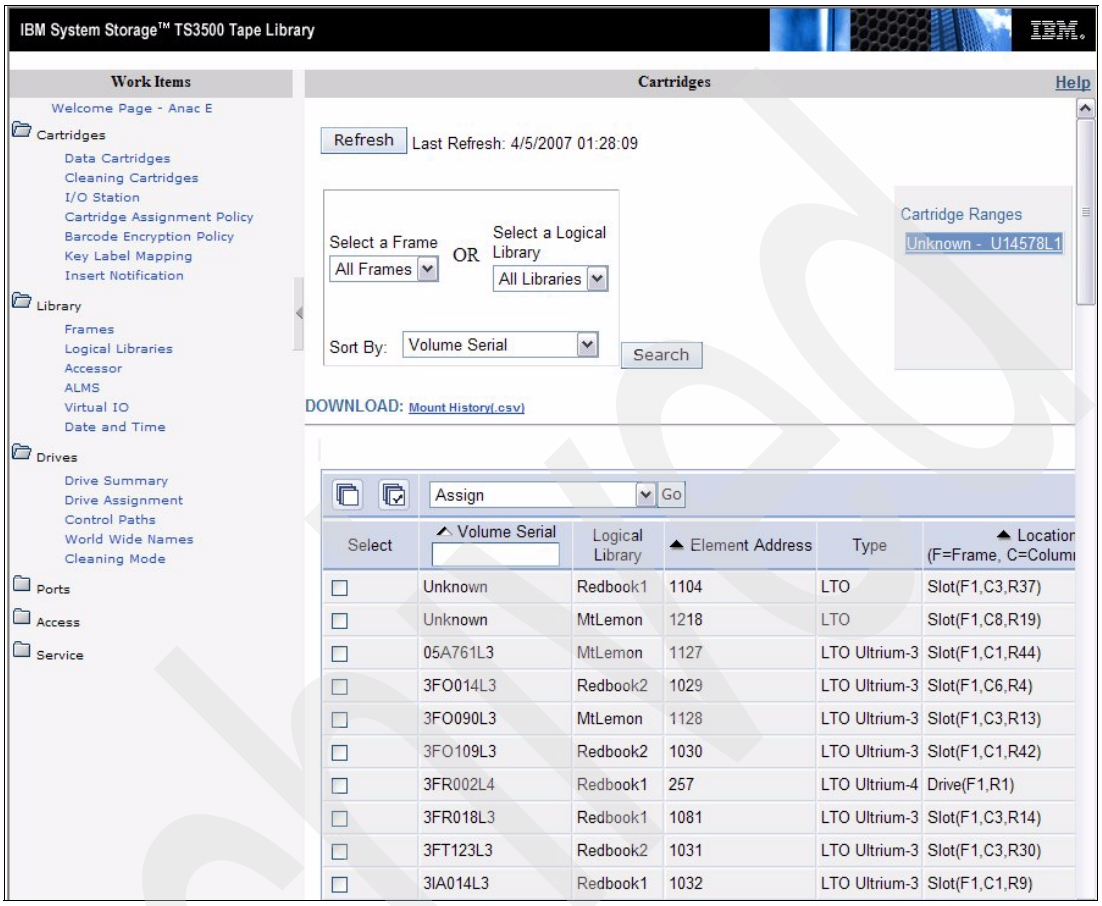


Figure 2-58 Cartridge list

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 (nondisruptive to other logical libraries).
- Unassign drive (nondisruptive to other logical libraries).
- Reassign drive (nondisruptive to other logical libraries).
- Assign drive to multiple logical libraries.
- Change control paths.

Although the drive assign procedure is nondisruptive, the application or server to which the drive is assigned must be configured. This server or application configuration may not necessarily be nondisruptive. In addition, a reconfiguration of the SAN may be needed.

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. You may, however, 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**. In the introduction window 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. In the drive assignment window, you can easily assign and unassign tape drives to a logical library. On the left-hand side of the window, 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 the check boxes you can easily assign tape drives to logical libraries, as shown in Figure 2-59.

After you have completed your selections, select **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 need to share a tape drive, follow the recommendations given in “Shared drive assignment” on page 80. One drive may be shared by a maximum of 10 logical libraries.

In the example in Figure 2-59 on page 91, all logical libraries and applications need 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 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 needed, for example, if one dedicated tape drive becomes defective, or one application temporarily needs more tape bandwidth due to additional workload (additional restores).

Because the application needs 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 93. Notice that this is now the virtualized element addresses, and that each logical library may show the same element address.

Archive

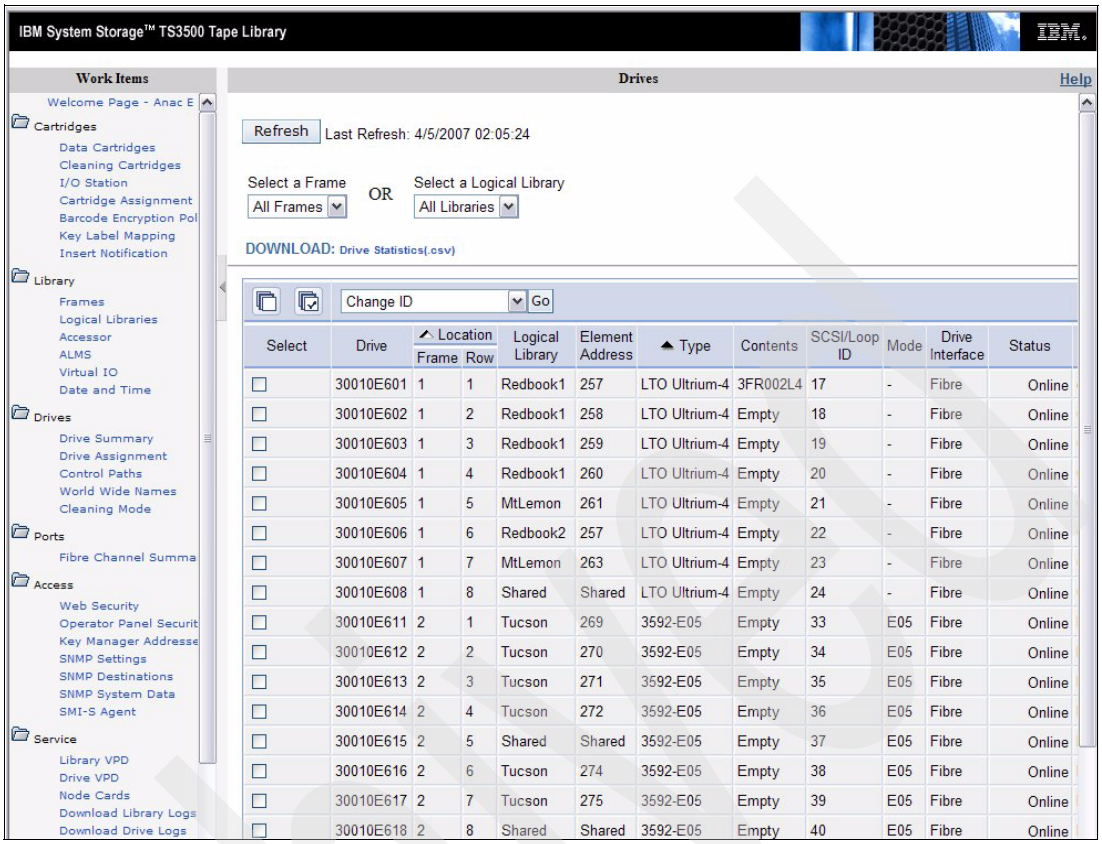


Figure 2-61 Drive details

Alternatively, if you let the cursor hover over assigned element as in Figure 2-62, you will get a small pop-up window 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 may be an element gap, as shown in Figure 2-63.

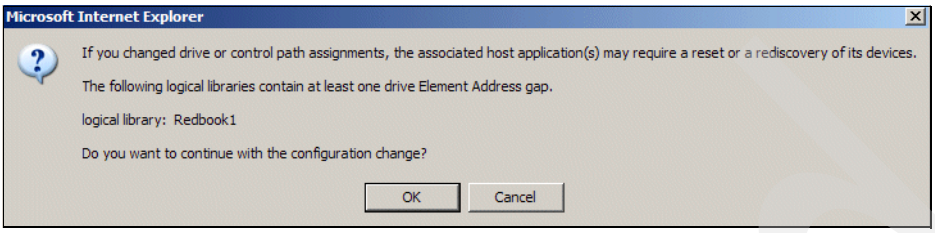


Figure 2-63 Drive gap warning

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 like 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 amount 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 **IBMtapeutil** program, which is part of the IBM-supplied device driver. For more information about **IBMtapeutil**, see 4.3, “Using IBM tape device driver” on page 161.

Example 2-1 Reported storage slots

```
# IBMtapeutil -f /dev/IBMchanger0 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 87.

Attention: Changing the maximum settings for a logical library may 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**.

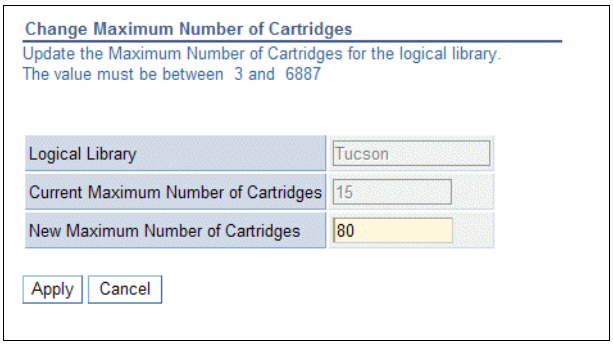


Figure 2-64 Change the maximum number of cartridges

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

Example 2-2 Reported storage slots

```
#IBMtapeutil -f /dev/IBMchanger1 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 **Details** in the drop-down box in the Logical Library menu (Figure 2-53 on page 87). This will then display as shown in Figure 2-65.

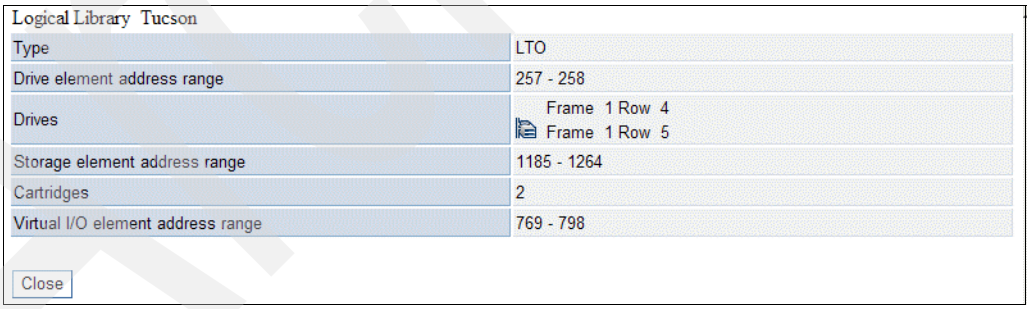


Figure 2-65 Logical Library details

This change is nondisruptive 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.

Archived

The ability to change the maximum number may 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 may 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 83.

When enabling ALMS, it reuses the existing library configuration. This means that you get the same number of logical libraries. Cartridges and tape drives that 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 78. 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 may change to the number of currently installed cartridge slots. Consequently, when you enable ALMS, your application may also need to be reconfigured. For some applications, like the IBM Tivoli Storage Manager, you just have to stop and restart the server; for other applications, like 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 84 for details).

To illustrate how ALMS changes the configuration of the logical libraries, we show the detailed information for a logical library named Redbook1 in Figure 2-66 on page 97 and Example 2-3 on page 97. 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.

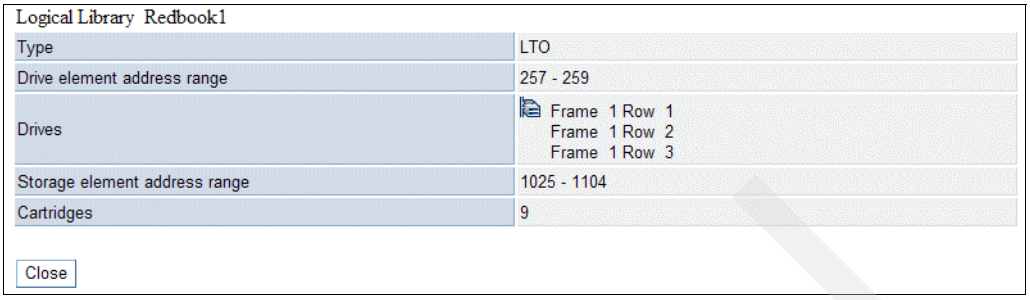


Figure 2-66 Detailed information before ALMS is enabled

Example 2-3 Elementinfo from logical library Redbook1

```
# IBMtapeutil -f /dev/IBMchanger4 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 on page 98, 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.

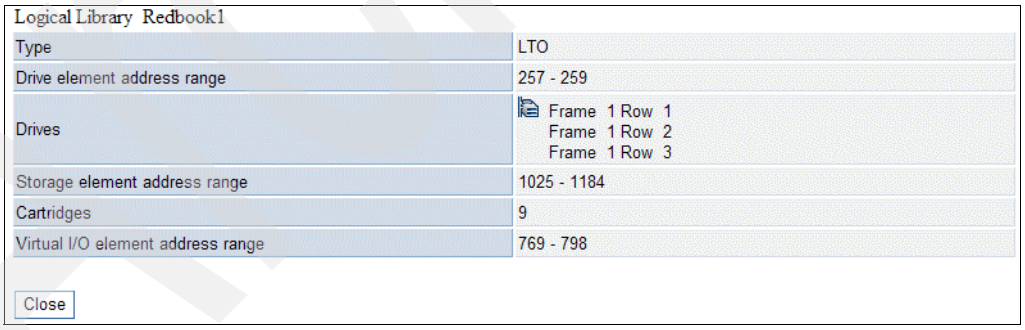


Figure 2-67 Detailed Information after ALMS enabled

Archived

Example 2-4 Element info after ALMS enabled

```
# IBMtapeutil -f /dev/IBMchanger4 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. Select **Cartridges** → **Data Cartridges**, and select **Move** in the drop-down menu to move the cartridge.

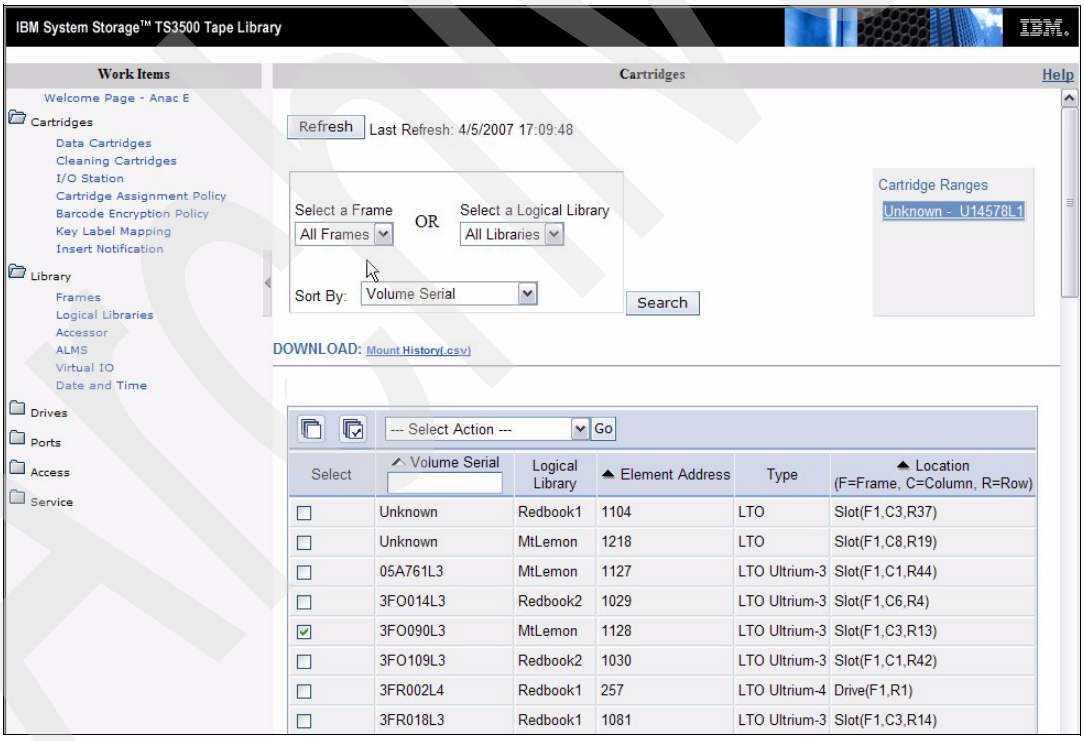


Figure 2-68 Inventory before move medium

A pop-up window will let you choose your move method. We select **Move to first empty storage slot**, as shown in Figure 2-69 on page 99.

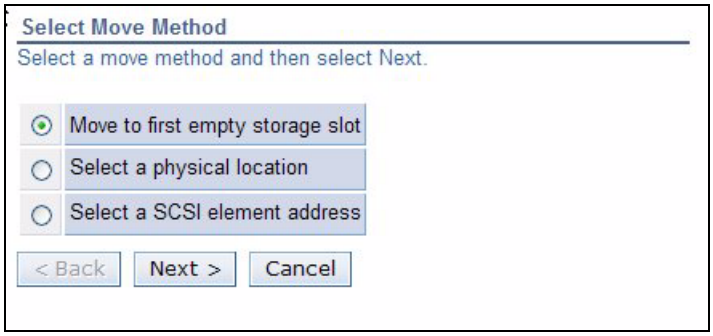


Figure 2-69 Select move method

Now, we again check the inventory of the library (see Figure 2-70). 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.

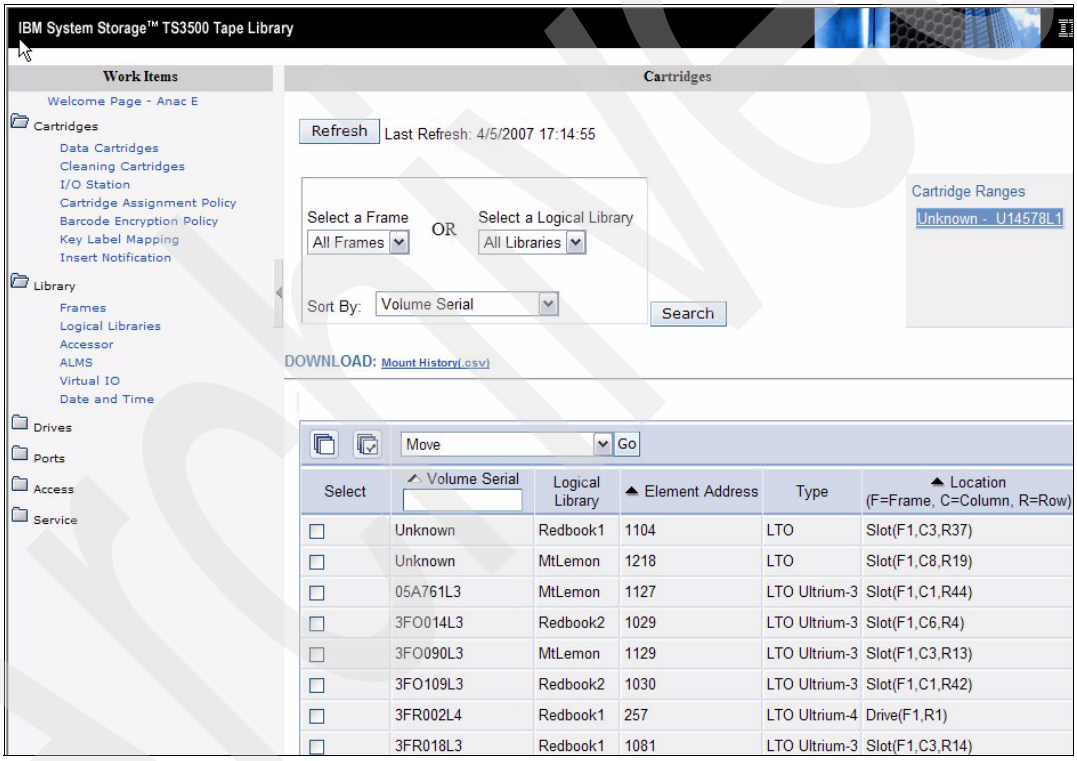


Figure 2-70 Inventory after moving cartridge

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 may no longer be needed, 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, may 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.

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3

Basic IBM tape setup for Windows

This chapter provides detailed information about the basic setup of the IBM TS3100 Tape Library for Windows 200x, including:

- Device and library drivers installation and update
- Removable Storage Manager and Windows 200x backup with LTO
- Using the IBM System Storage Tape Library Specialist for the IBM Tape Libraries
  - IBM TS3100 System Tape Library Specialist
  - IBM TS3200 System Tape Library Specialist
  - IBM TS3310 System Tape Library Specialist
  - IBM TS3400 System Tape Library Specialist
  - IBM TS3500 System Tape Library Specialist
- Device, library, and RMU firmware upgrade
- Drive upgrade using the LTO-TDX tool

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3.1 IBM tape installation overview

The basic setup for IBM tape devices involves:

- Planning
- Installing the adapter card and driver
  - For SCSI Adapter installation, see 3.5, “Windows 200x SCSI adapter installation” on page 128.
  - For Fibre Channel HBA installation, see “Note for IBM Tivoli Storage Manager users” on page 131.
- Attaching the library and drives
- Installing the IBM Device Driver (See 3.2, “Installing IBM tape device drivers for Windows 200x” on page 104, and 3.3, “Path failover” on page 107.)
- Configuration and testing

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 IBM tape 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 the advanced functions needed by full tape management systems.

Note: LTO drives and libraries usually are used with vendor-provided software applications. These may work with the IBM-provided device drivers, their own provided device drivers, or even native operating system device drivers for the tape drive and medium changer (or 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, “LTO libraries and backup software” on page 197, we describe specific implementation for some of the most common application software for Windows 200x.

For further information and specific installation instructions for Windows 200x, refer to the *IBM Tape Device Drivers: Installation and User’s Guide, GC27-21300*, found at:

`ftp://index.storsys.ibm.com/devdrvr/Doc/`

3.1.1 Determine requirements

To check if your environment has the correct operating system level, combined with the appropriate server and the supported Host Bus Adapter (HBA) and SAN fabric components, go to the following link:

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

IBM tape libraries and devices are generally supported, at the time of the writing of this book, on Windows 2000 build 2195 (Service Pack 2) or later, or Windows 2003 build 3790 or later. Even though device driver media was shipped with your IBM tape hardware, we recommend that you always download the latest version from the appropriate Web site:

`ftp://ftp.software.ibm.com/storage/devdrvr/Windows/Win2000/Latest`
`ftp://ftp.software.ibm.com/storage/devdrvr/Windows/Win2003/Latest`

For Windows 2000, the file to download is named IBMTape.x86_*yyyy*.zip, where yyyy is the version number. Always download the latest version unless specifically directed otherwise by IBM Support.

For Windows 2003, the file to download is named IBMTape.Znn_yyyy.zip, where Znn is either x86 or x64 or i64 and yyyy is the version number:

- Intel x86 architecture (Windows 32-bit systems): Use IBMTape.x86_yyyy.zip.
- Intel IA64 architecture: Use IBMTape.i64_yyyy.zip.
- Intel EM64T architecture: Use IBMTape.x64_yyyy.zip.

Always download the latest version unless specifically directed otherwise by IBM Support.

Also, consult the readme file located in the same download directory for any additional considerations. The readme file is IBMTape.W200x.Readme.txt.

Note: A Windows certified version of the LTO device driver for 3580 drives is also available. The files are contained in a folder named LTO_WHQL_Cert. For Windows 2000, the file to download is named LTOCert.x86_*yyyy*.zip, where yyyy is the version number. For Windows 2003, the file to download is named LTO_CertZ*nn_yyyy*.zip, where Znn is either x86 or x64 or i64 and yyyy is the version number. The readme file is named LTO_WHQL_Cert.Readme.txt. Always download the latest version unless specifically directed otherwise by IBM Support.

This certified driver will operate only on IBM Ultrium 3580 tape drives, generations 1, 2, 3 and 4 installed in a tape library, or running in a stand-alone configuration. The driver that operates other IBM tape drives, such as the IBM 3590 and 3592, has not been certified, nor has the driver that operates IBM tape libraries, including the TS3200, TS3310, and TS3500 libraries.

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3.2 Installing IBM tape device drivers for Windows 200x

Attention: If your library has Control Path Failover (feature #1680) installed and you want to enable it for Windows 200x, follow the instructions in 3.3, “Path failover” on page 107.

If the LTO Tape Library is physically attached, Windows 200x will attempt to automatically install the drivers upon boot. The Driver Installation Wizard will appear and will request details regarding the location of the drivers and information files. The IBM tape library may be hot-plugged into the SCSI or fibre adapter; in this case, you may perform a hardware scan from Device Manager, as shown in Figure 3-1, to detect the added devices and initiate the Device Driver Install Wizard.

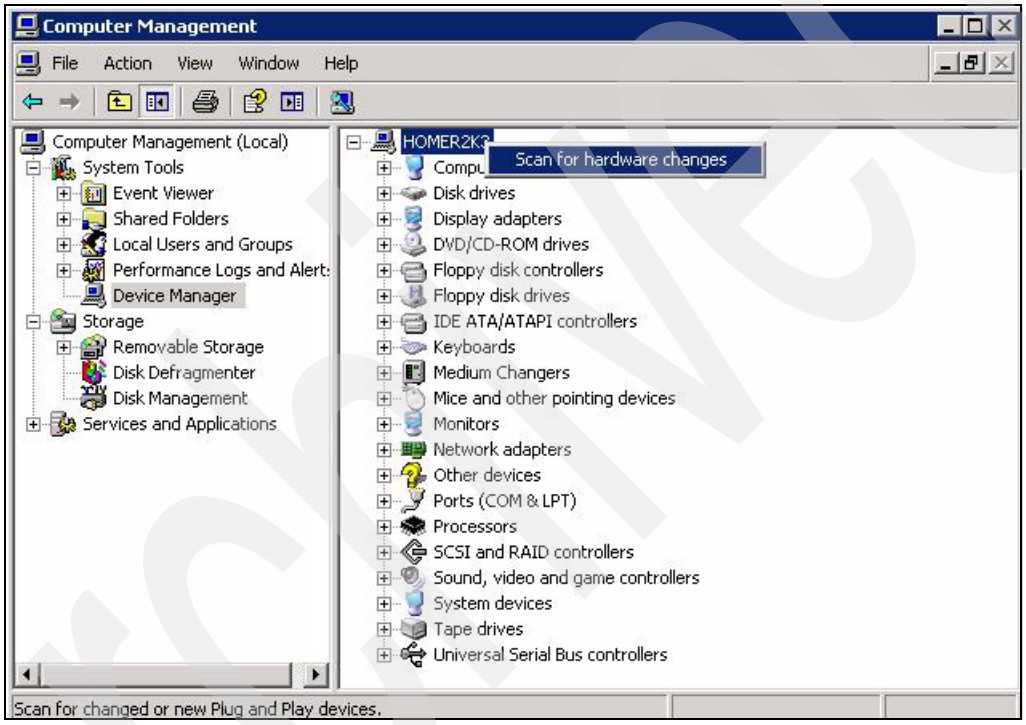


Figure 3-1 Performing a hardware scan

Execute the following steps:

1. Download and extract the latest IBM tape device drivers for Windows 200x.
2. Shut down the system.
3. Attach the library.
4. Restart the system.
5. Install the device drivers.

Downloading the drivers

Obtain the latest drivers for IBM tape libraries, as described in 3.1.1, “Determine requirements” on page 102.

Extracting the drivers

The IBM tape device driver will be downloaded as a zipped package. Unzip the package (we used the directory C:\IBMdrv\IBMTape.x86_6154), as shown in Figure 3-2 on page 105.

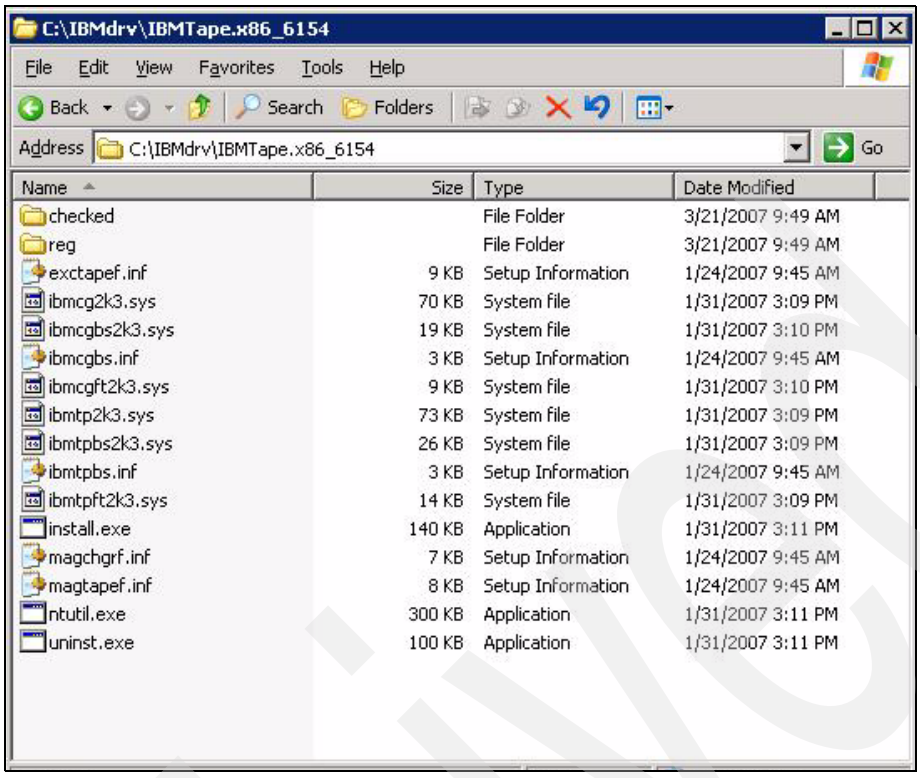


Figure 3-2 Extracted device driver package contents

Uninstalling the previous version

If an older version of IBM tape device driver is already installed on the system, uninstall it first. See “Removing the IBM tape device driver from the system (un-install)” on page 127 for more details.

3.2.1 Installing the medium changer and tape device driver

In order to reduce complexity, the file install.exe is included in the driver package to perform the installation steps automatically. Simply double-click the install.exe icon from within the driver install directory. The virtual and actual hardware will be installed correctly on your system. For more details, please refer to the *IBM Tape Device Drivers: Installation and User's Guide, GC27-2130*, found at:

`ftp://index.storsys.ibm.com/devdrvr/Doc/`

Note: If the Windows "Found New Hardware" Wizard begins during installation, cancel the wizard. Install.exe will perform the necessary steps.

Install.exe will prompt you to select between a driver customized for Tivoli Storage Manager (TSM) and a generic driver that should be used if you intend to run other applications, such as Microsoft Removable Storage Manager or Microsoft Backup, as shown in Example 3-1.

Example 3-1 Install.exe execution

```
Running installation application, version 6.1.5.4.

Select the driver file to be used for tape drives.
  1) exctapef.inf (default)
  2) magtapef.inf

NOTE: In most cases, it is recommended that exctapef.inf be selected.
This file installs a driver that has been customized for Tivoli
Storage Manager (TSM).  If you are running other applications,
such as Microsoft Removable Storage Manager or Microsoft Backup,
then you should select magtapef.inf.  For more information, consult
the README file on the CD or FTP site to determine which driver to use.

Select number, or press Enter for default: 1
exctapef.inf has been selected

Preparing system for driver installation...
Uninstalling existing medium changers...
Existing medium changers successfully uninstalled.
Uninstalling existing tape drives...
Existing tape drives successfully uninstalled.
Installing/updating the changer bus enumerator...
Successfully installed/updated the changer bus enumerator.
Installing/updating the tape bus enumerator...
Successfully installed/updated the tape bus enumerator.
Installing driver for medium changers...
Driver for medium changers installed.
Installing driver for tape drives...
Driver for tape drives installed.

Program successful.
```

You will see a Program Status window with the message that the installation was successful. Click **OK**.

You should be able to verify that the device was installed correctly (see Figure 3-3 on page 107). Repeat this procedure for every device you install. Remember, if you are installing a tape library, you will need to install drivers for both the tape drives and the medium changer.

Note: In order to reduce installation complexity, the file install.exe is included in the driver package to perform the installation steps automatically. Beginning in Version 6.1.6.7 of the device driver, the non-exclusive option for use with RSM™ is implemented through an installer option. Double click **install.exe** or run **`install.exe`** without any option if the user runs Tivoli Storage Manager.

Run **`install.exe`** with the -n option from a command line if you want to run with RSM. For example, **`C:\>install -n`**.

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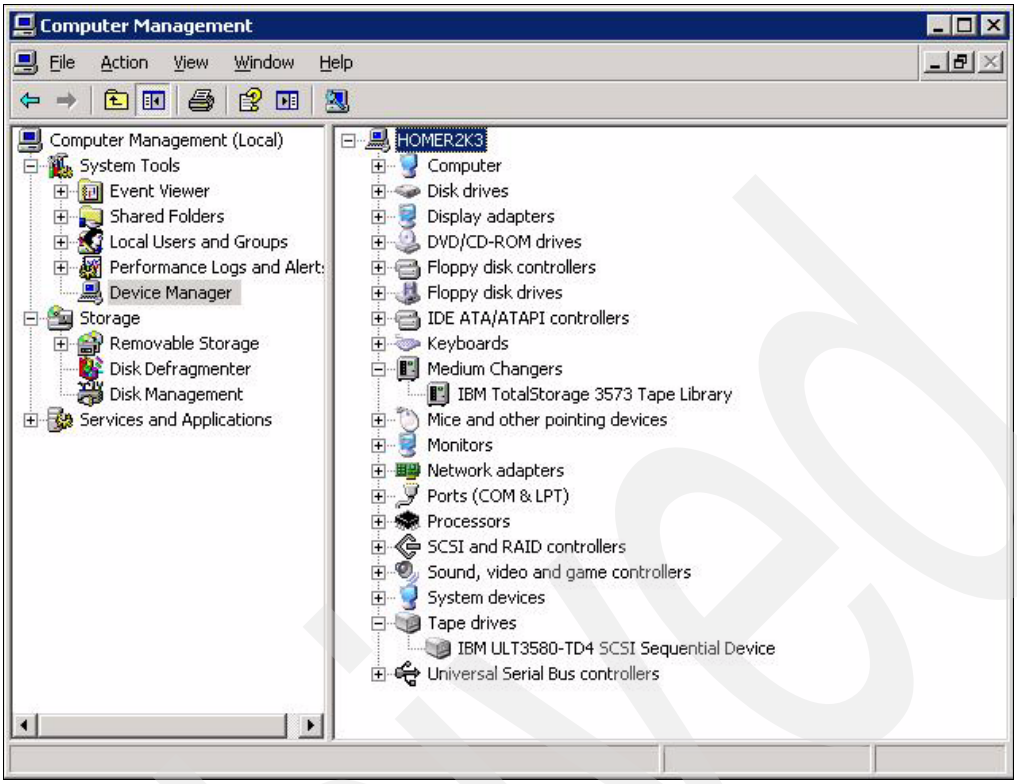


Figure 3-3 Verify IBM tape device driver installation

If you are installing a driver that has not been certified by the Microsoft Windows Hardware Quality Laboratories (WHQL), you will be presented with a warning screen. If you want to continue installing the driver, select **Continue Anyway**.

Note: All drivers released by IBM have been through a complete test to ensure that they are stable and conform to specified requirements.

3.3 Path failover

In this section we will cover Path Failover features in IBM Tape Libraries and how to configure them using IBM Tape Library Specialist, Tape Library Operator panel, and IBM tape device driver.

Path failover includes the Control Path Failover (CPF) for tape libraries and Data Path Failover (DPF) for tape drives. In earlier tape library products, CPF and DPF have separate feature codes such as FC1680 for CPF and 1681 for DPF. In the current tape library products, CPF and DPF have a common FC1682 with two licenses, one of five digits used for CPF and another one of 16 digits used for DPF.

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In order to use path failover support, the feature codes listed in Table 3-1 are required for the associated tape libraries. There are some exceptions: Tape library TS3400 has path failover support as one of the standard features. For IBM 3592 or TS1120 tape drives, no matter if they are stand-along or inside libraries, data path failover does not require any feature code.

Table 3-1 Feature Codes

Tape Library	Feature Code
TS3500	FC1682 (CPF and DPF)
TS3400	Standard Feature
TS3310	FC1682 (CPF and DPF)
TS3200	FC1682 (CPF and DPF)
3583	FC1680 (CPF), FC 1681 (DPF)
3582	FC1680 (CPF), FC 1681 (DPF)

3.3.1 Configuring and unconfiguring control path failover

Important: The library Control Path Failover FC1682 must be installed and enabled on the library (TS3200, TS3310, and TS3500 Tape Libraries) prior to enabling the alternate pathing support in the IBM 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 System Tape Library Specialist. This is shown in for the TS3200, TS3310, and TS3500 Tape Libraries.

The IBM 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 an optional priced feature that must be enabled with a license key.

For example, consider a simple multi-path architecture connection with two HBAs in a Windows 200x 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 Windows 200x server is booted, each HBA detects a control port to the library and two medium changer devices (changer0 and changer1) 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 changer0 or changer1.

Without the IBM device driver alternate pathing support, if an application opens changer0 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 (changer1), but this is a manual operation, and the last failing command has to be resent.

When alternate pathing support is enabled on both changer0 and changer1, 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 changer0 or changer1). If an application opens changer0 and a permanent path error occurs, the current operation continues on the alternate path without interrupting the application.

The following three sections show how to enable additional control paths through the Operator panel or System Storage Tape Specialist for the IBM TS3500.

Enable control path on IBM TS3500 Tape Library from the Operator screen

To enable Control Path Failover support feature on the library, follow these steps:

1. At the main activity screen, select **Menu**.
2. Select **Service** and press **ENTER**.
3. At the Service screen, select **Firmware Update** and press **ENTER**.
4. At the Firmware Update screen, select **Features** and press **ENTER**.
5. At the Features screen, select **Control Path Failover Feature Is Not Installed** and press **ENTER**.
6. At the Registration ID screen, enter the Control Path Failover License Key. Refer to the following notes as you enter the registration ID:
   a. Use the **UP** and **DOWN** buttons to select the first number of the key, then press **ENTER** to accept that number and move to the next position. Continue until all digits have been entered.
   b. If you enter an incorrect number, press **Back** to go back to the previous position.
7. When the key has been entered successfully, the message `The Control Path Failover Feature Is Enabled` is displayed. Press **ENTER**.
8. Once the Control Path Failover Feature is enabled, press **Back** until the main activity screen is displayed.

Enable control path on IBM TS3500 from the Tape Library Specialist

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

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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 3-4).

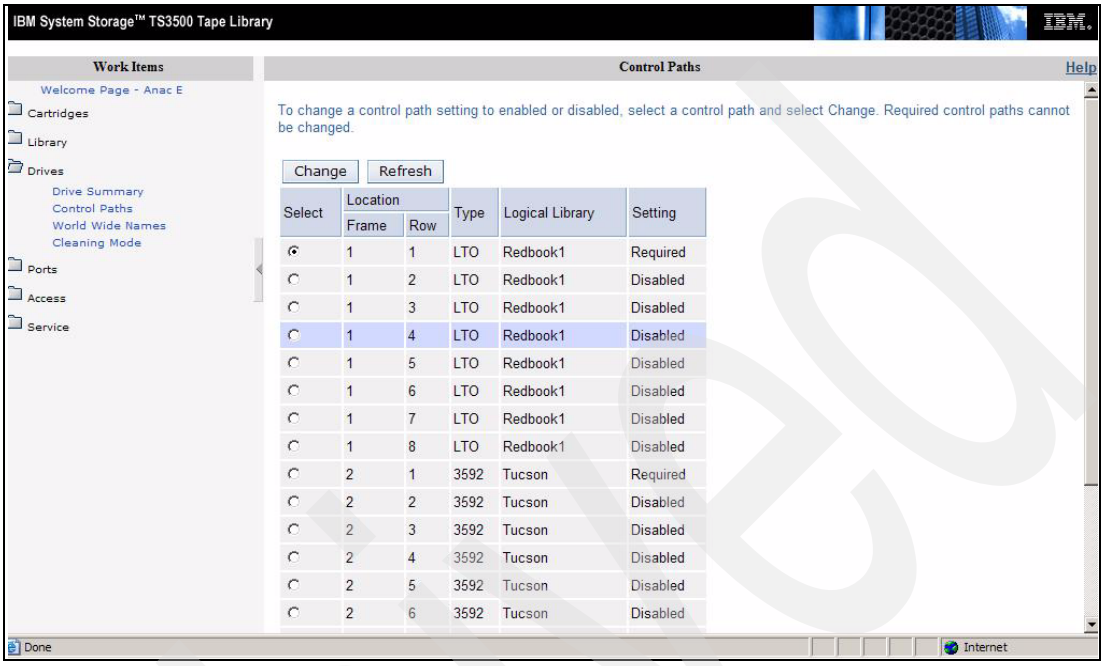


Figure 3-4 IBM TS3500: Enabling additional control paths without ALMS

To enable additional control paths using the Tape Library Specialist with ALMS enabled, do the following:

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 clicking the blue icon to the left of the check box; a drive icon appears, as shown in Figure 3-5 on page 111. In the example, drive 2703 was selected to enable as an alternate control path. Do *not* select a drive with a cartridge in it, such as drive 2702 in the example.
4. To confirm the changes, click the **Apply** button.
5. The Operation in Progress window displays, followed by a Success window that indicates that the changes are complete. Click **Close**.
6. The Drive Assignment window redisplays with the new assignments (Figure 3-5 on page 111).

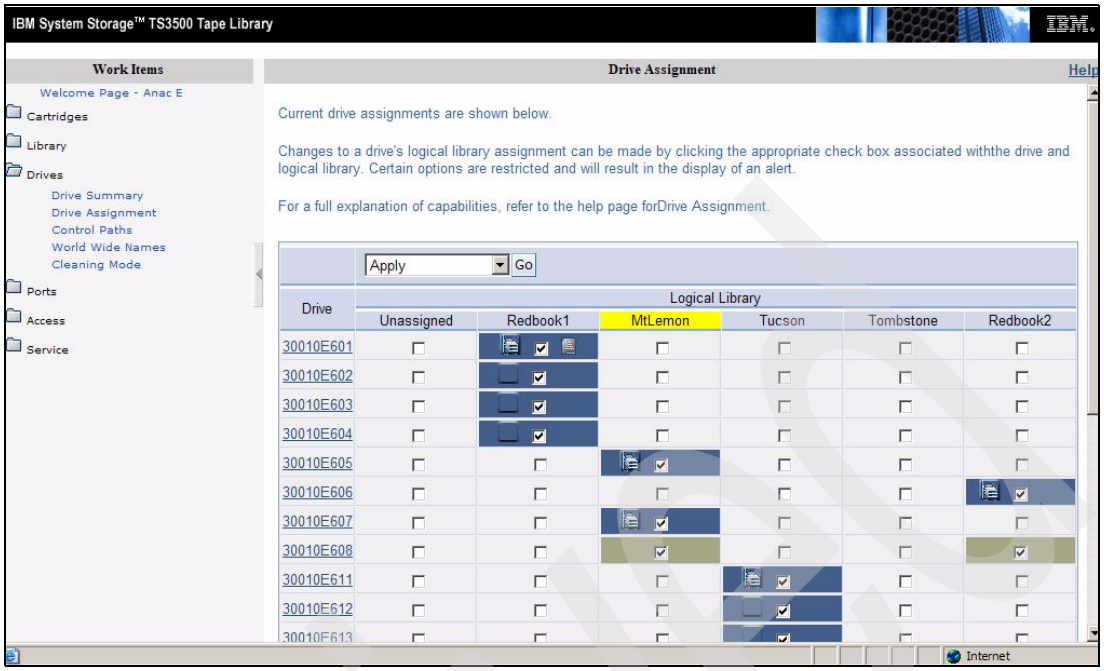


Figure 3-5 IBM TS3500: Enabling additional control paths with ALMS enabled

IBM TS3500 high availability

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

By using control path failover, you can achieve a fully redundant configuration, as shown in Figure 3-6 on page 112.

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 3-6 on page 112, the second control path is enabled on the second frame, and goes over a separate SAN switch and fabric (there is no interswitch 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.

Archive

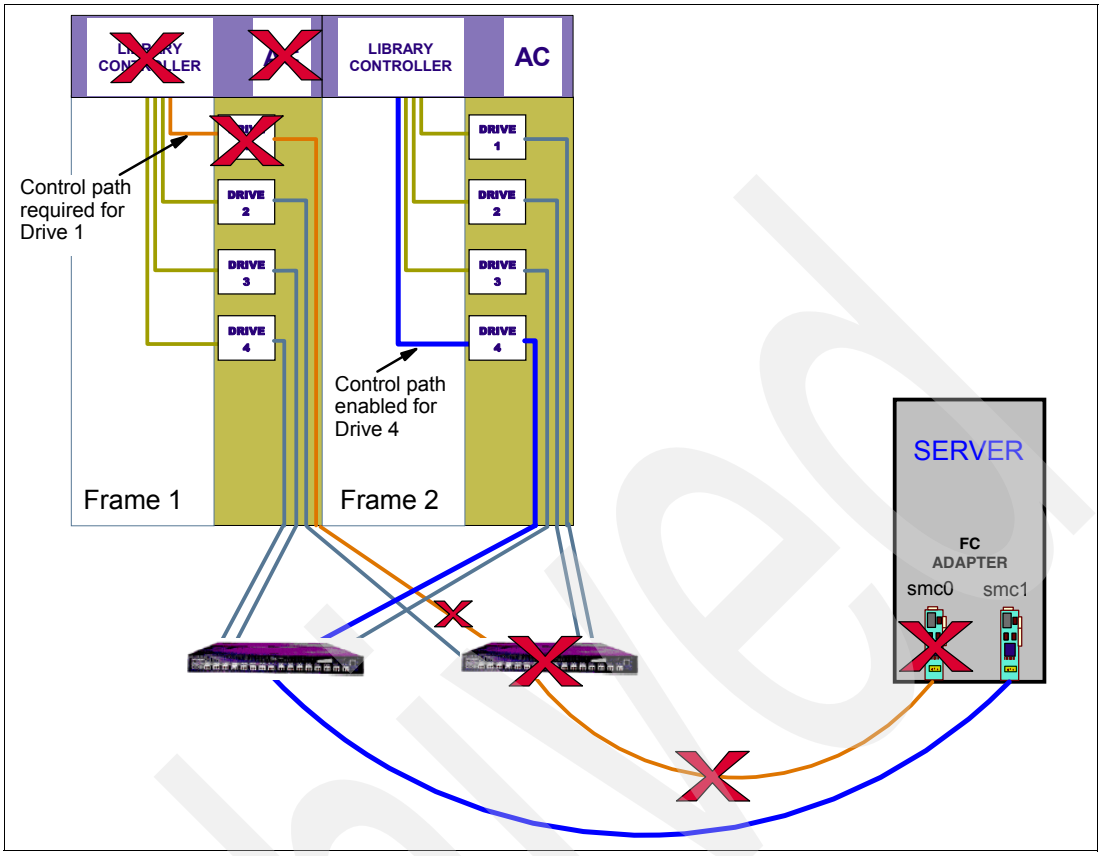


Figure 3-6 High availability control path configuration on an IBM TS3500

3.3.2 CPF driver installation using install.exe

The Control Path Failover (CPF) feature of the IBM tape device driver provides a mechanism whereby commands sent to a failing control path on a medium changer may fail over to a working control path. On Windows 2000 and Windows Server 2003, this support requires two kernel-level device drivers to be running on the system, in addition to the medium changer driver ibmcgxx.sys (the “base” driver). If CPF support is not provided, the base driver will be adequate to operate the changer.

One of the two additional drivers required to enable CPF support is a filter driver that will be installed automatically if the magchgrf.inf (rather than the magchgr.inf) file is used for the base driver install. Depending on the version of the driver you have, you may see either or both of these inf files when unzipping. The other additional driver is a virtual software bus, called the *Changer Bus Enumerator*, which must be installed using ibmcgbs.inf. The Changer Bus Enumerator must be installed before the base driver and filter driver installation. Because it is a virtual bus, no hardware will be plugged in and Windows will not recognize the presence of new hardware by the standard plug-and-play protocols.

In V6.0.8.2 and later of the IBM device driver support Control Path Failover (CPF), major architectural changes were made to the driver to include this support, and these changes are in effect regardless of whether your environment includes support for the CPF feature. A new procedure for installing the driver has been introduced. In particular, the changer driver on any given platform requires installation of three .sys files with their corresponding .inf files:

- ibmcgbs*xx*.sys (installed by ibmcgbs.inf)
- ibmcg*xx*.sys and ibmcgft*xx*.sys (installed by magchgrf.inf)

('xx' in the file name refers to either 2k or 2k3.)

Instructions on how to install ibmcgbsxx.sys are included in the document CPF_install.doc. Installation of the other two .sys files follows the instructions for Windows 200x in the *IBM Tape Device Drivers: Installation and User's Guide*, GA27-2130.

Note: In order to reduce complexity, the file install.exe is included in the driver package to perform the installation steps automatically. Simply double-click the install.exe icon from within the driver install directory. The virtual and actual hardware will be installed correctly on your system. Please refer to the *BM Tape Device Drivers: Installation and User's Guide*, GA27-2130 for more details.

To continue with the library installation process, see 3.2, "Installing IBM tape device drivers for Windows 200x" on page 104.

To disable the CPF feature after installation, so that the driver runs in single-path mode, double-click the file reg\DisableCPF.reg from the driver install package and reboot your machine. To re-enable the feature, double-click reg\EnableCPF.reg and reboot.

3.3.3 Configuring and unconfiguring Data Path Failover

The data path failover support provides error recovery on an alternate 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) in a Windows 200x host that is connected to an IBM TotalStorage 3592 Tape Drive. The first HBA is connected to port 0 of the drive, and the second HBA is connected to port 1 of the drive. This connection provides two physical paths to the same tape drive for redundancy if one path from an HBA to the drive fails.

When the Windows Host is booted, each HBA detects a 3592 tape drive, and two logical devices will be presented to the user through Device Manager. Each logical device is a physical path to the same tape drive. Typically, a backup and restore application can open and use only one logical device at a time.

Without the Windows Automatic Data Path Failover support, if an application opens \\.\Tape0 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 device (\\.\Tape1), but the application has to be restarted from the beginning. A long backup or restore operation may require operator intervention to reset the drive because a SCSI Reservation could still exist on the failing HBA path.

When Data Path Failover is enabled on the drive, 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, but both devices will now be represented by the same device name (\\.\Tape0). If an application opens \\.\Tape0 and a permanent path error occurs, the device driver initiates failover error recovery automatically on the alternate path. 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, and then retries the failing operation.

Data Path Failover support is enabled automatically when the device driver is installed. It may be disabled or reenabled for the entire set of attached drives by modifying the registry. The registry modifications can be performed by double clicking DisableDPF.reg and EnableDPF.reg, respectively, from the reg folder of the driver install package. A reboot will be necessary for any registry modification to take effect.

For more details about Data Path Failover, please refer to the *IBM Tape Device Drivers: Installation and User's Guide*, GA27-2130, found at:

`ftp://index.storsys.ibm.com/devdrvr/Doc/`

3.4 Testing the library with NTUTIL

NTUTIL is a utility that is packaged with the IBM tape device driver. It may be used to perform several functions, including:

- Read and write operations
- Media mounts and dismounts
- Microcode updates
- Forcing driver dumps
- Sending and obtaining status of SCSI commands and retrieving sense data from commands that encounter errors

For our purposes, we used NTUTIL to test basic operations as a way of verifying correct installation of the IBM tape library and drives.

Note that you must stop the Removable Storage Manager (RSM) service in Windows before you can use NTUTIL. NTUTIL will not be able to see the devices until RSM releases them. Alternatively, you may simply disable the IBM tape library in RSM.

NTUTIL can run in either interactive or batch mode. Interactive mode will present you with a menu of commands that you can use to drive the library and drives. Batch mode will pass on a series of commands from a user-generated file to the utility.

NTUTIL is unpacked with the device drivers. It can be installed at any location, but is typically installed in the c:\winnt\system32 or C:\Windows\system32 directory. Since this directory is in the system path, you can run NTUTIL from any command line. When NTUTIL is invoked without arguments, it will start in interactive mode.

There are two modes that NTUTIL can run in: Base Mode and Library Mode. The default mode is Base Mode. Option 8 toggles between the two modes. Both modes support Open/Close/Read/Write operations. However, you may only use medium changer commands such as **`move media`** while in library mode.

Example 3-2 on page 115 shows the main menu, which presents the option to run the utility in interactive (manual) or batch mode.

Note: The NTUTIL samples provided used the Windows 2003 NTUTIL Version 6.1.5.4. The menus displayed with other versions may vary slightly.

Archived

Example 3-2 NTUTIL main menu

```
NTutil - Copyright (c) 1997-2006 IBM Corporation

Main Menu:
Microsoft Windows 2003 version
==========

  1: Manual test
  2: Batch  test
  9: Exit ntutil

Enter selection:
```

Selecting 1: Manual test provides the menu in Example 3-3 for interactive commands.

Example 3-3 NTUTIL manual test menu (Base Mode)

```
Test tool version 6.1.5.4
Variable settings
=================== BASE MODE ========================================
tape-special-file-name: tape0
gp->fd0=FFFFFFFF  gp->fd1=FFFFFFFF block size=1024  block count=1
hex block id = 0000000000000000
return_error_when_fail 1  exit_on_unexpected_result 0  trace_flag 0

manual test menu:
=========================================================================
  1: set device special file            2: display symbols
  3: set block size R/W (now !0 fixed)  4: library only mode (OFF)
  5: set return error when fail         6: set/reset trace
  7: set exit on unexpected result      8: Library Mode
=========================================================================
 20: open                              21: close
 22: read                              23: write
 24: read and display block            25: flush (buffer->media)
 26: read block id                     27: erase
 28: locate block id                   29: display block data
=========================================================================
 30: write filemark(s)                 31: rewind
 32: forward space filemark(s)         33: unload
 34: reverse space filemark(s)         35: load
 36: forward space record(s)           37: return error
 38: reverse space record(s)           39: test unit ready
 43: set media parms (block size)      44: set dev parms(compression)
 46: get device information            47: restore data
 48: get medium information            49: inquiry
 50: poll registered devices
 53: space EOD                         54: display message
 59: get encryption state
=========================================================================
 70: system command

=========================================================================
 80: Force Dump                        81: Read Dump
 82: Update MicroCode                  83: Log Sense
 84: Get Last Sense                    85: Get Version
 86: Associative/Persistent WProtect   87: Read/Write Test
 88: List registered devices           89: Get MTDevice Info
=========================================================================
```

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```
 99: return to main menu

==============================================================================
enter selection:
```

Note that option 8 says Library Mode. This indicates that NTUTIL is running in base mode. To change to library mode, select 8: Library Mode.

Example 3-4 shows the NTUTIL manual test menu (Library Mode).

Example 3-4 Library Mode menu

```
Test tool version 6.1.5.4
Variable settings
=================== LIBRARY MODE ====================================
tape-special-file-name: tape0, changer-special-file-name: Changer0
gp->fd0=FFFFFFFF  gp->fd1=FFFFFFFF block size=1024  block count=1
hex block id = 0000000000000000
return_error_when_fail 1  exit_on_unexpected_result 0  trace_flag 0

manual test menu:
==============================================================================
  1: set device special file            2: display symbols
  3: set block size R/W (now !0 fixed)  4: library only mode (OFF)
  5: set return error when fail         6: set/reset trace
  7: set exit on unexpected result      8: Base Mode
==============================================================================
 10: return library inventory          11: move medium
 12: initialize element status         13: get changer parameter
 14: exchange medium                   15: get changer bus info
==============================================================================
 20: open                              21: close
 22: read                              23: write
 24: read and display block            25: flush (buffer->media)
 26: read block id                     27: erase
 28: locate block id                   29: display block data
==============================================================================
 30: write filemark(s)                 31: rewind
 32: forward space filemark(s)         33: unload
 34: reverse space filemark(s)         35: load
 36: forward space record(s)           37: return error
 38: reverse space record(s)           39: test unit ready
 43: set media parms (block size)      44: set dev parms(compression)
 46: get device information            47: restore data
 48: get medium information            49: inquiry
 50: poll registered devices
 53: space EOD                         54: display message
 59: get encryption state
==============================================================================
 70: system command

==============================================================================
 80: Force Dump                        81: Read Dump
 82: Update MicroCode                  83: Log Sense
 84: Get Last Sense                    85: Get Version
 86: Associative/Persistent WProtect   87: Read/Write Test
 88: List registered devices           89: Get MTDevice Info
==============================================================================
 99: return to main menu
```

```
==========================================================================
enter selection:
```

To view the installed library and drive, select 88: List registered devices. Medium changer devices are given a device special name of *Changerx*, and tape drives are known as *Tapex*. The bus, target ID, and LUN ID for each device are also shown here. Example 3-5 shows the device listing for a SAN attachment.

Example 3-5 Registered devices on a SAN

```
==========================================================================
enter selection: 88
Device found: Tape1 @"Scsi Port 2\Scsi Bus 0\Target Id 0\Logical Unit Id 0"
Device found: Changer1 @"Scsi Port 2\Scsi Bus 0\Target Id 0\Logical Unit Id 1"
Device found: Tape0 @"Scsi Port 2\Scsi Bus 0\Target Id 1\Logical Unit Id 0"
Device found: Tape2 @"Scsi Port 2\Scsi Bus 0\Target Id 2\Logical Unit Id 0"
Device found: Changer0 @"Scsi Port 2\Scsi Bus 0\Target Id 2\Logical Unit Id 1"
Total elapsed time in seconds =     0.00
Return to continue:
```

To perform any operations, you usually need to open the desired device (select 1: Set device special file, then select the appropriate device from the device listing, and open it with 20: Open). Example 3-6 and Example 3-7 show these selections.

Example 3-6 Selecting a device special file

```
==========================================================================
enter selection: 1
Enter device special file (tape path) name or return for no change: tape2
Enter device special file (changer path) name, or "def" for
default lun1 changer or return for no change: changer0
Total elapsed time in seconds =    26.00
Return to continue:
```

Example 3-7 Performing an open call on a selected device special file

```
==========================================================================
enter selection: 20
Enter open mode (1) RW (2) RO: 1
special file (\\.\tape2) will be opened
special file (\\.\changer0) will be opened
analyze() called with  rc 1 status 0 (SUCCESS) data 0
Total elapsed time in seconds =     2.00
Return to continue:
```

To test the Medium Changer, we load a tape to a drive, perform a read/write test on it, and then unload the tape. Select Library Mode first and then open the device. By default, changer0 and tape0 will be selected unless overridden. Select 20: Open. In this case, tape2 and changer0 are opened, because they were previously selected in Example 3-7.

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To display information about the Medium Changer, select 13: get changer parameter, as shown in Example 3-8.

Example 3-8 Get Changer parameters

```
==========================================================================
enter selection: 13
NumberofTransports:           1, FirstTransportNumber:     0x0001
NumberofStorageElements:      23, FirstStorageElement:      0x1000
NumberofIEElements:           0, FirstIEElement:           0x0000
NumberofDataTransferElements: 1, FirstDataTransferElement: 0x0100
Features0:                    0x04025c83
Features1:                    0x00000000
Features:
    CHANGER_BAR_CODE_SCANNER_INSTALLED
    CHANGER_INIT_ELEM_STAT_WITH_RANGE
    CHANGER_LOCK_UNLOCK
    CHANGER_POSITION_TO_ELEMENT
    CHANGER_REPORT_IEPORT_STATE
    CHANGER_STORAGE_DRIVE
    CHANGER_STORAGE_SLOT
    CHANGER_PREDISMOUNT_EJECT_REQUIRED
    CHANGER_SERIAL_NUMBER_VALID
analyze() called with  rc 1 status 0 (SUCCESS) data 0
Total elapsed time in seconds =     0.00
Return to continue:
```

To move the cartridge, you need to know the source and destination addresses for the media. These are obtained by selecting 10: return library inventory, as shown in Example 3-9 on page 119. The addresses are given in hexadecimal format and need to be entered as such when using the **move medium** command. Each entry in the inventory has an element type and a number in hexadecimal format. The element type indicates the classification of the element and is one of the following:

1. MTE: Medium Transport Element (picker)
2. SE: Storage Element (storage slot)
3. IEE: Import/Export Element (Medium Changer bulk I/O slots)
4. DTE: Data Transfer Element (the drives)

The command output (Example 3-9 on page 119) shows that there is one MTE (cartridge picker), one drive (DTE), and 17 storage slots (SE) in the TS3100's inventory. Each entry also shows if there is a cartridge present (by indicating full or empty).

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Example 3-9 Return library inventory

```
==========================================================================
enter selection: 10
Type: MTE, Addr: 0x00000000, Empty
Type: SE , Addr: 0x00000000, Empty Access
Type: SE , Addr: 0x00000001, Empty Access
Type: SE , Addr: 0x00000002, Empty Access
Type: SE , Addr: 0x00000003, Empty Access
Type: SE , Addr: 0x00000004, Empty Access
Type: SE , Addr: 0x00000005, Empty Access
Type: SE , Addr: 0x00000006, Full  Access BC 3FZ331L3
Type: SE , Addr: 0x00000007, Empty Access
Type: SE , Addr: 0x00000008, Empty Access
Type: SE , Addr: 0x00000009, Empty Access
Type: SE , Addr: 0x0000000a, Empty Access
Type: SE , Addr: 0x0000000b, Full  Access BC 3MO045L3
Type: SE , Addr: 0x0000000c, Empty Access
Type: SE , Addr: 0x0000000d, Empty Access
Type: SE , Addr: 0x0000000e, Empty Access
Type: SE , Addr: 0x0000000f, Empty Access
Type: SE , Addr: 0x00000010, Empty Access
Type: SE , Addr: 0x00000011, Empty Access
Type: SE , Addr: 0x00000012, Empty Access
Type: SE , Addr: 0x00000013, Empty Access
Type: SE , Addr: 0x00000014, Empty Access
Type: SE , Addr: 0x00000015, Empty Access
Type: SE , Addr: 0x00000016, Empty Access
Type: DTE, Addr: 0x00000000, Empty Access            TgtId invalid  1300000978
analyze() called with  rc 1 status 0 (SUCCESS) data 0
Total elapsed time in seconds =    1.00
Return to continue:
```

You can see that there is a slot (SE) 00000006 with a state of Full Access. This is the cartridge we want to move in our example. We will be loading that cartridge into a tape drive, specifically, the DTE (tape drive) with an address of 00000000.

Example 3-10 shows how to move a tape cartridge from a slot in the library and mount it in a drive. We selected option 11: move medium.

At this stage, we simply want to mount a tape volume into the drive using the Medium Changer. We specify SE (Storage Element Slot) as the source type. NTUTIL then prompts for a valid source address, which we enter in hexadecimal format (00000006). We then provide a destination type, which is a tape drive (DTE) followed by a destination address (00000000).

Example 3-10 Move media

```
==========================================================================
enter selection: 11
source type [moving from]: 2 = SE, 3 = IEE, 4 = DTE: 2
source address moving from: 00000006
destination type [moving to]: 2 = SE, 3 = IEE, 4 = DTE: 4
destination address moving to: 00000000
execute move_medium stype = 2, saddr = 6, dtype = 4,  daddr = 0
analyze() called with  rc 1 status 0 (SUCCESS) data 0
Total elapsed time in seconds =    98.00
Return to continue:
```

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Once the tape is mounted (indicated by the SUCCESS output), you may perform a read/write test (option 87) on the cartridge (Example 3-11). Note this overwrites any data on the tape; NTUTIL does not interact with any applications, so it is not aware of whether the tape has valid data on it or not. Therefore, be careful about which tape you choose for this operation.

Example 3-11 Read/write test

```
==============================================================================
enter selection: 87
This will rewind and write on tape! Are you sure?? Y or N
y
ntutil execute_command_read_write test
rewinding
Rewind OK, set blocksize to 32K
Set Block Size OK, writing 32K
Write 32K OK, rewinding
Rewind after Write OK, reading data
Read after Rewind OK, comparing  data
analyze() called with  rc 1 status 0 (SUCCESS) data 0
Total elapsed time in seconds =     4.00
Return to continue:
```

The tape has been successfully written to, as shown in Example 3-11. We may now unload the cartridge by selecting 33: Unload, then selecting 11: move medium, but this time the source and destination elements are reversed from the load operation, so the cartridge is moved from the drive back to its original slot (Example 3-12 and Example 3-13).

Example 3-12 Unload

```
==============================================================================
enter selection: 33
analyze() called with  rc 0 status 0 (SUCCESS) data 0
Total elapsed time in seconds =     0.00
Return to continue:
```

Example 3-13 Move media back to the slot

```
==============================================================================
enter selection: 11
source type [moving from]: 2 = SE, 3 = IEE, 4 = DTE: 4
source address moving from: 00000000
destination type [moving to]: 2 = SE, 3 = IEE, 4 = DTE: 2
destination address moving to: 00000006
execute move_medium stype = 4, saddr = 0, dtype = 2,  daddr = 6
analyze() called with  rc 1 status 0 (SUCCESS) data 0
Total elapsed time in seconds =    33.00
Return to continue:
```

To display information about the library or drive, including the serial number, use 49: inquiry (Example 3-14 on page 121). In Library Mode, you must specify from which device (changer or tape drive) you want to gather information. In Base mode, NTUTIL returns information only about the opened drive.

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Example 3-14 Inquiry

```
==============================================================================
enter selection: 49
Drive = 0, Library = 1: 1

Changer Path SCSI data:
  PortNumber 2, PathId 0
  TargetId   2, Lun    1

INQUIRY data:
  devtype(0):           08, rmb(1):           80
  ASO/ECMA/ANSI(2):     05, resp_data_fmt(3): 02
  additional_length(4): 45, reserved(5):      00
  SCSI_3(6):            00, flags(7):         02
  vendor_id (8-15): IBM
  product_id (16-31): 3573-TL
  Microcode Revision Level (32-35): 3.03
  Unit Serial Number: 00X2U78B0215_LL0
  vendor specific (bytes 36-55):
     58 32 30 30 58 32 55 37 38 42 30 32 31 35 00 00 00 00 00 01

analyze() called with  rc 1 status 0 (SUCCESS) data 0
Total elapsed time in seconds =     2.00
Return to continue:

==============================================================================
enter selection: 49
Drive = 0, Library = 1: 0

  Device Path SCSI data:
  PortNumber 2, PathId 0
  TargetId   2, Lun    1
INQUIRY data:
  devtype(0):           01, rmb(1):           80
  ASO/ECMA/ANSI(2):     03, resp_data_fmt(3): 02
  additional_length(4): 35, reserved(5):      00
  SCSI_3(6):            00, flags(7):         02
  vendor_id (8-15): IBM
  product_id (16-31): ULT3580-TD4
  Microcode Revision Level (32-35): 73FA
  Unit Serial Number: 1300000978
  vendor specific (bytes 36-55):
     00 00 00 00 00 00 00 00 00 00 00 00 00 20 30 00 00 00 00

analyze() called with  rc 1 status 0 (SUCCESS) data 0
Total elapsed time in seconds =     3.00
Return to continue:
```

NTUTIL can also be run in batch mode. For more information about NTUTIL, refer to the *IBM Tape Device Drivers: Installation and User's Guide*, GC27-2130. This guide is installed with the packaged device drivers. The manual *IBM Tape Device Drivers: Programming Reference*, GA32-0566, has information about issuing commands to tape device drivers and manipulating tape APIs.

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3.4.1 Creating a library device table

Operating system device names may not necessarily reflect the same order that the devices are physically installed in the library. Therefore, check your drive configuration carefully. We recommend creating a table like Table 3-2.

Table 3-2 Library device table

Windows device name	Serial number or WWN	Tape drive in the library	Element Number
Tape0	1110067680	drive 1	257
Tape1	1110068317	drive 2	257
Tape2	1110067231	drive 3	259

Keep in mind that rebooting the server may alter the device order. See “Set up persistent binding” on page 132 to understand how the operating system assigns device special file names, and the ways to keep it persistent across reboots.

To create this table, use the **`ntutil inquiry`** command and IBM System Tape Specialist. The function to return the device serial number is available at NTUTIL V5.0.7.9 and above.

3.4.2 Testing the library with NTBACKUP

The Windows 200x native backup utility NTBACKUP can use the IBM tape library and drives to perform basic backup, restore, and system state backup functions. To use the Windows backup utility, you must start the RSM service, and prepare within the libraries before it can be made available to the application. NTBACKUP will give an error if it is started without the RSM service running.

To start NTBACKUP, select **Start** → **Programs** → **Accessories** → **System Tools** → **Backup**, or run NTBACKUP at the command line. If you start NTBACKUP without any allocated media, you will see the message shown in Figure 3-7.

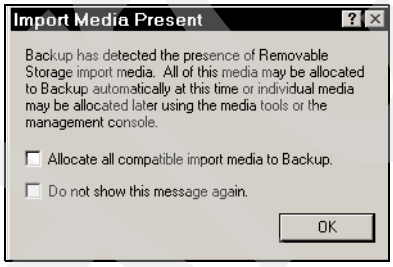


Figure 3-7 Import media present message

If you want to allocate all free media at this time, you may do so, bearing in mind that this operation will cause NTBACKUP to take ownership of all media. If there are other backup applications that use this media, do not allocate all media. Again, you may prepare (format) the tape volumes as needed through RSM, and NTBACKUP will allocate free (prepared) volumes when required.

The Windows 200x backup and restore functions, as used with IBM LTO tape libraries, are illustrated below, and are much the same as for any other natively attached tape libraries and drives. If new media is requested to be written to, then the tape mount preparations take place with RSM driving the Medium Changer in the background. Similarly, mount requests for restore operations are transparent to the application. From the **Backup** tab (Figure 3-8) you may select the files and directories to be backed up, the backup destination device, and the media to mount for the operation.

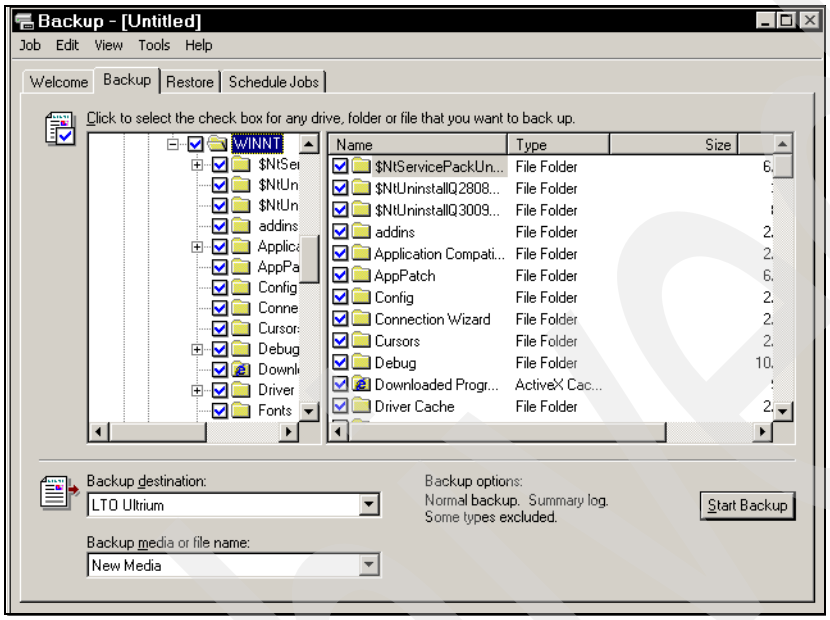


Figure 3-8 The NTBACKUP Backup tab

In our example, we have selected a full directory for backup. The backup destination is listed as *LTO Ultrium* (this has been configured through RSM), and the backup media as New Media, which means that NTBACKUP will automatically query the RSM database for a free scratch volume and ask for it to be mounted.

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Figure 3-9 shows the NTBACKUP restore window. Here you may select the media contained within the IBM tape library from which you want to restore. The available restore media are listed as defined in the RSM database. The LTO Ultrium tape pool shows the tape volumes that are candidates for restore operations. They are automatically stamped with the time of the backup operation. If we click the media, we will be able to see the backed up files and directories that it contains.

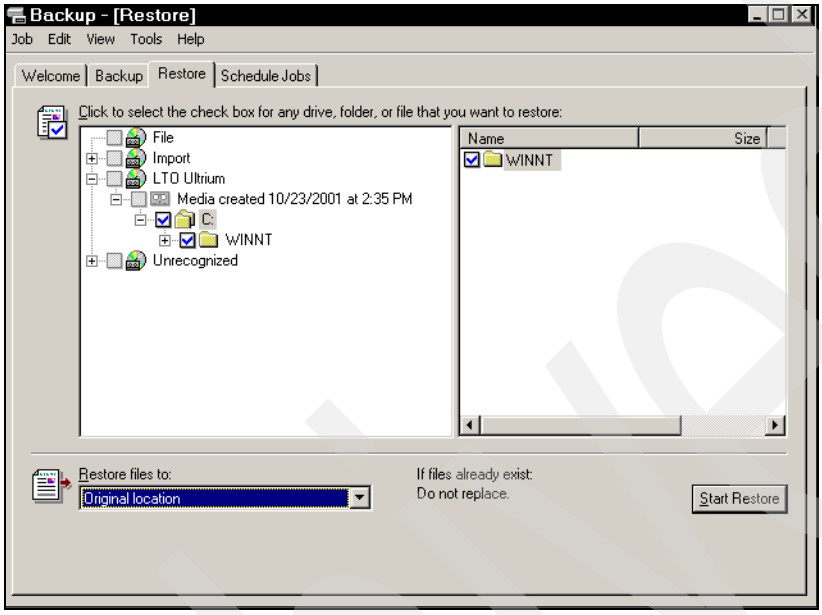


Figure 3-9 The NTBACKUP Restore tab

NTBACKUP with a SAN

It is not possible (by default) to use RSM, and therefore, NTBACKUP to drive the medium changer in a SAN-attached configuration. RSM can only auto-configure a robotic library when the following conditions are true:

- The robotic library hardware unit supports drive element address reporting with the Read ElementStatus SCSI command. (Consult the manufacturer to discover if your library hardware unit supports this feature.)
- All drives inside the robotic library are on the same SCSI bus as the library itself.
- The TAPE library is *not* attached to a Fibre Channel switch. (This may change in future versions of RSM.)

For native Fibre Channel attached drives, typically, a switch would be involved. RSM devices, however, may be configured using the RSMConfg.exe tool in the Windows 200x resource kit utility, or manually by editing the registry. Once this operation has been performed, you may be able to use NTBACKUP.

Updating microcode using NTUTIL

NTUTIL also allows you to update the drive microcode. Refer to 3.7, “Updating library, drive, and RMU firmware” on page 149 for instructions.

3.4.3 Deleting LTO devices

You may need to remove the tape device or the Medium Changer from the Windows device configuration. This is required for some application software that needs a specific device driver for the Medium Changer or the Tape Drive. You may also want to simply disable a driver, perhaps for troubleshooting purposes. In this section, we describe how to disable an IBM tape device in Windows 200x, and how to remove a device driver.

Disabling a tape medium changer or tape drive

To disable an IBM tape device in Windows 200x, open **Device Manager**, locate the device (in this case, under Medium Changers or Tape Drives), right-click the device and select **Disable**. Alternatively, you can do this from the Properties box for the device under the General tab. This is shown in Figure 3-10.

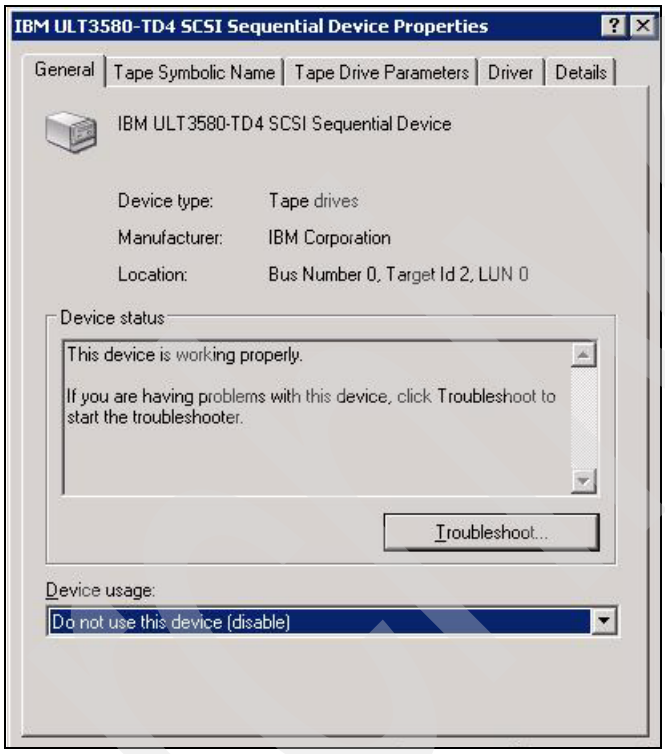


Figure 3-10 Disabling an IBM tape device

Disabling RSM

We recommend disabling RSM from the services window (select **Start** → **Programs** → **Administrative Tools** → **Services**, as shown in Figure 3-11) before removing the Ultrium devices. Ensure that all device activity has been halted before performing this step.

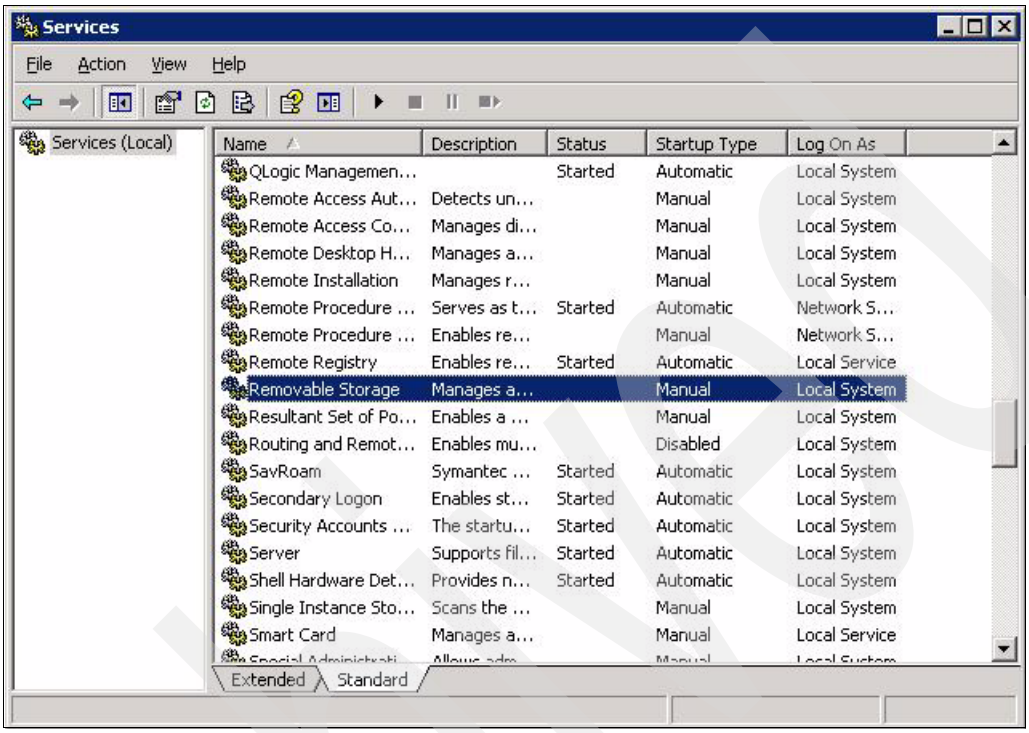


Figure 3-11 Services window

Double-click **Removable Storage** and select the **General** tab (Figure 3-12). From here, you may stop and then disable RSM.

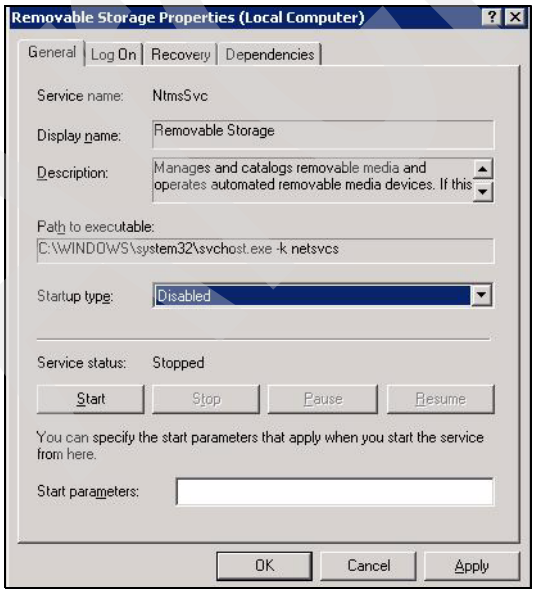


Figure 3-12 Disabling RSM

Removing the IBM tape device driver from the system (un-install)

To remove the IBM tape device driver, do the following:

1. Open **Device Manager** and right-click the device (Figure 3-13).

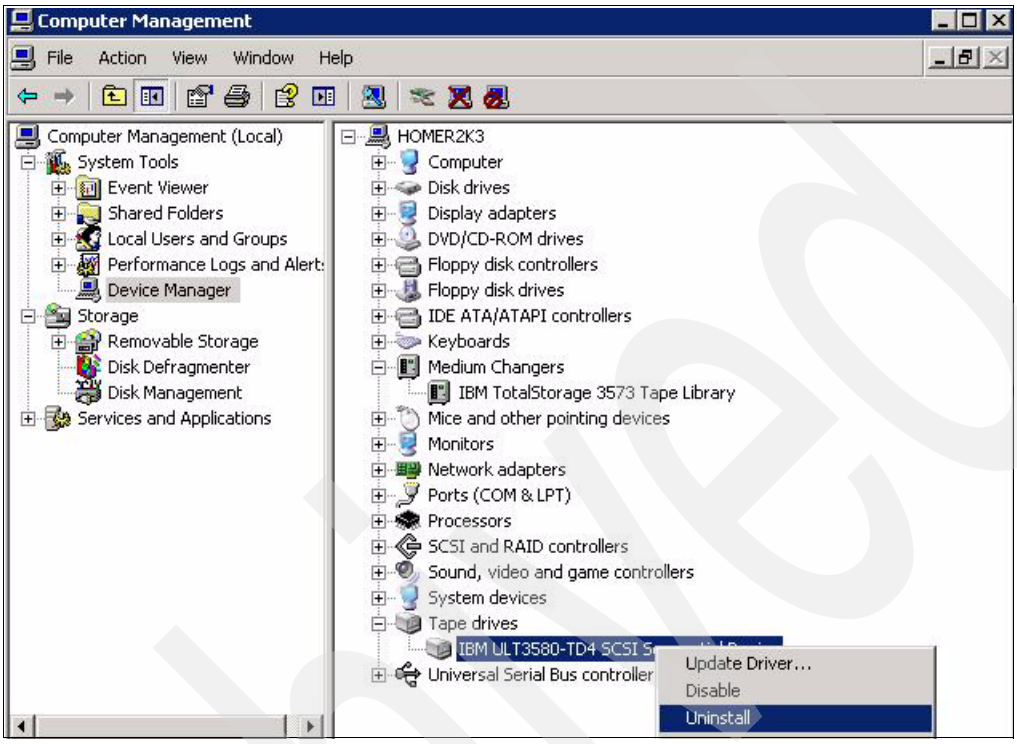


Figure 3-13 Uninstalling a tape drive

2. Click **Uninstall**. You will see a pop-up warning window to confirm that you really want to uninstall the device. Click **OK** to continue.

   Windows will proceed to remove the device drivers. Repeat these steps for all tape devices and the Medium Changer.

3. Run the file uninst.exe, located in the directory where the driver was extracted.

If you were in the process of upgrading the IBM tape device driver, you can now proceed to install the new version.

4. Shut down the operating system and physically detach the library if required. Uninstall.exe will not remove the .zip file or the files extracted from the .zip file. If you want to remove these files, you will need to do so manually.

Archived

3.5 Windows 200x SCSI adapter installation

To illustrate this topic, we use the IBM TS2340 Tape Drive directly SCSI-attached to a Windows, Intel based server, as depicted in Figure 3-14. The installation consists of:

- Intel server with Windows 2003 Server
- Adaptec 2940 LVD SCSI adapter
- IBM TS2340 Tape Drive

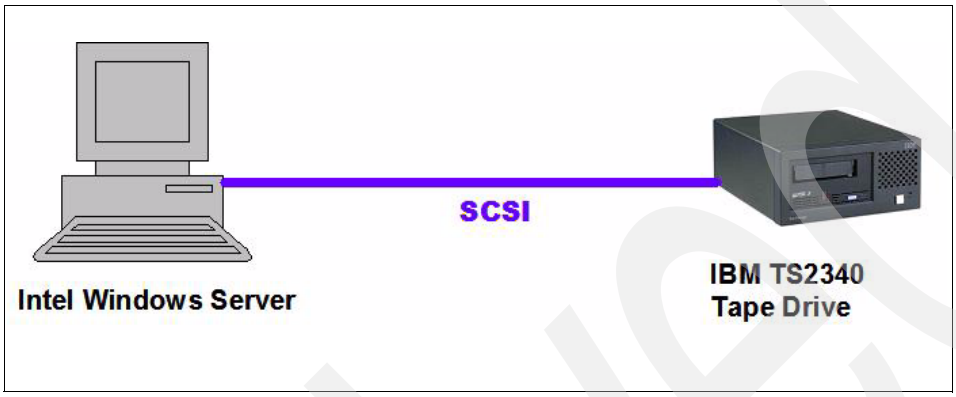


Figure 3-14 Windows SCSI attached configuration

SCSI host adapter compatibility for Windows 200x with IBM LTO devices is listed in 1.5.1, “Windows 2000/2003 SCSI direct attach” on page 35.

Additional information regarding SCSI interfaces and connector types may be found in:

- 1.9, “LVD and SAS” on page 40
- 1.10, “SCSI HD68 and VHDCI cable connectors” on page 41

For Adaptec adapters, we suggest that you obtain the latest driver levels and firmware updates for SCSI adapters from the Adaptec Web site:

`http://www.adaptec.com/en-US/support/scsi/`

Our configuration uses an Adaptec AHA-2940U2W (LVD). When installed in a Windows 200x machine, Windows 200x will detect the card and load its own drivers automatically. You may, however, update the adapter to a later driver level from the Adaptec Web site.

Note: The windows included in this section were obtained on a Windows 2003 system. Windows 2000 screens may vary slightly.

1. You will need to shut down the system to install the card. When Windows starts up, you will be prompted to reboot, as shown in Figure 3-15, since it has already loaded its own drivers.

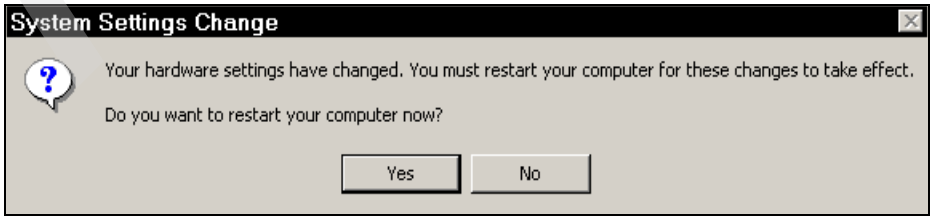


Figure 3-15 System settings change

2. Select **Yes** to reboot for a clean install. After the reboot, you may update to a later version of the device driver using Device Manager. Right-click **My Computer**, select **Device Manager** → **SCSI and RAID controllers**, right-click the SCSI card to be updated (Adaptec SCSI Card in our example), and select **Update Driver**, as shown in Figure 3-16.

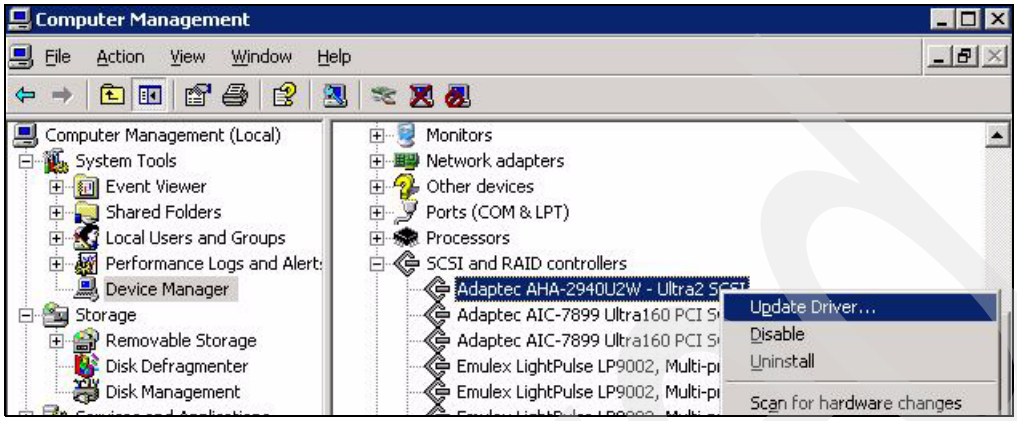


Figure 3-16 Accessing SCSI controller Update Driver

3. The Upgrade Device Driver Wizard starts, as in Figure 3-17. Click **Install from a list** and then click **Next** to begin.



Figure 3-17 Upgrade Device Driver Wizard

Archived

4. You are prompted to either search for a device driver or display a known list of drivers (Figure 3-18). Select the **Don't Search. I will choose the driver to install** option and click **Next**.

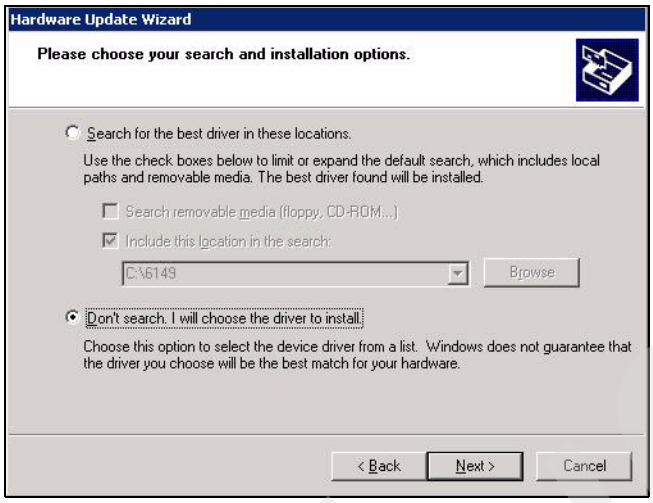


Figure 3-18 Device driver search options

5. Click **Show compatible hardware**, as shown in Figure 3-19, choose the correct hardware, and then click **Next**.

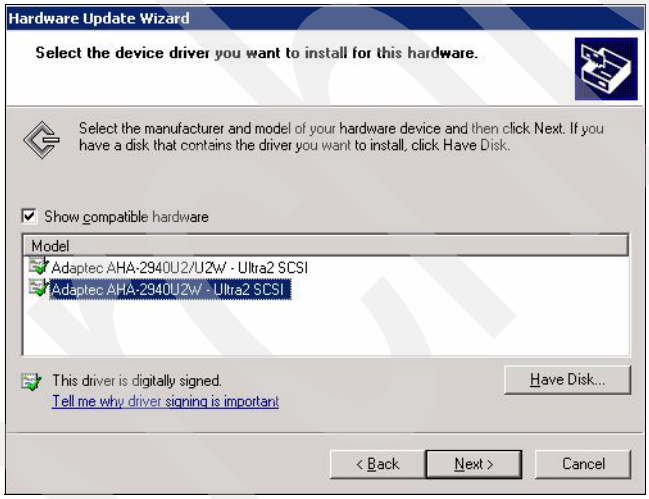


Figure 3-19 Device hardware selection

Specify the location of the driver file to use for the upgrade (Figure 3-20 on page 131). This is either the CD-ROM (if using a CD) or the directory where you downloaded the device driver.

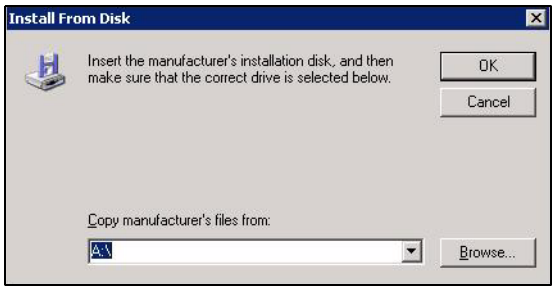


Figure 3-20 Device driver copy location

6. The Wizard completed the installation. Click **Finish** (Figure 3-21).



Figure 3-21 Device driver installation results

Note: If the driver is not digitally certified by Microsoft, you will see a warning message. This does not necessarily mean that the driver will not function with the LTO library. If you are unsure of the implications, see the readme file for the downloaded driver.

The driver is installed. You are notified of the successful installation of the device driver. You may also be prompted to restart the computer. We suggest that you reboot for a clean install.

Note for IBM Tivoli Storage Manager users

To allow the HBA to properly handle larger block sizes when using IBM Tivoli Storage Manager, modify MaximumSGList in the Windows registry under:

`HKEY_LOCAL_MACHINE->SYSTEM->Current Control Set->Services->`*`vendor device name`*`->Parameters->Device`

Archived

The *vendor device name* is substituted with the name of the vendor's device. For example, the Qlogic 2200 uses Ql2200 for the respective vendor device name. MaximumSGList is set to hex 41 to work properly with TSM (Figure 3-22).

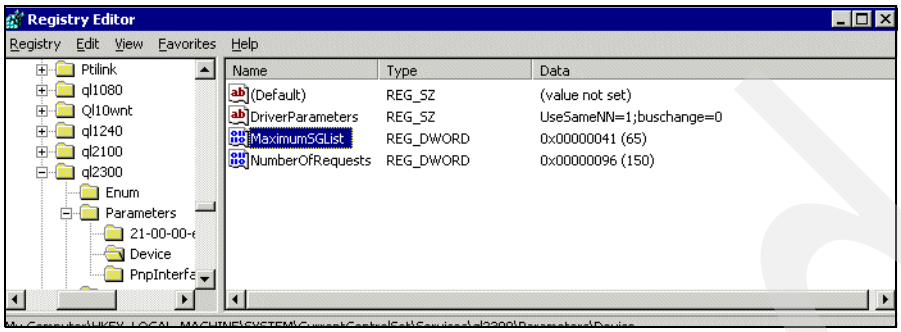


Figure 3-22 Recommended MaximumSGList value

Set up persistent binding

We recommend setting up persistent binding, which will permanently assign a SCSI ID to a specific target and maintain a constant view of the same SCSI ID/target relationship between the server reboots. Information about how to configure persistent binding on a HBA can be found at vendor documentations.

3.6 IBM System Storage Tape Library Specialists

We introduce the IBM System Storage Tape Library Specialist application in this section and illustrate how to use it to determine or upgrade the library and drive firmware.

The IBM System Tape Library Specialist is a Web-based graphical interface for configuring, updating, and administering IBM System Tape Libraries. This function is embedded in the Library Control Card, which is part of the library.

The communication is through an Ethernet connection between the host (where the Web browser runs) and the RMU. The Ethernet speed is 10/100 MB full duplex and is auto negotiated with the host or switch.

Once the library is set up for using the IBM Ultrium 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, which is available at:

`http://java.com/en/`

In the following sections, we describe, in more detail, the IBM System Tape Library Specialist applications for the IBM TS3100, TS3200, TS3310, TS3400, and TS3500 Tape Libraries.

Note: IBM Tape Library Specialist and Remote Management Unit (RMU) will be used interchangeably from here on.

In all our examples, we are using the default user ID and password to connect to the library using the RMU. However, for obvious security reasons, we recommend that you change the default password.

3.6.1 IBM TS3100 / TS3200 Tape Library Specialist

To set up the IP address, Subnet Mask, and gateway address, follow these steps to configure the RMU for IBM TS3100 / TS3200:

If you would like to use Dynamic Host Configuration Protocol (DHCP) as your library network setting, complete Steps 1, 2, 3, and 7. If you do not want to use DHCP as your library network setting, complete Steps 1, 2, 4, 5, 6, and 7.

1. Press the **DOWN** button to highlight the Network menu.
2. Press the **ENTER** button to display the Network screen.
3. If you do not want to select DHCP as your library network setting, skip this step and proceed to the next step. If you want to select DHCP as your library network setting, complete the following steps:
   a. Press the **ENTER** button to highlight the DHCP field.
   b. Press the **DOWN** button to select **ON**.
   c. Press the **ENTER** button to apply your selection.
   d. Skip to Step 7.
4. Press the **DOWN** button to select **IP Address**.
   a. Press the **ENTER** button to highlight the IP Address field.
   b. Press the **UP** or **DOWN** button to select the digit(s) of your library's IP Address.
   c. Press the **ENTER** button to highlight the next digit(s) in your IP Address.
   d. After entering the final digits, press the **ENTER** button to apply your entries.
5. Press the **DOWN** button to select **Netmask**.
   a. Press the **ENTER** button to highlight the Netmask field.
   b. Press the **UP** or **DOWN** button to select the digit(s) in your library's Netmask address.
   c. Press the **ENTER** button to highlight the next digit(s) in your library's Netmask address.
   d. After entering the final digit(s) in your Netmask address, press the **ENTER** button to apply your entries.
6. Press the **DOWN** button to select **Gateway**.
   a. Press the **ENTER** button to highlight the Gateway field.
   b. Press the **UP** or **DOWN** button to select the digit(s) in your library's Gateway address.
   c. Press the **ENTER** button to highlight the digit(s) in your library's Gateway address.
   d. After entering the final digits in your Gateway address, press the **DOWN** button and select one of the following:
      - **Save**: To save your network settings.
      - **Cancel**: To cancel all of your entries and leave the settings as they were.
7. Press the **ENTER** button to return to the Configure menu.
8. Press the **Cancel** button to return to the Main menu.
9. Press the **Cancel** button to return to the home screen.

Note: We recommend using a fixed IP address for the RMU. When DHCP is used, it is hard to determine the IP address of the RMU.

Archived

You should now be able to access the Tape Library Specialist from a Web browser by entering the RMU's IP address. Figure 3-23 shows the login page and Figure 3-24 shows the welcome page.



Figure 3-23 IBM TS3100 / TS3200 Tape Library login window



Figure 3-24 IBM TS3100 / TS3200 Tape Library welcome window

Log in as admin with the default password of secure. If you cannot log on, check that the library is not in Offline Mode. Notice that only one connection type can be used to communicate with the library. If you are already logged on using the RMU and then try to log on using the Operator panel, a warning is displayed in the Operator panel.

To verify the inventory of the TS3100 / TS3200 Tape Libraries, select **Monitor Library** → **Inventory**, as shown in Figure 3-25 on page 135.

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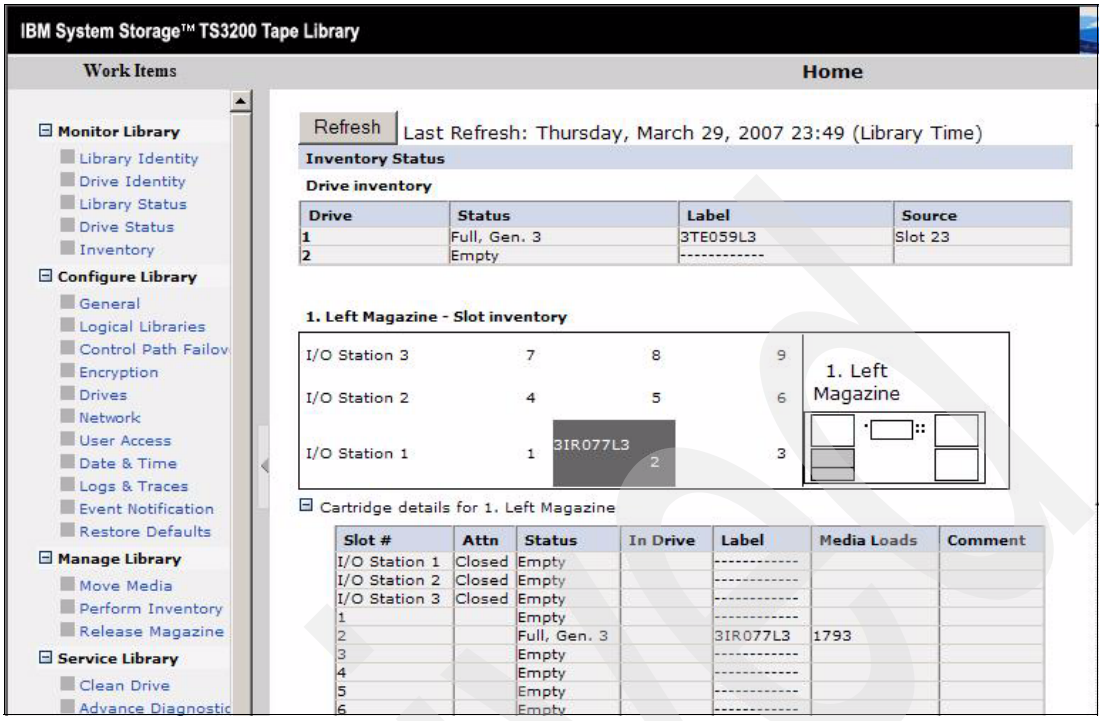


Figure 3-25 IBM TS3100 / TS3200 Inventory

From the Service Library menu, select **Upgrade Firmware** to upgrade the firmware of the drive and the medium changer, as shown in Figure 3-26.

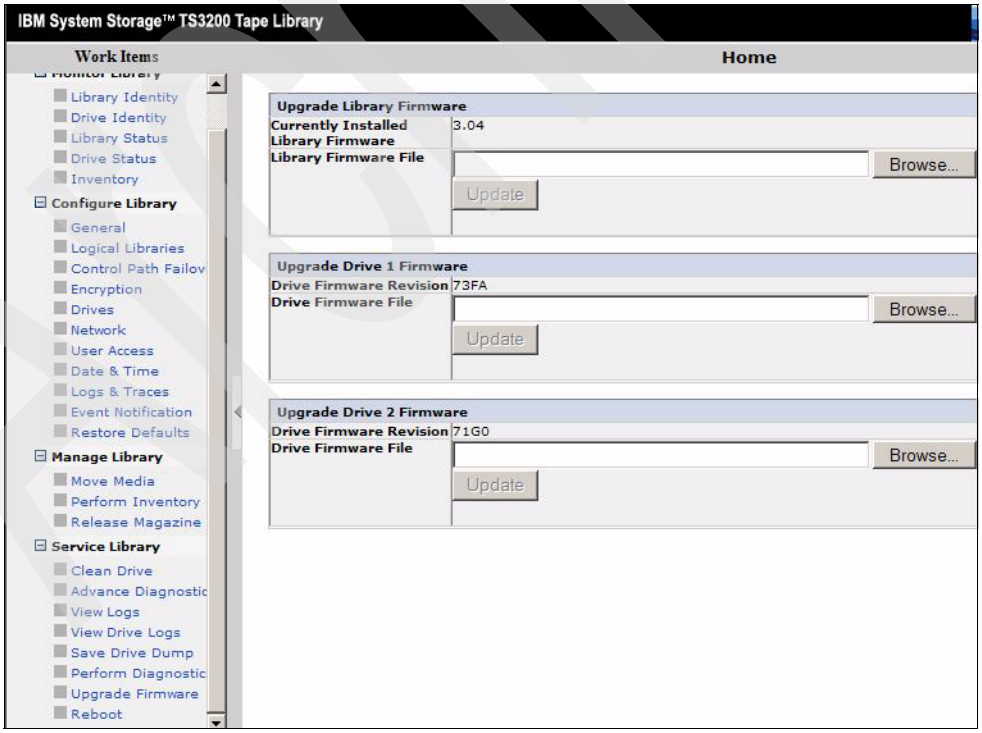


Figure 3-26 IBM TS3100 / TS3200 firmware update window

You can download the latest firmware from the following site:

http://www.ibm.com/storage/support/lto

For a complete overview of all the configuration settings, see the *IBM System Storage TS3100 Tape Library and TS3200 Tape Library Setup, Operator, and Service Guide*, GA32-0545.

3.6.2 IBM TS3310 Tape Library Specialist

To set up network settings using the TS3310 Operator panel, follow the steps below:

1. Determine your network settings (IP Address, Default Gateway, and Subnet Mask).
2. Touch **Yes** to begin configuring the library network.
3. Choose a name for your library.
4. Touch the Library Name text box to access the alphanumeric keyboards.
5. Using the alphanumeric keyboards, enter the name into the Library Name field.

   Note: The library name can be a maximum of 12 alphanumeric characters. Any letters used in the library name must be lowercase.

6. Select **Dynamic Host Configuration Protocol** (DHCP) to have the library network setting automatically configured.

   To configure your network manually, deselect **DHCP**, and enter the following network settings:

   – IP Address: The Internet protocol (IP) address of the library
   – Default Gateway: The IP address of the default gateway for your portion of the Ethernet network

     Note: Each IP address consists of four sets of numbers separated by periods. Do not use the last octet of the address because it will reset the gateway to the original address set at the factory.

   – Subnet Mask: The IP address of the subnetwork
7. Touch **Apply** to save the network settings.
8. After a successful save, touch **Close**.
9. Touch **Local** to complete configuring your library using the Operator panel.

You should now be able to access the Tape Library Specialist from a Web browser by entering the RMU's IP address. Figure 3-27 on page 137 shows the login page.

Note: We recommend using a fixed IP address for the RMU. When DHCP is used, it is hard to determine the IP address of the RMU.

When LDAP is enabled, the login screen gives the user a choice between using local authentication (the login and password are stored on the library) or LDAP authentication (the login and password are stored on a server, and the user must specify the LDAP domain name). If LDAP access is disabled, the LDAP options will not appear on the login screen.

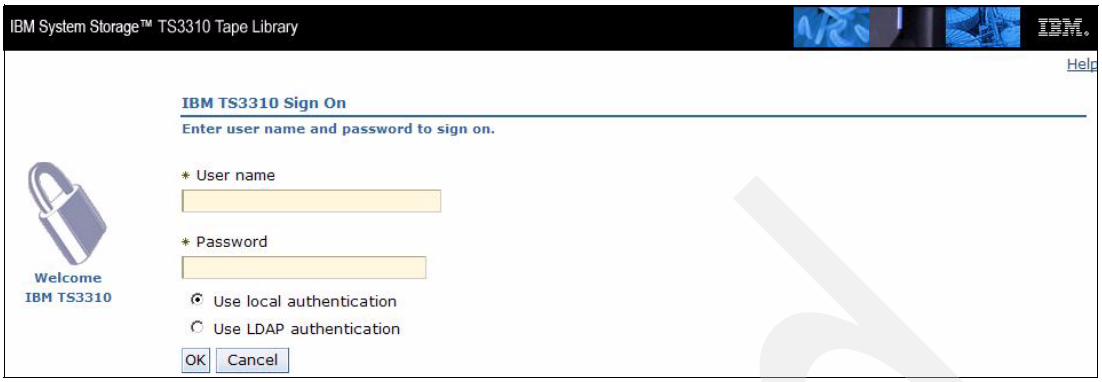


Figure 3-27 IBM TS3310 login page

To verify the library map of the TS3310 Tape Library, select **Monitor System** → **Library Map**, as shown in Figure 3-28.

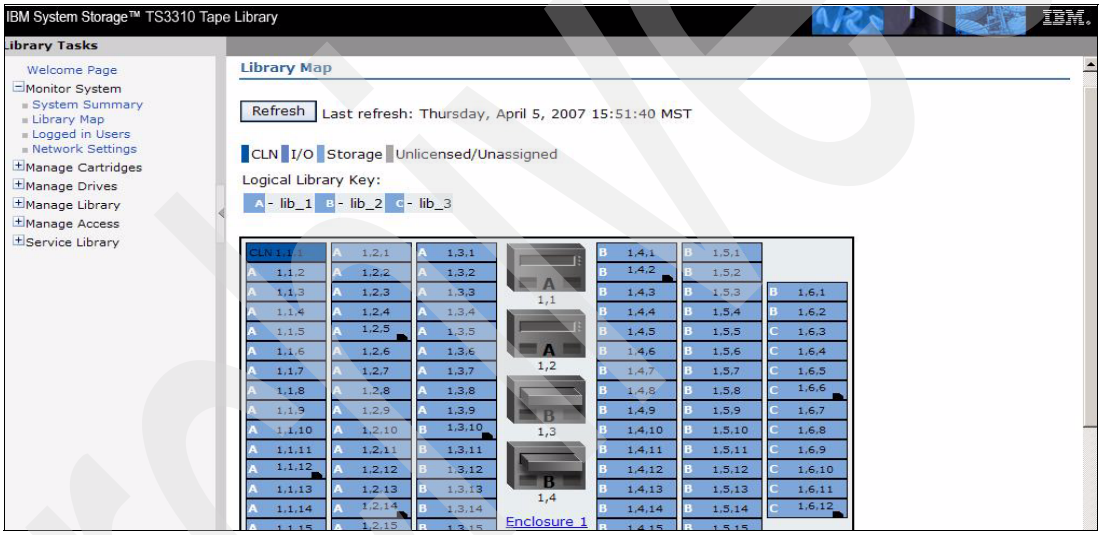


Figure 3-28 IBM TS3310 Library Map page

From the Service Library menu, select **View/Update Library Firmware Level** to upgrade the firmware of the library, as shown in Figure 3-29.

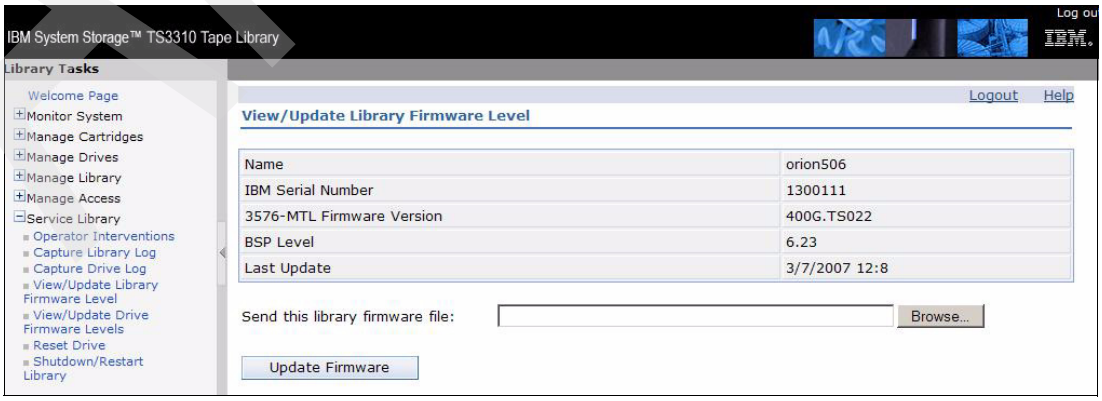


Figure 3-29 IBM TS3310 Update Library Firmware

For a complete overview of all the configuration settings, see the *IBM System Storage TS3310 Tape Library Setup and Operator Guide*, GA32-0477.

3.6.3 IBM TS3400 System Library Specialist

Using the IBM TS3400 Operator panel, set the IP address, subnet mask, and gateway address. Follow these steps to configure the RMU:

1. Press **ENTER** to display the User Login password screen.
2. Enter the 4 character password for the TS3400. The factory password is 0000.
3. From the top menu, select **Configuration** → **Network Settings** → **IP address**. Here you can configure the IP address for the TS3400 or one of the following settings:
   - Link Speed
   - Dynamic Host Configuration Protocol (DHCP)
   - Subnet Mask Address
   - Simple Network Time Protocol (SNTP)
   - Media Access Control (MAC) address

The TS3400 can now be remotely controlled from any server in the network. However, there are some prerequisites from a server point of view. The Web User Interface Java Applet, which is running on the TS3400, requires Java 1.5.0 or higher for full functionality, and is best viewed using Internet Explorer 6.0 or higher. If your server does not have Java installed or you need to upgrade your installation, download the latest version of the Java Runtime Environment (JRE™) for your platform from:

`http://www.java.com`

and follow the instructions provided to enable and configure the Java Runtime Environment for your browser. When the JRE on your server is installed or upgraded, open your browser and enter the IP address of the TS3400.

A warning message pops up the first time when you connect to the TS3400. This is message is normal and does not indicated an error.

Figure 3-30 shows the Java security warning message.



Figure 3-30 Java security warning

You can click the **Always trust content from this publisher** check box to avoid this message in subsequent browser sessions. After launching the Web User interface, the login window is displayed.

You should now be able to access the Tape Library Specialist from a Web browser by entering the RMU's IP address. The default account passwords are:

- Administrator account: *admin*, Password: *secure*

Figure 3-31 shows the login page.

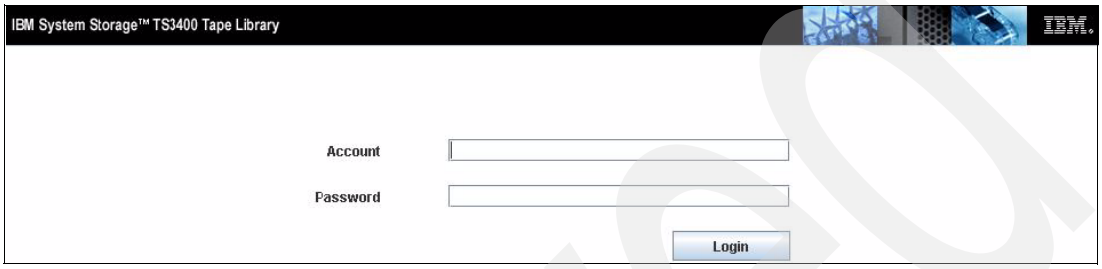


Figure 3-31 IBM TS3400 login page

After logging in the Welcome page is displayed. Figure 3-32 is an example when the Administrator account is used.

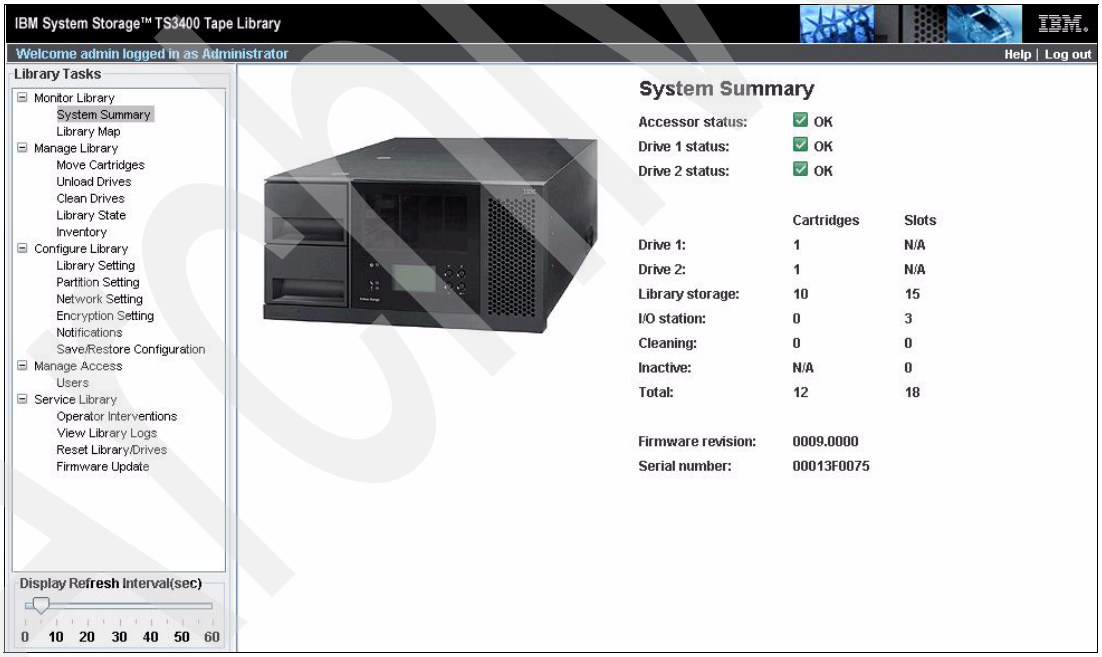


Figure 3-32 IBM TS3400 Welcome page

Archived

To verify the inventory of the TS3400 Tape Libraries, select **Library Map**, as shown in Figure 3-33.

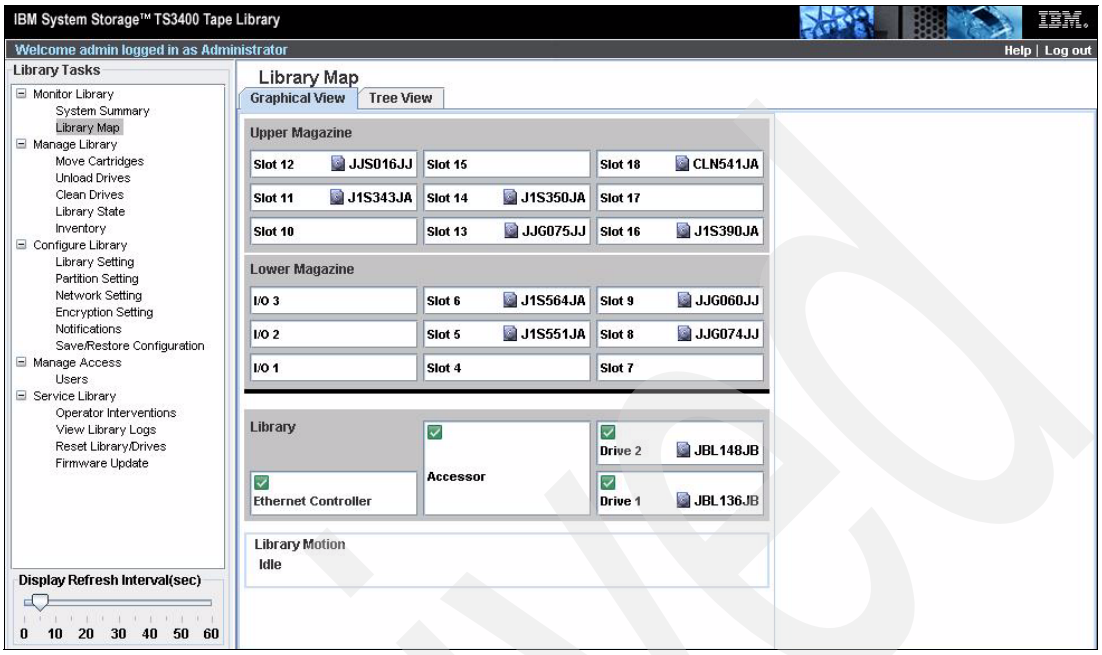


Figure 3-33 IBM TS3400 Library Map

From the Service Library menu, select **Firmware Update** to update the firmware of the drive and the medium changer, as shown in Figure 3-34.

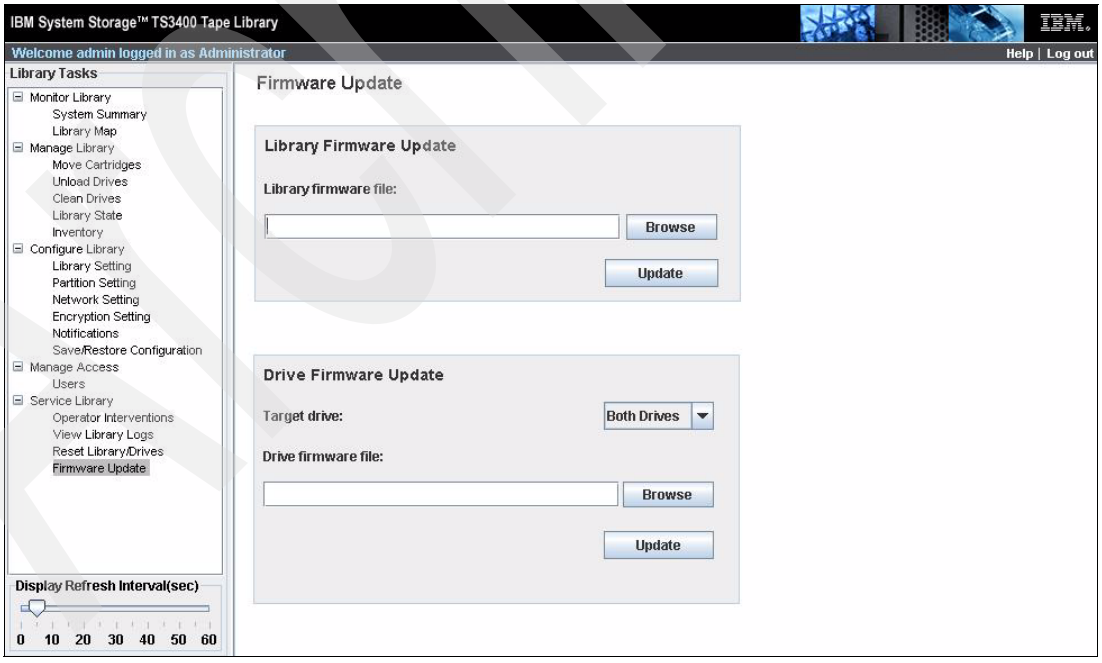


Figure 3-34 IBM TS3400 firmware update

You can download the latest firmware from the following site:

`http://www.ibm.com/storage/support/lto`

For a complete overview of all the configuration settings, see the *IBM System Storage TS3400 Tape Library Planning and Operator Guide*, GC27-2107.

3.6.4 IBM TS3500 Tape Library Specialist

The IBM TS3500 Tape Library Specialist is embedded in the Media Changer Pack (MCP).

You will need to attach the Ethernet port to your network with a suitable cable and configure the TCP/IP address information. Select **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 3-35.

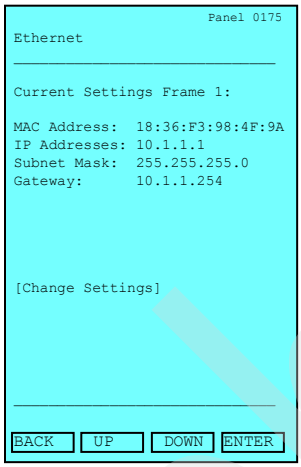


Figure 3-35 Change Ethernet parameters on TS3500

Click **ENTER** to make the changes. You can select to disable the Ethernet interface, use DHCP for automatically address assignment (if supported in your network), or manually configure the parameters.

Archive

After configuring the network connection for the IBM System Tape Library Specialist, enter the TCP/IP address of the library in your browser. The welcome page of the IBM TS3500 Specialist Web interface displays, as shown in Figure 3-36. With the Specialist, you can monitor the 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 **?** icon in the top right of the screen.

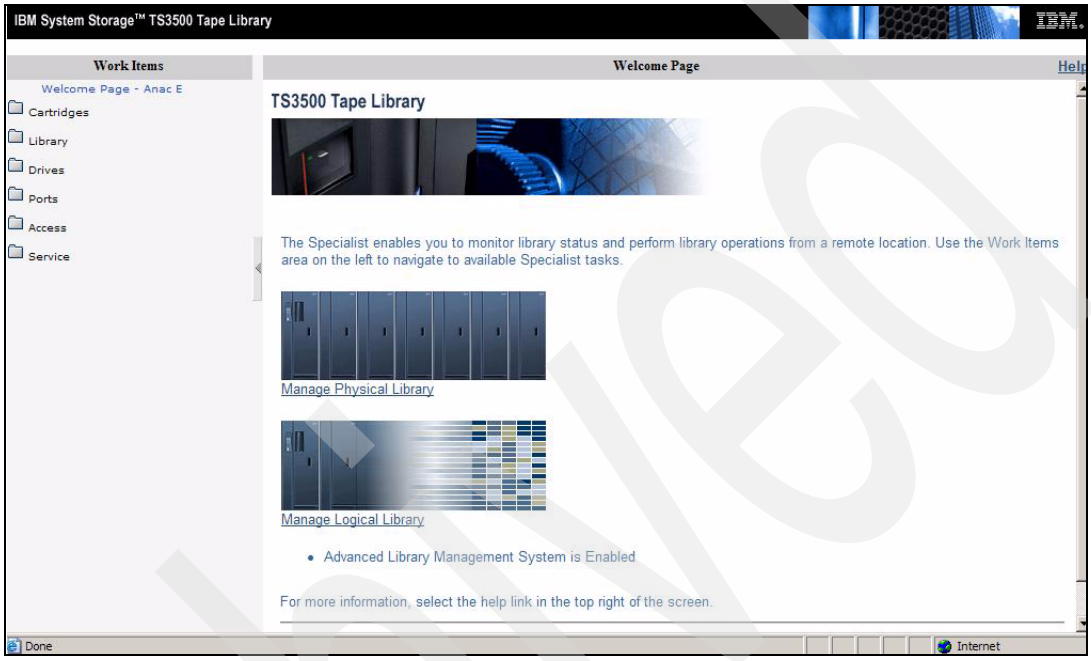


Figure 3-36 IBM TS3500 Specialist: Welcome page

Use the left-hand side of the panel to navigate between the menus. You can choose between the following options:

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 I/O
	Date and Time
Drives	Drive Summary
	Drive Assignment
	Control Paths
	World Wide Names
	Cleaning Mode
Ports	Fibre Channel Summary
Access	Web Security
	Operator panel Security
	Key Manager Addresses
	SNMP Settings

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	SNMP Destinations
	SNMP System Data
	SMI-S Agent
Service Library	Library VPD
	Drive VPD
	Node Cards
	Download Library Logs
	Download Drive Logs
	View Library Error Log
	View Drive Error Log
	Firmware Update
	Master Console
	Scanner Speed
	License Keys

You may also choose between managing the physical library or the logical libraries. For more information about the Advanced Library Management Services, please see 2.3, “ALMS” on page 77.

The IBM TS3500 Tape Library Specialist is a complete interface that allows you to easily configure and monitor the library operations, with graphics and tables like those shown in Figure 3-37.

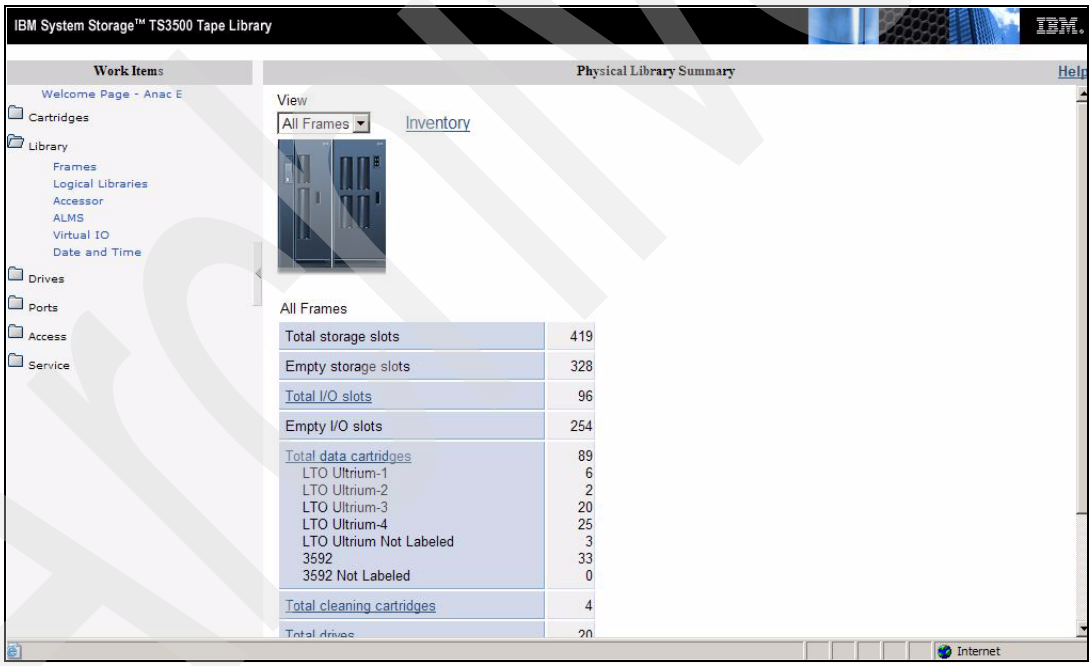


Figure 3-37 IBM TS3500 Specialist: Physical Library Summary window

The IBM TS3500 Library Specialist has menus to manage the cartridges, drives, or library.

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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 3-38 lists the cartridges in the logical library Redbook1. After selecting a cartridge, you may move it to a tape drive, remove it from the library, or assign it to a logical library.

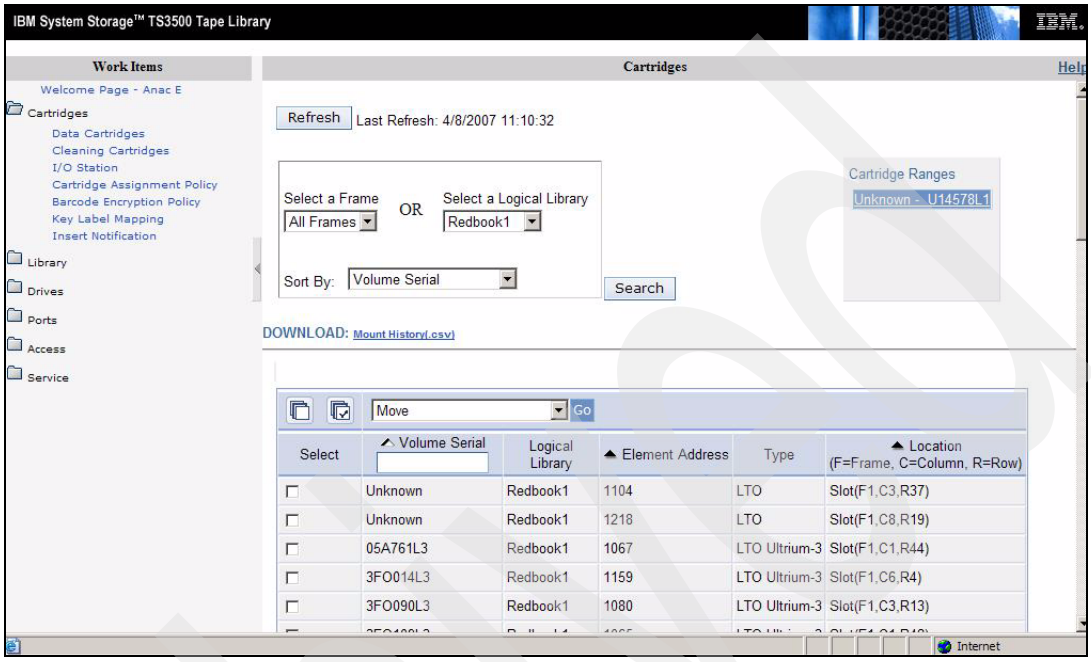


Figure 3-38 IBM TS3500 Specialist: Cartridges

For information about Cartridge Assignment Policy, please see “Cartridge assignment policy” on page 81.

To view a list of the drives in the library, select **Drives** → **Drive Summary**. On the Drives screen, you can use the drop-down menus to limit the drives selected to a specific frame or a specific logical library, or you can select all frames or all logical libraries, as shown in Figure 3-39 on page 145.

As shown in Figure 3-40 on page 145, 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 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.

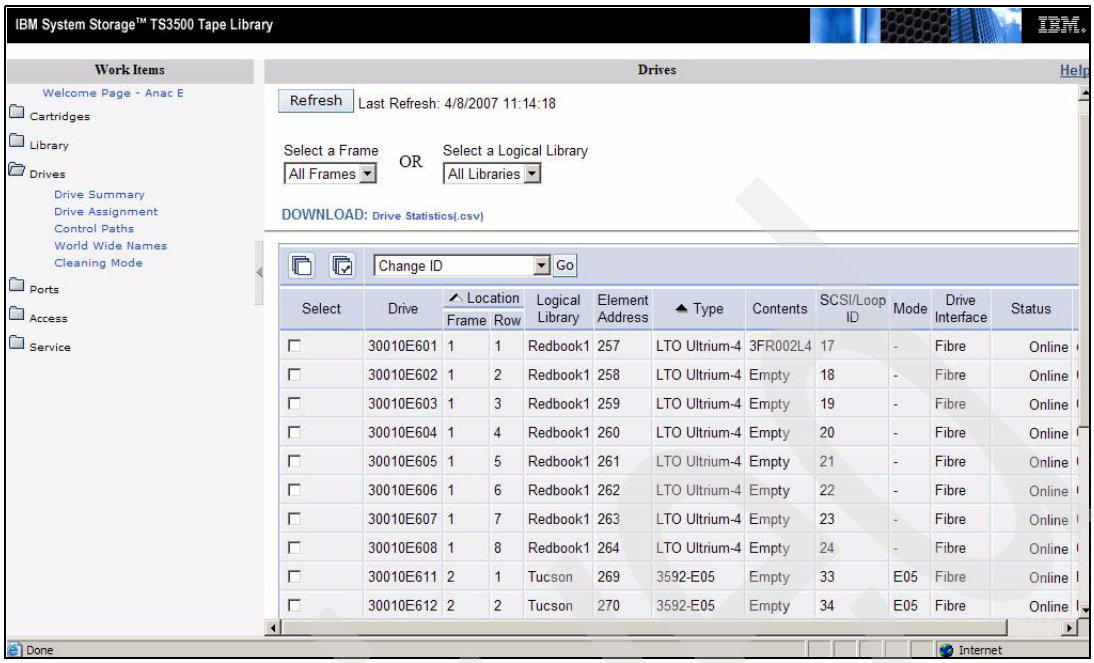


Figure 3-39 IBM TS3500 Specialist: drive summary

To change a drive's settings, select that drive from the Drives screen and click **Change ID**. You will get a warning (Figure 3-41 on page 146) stating this function may interrupt the library activity. Indeed, changing the Drive SCSI/Loop ID will interrupt library and drive activities and may require reconfiguring the host computers.

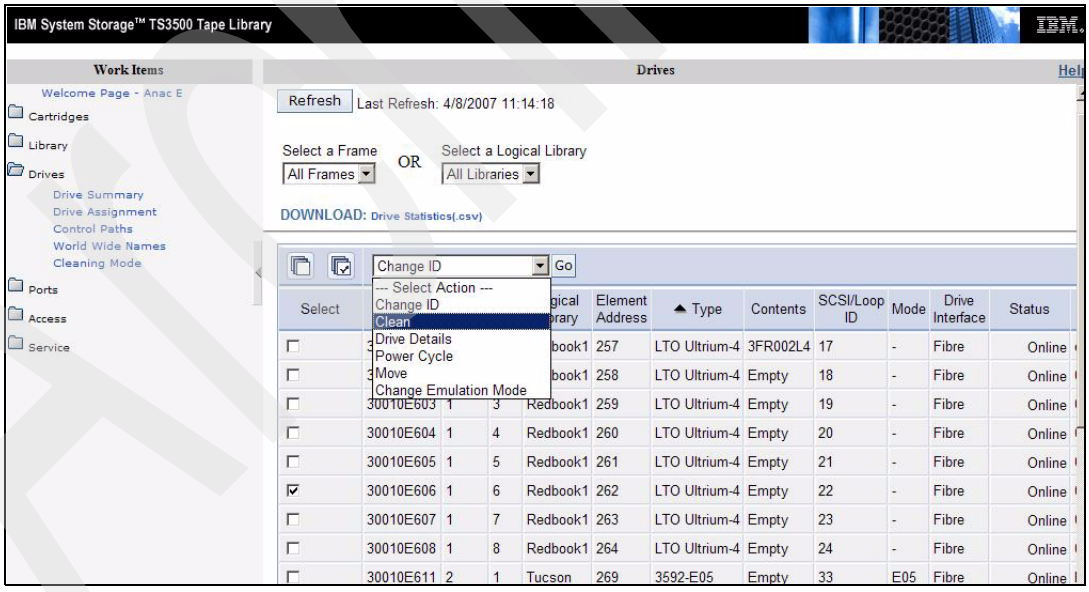


Figure 3-40 IBM TS3500 Specialist Clean Drive

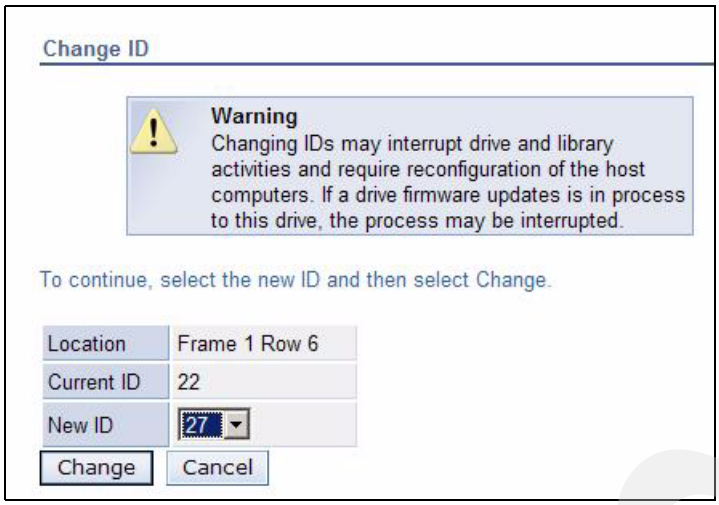


Figure 3-41 IBM TS3500 Specialist Change ID warning

Select **Drives** → **Drive Assignment** to display the Drive Assignment Filter window. You can select all drives or a specific drive, and all logical libraries or a specific logical library. In Figure 3-42, all drives for logical library Redbook1 are selected for display.

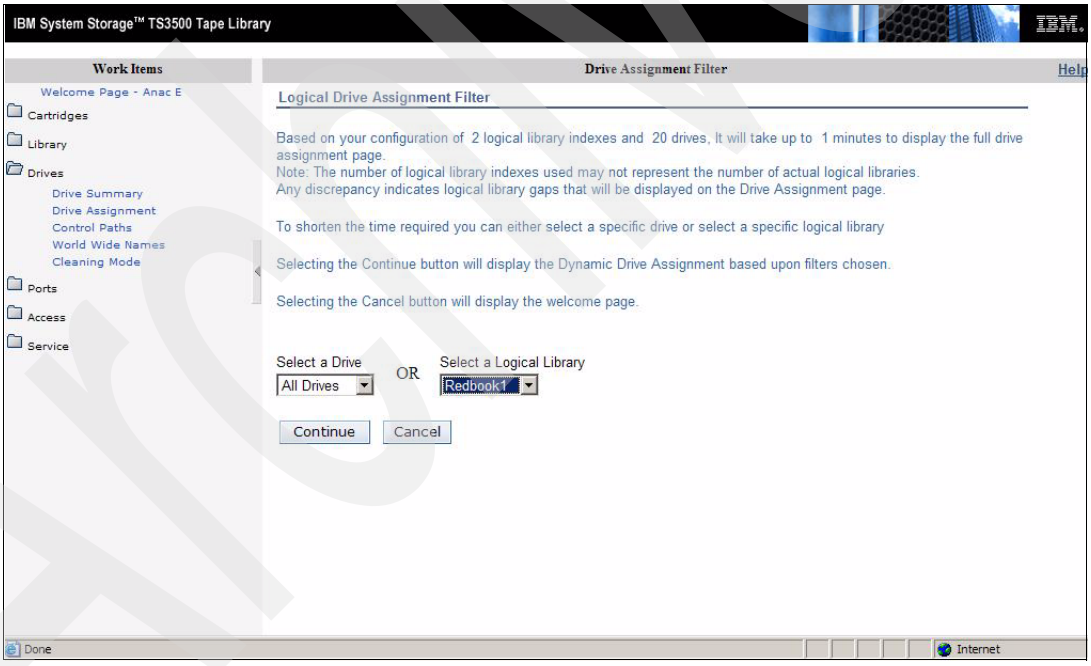


Figure 3-42 IBM TS3500 Specialist: Drive Assignment Filter

As shown in Figure 3-43 on page 147, after selecting a tape drive, you may 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 3-43 on page 147, drive 30010E601 is a control path, as is indicated by the icon shown on the left of the check box in the Redbook1 column.

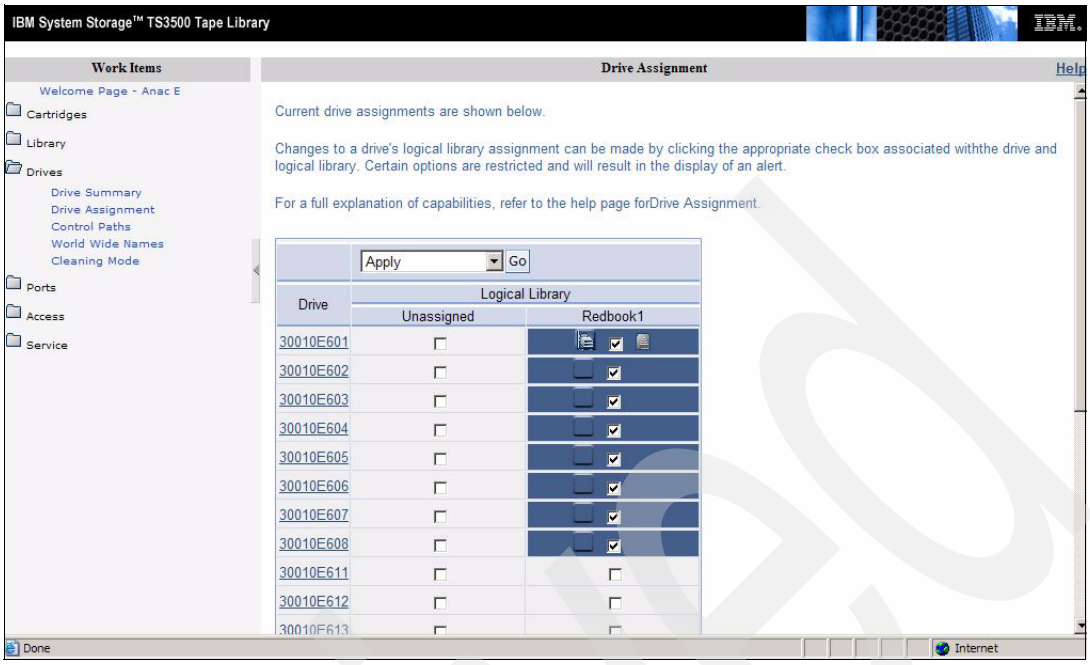


Figure 3-43 IBM TS3500 Specialist: Drive Assignment

You will see a warning (Figure 3-44) that changing a drive or control path assignment may affect the associated host applications and that a reset or rediscovery of its devices may be needed.

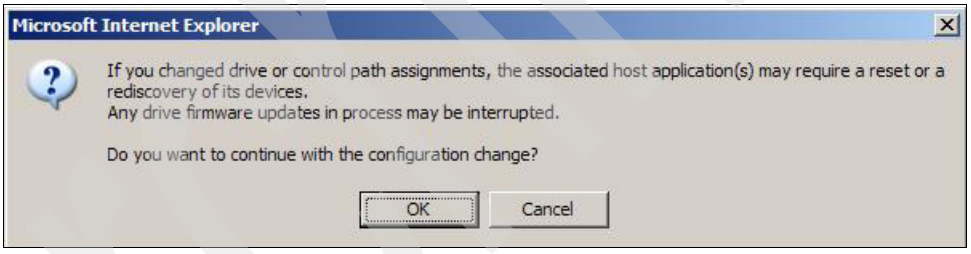


Figure 3-44 IBM TS3500 Specialist: Assignment Change warning

You can also configure the library directly from the Specialist panels, specifying the SAN parameters, or the SCSI control paths, control ports, and security options. Note that the TCP/IP configuration function is not available from the IBM System Tape Library Specialist.

With password protection on, users may change their password by selecting **Access** → **Web Security** (see Figure 3-45).

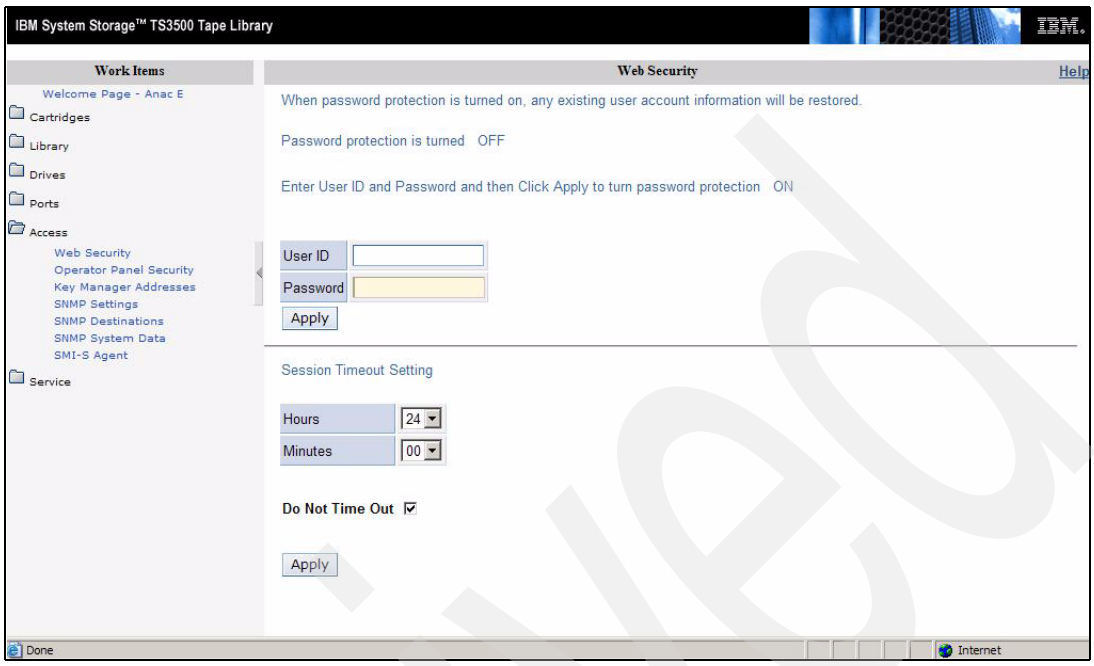


Figure 3-45 IBM TS3500 Tape Specialist Web Security window

If the password protection is ON, a password is required to access some functions of the Specialist, such as firmware update and the modification of the library configuration. The Specialist interface offers three levels of security access for its windows (also called pages). Before performing library functions, you must determine the type of security access that you need. Table 3-3 describes each level.

Table 3-3 Types of password protection

Type of password protection	Description
No password protection	You are never prompted to sign on.
Password protection for administration pages	You are prompted to sign on to access the administration pages. Administration pages are functions that allow you to change library settings.
Password protection for all pages	You are prompted to sign on whenever you use the IBM TS3500 Specialist. This type of protection allows you to view all pages (by using a user password) or to change administration pages (by using an admin password).

The factory default for the IBM TS3500 Specialist is no password protection. The first time that you choose password protection for administration pages or for all pages, the library generates an initial password, which can be changed. Also, if you set the security level back to no password protection, the password will deactivate.

The following administration functions are protected if the admin password is enabled:

- Change control port SCSI IDs.
- Change drive SCSI or Loop IDs.

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- Change the cleaning mode.
- Change the date and time.
- Change the Specialist Web interface admin password.
- Clean the drive.
- Configure logical libraries.
- Cycle power to the drive.
- Download logs.
- Enable or disable control paths.
- Import data or scratch cartridges (importing cleaning cartridges is not password-protected).
- Inventory the library.
- Move cartridges.
- Remove cartridges.
- Update control port firmware.
- Update library and drive firmware.

3.7 Updating library, drive, and RMU 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 LTO models.

3.7.1 Keeping up-to-date with drivers and firmware using My Support

My Support registration provides e-mail notification when new firmware levels have been updated and are 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 Edit Profile page.
   a. Under the Products drop-down menu, select **Storage**.
   b. In the next drop-down menu, select **Computer Storage**.
   c. In the next drop-down menu, select **Tape Storage Systems.**
   d. In the next drop-down menu, select either **Tape Libraries** (IBM TS3100, IBM TS3200, IBM TS3310, IBM TS3400, or IBM TS3500).
   e. Click the check boxes for the appropriate products.
   f. Click **Add products** at the bottom of the page.

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g. Review your profile for correctness.

h. Under Subscribe to e-mail, select **Storage** and then check the boxes labeled **Flashes and Downloads** and **Drivers**, and click **Update**.

i. 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.

3.7.2 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/
ftp://index.storsys.ibm.com/
```

For the library microcode, use the compressed file appcode.zip for Windows systems, or appcode.tar for UNIX systems.

Check IBM TS2340 installed firmware level

At installation time, verify that the most current firmware is installed. Because the TS2340 does not have a display to show the firmware level, we recommend using an IBM tool called the IBM Total Storage Diagnostic Tool (ITDT). ITDT scans the SCSI bus for any attached tape drive and will reflect the firmware of the tape drive.

This tool can also be used for testing the drive and collecting a drive dump for error analyses by the IBM Support Centers. The big advantage using ITDT that it is working device driver independent, which means that whatever device driver is installed (IBM or non-IBM device drivers), the TS2300 can be tested or the firmware can be updated or a drive dump can be made.

At the time of writing, ITDT is supported for the following Operating Systems: Microsoft Windows Server 2000 with SP4 (32-bit IX86), Microsoft Windows Server 2003 (32-bit IX86), AIX 5L™ V5.2 and V5.3 (64-bit pSeries®,Linux systems with Kernel 2.4 and 2.6, glibc 2.2.5 and later (32-bit IX86), Linux systems with Kernel 2.4 and 2.6, glibc 2.2.5 and later (64-bit pSeries), Solaris Version 9 and 10 (64-bit SPARC), HP-UX Version 11.xx (PA-RISC and Itanium®), and i5/OS V5.3 (iSeries). The ITDT can be downloaded from this Web site:

```
ftp://index.storsys.ibm.com/358x/tools/
```

In the readme file, there is installation instruction as well an instruction about how to use ITDT.

The latest firmware of the TS2340 can be found on the following Web site:

```
http://www-03.ibm.com/servers/storage/tape/lto/
```

Check IBM TS3100 / TS3200 installed firmware level

To check the installed firmware level from the IBM TS3100 / TS3200 using the Operator panel, select **Monitor** → **Library** → **Identify.**

You can also check the installed firmware level during power on sequence, as shown in Figure 3-46 on page 151.

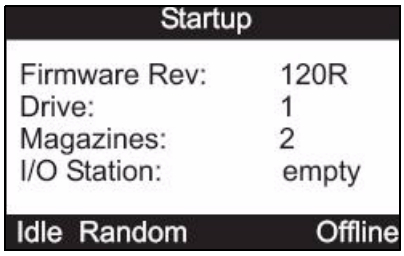


Figure 3-46 IBM TS3100 / TS3200 Installed firmware level

Check the IBM TS3310 installed firmware level

To check the installed firmware level from the IBM TS3310 Operator panel:

- Library firmware: Select **Tools** and then select **About Library**. The Firmware Version field displays the firmware level.
- Drive firmware: Select **Tools** and then select **Drive Info**. The Firmware Version field displays the firmware level.

Check the IBM TS3400 installed firmware level

To check the installed firmware level from the IBM TS3400 Operator panel, from the main menu, select **Revision**.

Check the IBM TS3500 installed firmware level

To check the installed firmware level from the IBM TS3500 System Tape Library Specialist:

- Library firmware: Select **Service** and then select **Library VPD**.
- Drive firmware: Select **Service** and then select **Drive VPD**.

Figure 3-47 shows the drive Firmware level.

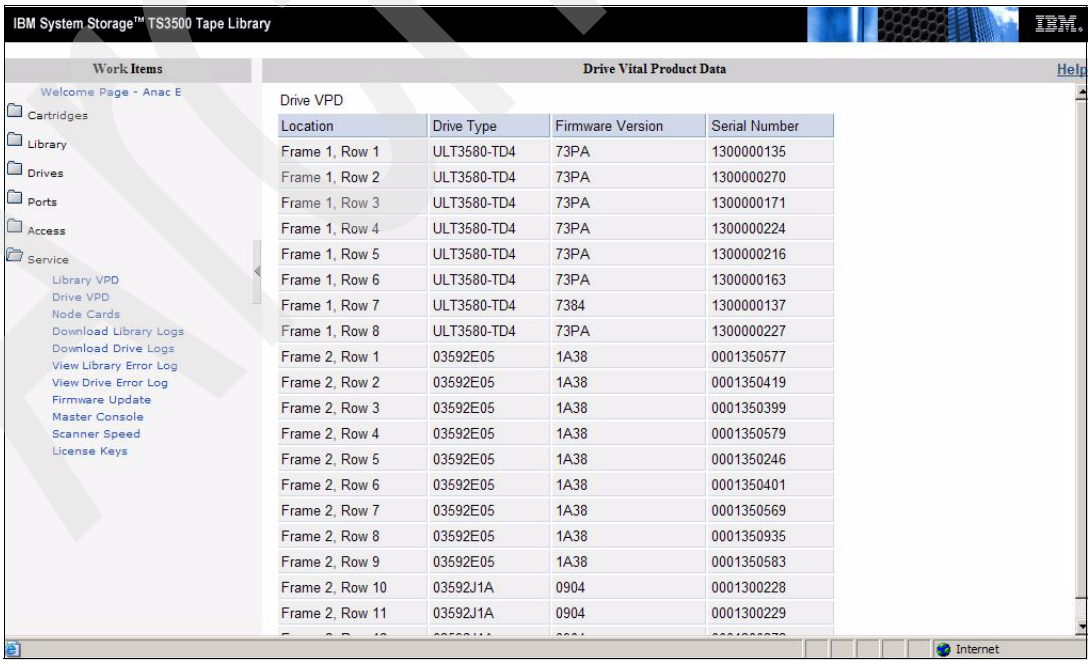


Figure 3-47 IBM TS3500 Specialist: Check drive firmware version

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How to update the firmware

You can use the following methods to update the firmware:

- Using the IBM System Tape Library Specialist
- Using NTUTIL
- Using the Field Microcode Replacement (FMR) tape (drive firmware only)
- Using the library serial port (not covered in this book)
- Using ITDT

Detailed instructions on how to update the firmware are in the *IBM System Tape Operator Guide* and at the following Web site. Select the appropriate LTO model and then **Download**:

http://www-1.ibm.com/servers/storage/support/lto/

As an example, we show how to upgrade the library and drive microcode through the SCSI bus interface using the NTUTIL utility for Windows 200x. Then we will discuss the new IBM tool called ITDT.

Upgrading library firmware using NTUTIL

The following procedure describes how to update the library firmware in the IBM TS3100, TS3200, TS3310, TS3400, or TS3500, over the SCSI bus using NTUTIL.

1. Download the latest library firmware from either of these sites to a directory:

   http://www-1.ibm.com/servers/storage/support/lto/
   ftp://ftp.software.ibm.com/storage/

2. If you have an application device driver other than the IBM tape device driver, you will need to stop it and start the IBM tape device driver. NTUTIL will only work with this device driver, so you will need to install it if you have not already done so. You must also stop the Removable Storage Manager (RSM) if it started. You will find RSM under **Start** → **Settings** → **Control Panel** → **Administrative Tools**.

3. Open an NTUTIL session on a command line from the directory where the library firmware image was saved (for example, c:\winnt\system32) by typing NTUTIL at a command prompt. This is not necessary, but if you do it now, then in a later step you do not need to type in the complete path.

4. Enter 1 for a manual test (Example 3-15).

Example 3-15 NTUTIL main menu

```
NTutil - Copyright (c) 1997-2000 IBM Corporation

Main Menu:
Microsoft Windows 2000 version
==========

  1: Manual test
  2: Batch  test
  9: Exit ntutil

Enter selection: 1
```

5. The NTUTIL interactive menu will be displayed (Example 3-16 on page 153).

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Example 3-16 Manual test menu

```
manual test menu:
========================================================================
  1: set device special file             2: display symbols
  3: set block size R/W (now !0 fixed)
  5: set return error when fail          6: set/reset trace
  7: set exit on unexpected result       8: Library Mode
========================================================================
 20: open                               21: close
 22: read                               23: write
 24: read and display block             25: flush (buffer->media)
 26: read block id                      27: erase
 28: locate block id                    29: display block data
========================================================================
 30: write filemark(s)                  31: rewind
 32: forward space filemark(s)          33: unload
 34: reverse space filemark(s)          35: load
 36: forward space record(s)            37: return error
 38: reverse space record(s)            39: test unit ready
 43: set media parms (block size)       44: set dev parms(compression)
 46: get device information             47: restore data
 48: get medium information             49: inquiry
 50: poll registered devices
 53: space EOD                          54: display message
========================================================================
 70: system command
========================================================================
 80: Force Dump                         81: Read Dump
 82: Update MicroCode                   83: Log Sense
 84: Get Last Sense                     85: Get Version
 86: Associative/Persistent WProtect    87: Read/Write Test
 88: List registered devices            89: Get MTDevice Info
========================================================================
 99: return to main menu
========================================================================
enter selection:
```

6. Change to Library mode by entering 8 (Example 3-17).

Example 3-17 Changing modes

```
========================================================================
enter selection: 8
Closing any open device before changing mode
Total elapsed time in seconds =     0.00
Return to continue:
```

7. Obtain the device names that will be used to set the device special file in the next step by entering 88 (Example 3-18).

Example 3-18 List registered devices

```
enter selection: 88
Device found: Tape0 @"Scsi Port 2\Scsi Bus 0\Target Id 0\Logical Unit Id 0"
Device found: Changer0 @"Scsi Port 2\Scsi Bus 0\Target Id 1\Logical Unit Id 1"
Device found: Tape1 @"Scsi Port 2\Scsi Bus 0\Target Id 1\Logical Unit Id 0"
Device found: Changer0 @"Scsi Port 2\Scsi Bus 0\Target Id 1\Logical Unit Id 1"
Total elapsed time in seconds =     0.00
Return to continue:
```

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8. Select 1: set device special file. Enter the name of the tape and library path displayed in the previous step. In this example, we use Tape0 and Changer0 (Example 3-19).

Example 3-19 Set special file

```
enter selection: 1
Enter device special file (tape path) name or return for no change: tape0
Enter device special file (changer path) name, or "def" for
default lun1 changer or return for no change: changer0
Total elapsed time in seconds =    10.00
Return to continue:
```

9. Enter 20 to open the tape device and Medium Changer. Enter 1 for read/write (RW) operations when prompted (Example 3-20).

Example 3-20 Open the library and tape devices

```
enter selection: 20
Enter open mode (1) RW (2) RO: 1
special file (\\.\tape0) will be opened
special file (\\.\changer0) will be opened
analyze() called with  rc 8 err 0 (ERROR_SUCCESS) data 0
Total elapsed time in seconds =     1.00
Return to continue:
```

10. Verify the connection by entering 49 (Example 3-21).

Example 3-21 Inquiry

```
enter selection: 49
Drive = 0, Library = 1: 1
Changer Path SCSI data:
  PortNumber 2, PathId 0
  TargetId   0, Lun    1
INQUIRY data:
  devtype(0):          08, rmb(1):           80
  ASO/ECMA/ANSI(2):    02, resp_data_fmt(3): 02
  additional_length(4): 33, reserved(5):     00
  SCSI_3(6):           20, flags(7):         00
  vendor_id (8-15): IBM
  product_id (16-31): ULT3582-TL
  Microcode Revision Level (32-35): 237B
  vendor specific (bytes 36-55):
     00 00 30 30 30 30 30 31 33 31 30 38 32 33 30 30 00 00 00 00
analyze() called with  rc 1 err 0 (ERROR_SUCCESS) data 0
Total elapsed time in seconds =     2.00
Return to continue:
```

11. Enter 82 from the menu to update the microcode.
12. Enter the name of the saved .lif file.
13. Enter 1 for the library.
14. Press Enter. Do not touch the drive until the firmware load has completed. During this time the library will reboot. The NTUTIL session will lose visibility to the library and will have to be restarted to enable communication (Example 3-22 on page 155).

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Example 3-22 Update library firmware

```
enter selection: 82
Enter microcode image name (1 to 8 characters), or return to skip: 370B_001.lif
Drive = 0, Library = 1: 1
Image size = 1442272
Transferring 65536 image bytes, total bytes = 65536
Transferring 65536 image bytes, total bytes = 131072
Transferring 65536 image bytes, total bytes = 196608
Transferring 65536 image bytes, total bytes = 262144
Transferring 65536 image bytes, total bytes = 327680
Transferring 65536 image bytes, total bytes = 393216
Transferring 65536 image bytes, total bytes = 458752
Transferring 65536 image bytes, total bytes = 524288
Transferring 65536 image bytes, total bytes = 589824
Transferring 65536 image bytes, total bytes = 655360
Transferring 65536 image bytes, total bytes = 720896
Transferring 65536 image bytes, total bytes = 786432
Transferring 65536 image bytes, total bytes = 851968
Transferring 65536 image bytes, total bytes = 917504
Transferring 65536 image bytes, total bytes = 983040
Transferring 65536 image bytes, total bytes = 1048576
Transferring 65536 image bytes, total bytes = 1114112
Transferring 65536 image bytes, total bytes = 1179648
Transferring 65536 image bytes, total bytes = 1245184
Transferring 65536 image bytes, total bytes = 1310720
Transferring 65536 image bytes, total bytes = 1376256
Transferring 65536 image bytes, total bytes = 1441792
Transferring 480 image bytes, total bytes = 1442272
Waiting for tape device to write flash-prom
Do not touch drive until complete
analyze() called with rc 1 err 0 (ERROR_SUCCESS) data 0
Total elapsed time in seconds =   1894.00
Return to continue:
```

The output indicates the firmware update was successful (ERROR_SUCCESS), as shown in Example 3-23. To verify that the firmware installed correctly, at the LTO tape library operator console, follow the instructions for your library listed in 3.7.2, “Check the installed firmware” on page 150 and check if the version shown is the same as the firmware version used to update the library.

Example 3-23 Firmware version

```
(C) 2003 IBM

SerNum:xxxxxxx
Version:370B
```

Upgrading drive firmware using NTUTIL

The following procedure describes how to update the drive firmware over the SCSI bus using the NTUTIL utility.

1. Download the latest drive firmware (xxxx.zip) to a local directory from either of these sites:

   http://www-1.ibm.com/servers/storage/support/lto/
   ftp://ftp.software.ibm.com/storage/

2. If you have an application device driver other than the IBM tape device driver, you will need to stop it and start the IBM tape device driver. NTUTIL will only work with this device driver, so you need to install it if you have not already done so. You also have to stop RSM if started. You will find the RSM under **Start** → **Settings** → **Control Panel** → **Administrative Tools**.
3. Open an NTUTIL session on a command line from the directory where the library firmware image was saved, by typing `NTUTIL` at a command prompt.
4. Select 1: manual test (Example 3-24).

Example 3-24 NTUTIL main menu

```
Main Menu:
Microsoft Windows 2003 version
==========
1: Manual test
  2: Batch  test
  9: Exit ntutil
Enter selection:
```

5. Open the device by entering 20 (Example 3-25).

Example 3-25 Open tape device

```
enter selection: 20
Enter open mode (1) RW (2) RO: 1
special file (\\.\tape0) will be opened
analyze() called with  rc 6 err 0 (ERROR_SUCCESS) data 0
Total elapsed time in seconds =     8.00
Return to continue:
```

6. Select read/write operations 1.
7. Update the microcode by entering 82.
8. Enter the name of the *.ro file.
9. Press Enter. Do not touch the drive until the firmware load has completed (Example 3-26).

Example 3-26 Update firmware

```
enter selection: 82
Enter microcode image name (1 to 8 characters), or return to skip: 53Y2L2F.ro
Image size = 1048576
Transferring 65536 image bytes, total bytes = 65536
Transferring 65536 image bytes, total bytes = 131072
Transferring 65536 image bytes, total bytes = 196608
Transferring 65536 image bytes, total bytes = 262144
Transferring 65536 image bytes, total bytes = 327680
Transferring 65536 image bytes, total bytes = 393216
Transferring 65536 image bytes, total bytes = 458752
Transferring 65536 image bytes, total bytes = 524288
Transferring 65536 image bytes, total bytes = 589824
Transferring 65536 image bytes, total bytes = 655360
Transferring 65536 image bytes, total bytes = 720896
Transferring 65536 image bytes, total bytes = 786432
Transferring 65536 image bytes, total bytes = 851968
Transferring 65536 image bytes, total bytes = 917504
Transferring 65536 image bytes, total bytes = 983040
Transferring 65536 image bytes, total bytes = 1048576
================================================================
Waiting for tape device to write flash-prom
```

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```
Do not touch drive until complete (Avg 45 - 50 sec)
Microcode updated, standby for the drive to initialize
analyze() called with  rc 1 err 0 (ERROR_SUCCESS) data 0
Total elapsed time in seconds =    97.00
Return to continue:
```

10. The `rc 1 err 0 (ERROR_SUCCESS)` message will be displayed after a successful download, and just above it, the instruction to exit NTUTIL and reboot the drive.

3.7.3 Upgrading the drive firmware using ITDT

The IBM Total Storage Diagnostic Tool (ITDT) is a tool that scans the SCSI bus for any attached tape drive and will reflect the firmware of the tape drive.

This tool can also be used for testing the drive and collecing a drive dump for error analyses by the IBM Support Centers. The big advantage of using ITDT is that it is working device driver independent, which means that whatever device driver is installed (IBM or non-IBM device drivers), the library and the drives can be tested or the firmware can be updated or a drive dump can be made.

At the time of writing, ITDT is supported for the following Operating Systems: Microsoft Windows Server 2000 with SP4 (32-bit IX86), Microsoft Windows Server 2003 (32-bit IX86), AIX 5L V5.2 and V5.3 (64-bit pSeries), Linux systems with Kernel 2.4 and 2.6, glibc 2.2.5 and later (32-bit IX86), Linux systems with Kernel 2.4 and 2.6, glibc 2.2.5 and later (64-bit pSeries), Solaris Version 9 and 10 (64-bit SPARC), HP-UX Version 11.xx (PA-RISC and Itanium), and i5/OS V5.3 (iSeries). The ITDT can be downloaded from this Web site:

`ftp://index.storsys.ibm.com/358x/tools/`

In the readme file, there is installation instruction as well instructions about how to use ITDT.

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4

Basic IBM tape setup for Linux

This chapter provides detailed information about the basic setup of the IBM tape drives and libraries on Linux on Intel and zSeries® platforms. This includes:

- Linux native tape driver usage
- IBM tape device driver installation
- Host Bus Adapter driver configuration

At the end of this chapter, you should be able to understand and implement the tasks required to:

- Install the required device drivers.
- Verify and use the IBM tape device.
- Configure the required Host Bus Adapter drivers.

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4.1 Hardware and software requirements

IBM LTO devices on Linux are supported on Intel, System p, and System z platforms.

Up-to-date information about supported Linux and LTO hardware and software configurations can be found at:

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

Be sure to check the Web site for supported operating system versions, kernel levels, adapters, and device drivers.

4.2 Installing library and tape device drivers

After physically installing and connecting your IBM tape drive or library to your environment, the next step in the basic implementation of the IBM tape library and drives is to make the devices accessible for your operating system.

In Linux, you can choose to use either the IBM tape drivers or the native Linux drivers to access the tape drive and library devices.

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. This means that you should use the IBM tape device drivers wherever this is possible. Nevertheless, you can use the Linux native drivers when that is required for your solution.

Note: IBM tape drives and libraries are usually used with vendor-provided software applications. These may work with the IBM-provided device drivers, their own provided device drivers, or even native operating system device drivers for the tape drive and medium changer (or 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 the following sections, we show how to give access to the functions required for basic tape operations (such as backup and restore) and medium changer operations (such as cartridge mount and dismount).

For more information and specific installation instructions for every platform, refer to the *IBM TotalStorage Tape Device Drivers Installation and User's Guide*, GC35-0154, which can be downloaded from:

ftp://ftp.software.ibm.com/storage/devdrvr/Doc/

In addition, there are several files in the IBM tape device driver download directory that provide additional information regarding the use of IBM tape drives and libraries with Linux. See these at:

ftp://ftp.software.ibm.com/storage/devdrvr/Linux/

We recommend reading at least IBMtape_Ultrium.ReadMe's for LTO or IBMtape_359x.ReadMe for IBM TS1120, IBMtape.fixlist, and LinuxNative.pdf. The Readme files are located in the relevant OS folders.

The IBMtapeutil.ReadMe and IBMtapeutil.fixlist files contain additional information for the users of IBMtapeutil for particular versions and levels of Linux. The LinuxNative.pdf file contains hints and tips about using the native device drivers and standard Linux commands, such as **mt** or **tar**.

The device drivers allow the operating system and the application software to interface with 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*. The special device file name is the name used to address the tape or media changer device (see Table 4-1 for more information).

Table 4-1 Special device file names used with Linux

	Native Linux device drivers	Native Linux device drivers with scsidev	IBM tape device drivers
Medium changer	/dev/sg[0-32]	/dev/scsi/sgh0-0c0i1l0	/dev/IBMchanger[0-32]
Tape device	/dev/st[0-32] /dev/nst[0-32] /dev/sg[0-32]	/dev/scsi/sth0-0c0i1l0 /dev/scsi/nsth0-0c0i1l0 /dev/scsi/sgh0-0c0i1l0	/dev/IBMtape[0-32] /dev/IBMtape[0-32]n

4.3 Using IBM tape device driver

The IBM tape device driver is certified specifically to a particular Linux distribution and kernel versions. If you want to use a kernel version that is not supported by the IBM tape device driver, you will need to use the native Linux device driver.

4.3.1 Installing the IBM tape device driver and utilities

The IBM tape device driver for Linux can be downloaded from the following site or one of its mirror sites:

ftp://ftp.software.ibm.com/storage/devdrvr/Linux/

Find the sub-directory corresponding to your Linux distribution and version. The driver comes in an RPM package in the form Lin_tape-x.x.x-y.y.y.-y.zzzz.rpm.bin or IBMtape-x.x.x-y.y.y.-y.zzzz.rpm.bin, where x.x.x is the version of the driver itself, y.y.y-y is the version of the Linux kernel that it supports, and zzzz is the type of the machine. Both of Lin_tape and IBMtape are IBM tape device drivers; the first one is open source and the later one is closed source.

You also need to download, from the same directory, the **IBMtapeutil** program (which includes the **IBMtapeconfig** tool). **IBMtapeutil** provides a comprehensive collection of tape and library commands. The IBMtapeutil utilities exist in a separate tar package from the device driver. The package is called IBMtapeutil.*x.x.x*.zzzz.tar.bin.

We are installing the IBM tape device driver in the following environment:

- IBM System x 335 server with RHAS 4 64-bit
- QLogic QLA2342 64-bit PCI Fibre Channel HBA
- IBM System Storage TS3200 server with native FC drives

Example 4-1 shows the installation of the IBM tape device driver. Details can also be found in the *IBM Tape Device Drivers: Installation and User's Guide*, GC27-2130, available at:

ftp://index.storsys.ibm.com/devdrvr/Doc/

To install the device driver, use **rpm**.

Example 4-1 Installing IBM tape device driver

```
# rpm -i IBMtape-3.0.5-2.6.9-42.EL.x86_64.rpm
Installing IBMtape
IBMtape loaded
```

If you are running the IBM tape device driver, V1.4.1 or higher, and the IBMtaped daemon is running, IBMtaped will automatically create the special files under the /dev directory for you. In our case, the IBMtaped started automatically. Otherwise, you need to run **IBMtapeconfig** to manage the creation of special files for the attached devices.

The following two commands, shown in Example 4-2, allow you to view the devices (tape drives and changer) created by the IBMtape device driver:

```
cat /proc/scsi/IBMtape
cat /proc/scsi/IBMchanger
```

Example 4-2 Viewing devices created by IBMtaped

```
# cat /proc/scsi/IBMtape
IBMtape version: 3.0.5
IBMtape major number: 252
Attached Tape Devices:
Number  Model       SN              HBA                     FO Path
0       ULT3580-TD4 1300000979      qla2xxx                 NA
1       ULT3580-TD4 1300001012      qla2xxx                 NA

# cat /proc/scsi/IBMchanger
IBMtape version: 3.0.5
IBMtape major number: 252
Attached Tape Devices:
Number  Model       SN              HBA                     FO Path
0       3573-TL     000000000000_LL0  qla2xxx               NA
1       3573-TL     000000000000_LL0  qla2xxx               NA
```

To verify that the installation was successful, use the command **rpm -qs IBMtape**, as shown in Example 4-3. For a successful install, the status should show normal.

Example 4-3 Checking the status of the IBM Ultrium tape device driver

```
# rpm -qs IBMtape
normal        /etc/IBMtaped.conf
normal        /lib/modules/2.6.9-42.EL/kernel/drivers/scsi/IBMtape.ko
normal        /lib/modules/2.6.9-42.ELsmp/kernel/drivers/scsi/IBMtape.ko
normal        /usr/bin/IBMtaped
normal        /usr/bin/startIBMtape
normal        /usr/include/sys/IBM_tape.h
normal        /usr/share/doc/IBMtape-3.0.5
normal        /usr/share/doc/IBMtape-3.0.5/IBMtape_359X.ReadMe
normal        /usr/share/doc/IBMtape-3.0.5/IBMtape_Ultrium.ReadMe
normal        /usr/share/doc/IBMtape-3.0.5/IBMtaped.ReadMe
normal        /usr/share/doc/IBMtape-3.0.5/License
```

Archived

Now we can install IBMtapeutil package to test the communication between the operating system and the IBM tape library. Example 4-4 shows the installation of IBMtapeutil.

Example 4-4 IBMtapeutil installation

```
# tar -xvf IBMtapeutil.1.4.1.x86_64.tar
IBMtapeutil.1.4.1/
IBMtapeutil.1.4.1/IBMtapeutil
IBMtapeutil.1.4.1/IBMtapeconfig
IBMtapeutil.1.4.1/IBM_tape.h
IBMtapeutil.1.4.1/IBMtapeutil.c
IBMtapeutil.1.4.1/IBMtapeutil.ReadMe
IBMtapeutil.1.4.1/IBMtapeutil.h
IBMtapeutil.1.4.1/makefile

# make install
cp -f IBMtapeutil /usr/bin/.
cp -f IBMtapeconfig /usr/bin/.
```

Now we are ready to use the Ultrium tape and library devices with the IBM driver. Even if you plan to use the IBM Ultrium tape and library devices with the native Linux drivers, we recommend installing the IBM drivers to allow microcode updates of the IBM Ultrium tape and library devices. If you are using a Linux kernel version that is not supported by the IBM drivers, we recommend installing a supported kernel as an alternative boot kernel for this purpose.

Example 4-5 shows the initial invocation screen for **IBMtapeutil**.

Example 4-5 Start screen of IBMtapeutil

```
IBMtapeutil for Linux, Version 1.4.1, Jan. 03, 2007
=========================================
         1. Tape
         2. Changer
         3. Quit
=========================================

Enter your choice:
```

Example 4-6 shows the general SCSI commands as well as the tape-specific commands that are available through **IBMtapeutil**.

Example 4-6 Tape command selection screen of IBMtapeutil for Linux

```
------------------------- General Commands: -----------------------------
    1. Open a Device                 9. Mode Sense Pag
    2. Close a Device               10. Switch Tape/Changer Devic
    3. Inquiry                      11. Create Special Files
    4. Test Unit Ready              12. Query Driver Version
    5. Reserve Device               13. Query Device Path
    6. Release Device               14. Display All Paths
    7. Request Sense                15. Enable A Path
    8. Log Sense Page               16. Disable A Path
    Q. Quit IBMtapeutil
-------------------------- Tape Commands: -------------------------------
   20. Rewind                       33. Set Block Size
   21. Forward Space Filemarks      34. Retension Tape
   22. Backward Space Filemarks     35. Query/Set Tape Position
   23. Forward Space Records        36. Query Tape Status
   24. Backward Space Records       37. Load Tape
```

Archived

```
   25. FSFM                          38. Unload Tape
   26. BSFM                          39. Lock Tape Drive Door
   27. Space to End of Data          40. Unlock Tape Drive Door
   28. Read and Write Tests          41. Take Tape Offline
   29. Write Filemarks               42. Enable/Disable Compression
   30. Read or Write Files           43. Flush Drive's Buffer
   31. Erase                         44. Self Test
   32. Reset Drive                   45. Display Message
-------------------------- IBMtape Commands: ------------------------------
   46. Query Sense                   53. Read Tape Position
   47. Query Inquiry                 54. Query Mtdevice Number
   48. Query/Set Tape Parameters     55. Synchronize Buffers
   49. Query/Set Tape Position       56. List Tape Filemarks
   50. Query/Set MT/ST Mode          57. Query Encryption Status
   51. Report Density Support
   52. Locate Tape Position
-------------------------- Service Aid Commands: ------------------------
   70. Dump Device                   74. Read Persistent Reservation Keys
   71. Force Dump                    75. Read Persistent Reservations
   72. Load Ucode                    76. Register Persistent Reservation Key
   73. Reset Drive                   77. Remove Persistent Reservation
                                     78. Clear All Persistent Registrations
--------------------------------------------------------------------------
   99. Back To Main Menu

Enter Selection:
```

Example 4-7 shows, as an example of using **IBMtapeutil**, how a SCSI inquiry command can be sent to the tape device.

Example 4-7 Sending a SCSI inquiry command to an LTO tape drive with IBMtapeutil

```
Enter Selection: 1

Enter device name (<enter> for /dev/IBMtape0):
Select mode (<enter> or 1=Read/Write, 2=Read Only, 3=Write Only, 4=Append): 1

Opening device...

Hit <enter> to continue...
(...)

Enter Selection for /dev/IBMtape0: 3

Enter page code in hex or <enter> for standard inquiry:
Issuing inquiry...

Inquiry Data:
Peripheral Qualifier------------------0x00
Peripheral Device Type----------------0x01
Removal Medium Bit--------------------1
Device Type Modifier------------------0x00
ISO version---------------------------0x00
ECMA version--------------------------0x00
ANSI version--------------------------0x03
Asynchronous Event Notification Bit---0
Terminate I/O Process Message Bit-----0
Response Data Format------------------0x02
Additional Length---------------------0x35
Medium Changer Mode-------------------0x00
```

Archived

```
Relative Addressing Bit---------------0
32 Bit Wide Data Transfers Bit--------0
16 Bit Wide Data Transfers Bit--------0
Synchronous Data Transfers Bit--------0
Linked Commands Bit-------------------0
Command Queueing Bit------------------1
Soft Reset Bit------------------------0
Vendor ID-----------------------------IBM
Product ID----------------------------ULT3580-TD4
Product Revision Level----------------71G0

vendor1,  Length 20

           0 1  2 3  4 5  6 7  8 9  A B  C D  E F   0123456789ABCDEF
    0000 - 0000 0000 0000 0000 0000 0000 0000 2030  [.............. 0]
    0010 - 0000 0000                                [....           ]


vendor2,  Length 31

           0 1  2 3  4 5  6 7  8 9  A B  C D  E F   0123456789ABCDEF
    0000 - 0000 0000 0000 0000 0000 0000 0000 0000  [................]
    0010 - 0000 0000 0000 0000 0000 0000 0000 00    [............... ]


Hit <enter> to continue...
Enter Selection for /dev/IBMtape0: 2

Device closed...
```

Example 4-8 shows that a similar set of commands are available to interact with the tape library (Option 2 from the start screen in Example 4-5 on page 163).

Example 4-8 Library command selection screen of IBMtapeutil for Linux

```
------------------------- General Commands: -----------------------------
    1. Open a Device                9. Mode Sense Pag
    2. Close a Device               10. Switch Tape/Changer Devic
    3. Inquiry                      11. Create Special Files
    4. Test Unit Ready              12. Query Driver Version
    5. Reserve Device               13. Query Device Path
    6. Release Device               14. Display All Paths
    7. Request Sense                15. Enable A Path
    8. Log Sense Page               16. Disable A Path
    Q. Quit IBMtapeutil
------------------------ Medium Changer Commands: ----------------------
   60. Element Information          65. Load/Unload Medium
   61. Position To Element          66. Initialize Element Status
   62. Element Inventory            67. Prevent/Allow Medium Removal
   63. Exchange Medium              68. Initialize Element Status Range
   64. Move Medium                  69. Read Device Identifiers
------------------------- Service Aid Commands: -------------------------
   70. Dump Device                  72. Load Ucode
   71. Force Dump                   73. Reset Drive
-------------------------------------------------------------------------
   99. Back To Main Menu

Enter Selection:
```

Archived

Example 4-9 shows how the Ultrium Tape Library Medium Changer answers to a SCSI inquiry command.

Example 4-9 Sending a SCSI inquiry command to an LTO library with IBMtapeutil

```
Enter Selection: 1

Enter device name (<enter> for /dev/IBMchanger0):
Opening device...

Hit <enter> to continue...
(...)

Enter Selection for /dev/IBMchanger0: 3


Enter page code in hex or <enter> for standard inquiry:
Issuing inquiry...

Inquiry Data:
Peripheral Qualifier-------------------0x00
Peripheral Device Type----------------0x08
Removal Medium Bit---------------------1
Device Type Modifier-------------------0x00
ISO version----------------------------0x00
ECMA version---------------------------0x00
ANSI version---------------------------0x05
Asynchronous Event Notification Bit---0
Terminate I/O Process Message Bit-----0
Response Data Format-------------------0x02
Additional Length----------------------0x45
Medium Changer Mode--------------------0x00
Relative Addressing Bit----------------0
32 Bit Wide Data Transfers Bit--------0
16 Bit Wide Data Transfers Bit--------0
Synchronous Data Transfers Bit--------0
Linked Commands Bit--------------------0
Command Queueing Bit-------------------1
Soft Reset Bit-------------------------0
Vendor ID-----------------------------IBM
Product ID----------------------------3573-TL
Product Revision Level----------------3.04

vendor1,  Length 20

          0 1  2 3  4 5  6 7  8 9  A B  C D  E F   0123456789ABCDEF
    0000 - 4759 3030 3030 3030 3030 3030 3030 0000  [GY000000000000..]
    0010 - 0000 0001                                [....           ]


vendor2,  Length 31

          0 1  2 3  4 5  6 7  8 9  A B  C D  E F   0123456789ABCDEF
    0000 - 0000 0000 0000 0000 0000 0000 0000 0000  [................]
    0010 - 0000 0000 0000 0000 0000 0000 0000 00    [............... ]


Hit <enter> to continue...
(...)

Enter Selection for /dev/IBMchanger0: 2
```

```
Device closed...
```

4.3.2 Creating a library device table

Operating system device names may not necessarily reflect the same order as the devices physically installed in the library. Therefore, check your drive configuration carefully. We recommend creating a table like Table 4-2.

Table 4-2 Library device table

Device name	Serial number/WWN	Tape drive in the library	SCSI element address
IBMtape0	1300000979	Drive 2	257
IBMtape1	1300001012	Drive 1	256

Here are some ways to create this table:

- “Check the /proc/scsi/IBMtape file” on page 167
- “Issue IBMtapeutil inqpage command” on page 168

You should keep in mind that rebooting the server or executing the **IBMtapeconfig** command will refresh the list. You should also refer to 5.3, “Persistent binding” on page 194 to understand how the operating system assigns device special file names, and how to keep them persistent across reboots.

Check the /proc/scsi/IBMtape file

In this section, we discuss the /proc/scsi/IBMtape file.

In Example 4-10, we have two LTO Ultrium 4 drives, /dev/IBMtape0 and /dev/IBMtape1, with the serial numbers as shown. Compare the serial number to the number written on the drives in the library. You may also determine the serial by correlating the SCSI element address on the medium changer using the command:

```
IBMtapeutil -f /dev/IBMchangerX devids
```

Example 4-11 on page 168 shows the output of this command.

Example 4-10 Verify the device by checking the serial number in the /proc/scsi/IBMtape file

```
# cat /proc/scsi/IBMtape
IBMtape version: 3.0.5
IBMtape major number: 252
Attached Tape Devices:
Number  Model       SN                HBA                             FO Path
0       ULT3580-TD4 1300000979        qla2xxx                         NA
1       ULT3580-TD4 1300001012        qla2xxx                         NA
```

Example 4-11 The tapeutil devids command output sample

```
# IBMtapeutil -f /dev/IBMchanger0 devids
Reading element device ids...

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 Vaild ......... No
  Logical Unit Number Valid ...... No

Device ID,  Length 34

           0 1  2 3  4 5  6 7  8 9  A B  C D  E F   0123456789ABCDEF
    0000 - 4942 4D20 2020 2020 554C 5433 3538 302D  [IBM     ULT3580-]
    0010 - 5444 3420 2020 2020 3133 3030 3030 3130  [TD4     13000010]
    0020 - 3132                                     [12              ]


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

Device ID,  Length 34

           0 1  2 3  4 5  6 7  8 9  A B  C D  E F   0123456789ABCDEF
    0000 - 4942 4D20 2020 2020 554C 5433 3538 302D  [IBM     ULT3580-]
    0010 - 5444 3420 2020 2020 3133 3030 3030 3039  [TD4     13000009]
    0020 - 3739                                     [79              ]
```

Issue IBMtapeutil inqpage command

Another method to verify a device is to issue an **IBMtapeutil** inquiry on log sense page 0x80. This command will return a serial number for the device represented by the specified device special file. Compare the number to the number written on the drives, or to the number returned by the **IBMtapeutil devids** command:

```
IBMtapeutil -f /dev/IBMtapeX inqpage 80
```

Example 4-12 on page 169 shows that /dev/IBMtape0 is a tape drive with the serial number of 1300000979.

Archived

Example 4-12 Verify the device by using the IBMtapeutil inqpage command

```
# IBMtapeutil -f /dev/IBMtape0 inqpage 80
Issuing inquiry for page 0x80...

Inquiry Page 0x80,  Length 14

           0 1  2 3  4 5  6 7  8 9  A B  C D  E F   0123456789ABCDEF
    0000 - 0180 000A 3133 3030 3030 3039 3739      [....1300000979  ]
```

4.3.3 Uninstalling the tape device driver and utilities

If you need to uninstall the IBM tape device driver from the Linux system, this can be done as shown in Example 4-13.

Example 4-13 Uninstalling the IBM tape device driver and utilities

```
# rpm -qa IBMtape
IBMtape-3.0.5-0
# rpm -e IBMtape-3.0.5-0

# cd IBMtapeutil.x.x.x
# make uninstall
rm -f /usr/bin/IBMtapeutil
rm -f /usr/bin/IBMtapeconfig
```

Note: All tape devices that use the IBMtape driver must be closed and cannot be in use when IBMtape is uninstalled or the uninstall fails.

4.3.4 Setting up control path failover on Linux

The Linux IBM tape device driver control path failover 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.

For example, consider a simple multipath connection that consists of two Host Bus Adapters (HBAs), which are connected to a library with two drive control ports enabled. The first HBA is connected to the first control port drive, and the second HBA is connected to the second control port drive. This connection provides two physical control paths to the same library for redundancy.

When the HBA device drivers are loaded into the running system, each HBA detects a control path to the same library, and two logical devices can be created (for example, /dev/IBMchanger0 and /dev/IBMchanger1) by the IBMtaped daemon or the IBMtapeconfig script. Each logical device represents a physical path to the same library. An application can open and use only one logical device at a time, either IBMchanger0 or IBMchanger1, because they represent the same physical device. Without the IBMtape control path failover support, if an application opens IBMchanger0 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 a manual failover by restarting the application on the alternate logical device (IBMchanger1), but the failed transaction has to be restarted from the beginning.

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When the data path failover 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 IBMchanger0 or IBMchanger1). If an application opens IBMchanger0 and a permanent path error occurs, the device driver initiates failover error recovery automatically on the alternate path (IBMchanger1). If successful, the current operation continues on the alternate path without interrupting the application.

Important: The library Control Path Failover FC1680 must be installed and enabled on the library (IBM 3582, and 3583) and FC1682 on the libraries IBM TS3200, TS3310, and TS3500 in order for the Linux IBM tape 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 TotalStorage Specialist. For instructions on enabling the control path through these interfaces, see 3.3.3, “Configuring and unconfiguring Data Path Failover” on page 113.

Enabling/disabling control path failover support

Control path failover support is not enabled automatically when the device driver is installed. The Linux IBM tape device driver provides a driver parameter alternate_pathing for you to enable the library control path failover.

To enable the failover support in the IBM tape device driver software, you need to do the following after installing the IBM tape device driver RPM package:

1. Stop the IBMtaped daemon:

   ```
   IBMtaped stop
   ```

2. Unload the IBMtape driver from the memory:

   ```
   rmmod IBMtape
   ```

3. Add the following line in your /etc/modules.conf file for the 2.4 kernel or /etc/modprobe.conf.local file for the 2.6 kernel file:

   ```
   options IBMtape alternate_pathing=1
   ```

4. Run **depmod**.

5. Re-load the IBMtape driver into memory:

   ```
   modprobe IBMtape
   ```

6. Re-start the IBMtaped daemon:

   ```
   IBMtaped
   ```

   You may ignore the `Unresolved symbols in /lib/modules/<your kernel name>/drivers/scsi/IBMtape.o` message after the **depmod** command.

You can check if the IBMtape driver has recognized multiple control paths for your library by reading the /proc/scsi/IBMchanger file. If your library lists Primary or Alternate under the FO Path, as in Example 4-14 on page 171, then you have successfully enabled the control path failover feature for your library. If NA is listed under the FO Path, then the control path failover is not enabled.

When IBMtape is loaded into kernel memory, the first logical medium changer device that IBMtape sees in the system will be the primary path for that medium changer. The other logical medium changers that IBMtape 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 4-14 An example of the /proc/scsi/IBMchanger file

```
[root@saab root]# cat /proc/scsi/IBMchanger
IBMtape version: 1.4.11
IBMtape major number: 253
Attached Changer Devices:
Number  Model       SN              HBA                          FO Path
0       ULT3583-TL  IBM1234567      QLogic Fibre Channel 2200    Primary
1       ULT3583-TL  IBM1234567      QLogic Fibre Channel 2300    Alternate
2       ULT3583-TL  IBM1234567      QLogic Fibre Channel 2300    Alternate
```

Alternatively, you can display the primary and alternate path configuration for any device by running the following command:

```
IBMtapeutil -f /dev/IBMchangerx path
```

IBMchangerx is the logical name of any device.

After the alternate pathing support is enabled, it remains set until the IBMtape driver is reloaded 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 IBMtape device driver, execute the following steps:

1. Run **IBMtaped stop**.
2. Run **rmmod IBMtape**.
3. Delete the following line in your /etc/modules.conf file:

   ```
   options IBMtape alternate_pathing=1
   ```

4. Run **depmod**.
5. Run **modprobe IBMtape**.
6. Run **IBMtaped**.

Disabling and enabling primary and alternate control paths

Once you load the IBMtape device driver with the alternate_pathing parameter set ON, 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, you may run the following commands:

- **IBMtapeutil -f /dev/IBMchangerx path**

  This command is used to discover the number of this path.

- **IBMtapeutil -f /dev/IBMchangerx disablepath *number***

  The *number* will be the number of the path you want to disable.

- **IBMtapeutil -f /dev/IBMchangerx path**

  This command is used to make sure the path is labeled as “disabled”.

Correspondingly, in the /proc/scsi/IBMchanger file, the disabled path will be listed as Disabled under the FO Path column.

To enable a path from a disabled state, use the following command:

```
IBMtapeutil -f /dev/IBMchangerx enablepath number
```

The *number* will be the number of the path you want to enable.

4.3.5 Setting up data path failover on Linux

The Linux IBM tape device driver 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).

Note: These functions are supported only on IBM Ultrium 3 and 4 native Fibre Channel drives and IBM TS1120 tape drives.

Consider a simple multipath connection that consists of two Host Bus Adapters (HBA) in a Linux host that is connected through a switch to the tape drive. This connection provides two physical paths to same tape drive for redundancy if one path from an HBA to the drive fails.

When the HBA device driver is loaded into the running system, the HBA detects two logical devices of the tape drive. For example, /dev/IBMtape0 and /dev/IBMtape1 will be created by the IBMtaped daemon or the IBMtapeconfig script. 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 /dev/IBMtape0 or /dev/IBMtape1, because they represent the same physical device.

Without the data path failover support, if an application opens /dev/IBMtape0 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 (/dev/IBMtape1), 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 data path failover support is enabled on both /dev/IBMtape0 and /dev/IBMtape1, 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 /devIBMtape0 or /dev/IBMtape1). If an application opens /dev/IBMtape0 and a permanent path error occurs, the device driver initiates failover error recovery automatically on the alternate path (/dev/IBMtape1). 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, and 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.

Important: The library data path failover FC1681 must be installed on the library (IBM 3582 and 3583) and FC1682 on IBM TS3200, TS3310, and TS3500 Tape Libraries prior to enabling alternate data path support in the Linux IBM tape device driver for IBM Ultrium 3 and 4 drives. The feature code is not required for IBM TS1120 Enterprise drives.

Enabling/disabling data path failover and dynamic load balancing support

Data path failover and dynamic load balancing support for tape drives is not enabled automatically when the IBM tape device driver is installed. You will need to provide the data path failover feature key (required for Ultrium drives only) and enable the Linux IBM tape device driver parameter alternate_pathing.

To enable data path failover support in the IBMtape device driver software, you need to complete the following steps after installing the IBMtape RPM package:

1. Stop the IBMtaped daemon:

   ```
   IBMtaped stop
   ```

2. Unload the IBMtape driver from the memory:

   ```
   rmmod IBMtape
   ```

3. Add the following line to your /etc/modules.conf file for the 2.4 kernel or /etc/modprobe.conf.local file for the 2.6 kernel file:

   ```
   options IBMtape alternate_pathing=1 dpf_keys="abcdefghijklmnop"
   ```

   where “abckdefghijklmnop” is an example of a data path failover feature key. If you have multiple libraries and multiple data path failover feature keys, input your keys as follows:

   ```
   dpf_keys="key1;key2;..."
   ```

   Note that no feature key is required for 3592 drives.

4. Run **depmod**.

5. Re-load the IBMtape driver into memory:

   ```
   modprobe IBMtape
   ```

6. Re-start the IBMtaped daemon:

   ```
   IBMtaped
   ```

   You may ignore the Unresolved symbols in /lib/modules/<your kernel name>/drivers/scsi/IBMtape.o message after the **depmod** command.

7. You can check if the IBMtape driver has recognized multiple data paths for your library by reading the /proc/scsi/IBMtape file. If your library lists Primary or Alternate under the FO Path, as shown in Example 4-15, then you have successfully enabled the data path failover feature for your library. If NA is listed under the FO Path, then the data path failover feature is not enabled.

Example 4-15 An example of the /proc/scsi/IBMtape file

```
IBMtape version: 1.5.3
IBMtape major number: 253
Attached Tape Devices:
Number  Model      SN                HBA                             FO Path
0       ULT3583-TL  IBM1234567        QLogic Fibre Channel 2200       Primary
1       ULT3583-TL  IBM1234567        QLogic Fibre Channel 2300       Alternate
2       ULT3583-TL  IBM1234567        QLogic Fibre Channel 2300       Alternate
```

Alternatively, you can display the primary and alternate path configuration for any device by running the following command:

```
IBMtapeutil -f /dev/IBMtapex path
```

IBMtapex is the logical name of any device.

After the alternate pathing support is enabled, it remains set until the IBMtape driver is reloaded 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 data path failover feature in the IBMtape device driver, execute the following steps:

1. Run **IBMtaped stop**.
2. Run **rmmod IBMtape**.
3. Delete the following line in your /etc/modules.conf file:

   ```
   options IBMtape alternate_pathing=1
   ```

4. Run **depmod**.
5. Run **modprobe IBMtape**.
6. Run **IBMtaped**.

Disabling and enabling primary and alternate data paths

Once you load the IBMtape device driver with the alternate_pathing parameter to ON, 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, you may run the following commands:

- **IBMtapeutil -f /dev/IBMtapex path**

  This command is used to discover the number of this path.

- **IBMtapeutil -f /dev/IBMtapex disablepath *number***

  The *number* will be the number of the path you want to disable.

- **IBMtapeutil -f /dev/IBMtapex path**

  This command is used to make sure the path is labeled as “disabled”.

Correspondingly, in the /proc/scsi/IBMtape file, the disabled path will be listed as Disabled under the FO Path column.

To enable a path from a disabled state, run the following command:

```
IBMtapeutil -f /dev/IBMtapex enablepath number
```

The *number* will be the number of the path you want to enable.

4.4 Intel Linux Fibre Channel HBA installation

The following sections shows how to install the QLogic 2300 HBA in a Linux environment. The Linux kernels of the major distributions will often already contain a driver for this HBA; nevertheless, we will describe how the latest drivers can be integrated into a Linux kernel that does not contain the Fibre Channel drivers. This will be necessary in a case where you need to update the kernel or driver in your Linux environment.

Note: Newer HBAs use similar processes for installation and configuration. Refer to the manufacturer’s documentation for specifics.

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4.4.1 QLogic 23xx

The driver for the QLogic 23xx Fibre Channel adapter can be found at:

http://www.qlogic.com/support/ibm_page.html

Check carefully for the correct driver version related to the Linux and kernel version. The driver for the QLogic card comes as a source code tgz-archive. Download and unpack the .tgz file and follow the instructions in the Readme.qla2x00 for installation steps.

As always, it is a good idea to review all kernel settings and to keep a backup kernel that allows the machine to be rebooted in case anything goes wrong with the new kernel. If the new kernel boots successfully, the boot messages should look similar to the output in Example 4-16.

Example 4-16 Boot messages from the QLA2300 adapter

```
caddi:~ # dmesg
(...)
SCSI subsystem initialized
QLogic Fibre Channel HBA Driver (f918ba20)
ACPI: PCI interrupt 0000:01:02.0[A] -> GSI 18 (level, low) -> IRQ 18
qla2300 0000:01:02.0: Found an ISP2312, irq 18, iobase 0xf90f6000
qla2300 0000:01:02.0: Configuring PCI space...
qla2300 0000:01:02.0: Configure NVRAM parameters...
qla2300 0000:01:02.0: Verifying loaded RISC code...
qla2300 0000:01:02.0: LIP reset occurred (f7f7).
qla2300 0000:01:02.0: Waiting for LIP to complete...
qla2300 0000:01:02.0: LOOP UP detected (2 Gbps).
qla2300 0000:01:02.0: Topology - (F_Port), Host Loop address 0xffff
scsi0 : qla2xxx
qla2300 0000:01:02.0:
 QLogic Fibre Channel HBA Driver: 8.00.00
  QLogic QLA2340 - 133MHz PCI-X to 2Gb FC, Single Channel
  ISP2312: PCI-X (100 MHz) @ 0000:01:02.0 hdma-, host#=0, fw=3.03.01 IPX
  Vendor: IBM       Model: ULTRIUM-TD3       Rev: 54KC
  Type:   Sequential-Access                  ANSI SCSI revision: 03
qla2300 0000:01:02.0: scsi(0:0:0:0): Enabled tagged queuing, queue depth 32.
  Vendor: IBM       Model: 03584L32          Rev: 465u
  Type:   Medium Changer                     ANSI SCSI revision: 03
qla2300 0000:01:02.0: scsi(0:0:0:1): Enabled tagged queuing, queue depth 32.
  Vendor: IBM       Model: ULTRIUM-TD3       Rev: 54KC
  Type:   Sequential-Access                  ANSI SCSI revision: 03
qla2300 0000:01:02.0: scsi(0:0:1:0): Enabled tagged queuing, queue depth 32.
  Vendor: IBM       Model: ULTRIUM-TD3       Rev: 54KC
  Type:   Sequential-Access                  ANSI SCSI revision: 03
qla2300 0000:01:02.0: scsi(0:0:2:0): Enabled tagged queuing, queue depth 32.
Attached scsi tape st0 at scsi0, channel 0, id 0, lun 0
st0: try direct i/o: yes (alignment 512 B), max page reachable by HBA 1048575
Attached scsi tape st1 at scsi0, channel 0, id 1, lun 0
st1: try direct i/o: yes (alignment 512 B), max page reachable by HBA 1048575
Attached scsi tape st2 at scsi0, channel 0, id 2, lun 0
st2: try direct i/o: yes (alignment 512 B), max page reachable by HBA 1048575
Attached scsi generic sg0 at scsi0, channel 0, id 0, lun 0,  type 1
Attached scsi generic sg1 at scsi0, channel 0, id 0, lun 1,  type 8
Attached scsi generic sg2 at scsi0, channel 0, id 1, lun 0,  type 1
Attached scsi generic sg3 at scsi0, channel 0, id 2, lun 0,  type 1
(...)
```

All the devices found at the Fibre Channel are made available through a generic device entry (sgx). In Example 4-17, we can see how the **sg_scan** command displays the devices that are available.

Example 4-17 Showing all devices accessible through the FC HBA

```
caddi:~ # sg_scan -i
/dev/sg0: scsi0 channel=0 id=0 lun=0
    IBM       ULTRIUM-TD3       54KC [rmb=1 cmdq=1 pqual=0 pdev=0x1]
/dev/sg1: scsi0 channel=0 id=0 lun=1
    IBM       03584L32          465u [rmb=1 cmdq=1 pqual=0 pdev=0x8]
/dev/sg2: scsi0 channel=0 id=1 lun=0
    IBM       ULTRIUM-TD3       54KC [rmb=1 cmdq=1 pqual=0 pdev=0x1]
/dev/sg3: scsi0 channel=0 id=2 lun=0
    IBM       ULTRIUM-TD3       54KC [rmb=1 cmdq=1 pqual=0 pdev=0x1]
```

If more than one HBA is installed, there are three possibilities for handling the duplicate devices generated by multiple HBAs:

- Configure only one device representation in the backup application. The other representations can be used for a manual failover solution if the backup application provides an easy way to update the device definitions.
- Hide the remaining appearances through Switch Zoning on the FC switch.
- Assign a specific device to a specific host adapter through persistent binding. Refer to 5.3, “Persistent binding” on page 194 for more details.

While the first two alternatives are always possible, the third possibility depends on the capabilities of the FC device driver. Persistent binding is a function of the adapter and adapter device driver. Please check with the adapter vendor for support.

4.5 Using IBM tape driver in Linux on System z

IBM LTO drives and libraries can connect to Linux on System z using the Fibre Channel Protocol (FCP). Only Fibre Channel connectivity to IBM TSXXXX drives and libraries are supported when connecting to Linux on the System z platform.

Here are the requirements to enable FC connectivity to a native FC connected tape library only. This section assumes that the correct FICON adapter(s) have been installed and firmware has been loaded to enable the Fibre Channel Protocol on the FICON device. Figure 4-1 on page 177 shows a typical connectivity setup. For additional FCP connectivity information, refer to:

http://www-1.ibm.com/servers/eserver/zseries/connectivity/

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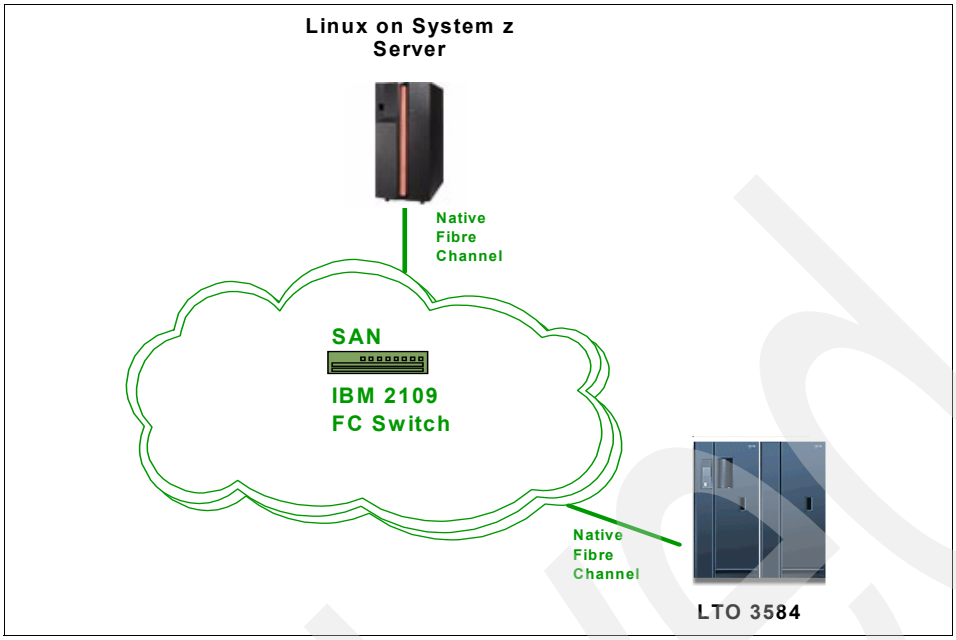


Figure 4-1 Typical Linux on System z SAN

The Fibre Channel topology supported for the System z models is fabric only. Neither point-to-point connection nor arbitrated loops are supported by the current System z Fibre Channel Protocol. Please see the IBM Redpaper *Getting Started with zSeries Fibre Channel Protocol*, REDP-0205, for more details on the supported configurations for Fibre Channel device attachment on System z models. This document can be downloaded from this Web site:

`http://www.redbooks.ibm.com/redpapers/pdfs/redp0205.pdf`

The Linux Fibre Channel adapter device driver zfcp is available in the kernel that supports the System z Fibre Channel Protocol. The zfcp device configuration methods in 2.6 and 2.4 kernels are different. For 2.6 kernels, see Chapter 5, “SCSI-over-Fibre Channel device driver“, in *Linux for zSeries and S/390: Device Drivers, Features, and Command*, *November 30, 2004*, LNUX-1403, found at:

`http://awlinux1.alphaworks.ibm.com/developerworks/linux390/docu/lx26apr04dd03.pdf`

For 2.4 kernels, there are three ways to load the zfcp device driver in order to see the attached tape devices:

- Create an /etc/zfcp.conf file and make a ramdisk to statically attach tape devices to your system. You may use this method only if you have a persistent mapping in a SAN environment. Every time you reboot the system, the zfcp will be automatically loaded and the tape devices can be seen from the system.
- Modify the /etc/modules.conf file to add the zfcp module parameters, and then run the **`depmod -A`** and **`modprobe zfcp`** commands. Please do not use this choice together with option 1, or it will cause conflicts. The zfcp map in /etc/modules.conf always takes higher priority than the map in /etc/zfcp.conf.
- Run the **`modprobe zfcp`** command first, then dynamically add a tape device into the system after you physically attach a Fibre Channel tape device to the switch.

These three options are described further in the following sections.

4.5.1 Use /etc/zfcp.conf file

First, you need to add the device map into this file. The following is an example of zfcp.conf:

```
0xf1c0 0x1:0x5005076300402733 0x0:0x0000000000000000;\
0xf1c1 0x1:0x5005076300402733 0x0:0x0001000000000000
```

The zfcp device driver uses the map module parameter to recognize a physically attached tape device. The map takes the following format:

```
map="<devno><port scsi-id>:<wwpn><unit-scsi-lun>:<fcp-lun>;
```

Where:

- devno: The device number of the HBA (16 bits, see /proc/subchannels). It is 0xf1c0 or 0xf1c1 in the above example.
- port scsi-id: The Linux internal SCSI ID assigned to the Fibre Channel port of the SCSI target device (32-bit, must not be 0, and must be a unique one-to-one mapping for each World Wide Port Name). It is 0x1 in the above example.
- wwpn: The World Wide Port Name that identifies the Fibre Channel port of the SCSI target device (64-bit). It is 0x5005076300402733 in the above example.
- unit scsi-lun: The Linux internal SCSI Logical Unit Number (32-bit). It is 0x0 in the above example.
- fcp-lun: The Logical Unit Number associated with the SCSI target device (64-bit). In the above example, 0x0000000000000000 is the Logical Unit Number 0, and 0x0001000000000000 is the Logical Unit Number 1.

We recommend, for tape attachment, that each LUN be associated with a unique devno. If you use the same devno numbers for several logical units, you should ensure that each <unit-scsi-lun> is unique.

After /etc/zfcp.conf is created, run the following commands:

```
>mk_initrd
>zipl
```

Reboot the system. After it is booted up, your tape device should be shown in the /proc/scsi/scsi file.

4.5.2 Modify the /etc/modules.conf file

You may add tape device mapping into /etc/modules.conf if you do not want to use /etc/zfcp.conf. The following example demonstrates the zfcp configuration in /etc/modules.conf:

```
options zfcp map="\
0xf1c0 0x1:0x5005076300402733 0x0:0x0000000000000000;\
0xf1c1 0x1:0x5005076300402733 0x0:0x0001000000000000"
```

The map arguments are the same as the ones listed for the /etc/zfcp.conf file.

After modifying /etc/modules.conf, save and close it. Then run the following commands:

```
>depmod -A
>modprobe zfcp
```

This will install the zfcp device driver and all of its prerequisite kernel modules.

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Now you can check the /proc/scsi/scsi file to see if all of the attached tape devices are shown in this file. If not, then check the Fibre Channel connection, such as the fibre cables, or if the devices are powered on, and so on.

Then run the following commands to install zfcp:

```
>rmmod zfcp
>modprobe zfcp
```

4.5.3 Dynamically attaching a tape device

If you physically attach a tape device on the switch and zfcp is already loaded, you do not need to reboot the Linux system to add this entry in the /proc/scsi/scsi file. The zfcp device driver provides an add_map proc system entry under the directory /proc/scsi/zfcp to allow you to dynamically add the device into the system. For example, to add two LUNs from the above example into the system, you may issue the following commands:

```
>echo "0xf1c0 0x1:0x5005076300402733 0x0:0x0000000000000000;\
0xf1c1 0x1:0x5005076300402733 0x0:0x0001000000000000">/proc/scsi/zfcp/add_map
>echo "scsi add-single-device 0 0 10">/proc/scsi/scsi
>echo "scsi add-single-device 1 0 11">/proc/scsi/scsi
```

The **scsi add-single-device** command takes four parameters, corresponding to the four parameters scsi, channel, id, and lun in the /proc/scsi/scsi file. The value of scsi is 0 for the first devno, 1 for the second devno (if it is different from the first devno), and so on. The value of channel can start from 0 for each different SCSI value. The value of id is the one you use for <unit scsi-lun> in the above mapping. The value of lun is the LUN of the target device, for example, the last number in the above mapping.

Currently, the zfcp device driver does not support dynamically removing the attached devices. If you need to remove the tape devices from the system, run **rmmod zfcp**. Then you can delete the entry in /etc/modules.conf and reload zfcp, or reload zfcp first and dynamically add the devices you want.

After you have done all the mapping, if you can see all of the attached tape devices in /proc/scsi/scsi, you have successfully attached those devices to your system. Refer to 4.3.1, “Installing the IBM tape device driver and utilities” on page 161 for details on installing the IBM Tape Device Drivers.

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5

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 also provide additional information about SAN setup for the IBM TotalStorage 3583 Tape Library and IBM TotalStorage 3584 Tape Library where necessary.

We assume the reader is already familiar with basic SAN concepts. For more information about general SAN concepts and design, please refer to these IBM Redbooks publications:

- *Designing an IBM Storage Area Network*, SG24-5758
- *IBM System Storage: 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

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5.1 SAN design considerations for IBM tape libraries

In this section, we cover the following IBM tape SAN design considerations:

- What bandwidth do we need for FC Tape?
- How do we 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.

5.1.1 What bandwidth do we need 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 high bandwidth, which 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/s and the IBM TS1120 with 104 MB/s, 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 Gb SAN is 200 MB/s. In reality, we typically see an effective data transfer rate of about 160 MB/s. In a 1 Gb SAN, we just see an effective data transfer rate of 80 MB/s.

Ultrium 3 drives have a sustained data transfer rate of 80 MB/s uncompressed, and 160 MB/s using 2:1 compression. In theory, this means you should be able to run two uncompressed tape drives or one compressed tape drive concurrently on an HBA without performance degradation.

However, the data transfer rates that will be 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 may get a transfer rate of up to 240 MB/s (Ultrium 4) or even more. In that case, you should only run one Ultrium 4 drive on one HBA. On the other hand, if writing small files or uncompressible files, then you may see transfer rates of less than 120 MB/s (Ultrium 4). In this case, more than one Ultrium 4 drive can be run together on one HBA. Nevertheless, we do not recommend that you try to work concurrently with more than two Ultrium 4 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 5-1 on page 183). 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, a FC link can sustain about 160 MB/s. An ISL may handle slightly more, but as already discussed, with one to two (depending on the data and compression) Ultrium 4 tape drives running simultaneously, you can overload one single 2 Gb ISL.

Overloaded ISLs or HBAs may 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 enlarge your bandwidth if you install additional HBAs and increase the number of ISLs.

Table 5-1 provides a rule of thumb for how many tape drives per HBA and ISL could run concurrently. Figure 5-1 shows a typical SAN layout with ISL between the servers and tapes.

Table 5-1 How many tape drives can run concurrently on HBA or ISL

Drives per HBA / ISL	per Drive	4 Gb	2 Gb
TS1120	104 MB/s	1 - 2	1
IBM LTO Gen4	120 MB/s	1 - 2	1
IBM LTO Gen4	80 MB/s	1 - 2 - 3	1 - 2

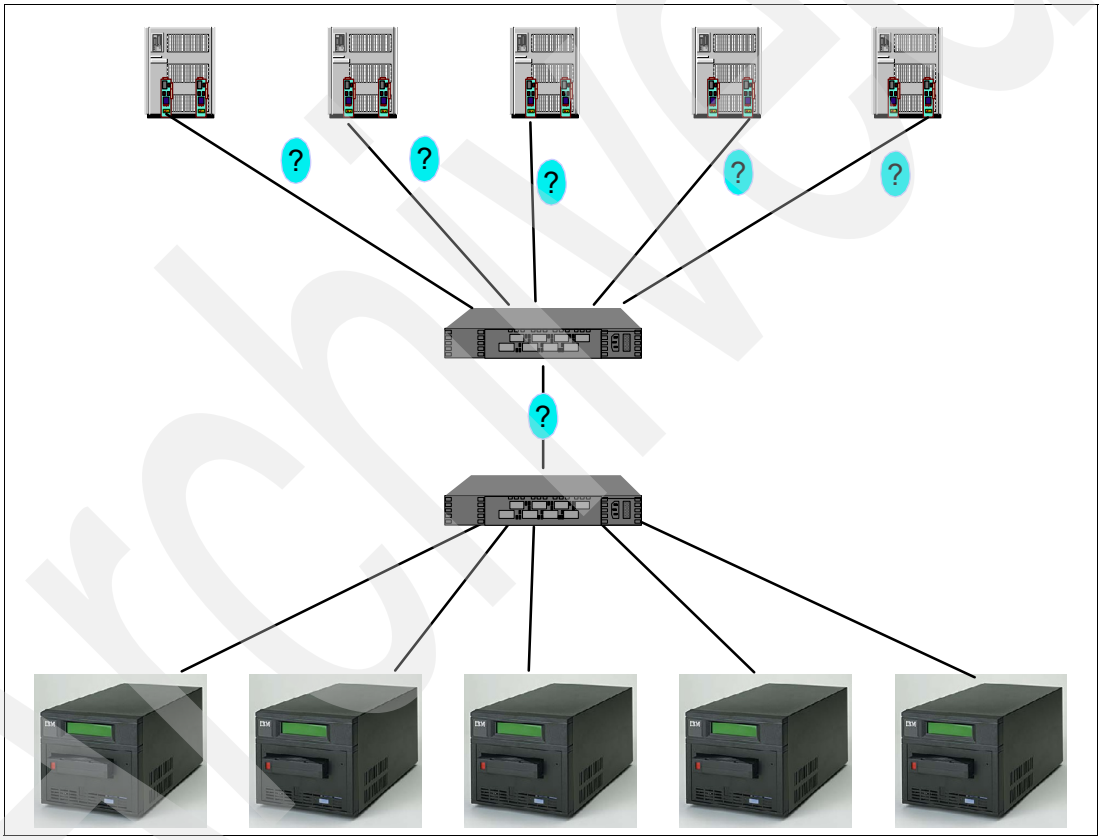


Figure 5-1 SAN Bandwidth for tape

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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 5-2) to bring up the Switch Management View.

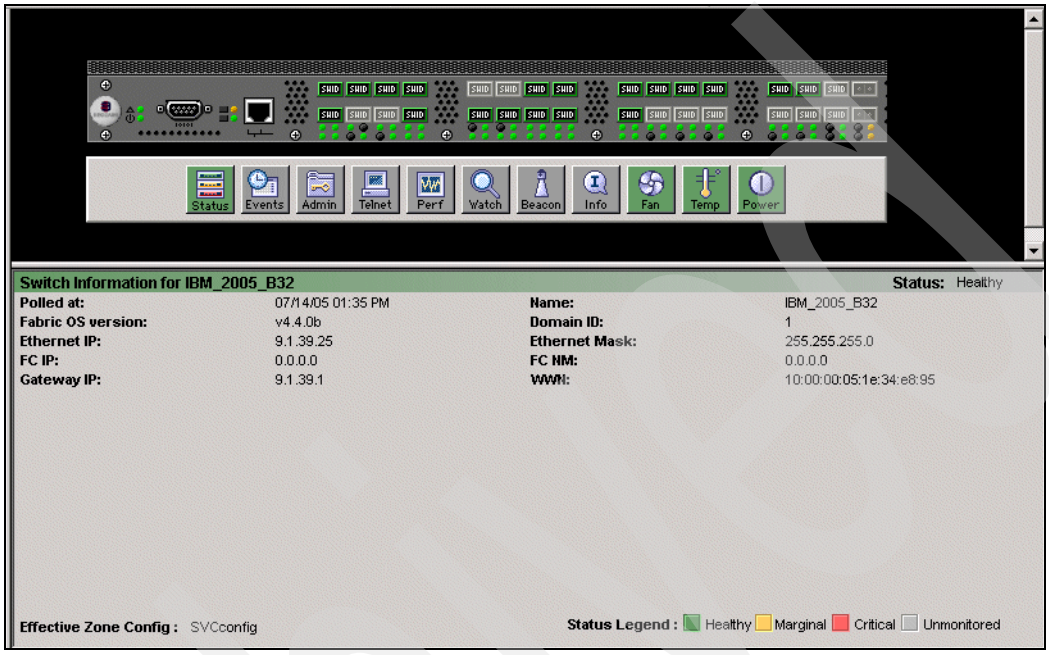


Figure 5-2 Switch Management window

You can also use the command-line interface on the IBM 2109 switches. Use the **portperfshow** command to show the data transfer rate on the switch.

5.1.2 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. Let us discuss this in the context of our lab configuration.

We have one System x server with two FC HBAs. These HBAs are connected to a SAN Fabric consisting of IBM 2109 switches. We have an IBM TS3500 Tape Library with two drives installed (see Figure 5-3 on page 185).

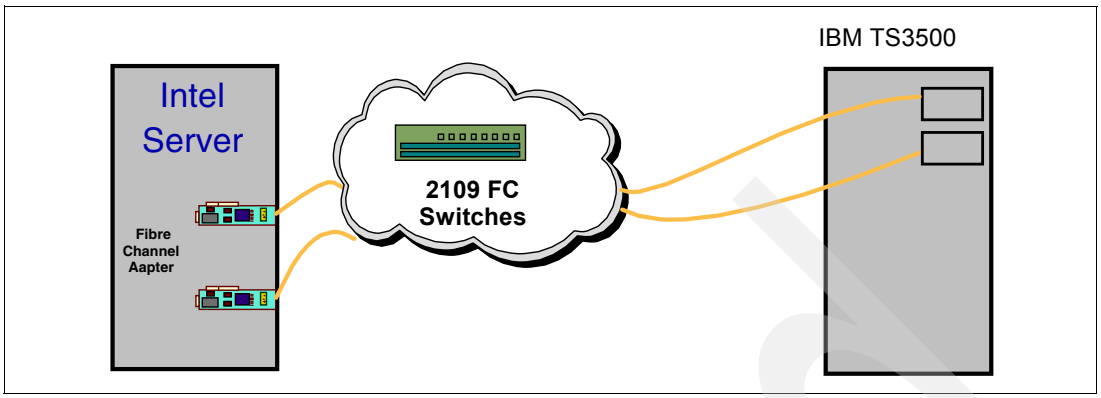


Figure 5-3 Our lab configuration

The IBM Ultrium drivers have been installed.

Boot the server to detect the new devices. To display the devices, select **Start** → **Settings** → **Control Panel** → **System** → **Hardware** → **Device Manager**. In Figure 5-4, you can see that the medium changer and two tape drives have been detected twice, once on each HBA in the 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.

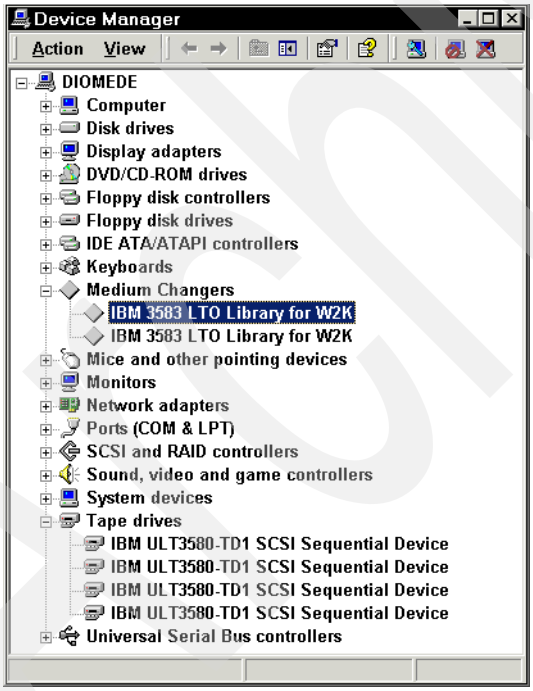


Figure 5-4 Device Manager

To solve this problem:

- You can enable zoning, which allows one HBA to see only certain tape drives.
- You can use persistent binding for the HBAs to see only certain WWN.
- You can use the alternate path function within the IBM tape device driver.

The different options are described in:

- 5.2, “Zoning” on page 190
- 5.3, “Persistent binding” on page 194
- 3.3, “Path failover” on page 107
- 4.3.4, “Setting up control path failover on Linux” on page 169

5.1.3 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 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 Fibre Channel, 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/s, then you have also to read 80 MB/s from the disk. With both data streams going through the same HBA, it means that the HBA must handle at least 160 MB/s (Figure 5-5 on page 187).

Important: IBM does not recommend sharing disk and tape I/O on the same HBA.

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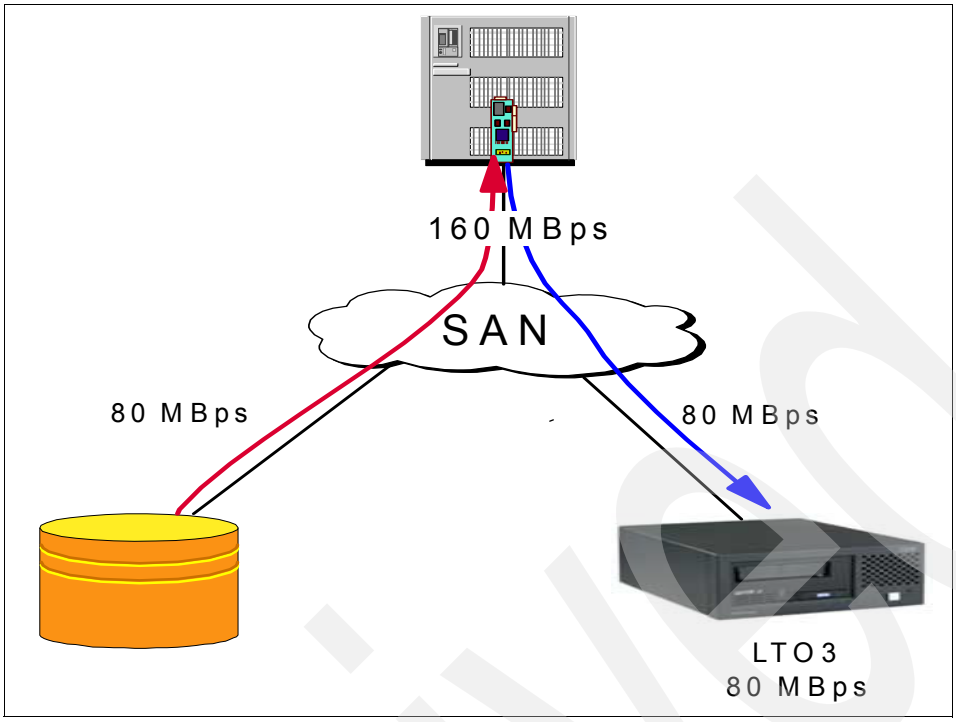


Figure 5-5 Tape and disk on the same HBA

As long as there is no other disk I/O activity during the backup operation, it may work without problems. But, if during the backup, other applications are running that also access the disk, performance will be impacted. Because disk access uses smaller blocksize 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 command 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 5-6 on page 188). This is especially true for backup servers using a disk storage pool (for example, 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 (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.

Note: Monitor your environment over time, and when traffic grows, consider the installation of additional HBAs.

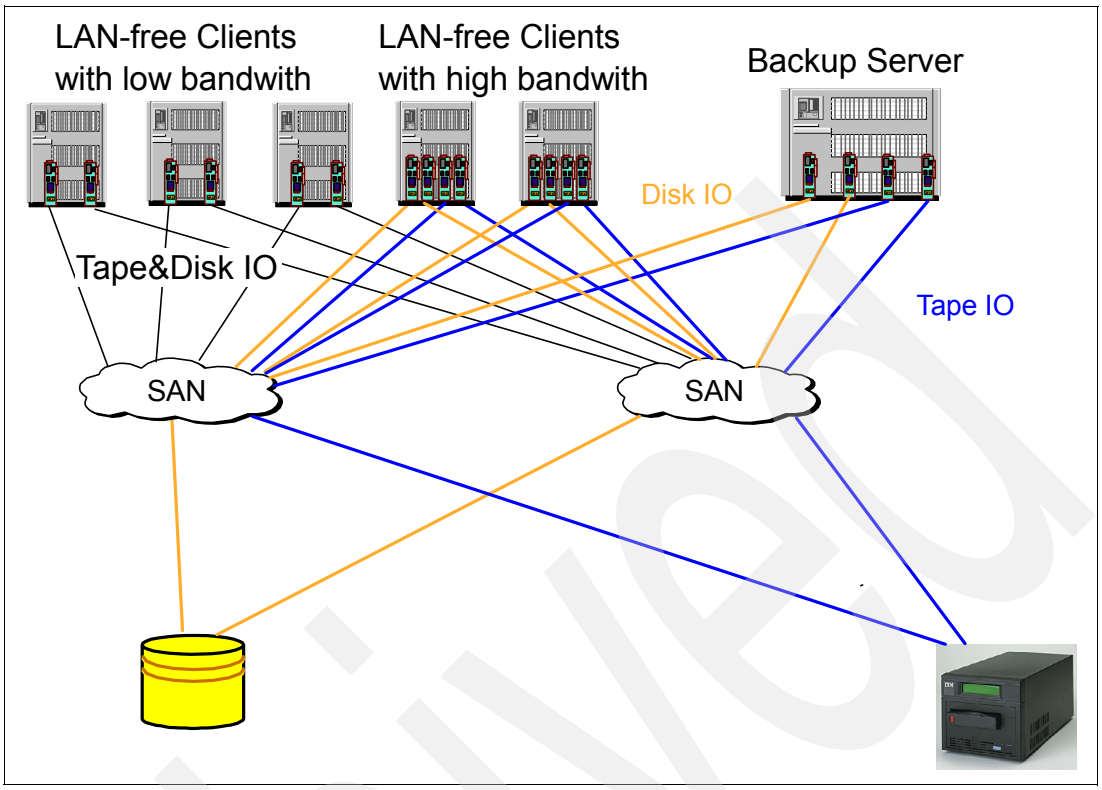


Figure 5-6 SAN example for backup

If you cannot avoid combining disk and tape I/O (for example, 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 5.3, “Persistent binding” on page 194).
- Disable SCSI Bus Reset to tape devices, if possible.
- Enable PLOGI instead of PDISC after LIP.
- Design your SAN for high bandwidth, as high bandwidth is needed for tape I/O.
- Do not overload the HBA. Provide enough HBAs, as described in 5.1.1, “What bandwidth do we need for FC tape” on page 182.
- Pay attention to the PCI bus performance (see “PCI bus performance” on page 189).
- Provide enough bandwidth between the switches (ISLs), and consider enabling trunking for the ISL (see also 5.1.1, “What bandwidth do we need for FC tape” on page 182).

Most SANs are designed for disk I/O (high IOPS) rather than high bandwidth (for example, tape), which means there may not be enough ISLs for high bandwidth. As discussed in 5.1.1, “What bandwidth do we need for FC tape” on page 182, you need at least one ISL for every three to four 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 as long there is no trunking enabled.

Archive

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 **`dlsset`**. 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, our general 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 an 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 may choose to tell the client that the only fix is to separate the traffic.

Important: We does not recommend sharing of disk and tape I/O on the same HBA.

PCI bus performance

Different types of PCI buses have different performance specifications, as shown in Table 5-2. It does make 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, as the throughput will be saturated.

Note: Bandwidth throughputs in Table 5-2 on page 189 are burst rates. Sustained throughput rates are typically around 50% of the burst rates.

Table 5-2 PCI buses

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

Archive

5.1.4 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 SAN separately and independently.
- Backup and Storage teams can design their SAN for their specific needs and requirements.
- If there are different vendors for Storage and Backup, then service and maintenance will likely be easier and simpler. Each vendor is responsible for its own SAN.

Therefore, separating disk and tape into different SANs is principally useful for:

- A large environment with a need for high availability
- An environment with different vendors for disk and tape

5.2 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 5-7 on page 191 shows two slightly overlapping zones, represented by the solid lines and the dotted lines.

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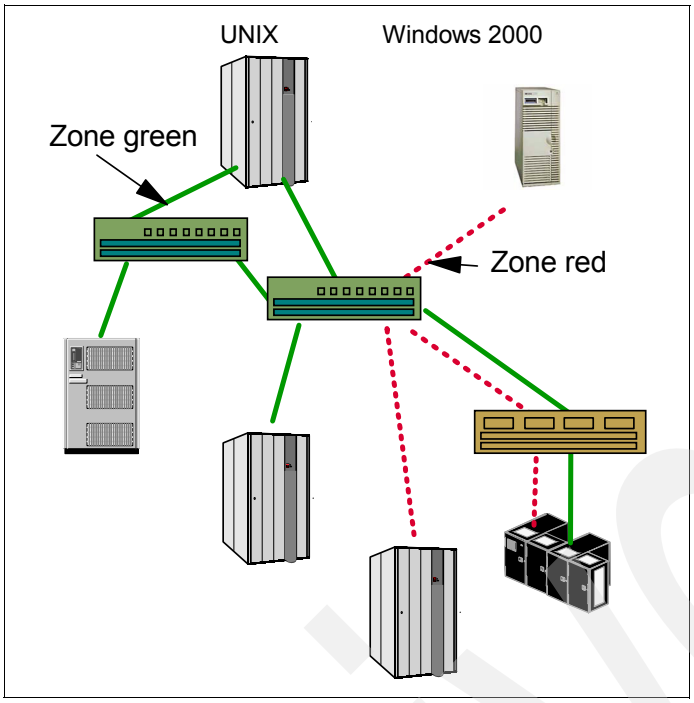


Figure 5-7 Zoning

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 preconfigured 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.

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Figure 5-8 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 could be zoned by WWN or a physical port connection on the FC switch creating a single path between host and tape drive.

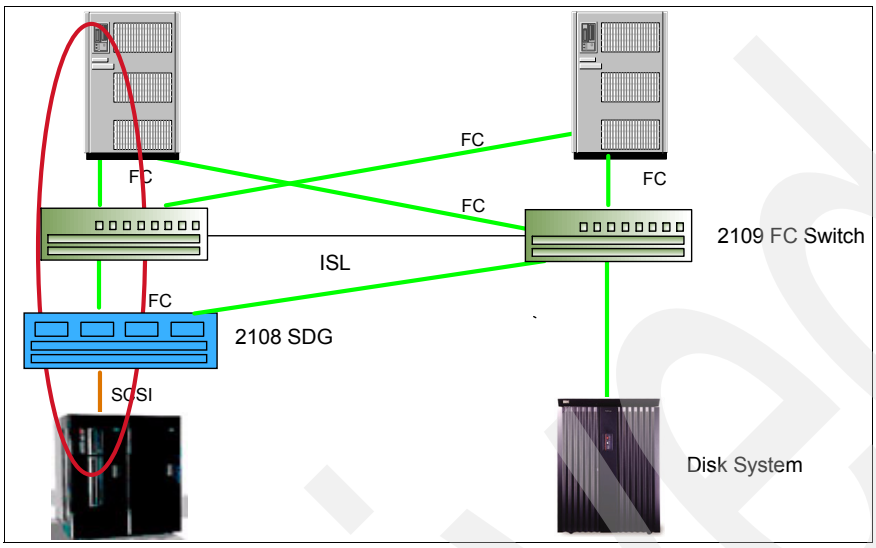


Figure 5-8 Zone to restrict the tapes to one HBA only

In the next example (shown in Figure 5-9), there are multiple tape drives and HBAs. You might use zones as shown so that the drives are split between the HBAs for performance or security reasons. Without zoning or other configurations, you would see the same dual pathing issue, as mentioned in 5.1.2, “Multiple paths to tape drives” on page 184.

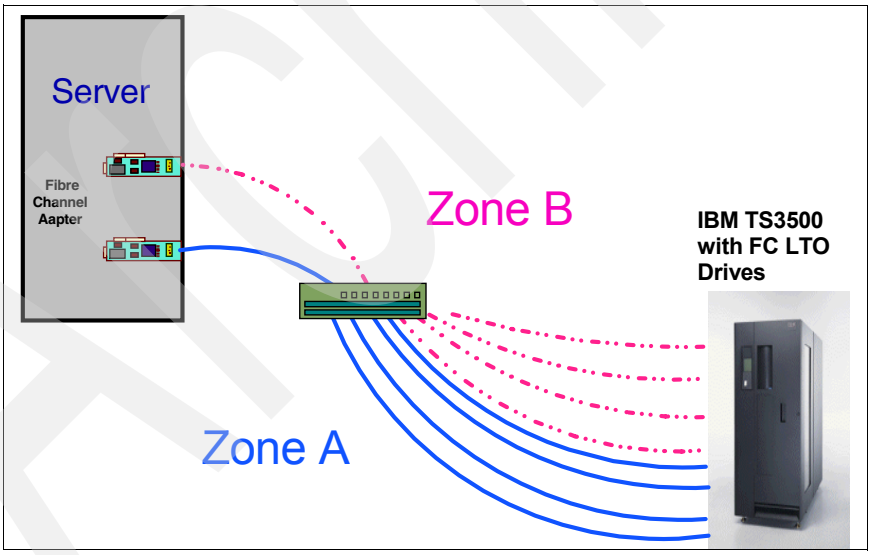


Figure 5-9 IBM TS3500 with 8 FC LTO Drives, 1 server with 2 HBA, 2 zones

You may also manage this scenario by using persistent binding, as described in 5.3, “Persistent binding” on page 194.

5.2.1 Some basic information about 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 done with care.
- Zoning configuration is generally a function of the switch devices. For an IBM 2109/2005, zoning can be configured and administered by telneting 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, please refer to the SAN Redbooks cited in the introduction to this chapter, or to your switch documentation.

5.2.2 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

The 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, hard 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. Careful documentation is always a necessary task for managing a SAN.

Software zoning

Software zoning 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 zone(s) are returned. Other devices are hidden from the name server query reply.

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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.

5.2.3 Suggestion on zoning for tapes

Consider the following suggestions if 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, such as 'ServerA_Tape1'.

5.2.4 World Wide Names of FC Host Bus Adapter

To set up software zoning to 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 about the different systems.

5.3 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 on 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, will wait indefinitely for a media mount or until the request is manually killed. We show how to display element addresses for drives as well as the slots in Appendix C, "Additional information" on page 291.

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.

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Note: The default Microsoft Windows naming scheme for tape devices means that dynamic and device names change as devices are added and removed. It assigns device names in the form \\.\Tape*x*, where x is a number. In this naming scheme, tape devices are given names starting with the tape device with the lowest SCSI address first and then numbered in ascending order starting from zero.

The disadvantage of this is that regardless of persistent binding, the name assigned to a physical device can easily change if new devices are added with lower SCSI addresses. Windows will name the new devices starting from \\.\Tape0 and the names assigned to existing devices will change. Correspondingly, if devices fail or are removed from the fabric, existing \\.\Tapex device names can change.

5.4 Connection type of IBM tapes

Because all IBM tape drives use a public loop if connected through FC-AL to a SAN switch, the server sees no difference whether the tape drive is connected as FC-AL or FCP. Through the public loop capabilities, the tape drive sends its WWN to the name server of the switch during the FLOGI (fabric login). If a server wants to communicate to the tape drive, then the server queries the name server of the switch, gets the WWN of the drive, and proceeds with a PLOGI (N-Port login) (see Figure 5-10). The same PLOGI will happen if the tape drive is connected as a FCP device.

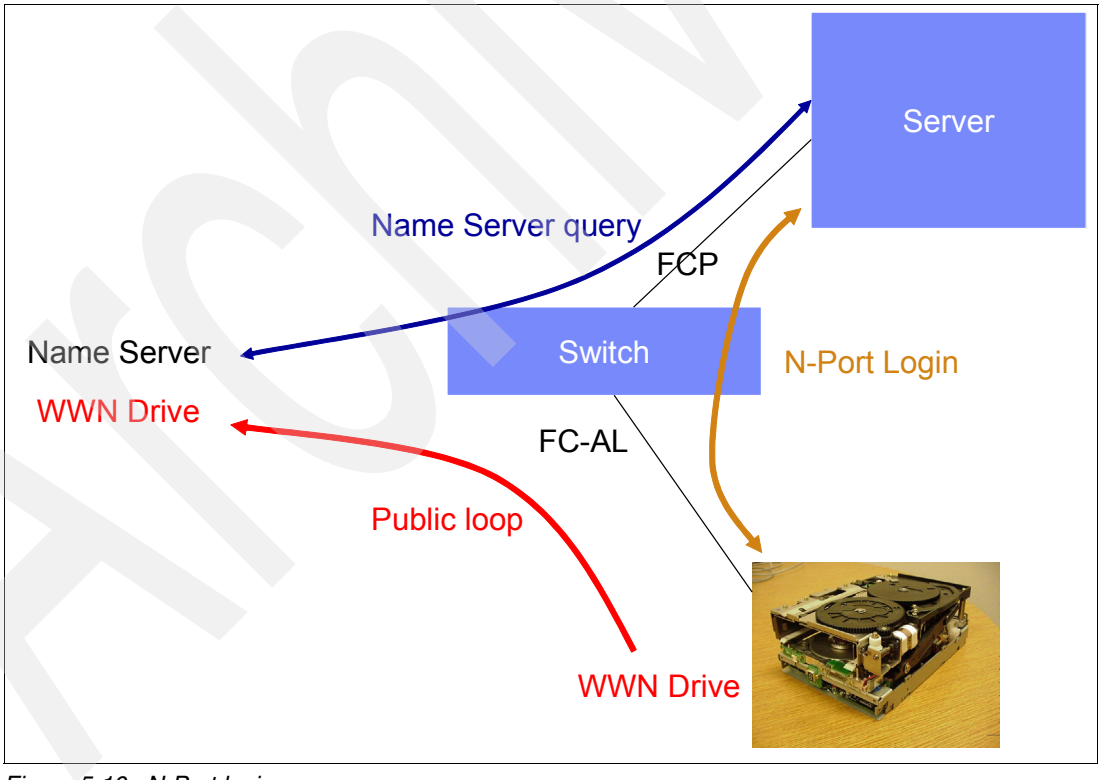


Figure 5-10 N-Port login

Per SNIA specification, IBM LTO3 and LTO4 drives attempt first to negotiate as a Loop device. If unsuccessful, then the drive attempts to log in as a fabric device. If you want the LTO3 or LTO4 drive to log in always as a fabric device, then you need to change the settings on your switch so that FC-AL login is disallowed. Here is an example, for an IBM 2109 or 2005 switch, of how to change the settings so that the switch only allows FCP devices:

1. Telnet to the switch.
2. Display Port Config:

   ```
   portcfgshow nn
   ```

3. Disable the switchport:

   ```
   disableport nn
   ```

4. Set port characteristics:

   ```
   portcfggport nn 1
   ```

5. Enable the switchport:

   ```
   enableport nn
   ```

For other switches, refer to your vendor documentation.

You can change the port settings for IBM tape drives using the IBM TS3100, TS3200, TS3310, TS3400, and TS3500 console or Web interface.

Refer to Appendix A, “Recommended HBA settings for LTO drives and libraries” on page 267 for further details about HBA settings.

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Part 2

LTO libraries and backup software

In Part 2, we describe how to implement IBM LTO drives and libraries with popular backup software packages. In general, the following steps are required for each package:

1. Identify the correct device driver to use for both the drives and the medium changer. This can be the IBM Ultrium driver, a native operating system driver, or a driver provided by the application itself.
2. Install the application.
3. Define and configure the drives and library to the application.
4. Perform any application-specific steps to make the drives and library available as a backup destination.

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6

Configuring IBM Tivoli Storage Manager on Windows and Linux

This chapter describes the installation and implementation of IBM Tivoli Storage Manager in Windows 2003 and Linux environments, explaining the ways to install IBM tape library with either IBM LTO or TS1120 drives. In particular, we review Tivoli Storage Manager's ability to:

- Achieve normal backup/restore processing
- Allow multiple servers to share the IBM tape libraries
- Provide LAN-free backup services
- Considerations for device and media coexistence and migration

We provide information about migrating between the generations of LTO technology with Tivoli Storage Manager, how to define various types of LTO and TS1120 cartridges to Tivoli Storage Manager, and discuss some features available with Tivoli Storage Manager V5.3 and V5.4 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 IBM 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

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6.1 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 offsite storage. It scales to protect hundreds to thousands of computers running more than a dozen operating systems, ranging from mobile computers to mainframes and connected together through the internet, WANs, LANs, or SANs. IBM 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 24x7 to utilize IBM 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. IBM Tivoli Storage Manager Extended Edition provides disaster planning capability, NDMP control for NAS filers, and support for large tape libraries.

IBM Tivoli Storage Manager is ideal for heterogeneous, data-intensive environments, supporting over 35 platforms and over 250 storage devices across LANs, WANs and SANs, plus providing protection for leading databases and e-mail applications (see Figure 6-1).

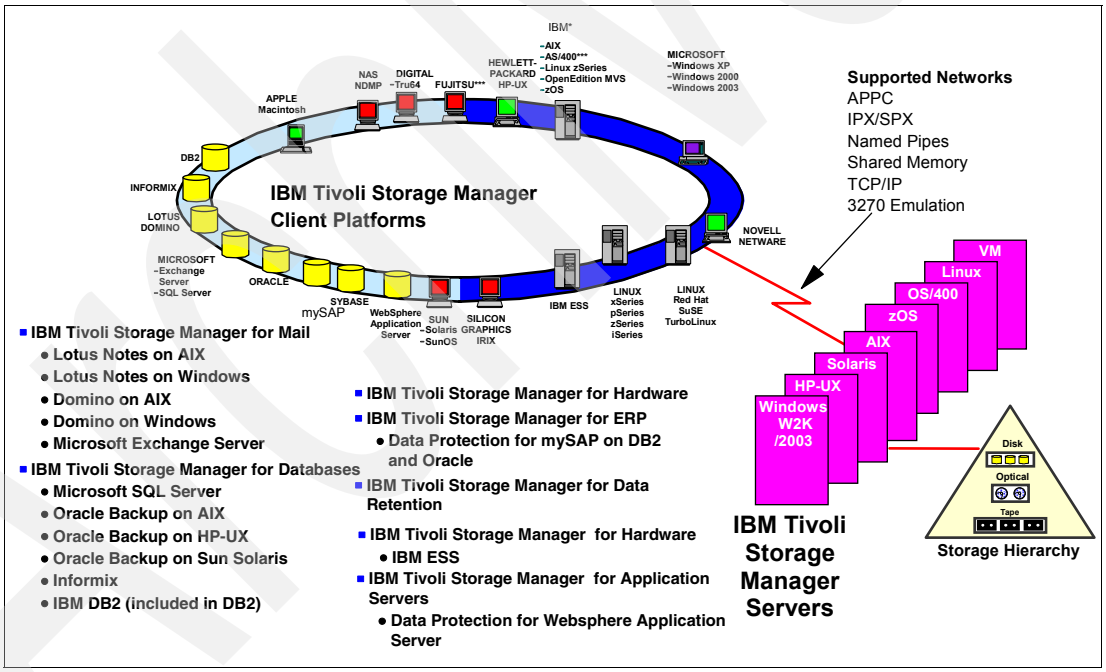


Figure 6-1 IBM Tivoli Storage Manager supported platforms

IBM 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. IBM Tivoli Storage Manager is intended for companies with homogeneous or heterogeneous platforms and complex environments that include both 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. It protects a broad range of data across the enterprise from the mobile computer to the data

center. IBM Tivoli Storage Manager is an industrial-strength centralized storage management product for your enterprise.

IBM Tivoli Storage Manager can protect almost any backup-archive client, as shown in Figure 6-1 on page 200. IBM Tivoli Storage Manager server is provided for z/OS, Windows 2000/2003, AIX, Solaris, HP-UX, Linux, and OS/400®. 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. IBM 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 users.

IBM 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 IBM Tivoli Storage Manger servers to share a library, and off-load backup processing from mission-critical servers.

IBM Tivoli Storage Manager includes LAN-free backup/restore functionality for many databases and applications, as well as the file-based backup/archive clients.

For more information about IBM Tivoli Storage Manager, 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

6.1.1 IBM 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 IBM 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 may share access to a common server. In IBM Tivoli Storage Manager terms, a client is a computer system that has data assets requiring protection by the IBM 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 may 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, while the IBM TS3500 does not.

- Tape library partitioning

  Some tape libraries (for example, IBM TS3200, TS3310, 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 IBM 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 may or may not be shared among the attached servers.

6.1.2 IBM Tivoli Storage Manager and tape library sharing

Now, let us look at the IBM Tivoli Storage Manager implementation of tape library sharing. This feature allows multiple IBM 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 IBM 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 6-2.

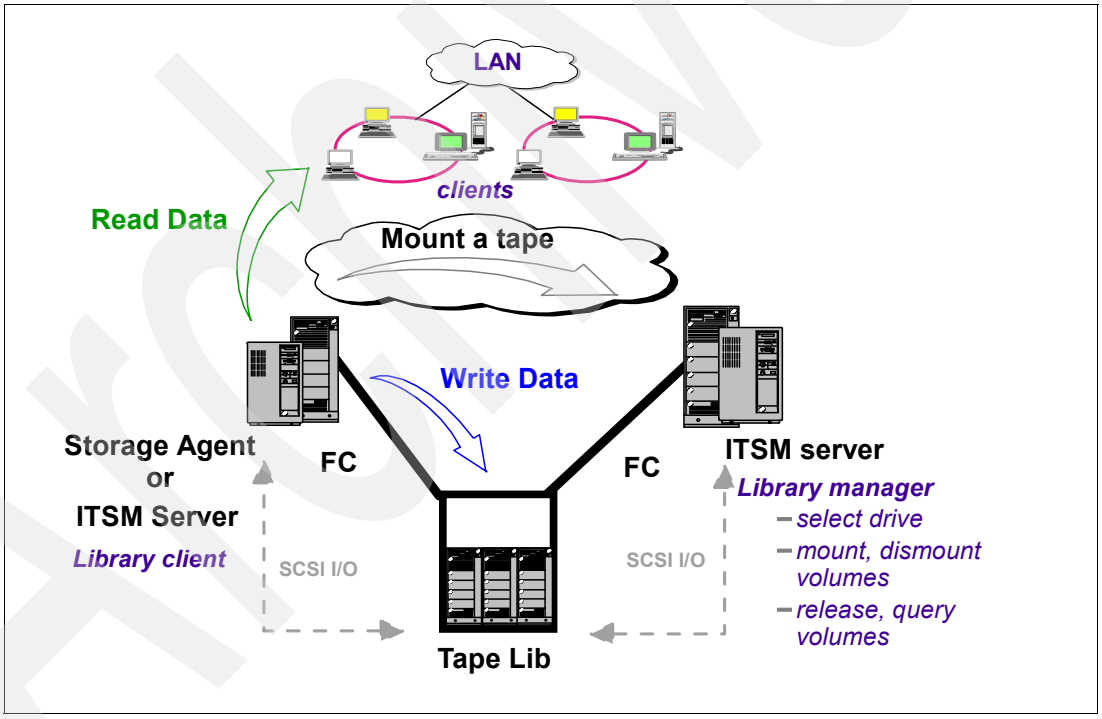


Figure 6-2 IBM Tivoli Storage Manager library sharing overview

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 is using a tape drive at the same time. The check-in and check-out of volumes will be performed by the Library Manager.

This IBM 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 (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 IBM Tivoli Storage Manager allows the SAN to be used as an alternative path for moving data between the IBM Tivoli Storage Manager clients and the server. LAN-free data transfer exploits this SAN path by enabling the IBM Tivoli Storage Manager client to back up and restore data directory to and from SAN-attached storage (tape), which is shared between the IBM 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 IBM Tivoli Storage Manager backup, but transfers directly from the client to the SAN-attached storage devices.

IBM Tivoli Storage Manager currently provides LAN-free data transfer for normal files, the database, and other applications through certain IBM Tivoli Storage Manager for Mail, IBM Tivoli Storage Manager for Databases, and IBM Tivoli Storage Manager for ERP products. These clients require an additional Storage Agent to be installed, which directs the movement of the data from the client disk to the SAN-attached storage. This process is shown in Figure 6-3 on page 204. For a complete list of operating systems and applications supported in a LAN-free environment, see:

http://www-306.ibm.com/software/tivoli/products/storage-mgr-san/

Archive

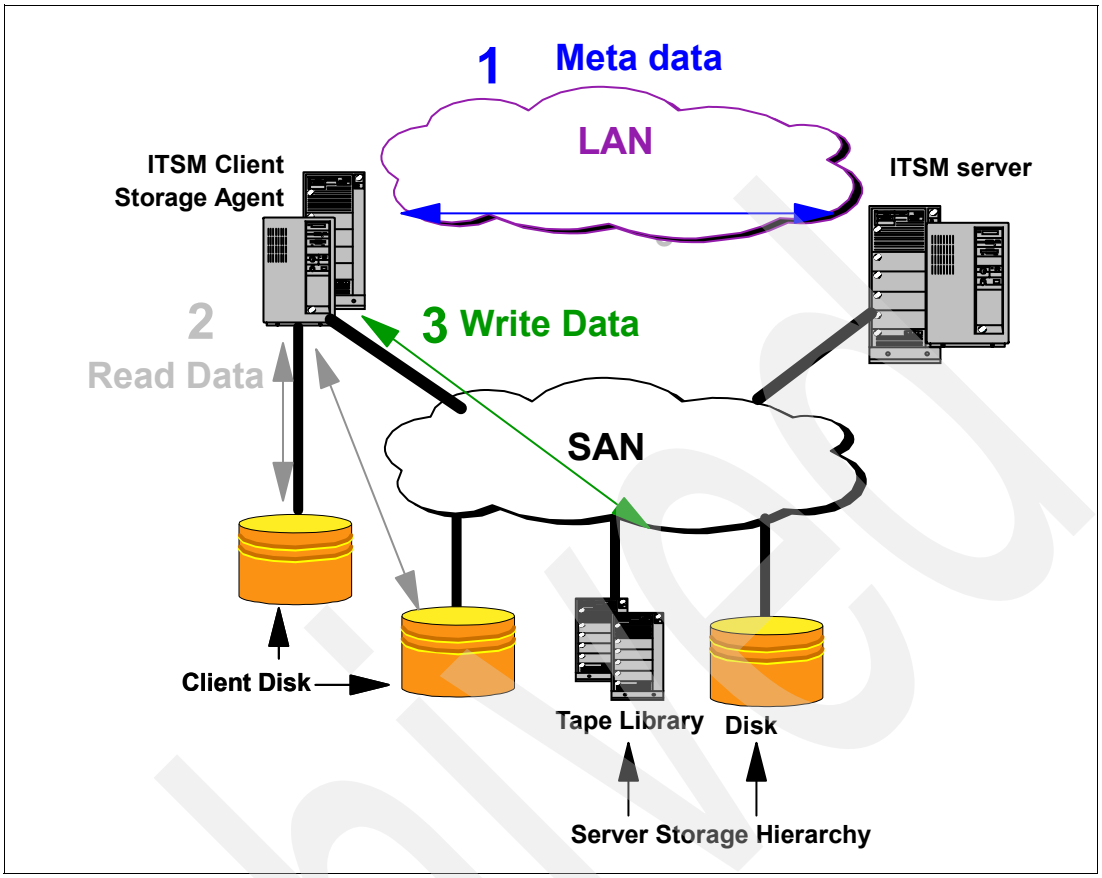


Figure 6-3 IBM Tivoli Storage Manager LAN-free data transfer overview

6.2 Non-shared devices with Tivoli Storage Manager for Windows

In this section, we discuss installing IBM tape libraries with Tivoli Storage Manager in the Windows environment. We used a tape library with Fibre Channel connections. The actual installations in the Windows environment was for Windows 2003.

- Intel server, Windows 2003 SP1 (build 3790), and QLogic QLA2300 HBA
- IBM 2109 FC switch
- IBM TS3400 with two TS1120 drives

6.2.1 Installing Tivoli Storage Manager

To install Tivoli Storage Manager Version 5.3 and 5.4, use the Tivoli Storage Manager Installation Guide manuals for the relevant operating system. For Windows, this will be *IBM Tivoli Storage Manager for Windows Installation Guide*. The manuals can be found at this URL:

`http://publib.boulder.ibm.com/infocenter/tivihelp/index.jsp`

Installation summary

When installing IBM Tivoli Storage Manager, the default configuration sets up a disk storage pool for storing backup data. Before you can begin using a tape device as a backup destination, you must do the following:

1. Disable RSM (using the procedure in “Disabling RSM” on page 126).
2. Attach the devices to your system.
3. Install the IBM LTO Ultrium device drivers for the Windows system you are using (as described in 3.2.1, “Installing the medium changer and tape device driver” on page 105).
4. Install the Tivoli Storage Manager server software.
5. Initialize the server.
6. Define the library.
7. Define the library path.
8. Define the drives in the library.
9. Define the drive paths.
10. Define a device class using the library.
11. Define a storage pool associated with the device class.
12. Include the storage pool in the storage hierarchy.
13. Label the tape library media.

After completing step 3, follow the instructions in IBM *Tivoli Storage Manager for Windows Installation Guide* (for your version of Tivoli Storage Manager) to install Tivoli Storage Manager (step 4). We installed the Tivoli Storage Manager server first (using the Custom option with the default features), then the Tivoli Storage Manager device driver (tsmscsi). Before installing, you should always check that you have the latest code fixes. 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`

To perform the subsequent tasks, you can use any one of the following interfaces:

- Tivoli Storage Manager configuration wizard
- Administrative client command line
- Web administration interface

We will continue the configuration (step 5) by initializing the server using the IBM Tivoli Storage Manager configuration wizard. The other configuration tasks will be shown using the configuration wizards and the administrative command line. The command-line interface is the same across all present IBM Tivoli Storage Manager versions. For the Web-based administrator interface, refer to the Tivoli Storage Manager manuals and IBM Redbooks publications for details for using the Administrative Console interface.

Initialize the server

After the Tivoli Storage Manager server and device driver installation, you will have to reboot the server. You may begin to configure your Tivoli Storage Manager server and, in particular, configure your IBM tape library and drives for use. The examples are shown using the Tivoli Storage Manager configuration wizard, with additional examples showing the commands associated with each action taken. You must use the wizard to initialize your server before running additional configuration commands through the Web administrator or command-line interface (CLI).

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If you want to use the CLI (**dsmadmc**) to configure your server, you must install the client code on the IBM Tivoli Storage Manager server using a *Custom* installation, during which you may opt to install the administrative command line. If you are new to the product, we suggest that you run through the wizard configuration first to quickly get the server up and running. The server parameters may be reconfigured later using the Web browser interface or the command line. We will here specifically show how to get the IBM Tivoli Storage Manager server up and running with the IBM tape library and drives only.

You can start the configuration wizard by clicking the Tivoli Storage Manager Management Console icon on the desktop, or by selecting **Start** → **Programs** → **Tivoli Storage Manager** → **Management Console**. Note that the Management Console is an application for the Microsoft Management Console (MMC).

If the Initial Configuration Task Window (Figure 6-5 on page 207) does not appear automatically, click **Tivoli Storage Manager** and scroll down to the entry that matches the server just installed. In this instance, this is server LILO. Right-click the server name and select **Add a new Tivoli Storage Manager Server**, as shown in Figure 6-4.

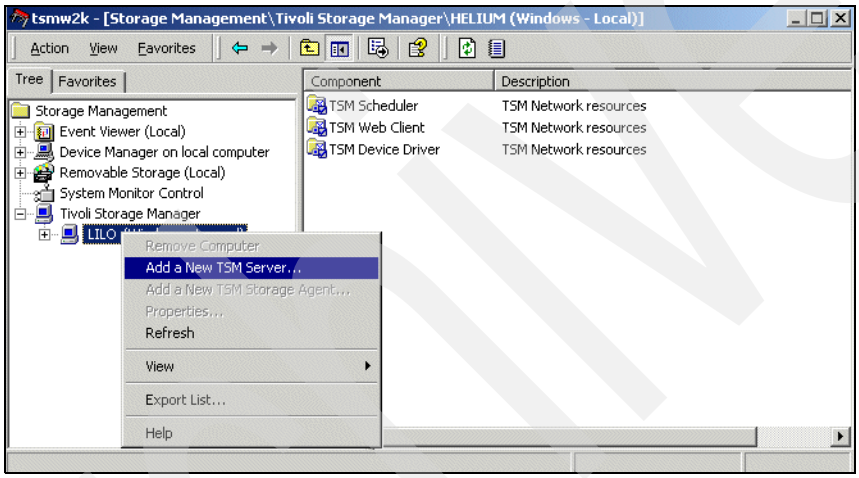


Figure 6-4 Initializing the Tivoli Storage Manager server

This will begin the Initial Configuration Task List (Figure 6-5 on page 207). In the list window, click **Start** and the wizard will commence. Note that the wizard will perform all of the listed tasks in succession. You may, however, choose the Minimal configuration, or cancel out of the wizard at any stage to configure the server later.

We will show you how to configure IBM tape devices using the wizard configuration, and using the command line.

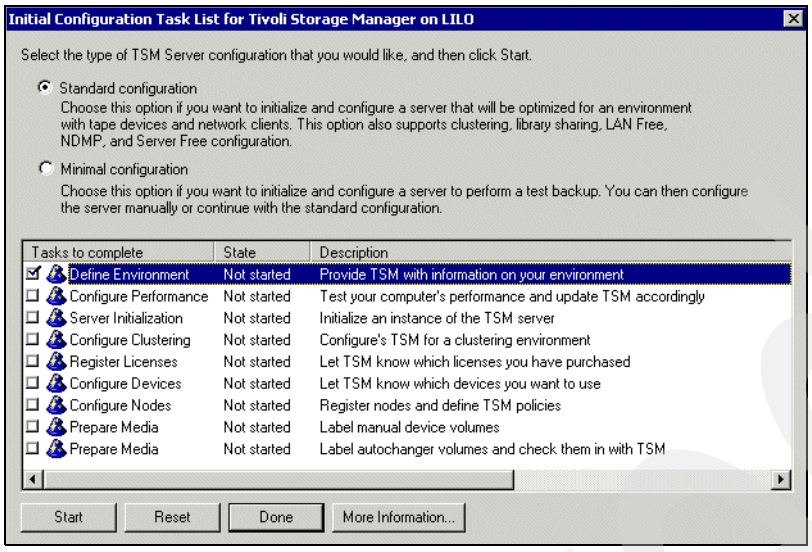


Figure 6-5 Initial configuration task list

Disabling ITSM Device Driver from boot (Windows 2000 only)

We recommend installing the IBM Tivoli Storage Manager Device Driver, even though we will use the IBM tape device driver for the LTO devices. The IBM Tivoli Storage Manager device driver allows you to see the Tivoli Storage Manager device names in the Tivoli Storage Manager Management Console. However, you need to disable the Tivoli Storage Manager Device Driver from starting at boot time and claiming the devices that the IBM tape device driver is supposed to claim. To do this, modify the options for the Tivoli Storage Manager Device Driver service to startup type Manual, by accessing the Tivoli Storage Manager Management Console. Select **Start** → **Programs** → **Tivoli Storage Manager** → **Management Console**. Select **Servername (Windows - Local)** → **TSM Device Driver** → **Reports** → **Service Information**. In the Service Information pane, right-click the **TSM Device Driver** service and select **Properties**, as shown in Figure 6-6.

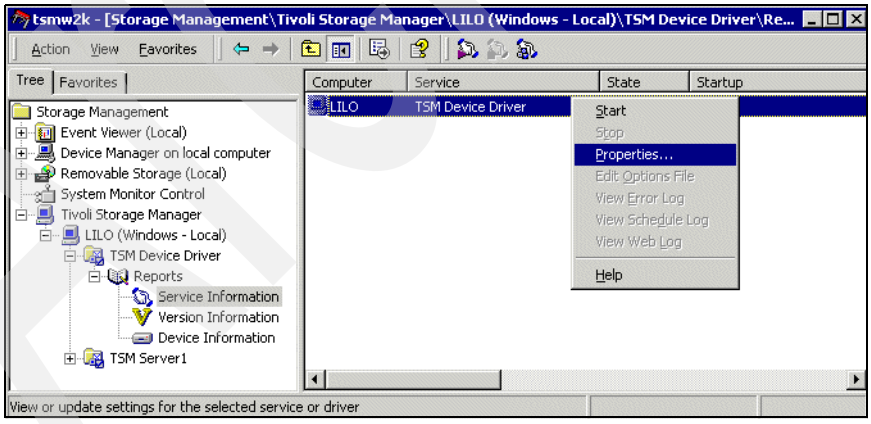


Figure 6-6 Tivoli Storage Manager Management Console Service Information

As shown in Figure 6-7, the Properties window lists the devices using the alias names as Tivoli Storage Manager would normally see them. The window should look somewhat similar to the one below; you should have all of your IBM tape devices on the right side, meaning that Tivoli Storage Manager will not claim those devices.

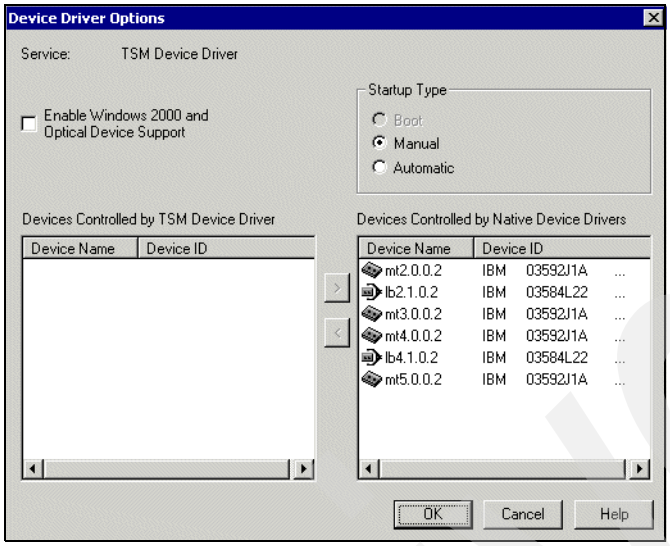


Figure 6-7 Device Driver options

6.2.2 Defining the library and drives using the Configuration Wizard

You should have already installed the tape drives and library using the IBM Ultrium device drivers for Windows 2003, according to Chapter 3, “Basic IBM tape setup for Windows” on page 101.

The Device Configuration Wizard will start automatically if we run through the Tivoli Storage Manager configuration wizard from the beginning, as detailed in “Initialize the server” on page 205. Alternatively, you may run it at any time if you have not already done so by accessing the Tivoli Storage Manager Management Console from the desktop**.** Click **Wizards** and then **Device Configuration**. Note that the server must have been initialized for use before performing this step. The Device Configuration Wizard will commence, as in Figure 6-8 on page 209. Click **Next**.

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Figure 6-8 Device Configuration Wizard

Note For Windows 2000 only: If the IBM Tivoli Storage Manager Device Driver is not running, you will be prompted to start it (Figure 6-9 on page 209). Answer **No**, since we use IBM tape driver to control both the library medium changer and the tape drives.

Note: As of IBM Tivoli Storage Manager, the IBM Tivoli Storage Manager Device Driver is no longer used to control the IBM tape library medium changer. Use the IBM Ultrium Device Driver for both medium changer and drive.



Figure 6-9 IBM Tivoli Storage Manager Device Driver start prompt

The wizard will detect the IBM tape library and drives attached to the system, as shown in Figure 6-10 on page 210. The device name, type, and location are listed in the left panel. The device name will be listed as:

- lbx.x.x.x: Library
- mtx.x.x.x: Tape device

The Xs represent the SCSI ID, LUN, bus, and port numbers, respectively. For example, a device listed as lb2.1.0.2 corresponds to a library at SCSI ID 2, LUN1, bus0, and port2.

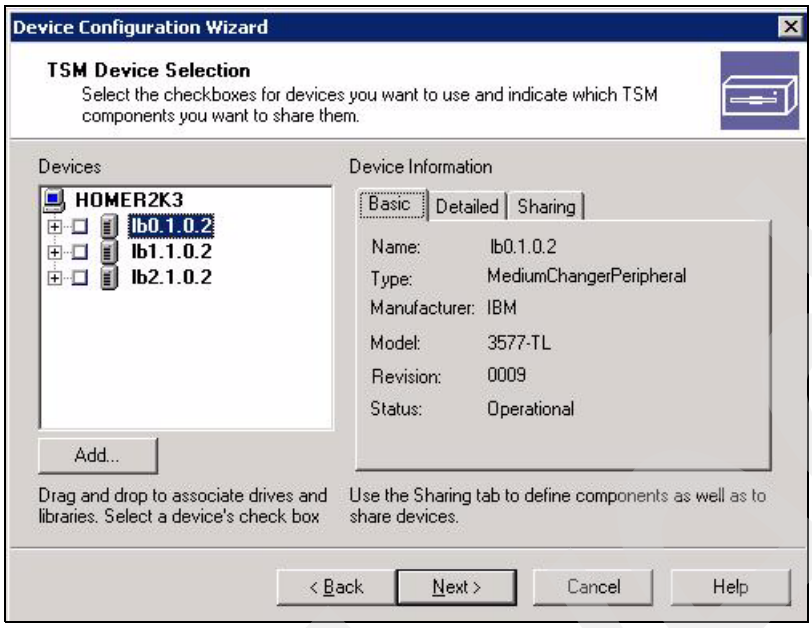


Figure 6-10 IBM Tivoli Storage Manager device selection

The element address and serial number will appear on the Detailed tab. When configuring multiple tape drives in a library, you can determine which entry corresponds to which physical tape drive. You may want to reorder them so they match the order of the physical installation. For some cases, the element address and serial number may not appear here; in this case, check the device information using the procedures described in 3.4.1, “Creating a library device table” on page 122 (Windows) or 4.3.2, “Creating a library device table” on page 167 (Linux).

Check the devices you want to define to Tivoli Storage Manager and click **Next** (Figure 6-11).

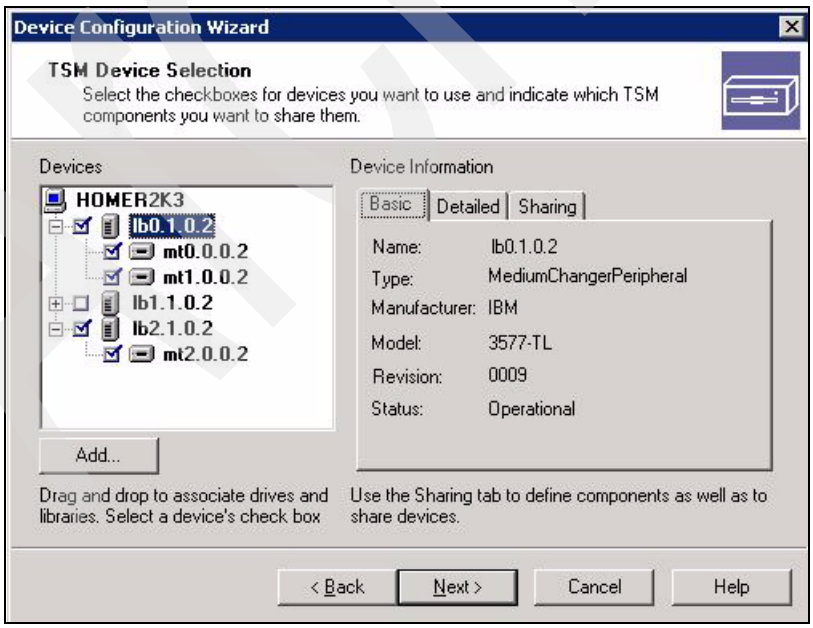


Figure 6-11 IBM Tivoli Storage Manager devices selected

You will be asked to select the format type of the device, as shown in Figure 6-12. Choose the Ultrium generation (or TS1120) that is appropriate for the drives in your library. You would, in most cases, select a format with compression for performance reasons. Refer to 6.2.5, “Defining the device class using the command line” on page 214 for more details on format types.

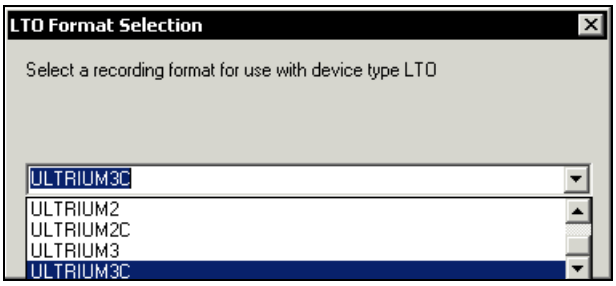


Figure 6-12 Choose recording format

Tape drive element addresses

IBM Tivoli Storage Manager normally obtains the element address of the drive automatically when you define IBM tape devices. However, you can also define *element_number* specifically, and these numbers may be found in the operator guide for your library. You can also obtain this information at the following Web site:

`http://www-306.ibm.com/software/sysmgmt/products/support/IBM_TSM_Supported_Devices_for_AIXHPSUNWIN.html`

Select **LTO Tape libraries**, and scroll to the IBM tape libraries. Click either IBM Tape Libraries to obtain the element addresses. It is worth noting that different element addresses are provided for devices controlled by RSM on behalf of Tivoli Storage Manager and for Tivoli Storage Manager controlled devices. We recommend disabling RSM and having Tivoli Storage Manager control the devices.

For example, Figure 6-13 shows the SCSI Element address for drives of the IBM TS3200, and Figure 6-14 on page 212 shows the SCSI Element address for drives of the IBM TS3500. As you may see in the Web page, if you are using Windows RSM, this will remap the element numbers to start with 0. Since we recommend turning off RSM, these are the relevant element numbers.

Element Type	Element Address Range
Media Transport (Accessor) Element (MTE)	1 (0x01)
I/O Station Elements (IEE)	16 (0x10), 17 (0x11), 18 (0x12)
Data Transfer (Drives) Elements (DTE)	256 (0x100), 257 (0x101)
Storage Elements (STE)	4096 (0x1000) - 4139 (0x102B)

Figure 6-13 SCSI Element number of tape drives in the IBM TS3200

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Frame	Range of SCSI DTE Addresses for Tape Drives	
	Row 1	Row 12
1	257(X'101')	268(X'10C')
2	269(X'10D')	280(X'118')
3	281(X'119')	292(X'124')
4	293(X'125')	304(X'130')
5	305(X'131')	316(X'13C')
6	317(X'13D')	328(X'148')
7	329(X'149')	340(X'154')
8	341(X'155')	352(X'160')
9	353(X'161')	364(X'16C')
10	365(X'16D')	376(X'178')
11	377(X'179')	388(X'184')
12	389(X'185')	400(X'190')
13	401(X'191')	412(X'19C')
14	413(X'19D')	424(X'1A8')
15	425(X'1A9')	436(X'1B4')
16	437(X'1B5')	448(X'1C0')

Figure 6-14 SCSI Element number of tape drives in the IBM TS3500

Note that the SCSI Element addresses for the TS3500 (Figure 6-14) are only true if the TS3500 library has been configured without ALMS.

Continuing the installation

The wizard will proceed to define the library and drives to the Tivoli Storage Manager server. To complete the device configuration wizard, click **Finish** on the final window. A pop-up window will appear to show that the device definitions have completed successfully.

Now we have successfully configured the library and drives. The wizard has automatically defined a device class, as well as a storage pool with the device class assigned to it. We will discuss the device class and storage pool definitions in 6.2.5, “Defining the device class using the command line” on page 214 and 6.2.7, “Defining the storage pool using the command line” on page 217.

Although the wizard has successfully configured the library, drive, device class, and storage pool, the process is less flexible than when using the command line to perform these operations. The wizard uses its own naming conventions and will use default operating parameters.

6.2.3 Defining the library and drives using the command line

Manually defining the library using the command line or Administrative interface allows greater control over the options associated with this action. Use the device names as seen in the Tivoli Storage Manager Management Console (Figure 6-15 on page 213) for defining the devices to the Tivoli Storage Manager server.

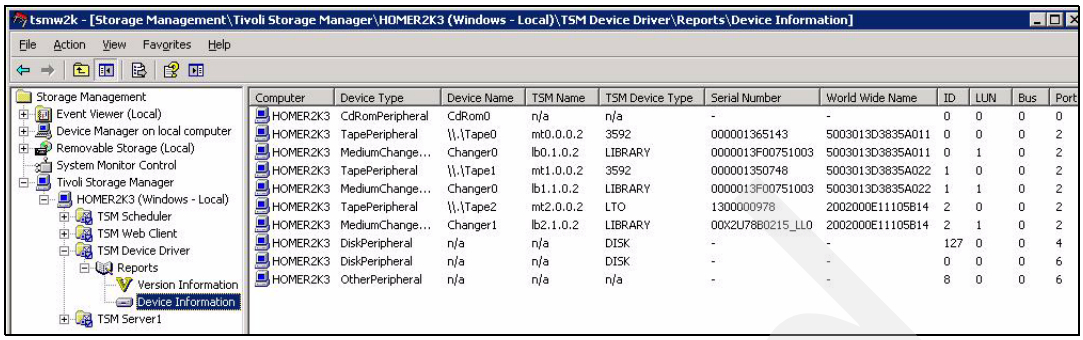


Figure 6-15 Checking the ITSM device name in Management Console

First, define the library and library path using the following commands. When there are multiple choices, the default setting is listed last.

```
DEFINE LIBRARY library_name LIBTYPE=SCSI
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 libts3400 LIBTYPE=SCSI
```

For server_name, specify the name you have set for your server with the SET SERVERNAME command This can be checked by issuing the QUERY STATUS command. In our case, we used the name homer2k3_server1. For dev_name, enter the full device name of library, such as lb.0.1.0.2.

```
DEFINE PATH homer2k3_server1 libts3400 SRCTYPE=SERVER DESTTYPE=LIBRARY DEVICE=lb0.1.0.2
```

Next, define each of the library's drives and drives paths with:

```
DEFINE DRIVE library_name drive_name
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 (libts3400 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, such as mt2.0.0.2. The element number will then be automatically detected by IBM Tivoli Storage Manager when the path to the drive is defined.

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 5.3, "Persistent binding" on page 194. Therefore, check carefully that the element address maps with your drive configuration.

We configured our drives in the IBM TS3400 with:

```
DEFINE DRIVE libts3400 drive01
DEFINE DRIVE libts3400 drive02
DEFINE PATH homer2k3_server1 drive01 SRCTYPE=SERVER DESTTYPE=DRIVE LIBRARY=libts3400
DEVICE=mt0.0.0.2
DEFINE PATH homer2k3_server1 drive02 SRCTYPE=SERVER DESTTYPE=DRIVE LIBRARY=libts3400
DEVICE=mt1.0.0.2
```

Tip: Before defining the drives and libraries, make sure that your library is online and your drives are available. Also, there should not be a cartridge loaded in the drive being defined.

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Continue the implementation in 6.2.5, “Defining the device class using the command line” on page 214.

6.2.4 Defining the device class using the Configuration Wizard

To allow the Tivoli Storage Manager server to correctly use the IBM tape library and drives, we must define a device class. A device class is best thought of as the interface that allows Tivoli Storage Manager to effectively communicate with a device.

If we run the Configuration Wizard to install the tape library and drives, the LTO device class and associated storage pool will be created automatically in the background. This will use system generated names, and we have a better control of the options by using the command line.

6.2.5 Defining the device class using the command line

To manually configure the device class, use the following commands.

For LTO drives, use LTO as the DEVTYPE parameter:

```
DEFINE DEVCLASS devclass_name LIBRARY=library_name DEVTYPE=LTO \
FORMAT=Ultrium3/Ultrium3C/Ultrium4/Ultrium4C/Drive MOUNTLIMIT=mount_limit/DRIVES
```

For IBM TS1120 drives, use 3592 as the 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.

- ultrium3

  This specifies that IBM Tivoli Storage Manager writes data using the ULTRIUM3 recording format. This format results in a cartridge capacity of 400 GB when using a Ultrium3 400 GB data cartridge. This value overrides the settings on the tape drive characteristics for hardware compression.

- ultrium3c

  This specifies that IBM 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 a Ultrium3 400 GB data cartridge. This value overrides the settings on the tape drive characteristics for hardware compression.

- ultrium4

  Specifies that IBM 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 IBM 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.

- 3592

  Specifies that IBM Tivoli Storage Manager writes data using the 3592 recording format. This format results in a cartridge capacity of 300 GB when using 3592 300 GB data cartridges. This value overrides the settings on the tape drive characteristics for hardware compression.

- 3592c

  Specifies that IBM 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 IBM Tivoli Storage Manager writes data using the 3592 recording format. This format results in a cartridge capacity of 500 GB when using 3592 500 GB data cartridges. This value overrides the settings on the tape drive characteristics for hardware compression.

- 3592-2C

  Specifies that IBM Tivoli Storage Manager writes data using the 3592 recording format with compression. This format results in a cartridge capacity of approximately 1500 GB when using 3592 500 GB 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=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 3 and 4 drives. Use the specific definitions, as described in detail in 6.12, “Device migration and coexistence” on page 248.)

If you use recording FORMAT=ultrium3c/ultrium4c/3592c/3592-2c/drive, then your LAN-free clients also use compression regardless of whether hardware compression is enabled.

Note that IBM 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 beneficial. If so, enable it and use the uncompressed (FORMAT=ultrium3/ultrium4/3592/3592-2) flag when defining the device class. If not, then tape drive compression should be used.

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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 may want to specify a number instead of the default drives to limit the number of drives each server has access to.
- If you have a mixture of LTO generation drives in the same library, see 6.12, “Device migration and coexistence” on page 248 for more information. We recommend that the default value of drives *not* be used for the older Ultrium x device classes. For example, when specifying MOUNTLIMIT=drives, the IBM Tivoli Storage Manager server will load Ultrium 3 cartridges into Ultrium 3 drives in preference to Ultrium 4 drives, but there exists the possibility that all Ultrium 4 drives could be loaded with Ultrium 3 cartridges and therefore an Ultrium 4 cartridge could not be loaded. It may 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.

To define the IBM TS3400 in our Windows environment, we called the device class TS3400CLASS, pointing to our previously defined library libts3400. In the example, we have two TS1120 drives in the library, so we specified DRIVE for the FORMAT parameter and we set the MOUNTLIMIT to DRIVES:

```
DEFINE DEVCLASS TS3400CLASS DEVTYPE=3592 LIBRARY=libts3400 FORMAT=DRIVE MOUNTLIMIT=DRIVES
```

Example 6-1 shows our device class definition.

Example 6-1 Device Class definition

```
tsm: HOMER2K3_SERVER1>Q DEVC TS3400CLASS F=D

             Device Class Name: TS3400CLASS
        Device Access Strategy: Sequential
            Storage Pool Count: 0
                   Device Type: 3592
                        Format: DRIVE
         Est/Max Capacity (MB):
                   Mount Limit: DRIVES
              Mount Wait (min): 60
         Mount Retention (min): 60
                  Label Prefix: ADSM
                  Drive Letter:
                       Library: LIBTS3400
                     Directory:
                   Server Name:
                  Retry Period:
                Retry Interval:
                     Twosided:
                       Shared:
            High-level Address:
              Minimum Capacity:
                          WORM: No
              Drive Encryption: Allow
               Scaled Capacity: 100
Last Update by (administrator): ADMIN
         Last Update Date/Time: 04/11/2007 10:41:46
```

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6.2.6 Defining the storage pool using the Configuration Wizard

If we run the Configuration Wizard to install the tape library and drives, the LTO device class and associated storage pool will be created automatically in the background. This will use system generated names, and we have a better control of the options by using the command line.

6.2.7 Defining the storage pool using the command line

Define the storage pool with:

```
DEFINE STGPOOL 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 ts3400class. We used poolts3400 as the stgpool_name:

```
DEFINE STGPOOL poolts3400 ts3400class MAXSCRATCH=200
```

Example 6-2 shows you the storage pool just defined.

Example 6-2 q stgpool poolts3400 f=d

```
             Storage Pool Name: POOLTS3400
               Storage Pool Type: Primary
               Device Class Name: TS3400CLASS
              Estimated Capacity: 0.0 M
              Space Trigger Util:
                        Pct Util: 0.0
                        Pct Migr: 0.0
                     Pct Logical: 0.0
                    High Mig Pct: 90
                    Low Mig Pct: 70
                Migration Delay: 0
             Migration Continue: Yes
            Migration Processes: 1
          Reclamation Processes: 1
              Next Storage Pool:
           Reclaim Storage Pool:
         Maximum Size Threshold: No Limit
                         Access: Read/Write
                    Description:
              Overflow Location:
           Cache Migrated Files?:
                      Collocate?: Group
          Reclamation Threshold: 60
      Offsite Reclamation Limit:
Maximum Scratch Volumes Allowed: 200
  Number of Scratch Volumes Used: 0
  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
  Last Update by (administrator): ADMIN
           Last Update Date/Time: 04/11/2007 10:48:51
        Storage Pool Data Format: Native
            Copy Storage Pool(s):
         Continue Copy on Error?:
                        CRC Data: No
                Reclamation Type: Threshold
```

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Now you can use this storage pool in your management class copy groups, so that the device will be used for backups or archives.

6.2.8 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 about 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.

IBM 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 TS3400 model 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 be 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 we can label them using the media labeling wizard or we can use the command line (see “Preparing the cartridges using the command-line interface” on page 221.

Preparing the cartridges using the Configuration Wizard

To access the Media Labeling Wizard, open up the Tivoli Storage Manager Management Console by selecting **Start** → **Program Files** → **Tivoli Storage Manager** → **Management Console**. Select **Wizards** and scroll down to the Configuration Wizard window, as shown in Figure 6-16.

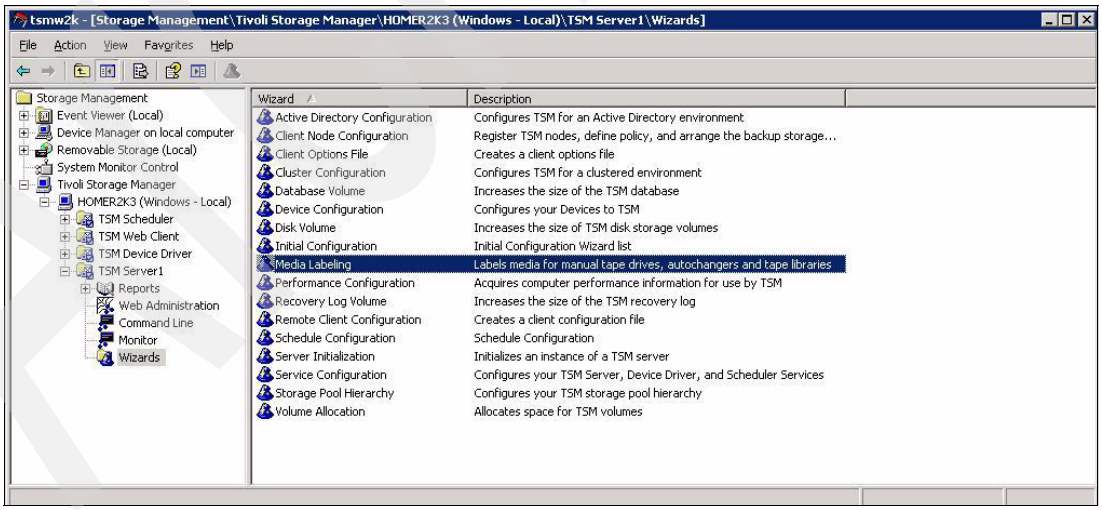


Figure 6-16 Selection for Media Labeling Wizard

Click the Media Labeling Wizard and click **Start**. When the wizard appears (Figure 6-17 on page 219), click **Next**.



Figure 6-17 Media Labeling Wizard

You are logged into the IBM Tivoli Storage Manager server and it presents you with a list of discovered devices. You will be prompted to make a drive selection. For our purposes, we want to label all tapes in the library so that they are initialized for IBM Tivoli Storage Manager. We must make our selection at the library level by checking the box next to the library name, as shown in Figure 6-18. This will also automatically select the tape drives attached to it and ensure that every tape in the library is detected as a candidate for the labeling operation.

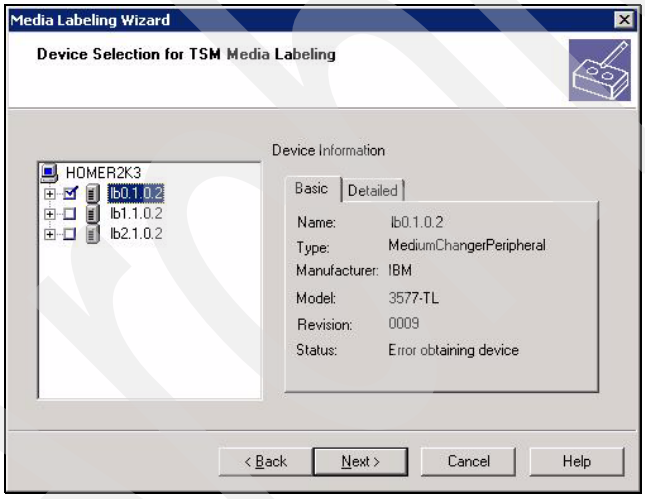


Figure 6-18 Device selection for labeling

Click **Next** and all tape volumes residing in the library will be detected (Figure 6-19 on page 220). Select the tapes that you want to label. There are several available options for labeling, including:

- Overwrite existing label: Specify this if you want to write a fresh label to the tape. The default is no, since it might lead to inadvertently overwriting a tape that contains valid data.
- Barcode reader: Tivoli Storage Manager will read the barcode label and use that to internally label the cartridge.
- Keep volumes in library: This will retain the volumes inside the library and not check them out once each is labeled.

- Prompt user to insert volumes: The user will be asked to insert cartridges to be labeled. To avoid this, insert the cartridges directly into the library or in the bulk I/O slot beforehand.

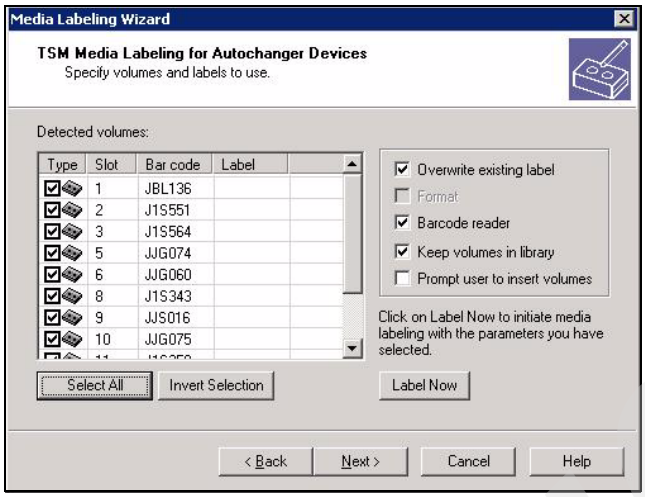


Figure 6-19 Volume selection for labeling

Click **Label Now** and the media labeling process begins. The Media labeling Monitor appears (Figure 6-20) showing the progress and the end of the operation.

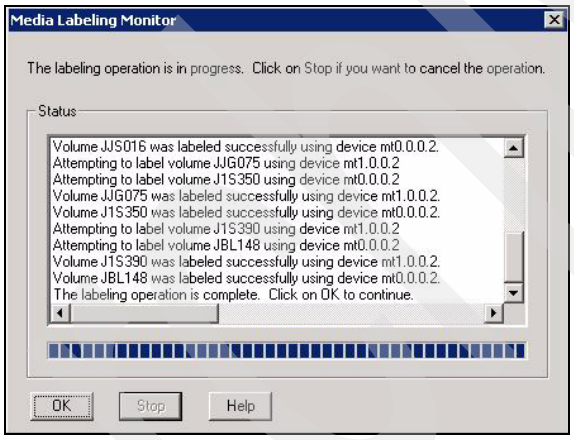


Figure 6-20 Media Labeling Monitor: volume selection for labeling

When finished, click **OK** and then **Next** and the Media Labeling Wizard will ask if you would like to check in the volumes that you have just labelled, as shown in Figure 6-21 on page 221. You must check in the tape volumes before they can be used by Tivoli Storage Manager. Select **Barcode Reader** to use the cartridge barcode label to check in the cartridges (unless you have created labels different from the external barcode label, or your tape device does not have a barcode reader). If you do not specify a barcode reader, you will be prompted to specify the volumes you want to check in.

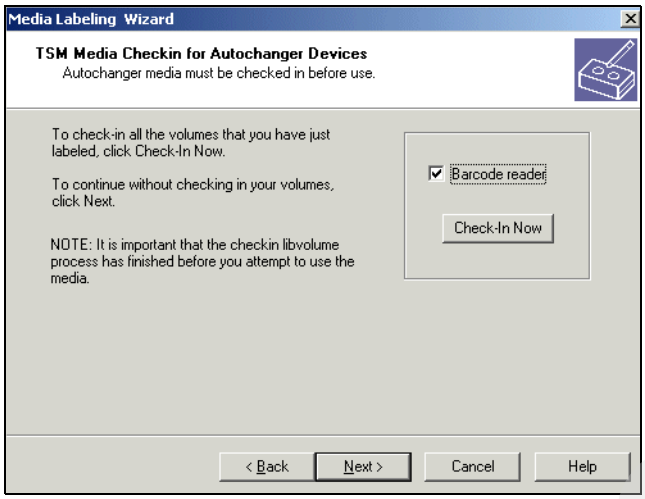


Figure 6-21 Tivoli Storage Manager media check-in

Click **Check-In Now** and the wizard will proceed to check in the library tape volumes. A pop-up window will appear (Figure 6-22) indicating that this can take some time and you can monitor the progress through the server console monitor.

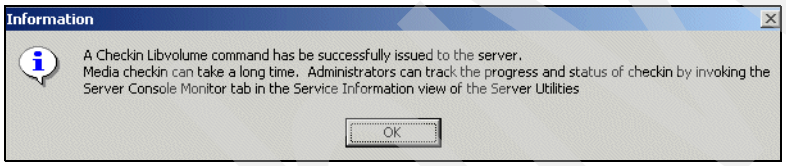


Figure 6-22 Media check-in issued

When the check-in is complete, click **Next** and another pop-up window will appear indicating that the task was successful. It will also suggest that you verify that the cartridges are able to be written to by performing a backup on an IBM Tivoli Storage Manager client.

Preparing the cartridges using the command-line interface

With the new tapes inserted into the library, use the following command:

```
LABEL LIBVOLUME libts3400 SEARCH=YES LABELSOURCE=barcode CHECKIN=SCRATCH
```

The parameter SEARCH=YES means that IBM 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. The tape is finally checked in and available for use by IBM Tivoli Storage Manager.

Attention: There should be no cleaning cartridges in the library inventory accessible from the host, as IBM 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 the above command, you can check on the status of the inserted volumes with the QUERY LIBVOL command. Example 6-3 shows all the labeled cartridges with scratch status. The element address is also displayed so that we can tell which physical location contains each volume.

Example 6-3 QUERY LIBVOL

```
Library Name  Volume Name  Status      Owner       Last Use   Home      Device
                                                              Element   Type
------------  -----------  ----------  ----------  ---------  -------   ------
LIBTS3400     J1S343       Scratch                            4,106     3592
LIBTS3400     J1S350       Scratch                            4,109     3592
LIBTS3400     J1S390       Scratch                            4,111     3592
LIBTS3400     J1S551       Scratch                            4,100     3592
LIBTS3400     J1S564       Scratch                            4,101     3592
LIBTS3400     JBL136       Scratch                            4,099     3592
LIBTS3400     JBL148       Scratch                            4,112     3592
LIBTS3400     JJG060       Scratch                            4,104     3592
LIBTS3400     JJG074       Scratch                            4,103     3592
LIBTS3400     JJG075       Scratch                            4,108     3592
```

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 also issue the commands QUERY REQUEST or QUERY ACTLOG to display information about pending mount requests.

Example 6-4 shows you an output of the activity log when inserting one cartridge into the IBM 3584. We used this command:

```
LABEL LIBVOLUME libts3400 SEARCH=bulk LABELSOURCE=barcode CHECKIN=scratch
```

followed by this command to continue the operation:

```
REPLY 001
```

Example 6-4 IBM Tivoli Storage Manager: query actlog for inserting new cartridges

```
04/11/2007 12:32:12  ANR2017I Administrator ADMIN issued command: LABEL
                      LIBVOLUME libts3400 SEARCH=bulk LABELSOURCE=barcode
                      CHECKIN=scratch (SESSION: 12)
04/11/2007 12:32:12  ANR0984I Process 6 for LABEL LIBVOLUME started in the
                      BACKGROUND at 12:32:12. (SESSION: 12, PROCESS: 6)
04/11/2007 12:32:12  ANR8799I LABEL LIBVOLUME: Operation for library LIBTS3400
                      started as process 6. (SESSION: 12, PROCESS: 6)
04/11/2007 12:32:12  ANR8373I 001: Fill the bulk entry/exit port of library
                      LIBTS3400 with all 3592 volumes to be processed within 60
                      minute(s); issue 'REPLY' along with the request ID when
                      ready.  (SESSION: 12, PROCESS: 6)
04/11/2007 12:32:34  ANR2017I Administrator ADMIN issued command: QUERY REQ
```

```
                     (SESSION: 12)
04/11/2007 12:32:34  ANR8352I Requests outstanding: (SESSION: 12)
04/11/2007 12:32:34  ANR8373I 001: Fill the bulk entry/exit port of library
                      LIBTS3400 with all 3592 volumes to be processed within 60
                      minute(s); issue 'REPLY' along with the request ID when
                      ready.  (SESSION: 12)
04/11/2007 12:32:51  ANR2017I Administrator ADMIN issued command: REPLY 001
                      (SESSION: 12)
04/11/2007 12:32:51  ANR8499I Command accepted. (SESSION: 12)
04/11/2007 12:33:28  ANR8810I Volume JJS016 has been labeled in library
                      LIBTS3400. (SESSION: 12, PROCESS: 6)
04/11/2007 12:34:03  ANR0985I Process 6 for LABEL LIBVOLUME running in the
                      BACKGROUND completed with completion state SUCCESS at
                      12:34:03. (SESSION: 12, PROCESS: 6)
```

Labeling data cartridges without a barcode reader

If your library has a barcode reader, 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, as 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 following 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 6-5 shows you an output of the activity log for using this method with one unlabeled cartridge in an IBM 3584. We use this command:

```
LABEL LIBVOLUME libts3400 unlab02 CHECKIN=SCRATCH
```

followed by this command to continue the operation:

```
REPLY 013
```

Example 6-5 Tivoli Storage Manager: query actlog output for manually labelling a cartridge

```
04/09/03 15:12:04     ANR2017I Administrator ADMIN issued command: LABEL
                       LIBVOLUME LIBTS3400 unlab02 CHECKIN=SCRATCH OVERWRITE=YES
04/09/03 15:12:04     ANR0984I Process 28 for LABEL LIBVOLUME started in the
                       BACKGROUND at 15:12:04.
04/09/03 15:12:04     ANR8799I LABEL LIBVOLUME: Operation for library LIBTS3400
                       started as process 28.
04/09/03 15:12:04     ANR0609I LABEL LIBVOLUME started as process 28.
04/09/03 15:12:04     ANR0405I Session 1368 ended for administrator ADMIN
                       (WebBrowser).
04/09/03 15:12:06     ANR8323I 013: Insert LTO volume UNLAB02 R/W into
                       entry/exit port of library LIBTS3400 within 60 minute(s);
                       issue 'REPLY' along with the request ID when ready.
04/09/03 15:12:25     ANR2017I Administrator SERVER_CONSOLE issued command:
                       REPLY 013
04/09/03 15:12:25     ANR8499I Command accepted.
04/09/03 15:15:32     ANR8810I Volume UNLAB02 has been labeled in library
```

```
                      LIBTS3400.
04/09/03 15:16:15     ANR8427I CHECKIN LIBVOLUME for volume UNLAB02 in library
                      LIBTS3400 completed successfully.
04/09/03 15:16:16     ANR8800I LABEL LIBVOLUME for volume UNLAB02 in library
                      LIBTS3400 completed successfully.
04/09/03 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 IBM Tivoli Storage Manager manage library cleaning, you need to insert some cleaning cartridges. Use the following command:

```
CHECKIN LIBVOLUME LIBTS3400 STATUS=cleaner CHECKLABEL=barcode SEARCH=bulk CLEANINGS=50
```

The parameter SEARCH=bulk means that IBM 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 and 3592, 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 6-6.

Example 6-6 Insert cleaner cartridge

```
04/11/2007 12:55:50  ANR2017I Administrator ADMIN issued command: CHECKIN
                     LIBVOLUME LIBTS3400 STATUS=cleaner CHECKLABEL=barcode
                     SEARCH=bulk CLEANINGS=50  (SESSION: 12)
04/11/2007 12:55:50  ANR0984I Process 8 for CHECKIN LIBVOLUME started in the
                     BACKGROUND at 12:55:50. (SESSION: 12, PROCESS: 8)
04/11/2007 12:55:50  ANR8422I CHECKIN LIBVOLUME: Operation for library
                     LIBTS3400 started as process 8. (SESSION: 12, PROCESS: 8)
04/11/2007 12:55:50  ANR8373I 002: Fill the bulk entry/exit port of library
                     LIBTS3400 with all 3592 volumes to be processed within 60
                     minute(s); issue 'REPLY' along with the request ID when
                     ready.  (SESSION: 12, PROCESS: 8)
04/11/2007 12:56:04  ANR2017I Administrator ADMIN issued command: REPLY 002
                     (SESSION: 12)
04/11/2007 12:56:04  ANR8499I Command accepted. (SESSION: 12)
04/11/2007 12:56:16  ANR8430I Volume CLN541 has been checked into library
                     LIBTS3400. (SESSION: 12, PROCESS: 8)
04/11/2007 12:56:16  ANR8431I CHECKIN LIBVOLUME process completed for library
                     LIBTS3400; 1 volume(s) found. (SESSION: 12, PROCESS: 8)
04/11/2007 12:56:16  ANR0985I Process 8 for CHECKIN LIBVOLUME running in the
                     BACKGROUND completed with completion state SUCCESS at
                     12:56:16. (SESSION: 12, PROCESS: 8)
```

Performance hints for Tivoli Storage Manager and tape

Refer to the detailed discussion in 6.3.1, “Performance hints for IBM Tivoli Storage Manager, LTO, and 3592” on page 230 for performance hints for IBM Tivoli Storage Manager and tape.

6.3 Non-shared device with Tivoli Storage Manager for Linux

In this section, we discuss the steps required to configure IBM tape libraries with IBM Tivoli Storage Manager for Linux.

Installing IBM Tivoli Storage Manager

Before you can begin using a tape device as a backup destination, you must do the following:

1. Install the IBMtape Device Drivers and IBMtapeutil.
2. Attach the devices to your system.
3. Configure the special device files for the tape library and drives.
4. Install the IBM Tivoli Storage Manager Server software.
5. Initialize the server.
6. Define the library.
7. Define the library path.
8. Define the drives in the library.
9. Define the drive paths.
10. Define a device class using the library.
11. Label the tape library media.

For steps 1 through 3, refer to Chapter 4, “Basic IBM tape setup for Linux” on page 159. Then follow the instructions in *IBM Tivoli Storage Manager for Linux Installation Guide V5.3*, GC32-1599 to install and initialize the Tivoli Storage Manager server (steps 4 and 5). Installation of the IBM Tivoli Storage Manager Device Driver (tsmscsi) is not mandatory because we are using the IBMtape Device Drivers.

Before installing, you should check that you have the latest code fixes. See the following Web site for Tivoli product requirements, supported devices, and code levels:

`http://www-306.ibm.com/software/sysmgmt/products/support/IBMTivoliStorageManager.html`

After installing and starting the server, we recommend using the administrative client command-line interface (CLI) to configure the subsequent steps. The command-line interface is the same across all present IBM Tivoli Storage Manager versions. Refer to the IBM Tivoli Storage Manager manuals for details about using the Administrative Console interface.

To use CLI (**`dsmadmc`**), you must install the client code on the IBM Tivoli Storage Manager server or an IBM Tivoli Storage Manager client. Our examples use the CLI.

We show how to set up the IBM Tivoli Storage Manager server with the IBM tape library and drives only. For more general information about the setup of the IBM Tivoli Storage Manager for Linux, see:

- *IBM Tivoli Storage Manager for Linux Administrator's Guide V5.3*, GC23-4690
- *IBM Tivoli Storage Manager for Linux Installation Guide V5.3,* GC32-1599
- *IBM Tivoli Storage Manager for Linux Administrator's Reference Guide V5.3*, GC23-4691
- *IBM Tivoli Storage Manager for Linux Administrator's Guide V5.*4, SC32-0119
- *IBM Tivoli Storage Manager for Linux Installation Guide V5.4, SC32-0136*
- *IBM Tivoli Storage Manager for Linux Administrator's Guide V5.4, SC32-0125*

We described how to install the IBMtape drivers in Chapter 4, “Basic IBM tape setup for Linux” on page 159. The following examples summarize the device installation and IBM Tivoli Storage Manager server installation.

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Defining libraries and drives

After installing IBM Tivoli Storage Manager, we must configure the library and devices to IBM Tivoli Storage Manager.

To determine which device special file to use for each of the devices you define in the IBM Tivoli Storage Manager, you should have prepared a library device table similar to Table 6-1. This is important because the operating system does not necessarily assign device special file names in the same order as the devices are physically installed in the library.

Table 6-1 Library device table

Device name	Serial number/WWN	Tape drive in the library	SCSI element address
IBMtape0	1300000979	Drive 1	257
IBMtape1	1300001012	Drive 2	258

First, define the library and library path using the following commands. When there are multiple choices, the default setting is listed last:

```
DEFINE LIBRARY library_name LIBTYPE=SCSI
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 libts3200 LIBTYPE=SCSI
```

For server_name, specify a name you have set for your server with the SET SERVERNAME command, which can be checked by issuing the QUERY STATUS command. In our case, we used the name saab. For dev_name, enter the full device name of library, such as /dev/IBMchanger0:

```
DEFINE PATH goofy libts3200 SRCTYPE=SERVER DESTTYPE=LIBRARY DEVICE=/dev/IBMchanger0
```

Next, define each of the library's drives and drives paths with:

```
DEFINE DRIVE library_name drive_name
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 (libts3200, 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, such as /dev/IBMtape0.

We configured our drives in the IBM TS3200 with the following commands:

```
DEFINE DRIVE libts3200 drive01
DEFINE DRIVE libts3200 drive02
DEFINE PATH goofy drive01 SRCTYPE=SERVER DESTTYPE=DRIVE LIBRARY=libts3200 \
DEVICE=/dev/IBMtape0
DEFINE PATH goofy drive02 SRCTYPE=SERVER DESTTYPE=DRIVE LIBRARY=libts3200 \
DEVICE=/dev/IBMtape1
```

Tip: Before defining the drives and libraries, make sure that your library is online and your drives are available. Also, there should not be any cartridges loaded in the drive being defined.

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Defining the device class

To configure the device class, use the following commands.

For LTO drives, use LTO as the DEVTYPE parameter:

```
DEFINE DEVCLASS devclass_name LIBRARY=library_name DEVTYPE=LTO
```

For IBM 3592 drives, use 3592 as the DEVTYPE parameter:

```
DEFINE DEVCLASS devclass_name LIBRARY=library_name DEVTYPE=3592
```

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

- ultrium3

  Specifies that IBM 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 IBM 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 IBM Tivoli Storage Manager writes data using the ULTRIUM4 recording format with compression. This format results in a cartridge capacity of approximately 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 IBM 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.

- 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 300 GB 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 3592C 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.

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- 3592-2

  Specifies that IBM Tivoli Storage Manager writes data using the 3592 recording format. This format results in a cartridge capacity of 500 GB when using 3592 500 GB data cartridges. This value overrides the settings on the tape drive characteristics for hardware compression.

- 3592-2C

  Specifies that IBM Tivoli Storage Manager writes data using the 3592 recording format with compression. This format results in a cartridge capacity of approximately 1500 GB when using 3592 500 GB 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=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 3 and 4 drives. Use the specific definitions, as described in detail in 6.12, “Device migration and coexistence” on page 248.)

If you use recording FORMAT=ultrium3c/ultrium4c/3592c/3592-2c/drive, then your LAN-free clients also use compression regardless of whether hardware compression is enabled.

Note that IBM 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=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 may want to specify a number instead of the default drives to limit the number of drives each server has access to.
- If you have a mixture of LTO generation drives in the same library, see 6.12, “Device migration and coexistence” on page 248 for more information. We recommend that the default value of drives *not* be used for the older Ultrium x device classes. For example, when specifying MOUNTLIMIT=drives, the IBM Tivoli Storage Manager server will load Ultrium 3 cartridges into Ultrium 3 drives in preference to Ultrium 4 drives, but there exists the possibility that all Ultrium 4 drives could be loaded with Ultrium 3 cartridges and therefore an Ultrium 4 cartridge could not be loaded. It may 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.

To define the IBM TS3200 in our Linux environment, we called the device class TS3200CLASS, pointing to our previously defined library libts3200. In the example, we have two LTO4 drives in the library:

```
DEFINE DEVCLASS ts3200class DEVTYPE=LTO LIBRARY=libts3200
```

Defining the storage pool using the command line

Define the storage pool with the following command:

```
DEFINE STGPOOL stgpool_name devclass_name MAXSCRATCH=number
```

This storage pool will be assigned to the device class we just defined, so we specify the name TS3200CLASS. We used ts3200pool as the stgpool_name:

```
DEFINE STGPOOL ts3200pool ts3200class MAXSCRATCH=9999
```

Example 6-7 shows you the storage pool that we defined.

Example 6-7 q stgpool ts3200pool f=d

```
              Storage Pool Name: TS3200POOL
               Storage Pool Type: Primary
               Device Class Name: TS3200CLASS
              Estimated Capacity: 0.0 M
              Space Trigger Util:
                        Pct Util: 0.0
                        Pct Migr: 0.0
                     Pct Logical: 0.0
                    High Mig Pct: 90
                     Low Mig Pct: 70
                 Migration Delay: 0
              Migration Continue: Yes
            Migration Processes: 1
          Reclamation Processes: 1
             Next Storage Pool:
           Reclaim Storage Pool:
         Maximum Size Threshold: No Limit
                         Access: Read/Write
                    Description:
              Overflow Location:
          Cache Migrated Files?:
                      Collocate?: Group
          Reclamation Threshold: 60
      Offsite Reclamation Limit:
 Maximum Scratch Volumes Allowed: 9,999
  Number of Scratch Volumes Used: 0
   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
  Last Update by (administrator): ADMIN
           Last Update Date/Time: 04/13/2007 17:04:10
        Storage Pool Data Format: Native
            Copy Storage Pool(s):
        Continue Copy on Error?:
                        CRC Data: No
               Reclamation Type: Threshold
```

Now you can use this storage pool in your management class copy groups, so that the device will be used for backups or archives.

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Preparing the cartridges

We can now start the process of labelling and checking tapes into the library for use. We used the LABEL LIBVOLUME command (Example 6-8) to label and check in the volumes into the library. Specifying `search=yes` will automatically try to label all the cartridges found in the logical library. For detailed information, refer to “Preparing the cartridges using the command-line interface” on page 221.

Example 6-8 LABEL LIBVOLUME

```
tsm: GOOFY> LABEL LIBVOLUME libts3200 search=yes checkin=scratch labelsource=barcode
tsm: GOOFY> query process
Process Process Description  Status
  Number
-------- -------------------- -------------------------------------------------
       3 LABEL LIBVOLUME      ANR8805I Labelling volumes in library LIBTS3200; 0
                               volumes(s) labelled.\

tsm: GOOFY> query actlog search=labeled
ANR8810I Volume 3FO188L3 has been labeled in library LIBTS3200.
ANR8810I Volume 3IA011L3 has been labeled in library LIBTS3200.
ANR8810I Volume 3IR077L3 has been labeled in library LIBTS3200.
ANR8810I Volume 3IR094L4 has been labeled in library LIBTS3200.
ANR8810I Volume 3SS010L3 has been labeled in library LIBTS3200.
ANR8810I Volume 3TE059L3 has been labeled in library LIBTS3200.

tsm: GOOFY> query libvolume
Library Name     Volume Name     Status         Owner          Last Use      Home Element
------------     -----------     ----------     ----------     ---------     ------------
LIBTS3200        3FO188L3        Scratch                                     4,119
LIBTS3200        3IA011L3        Scratch                                     4,121
LIBTS3200        3IR077L3        Scratch                                     4,097
LIBTS3200        3IR094L4        Scratch                                     4,109
LIBTS3200        3SS010L3        Scratch                                     4,120
LIBTS3200        3TE059L3        Scratch                                     4,102
```

Additional steps, such as creating domains, management classes, and copygroups are described in the IBM Tivoli Storage Manager manuals. They are beyond the scope of this book.

6.3.1 Performance hints for IBM Tivoli Storage Manager, LTO, and 3592

Since IBM Tivoli Storage Manager writes a record in 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 IBM 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 bigger the IBM Tivoli Storage Manager database log area needs to be.

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 dsmserv.opt on the IBM Tivoli Storage Manager server, as shown in Example 6-9 on page 231. 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, a restart of the Storage Agent process is required).

Example 6-9 TXNGroupmax entry in dsmserv.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 65000
*
```

Alternatively, the parameter may be set online by the command:

```
SETOPT TXNGROUPMAX 65000
```

To set the client parameter TXNBytelimit, edit dsm.sys (for UNIX clients) or dsm.opt (for all other clients). The entry should be similar to Example 6-10.

Example 6-10 TXNBytelimit entry in dsm.opt/dsm.sys

```
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.

6.4 LTO WORM (Write Once Read Many)

The Ultrium 3 tape drive now has WORM functionality. Special LTO 3 WORM cartridges (identified as LT cartridges) are designed to provide non-alterable, non-rewritable tape media for long-term records retention.

IBM LTO WORM devices are only available with Ultrium 3 devices and media. To use LTO WORM, an LTO WORM device class definition is required. This uses the WORM=YES parameter in the definition:

```
DEFINE DEVCLASS <class name> LIBRARY=<library name> DEVTYPE=LTO WORM=YES
```

IBM Tivoli Storage Manager can only distinguish LTO WORM media from rewritable media only 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 IBM Tivoli Storage Manager. Note that this also means that you cannot make use of the AUTOLABEL

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attribute of the library for WORM media. Once the media is checked into IBM Tivoli Storage Manager, IBM Tivoli Storage Manager is aware that this is a WORM cartridge and will treat it accordingly.

Note: This limitation is only for LTO in SCSI libraries, and does not apply to 3592 WORM in either SCSI or 3494 libraries.

6.5 Various IBM 3592 media types and ITSM

This section describes characteristics of the 3592 cartridges and drive functions, and how to use them with IBM Tivoli Storage Manager. For detailed information about 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. The IBM TS3400 library is especially suited in the Open Systems environments. Thus, it is part of the Open 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 300/500/700 GB R/W (JA) cartridge to allow a capacity trade off for improved access times.

Tivoli Storage Manager can utilize these functions by specifying the SCALECAPACITY parameter with the **`define/update devclass`** command.

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 the scratch state.

Each of the SCALECAPACITY parameter settings (20/90/100) will initialize the cartridge, as shown in Figure 6-23 on page 233.

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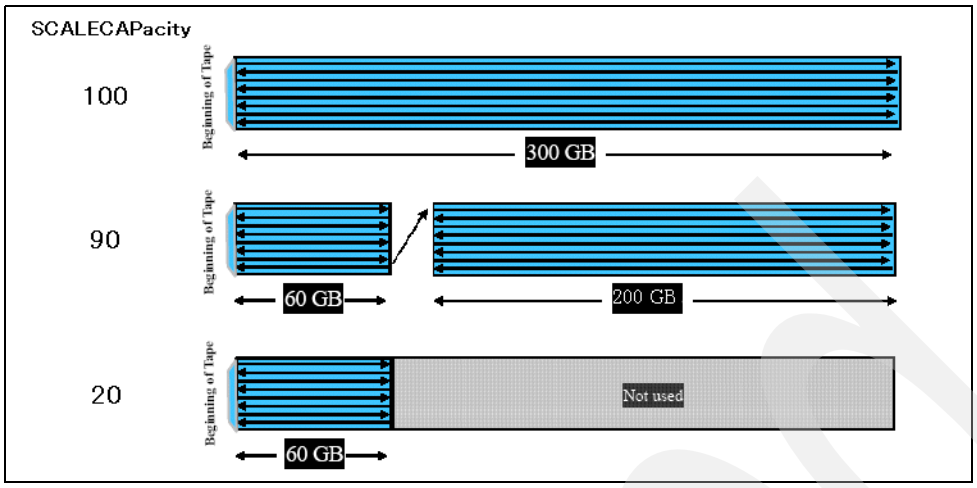


Figure 6-23 How each of the SCALECAPACITY parameters initialize 3592 JA cartridges

When SCALECAPACITY is set to 100 (default), Tivoli Storage Manager will initialize the cartridge as a 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 60 GB.

Depending on the client 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 need to be defined to a different storage pool to fully utilize the segmented function, but with the current IBM Tivoli Storage Manager architecture, it is not possible to define two storage pools for one volume.

Write Once Read Many (WORM)

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 WORM=yes parameter in the command DEFINE/UPDATE DEVCLASS.

Because IBM 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 the 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 cartridge, define the device class as below; 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 cartridges, define the device class as below:

```
DEFINE DEVCLASS devclass_name DEVTYPE=3592 FORMAT=3592/3592c/3592-2/3592-2c/drive \
LIBRARY=library_name
```

For JW and JR cartridges, define the device class as below:

```
DEFINE DEVCLASS devclass_name DEVTYPE=3592 FORMAT=3592/3592c/3592-2/3592-2c/drive \
LIBRARY=library_name WORM=yes
```

The SCALECAPACITY parameter with a 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 stgpool`** will show you 300 GB (or 900 GB for compress) for each of the volumes defined. When the EOV (end-of-volume) is reached, query commands will show the actual data written for the volume.

Set up fast access storage pool with 3592 and ITSM

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:

- If using method 1 (above) to configure 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 tapes will automatically be initialized to the storage pool it is called for.

- If using method 2 (above) to configure fast access storage pool:

  Since IBM 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).

6.6 Sharing LTO libraries with IBM Tivoli Storage Manager

The concepts of library sharing have been discussed in Chapter 2, “IBM Open System Tape Library sharing and partitioning” on page 43. In this section, we will briefly discuss configuration parameters to consider; for further in-depth discussion of IBM Tivoli Storage Manager and library sharing and the use of SAN, refer to *Get More Out of Your SAN with IBM Tivoli Storage Manager*, SG24-6687.

Several IBM Tivoli Storage Manager servers can share the same tape library using the library sharing feature, as shown in Figure 6-2 on page 202. Tape library sharing is supported between any combination of Windows, AIX, Solaris, Linux, and HP-UX IBM 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 a 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 example, 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, then the library client can write the data directly over the physical SAN path to the tape drive.

6.6.1 Configuring the Library Manager to share libraries

Install and configure your tape library and drives on the Library Manager, as described in 6.2, “Non-shared devices with Tivoli Storage Manager for Windows” on page 204. Define the library with the shared=yes parameter, such as:

```
DEFINE LIBRARY libts3400 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
```

6.6.2 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
```

As we have set crossdefine to on, the above commands should automatically create library client definitions on the Library Manager. Check this with the QUERY SERVER command.

6.6.3 Define library and drives for library client

See Chapter 3, “Basic IBM tape setup for Windows” on page 101, Chapter 4, “Basic IBM tape setup for Linux” on page 159, and Chapter 5, “SAN considerations” on page 181 for basic tape drive installation on the library clients.

You will need to define the library definition at each library clients. 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 5.3, “Persistent binding” on page 194. Therefore, check carefully that the element address matches your drive configuration.

You can check the result with the Q PATH command.

Now you can define the device class and the storage pool using the library definitions, as described in 6.2.7, “Defining the storage pool using the command line” on page 217.

6.6.4 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 requested 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 IBM Tivoli Storage Manager server is the “owner” of each volume, as shown in Example 6-11.

Example 6-11 Q LIBVOL on a Library Manager

```
Library Name   Volume Name   Status       Owner        Last Use    Home Element
------------   -----------   ----------   ----------   ---------   ------------
LTO_3584       ABA920        Private      SICILY       Data        4,114
LTO_3584       ABA922        Private      SICILY       Data        4,104
LTO_3584       ABA923        Scratch                               4,106
LTO_3584       ABA924        Scratch                               4,107
LTO_3584       ABA925        Private      SICILY                   4,130
LTO_3584       ABA926        Private      SICILY                   4,098
LTO_3584       ABA927        Private      BRAZIL       Data        4,102
LTO_3584       ABA928        Private      BRAZIL       Data        4,111
```

```
LTO_3584        ABA929        Private      BRAZIL       Data         4,112
LTO_3584        ABA990        Private      BRAZIL       Data         4,133
```

The library client is only using the drives, and has no knowledge of the library contents. Example 6-12 shows executing QUERY LIBVOLUME on a library client.

Example 6-12 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 (see Example 6-13).

Example 6-13 QUERY VOLUME on a shared library

```
tsm: SICILY>q volume

Volume Name              Storage      Device      Estimated    Pct   Volume
                         Pool Name    Class Name   Capacity   Util   Status
                                                     (MB)
------------------------ ----------- ---------- ---------- -----  --------
ABA920                   3584LTO_ST-  3580_DEVC-   95,367.0    2.4  Filling
                          GPOOL        LASS
ABA922                   3584LTO_ST-  3580_DEVC-  190,734.0    0.8  Filling
                          GPOOL        LASS
```

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 in or out of a volume from a shared library must be done from 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. This is because the Library Manager serves as 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.

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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 IBM 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.

6.7 LAN-free backup with IBM Tivoli Storage Manager

We will briefly discuss configuration parameters to consider for LAN-free backup. For in-depth discussion of this topic, see *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 6.6, “Sharing LTO libraries with IBM Tivoli Storage Manager” on page 234. 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 through 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 IBM Tivoli Storage Manager database). The metadata is transmitted over the LAN from the IBM Tivoli Storage Manager client to the IBM Tivoli Storage Manager server while the application data is moved directly over the SAN from the IBM Tivoli Storage Manager client to the storage device. Figure 6-3 on page 204 describes this process.

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 IBM Tivoli Storage Manager server that has no database or storage hierarchy of its own. It behaves like a library client, which contacts the IBM Tivoli Storage Manager server for volume access, and reads/writes data directly to SAN-attached devices.

6.7.1 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 SAN for Windows Storage Agent User's Guide V5.4,* SC32-0133.

Before beginning, set up your IBM Tivoli Storage Manager server as a Library Manager, as described in 6.6.1, “Configuring the Library Manager to share libraries” on page 235.

Table 6-2 on page 239 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 6-2 Configuring LAN-free backups

Step	On server	On client
1)	.....	Install tape drives according to above.
2)	.....	Install the IBM Tivoli Storage Manager client code.

3)	.....	Modify dsm.sys of the backup-archive client as follows:
		`ENABLELANFREE YES`
		`LANFREECommethod TCPIP`
		`LANFREETCPPort` *`port_number`*
		
		If the clients do not reside on the same system as the storage agent, set the following option with the appropriate value:
		`- LANFREETCPSERVERADDRESS` *`ip_address`*

4)	.....	Install the Storage Agent.
5)	.....	Specify the DEVCONFIG option in the dsmsta.opt of Storage Agent: `DEVCONFIG outputfile`
6)	Define each LAN-free client Storage Agent as though it was a server. Use the DEFINE SERVER 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.	.....
9)	.....	Obtain Tape Device information (see 7.7.2 6.7.2, “Define path considerations” on page 240).
10)	Use the DEFINE PATH command to define paths from the Storage Agent to the drives that are available to the IBM Tivoli Storage Manager server (see 6.7.2, “Define path considerations” on page 240).	.....
11)	.....	Test to see if the data transfer goes over the SAN.

Note: Make sure TXNGROUPMAX in dsmsta.opt is set at the same value as that in dsmserv.opt. When using LTO or 3592 drives, it is recommended to set this value to 256 or higher for performance reason (see 6.3.1, “Performance hints for IBM Tivoli Storage Manager, LTO, and 3592” on page 230).

Archive

6.7.2 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 that can be used by the Storage Agent are 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 on 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 known to the server will probably not match the device name known to the Storage Agent, as described in 5.3, “Persistent binding” on page 194.

Define paths on the server using the device names seen on the Storage Agent machine. 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 IBM 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, mt2.2.0.2).

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 5.3, “Persistent binding” on page 194. Therefore, check carefully that the element address matches your drive configuration.

6.8 NDMP backup with IBM Tivoli Storage Manager

Network Data Management Protocol (NDMP) is an open standard protocol developed to eliminate the issues centered around 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 IBM Tivoli Storage Manager platform; for example, for a Windows server, refer to:

- *IBM Tivoli Storage Manager for Windows Adminstrator's Guide V5.3*, GC32-0782
- *IBM Tivoli Storage Manager for Windows Adminstrator's Guide V5.4*, SC32-0121

Also see:

- *IBM Tivoli Storage Manager Implementation Guide*, SG24-5416

6.8.1 Network Attached Storage

NAS stands for Network Attached Storage and is a way to make large amounts of disk storage available to many clients using standard file sharing protocols. An NAS box (sometimes also called an 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 in 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 may or may 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.

6.8.2 Overview of IBM Tivoli Storage Manager NDMP backup

IBM Tivoli Storage Manager Enterprise Edition provides backup of supported NAS file servers. IBM Tivoli Storage Manager controls the backup operation remotely, but the NAS file server transfers the backup data locally. Typically, this in a direct SCSI attached configuration between the NAS file server and a tape library. It is possible to configure NDMP operations with IBM Tivoli Storage Manager using a SAN attached configuration. However, the library robotics must be logically but explicitly controlled by the IBM Tivoli Storage Manager server, and the tape drives must be logically but explicitly controlled by the NAS file server.

IBM 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, IBM Tivoli Storage Manager will restore the full backup first, followed by the differential backup.

6.8.3 Tivoli Storage Manager NDMP backup configurations

The fundamental physical requirement for IBM Tivoli Storage Manager NDMP backup is to have the tape devices connected to the NAS system. The library robotics may be controlled by either the NAS system or the IBM 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 IBM Tivoli Storage Manager server and the NAS system, then the library must be directly connected to the NAS system. The supported configurations are shown below.

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 6-24. The IBM Tivoli Storage Manager server sends commands to the library across the LAN to the NAS file server, which passes the commands onto the tape library. Any generated responses are sent back to the IBM Tivoli Storage Manager server through the NAS file server. In this configuration, the NAS file server may be separated from the IBM Tivoli Storage Manager server by a large distance, as TCP/IP connectivity is all that is required.

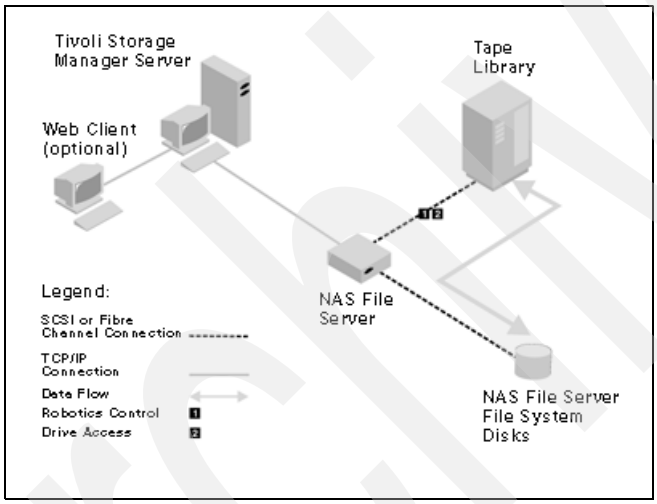


Figure 6-24 Library connected to NAS system

Library connected to IBM 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 6-25 on page 243. The IBM 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 IBM Tivoli Storage Manager server. This configuration is only possible within the physical connectivity limitations of SCSI or Fibre Channel.

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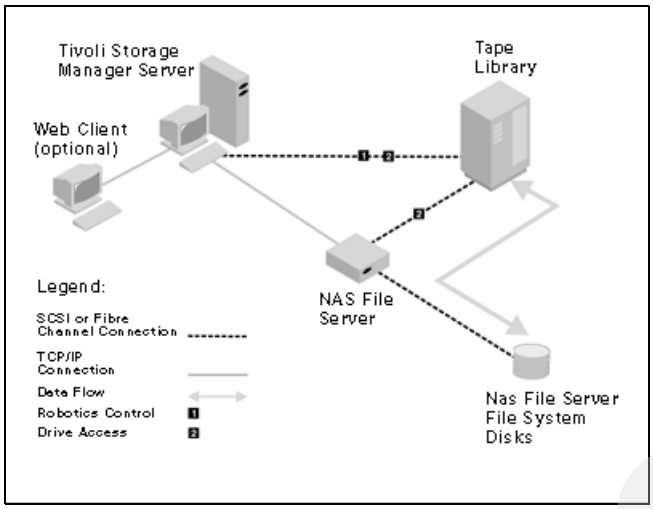


Figure 6-25 Library on Tivoli Storage Manager server: drives on NAS system

Expiration and retention policies for NDMP backup

When an NDMP backup is performed, the IBM Tivoli Storage Manager server checks if a valid full image backup exists. If it does not, a full image backup is performed. The IBM 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.

Let us say 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 IBM 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.

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, as shown in Figure 6-26, 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.

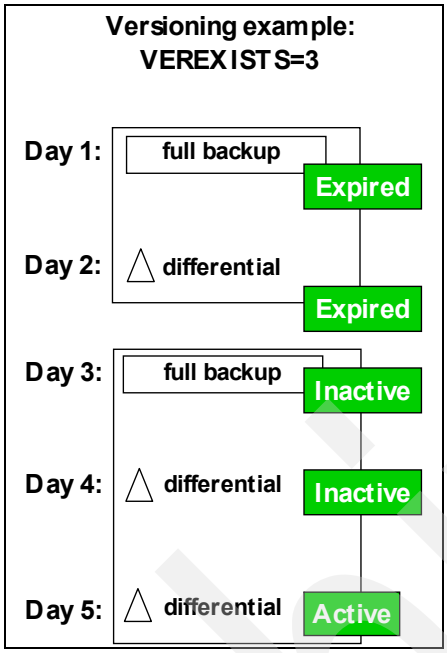


Figure 6-26 How version control works for NDMP backups

6.9 IBM Tivoli Storage Manager and redundant library control paths

The IBM TS3200, TS3310, TS3400, and TS3500 allow you to enable multiple control paths to a single logical library. 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 3.3, “Path failover” on page 107 and 4.3.4, “Setting up control path failover on Linux” on page 169 for further details in particular environments.

IBM Tivoli Storage Manager cannot automatically handle multiple control paths to one logical library on its own; however, it can work with automatic control path failover for the operating system. 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 on your IBM Tivoli Storage Manager server.

Figure 6-27 on page 245 shows an IBM TS3500 with two drives. Both drives have the control path enabled.

Archived

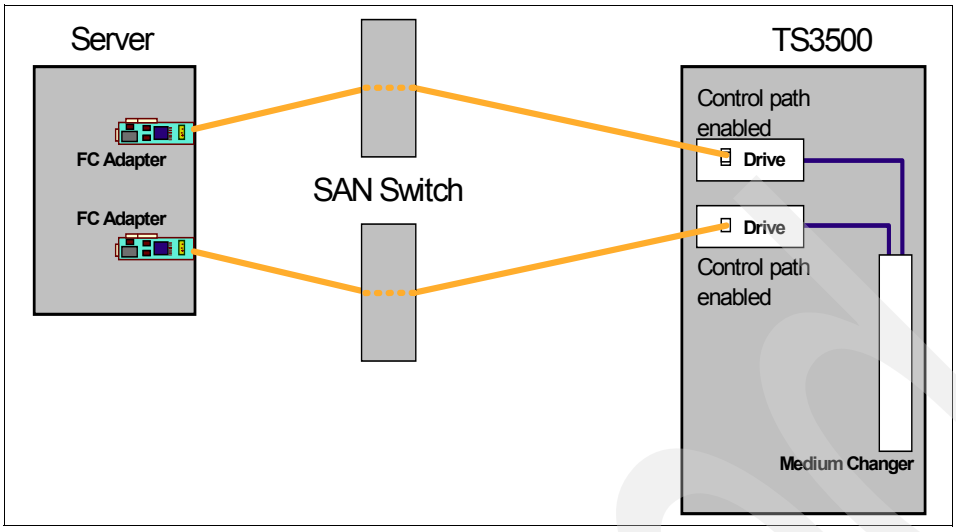


Figure 6-27 IBM TS3500 with multiple control paths enabled

If you enable multiple control paths on your IBM TS3200, TS3310, TS3400, and TS3500, you will see several SCSI media changer devices with primary and alternate paths. For example, with Linux, as in this example, you can check if the IBMtape driver has recognized multiple control paths for your library by reading the /proc/scsi/IBMchanger file. If your library lists Primary or Alternate under the FO Path, as in Example 6-14, then you have successfully enabled the control path failover feature for your library. If NA is listed under the FO Path, then the control path failover is not enabled. When IBMtape is loaded into kernel memory, the first logical medium changer device that IBMtape sees in the system will be the primary path for that medium changer. The other logical medium changers that IBMtape 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 6-14 An example of /proc/scsi/IBMchanger file

```
[root@saab root]# cat /proc/scsi/IBMchanger
IBMtape version: 1.4.11
IBMtape major number: 253
Attached Changer Devices:
Number  Model       SN              HBA                          FO Path
0       ULT3583-TL  IBM1234567      QLogic Fibre Channel 2200    Primary
1       ULT3583-TL  IBM1234567      QLogic Fibre Channel 2300    Alternate
2       ULT3583-TL  IBM1234567      QLogic Fibre Channel 2300    Alternate
```

Whether you use automatic control path failover or not, you should only configure one control path to the library in IBM 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 (IBMchanger0), and we do not use automatic control path failover, we could switch to the second path (IBMchanger1) with:

```
UPDATE PATH server_name library_name SRCTYPE=SERVER DESTTYPE=LIBRARY
DEVICE=/dev/IBMchanger1
```

With automatic control path failover enabled, we would not need to perform the UPDATE PATH command, since failover happens automatically.

6.10 IBM Tivoli Storage Manager and data path failover

The concept of control and data path failover is further discussed in the IBM Redbooks publication *Get More Out of Your SAN with IBM Tivoli Storage Manager*, SG24-6687.

The IBM tape device driver allows you to configure and automatically fail over between multiple data paths (single SAN fabric) to a single FC LTO, or two SAN fabrics to an IBM TS1120 drive. See 3.3.3, “Configuring and unconfiguring Data Path Failover” on page 113 for Windows, and see 4.3.5, “Setting up data path failover on Linux” on page 172 for details in the Linux environment. Note that the LTO drives have only one interface to the fabric, while IBM TS1120 has two.

Without the drivers' data path failover support in the Windows or Linux, if an application opens IBMtape0 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 (IBMtape1), but the application has to be restarted from the beginning. A long backup or restore operation may have been in progress when the path error occurred. Sometimes manual failover may require operator intervention to reset the drive because a SCSI Reservation can still exist on the failing HBA path.

When the data path failover support is enabled on both IBMtape0 and IBMtape1, 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 IBMtape0 or IBMtape1). If an application opens IBMtape0 and a permanent path error occurs, the device driver initiates failover error recovery automatically on the alternate path (IBMtape1). 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 6-28 shows an IBM TS3500 with TS1120 drives.

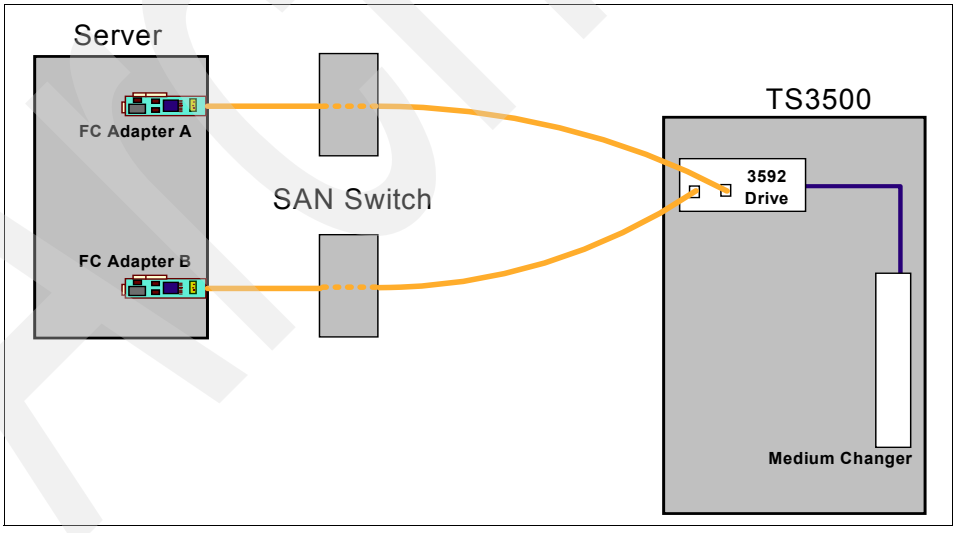


Figure 6-28 TS1120 drive with multiple data paths configured

You can check if the IBMtape driver has recognized multiple data paths for your library by reading the /proc/scsi/IBMtape file. If your library lists Primary or Alternate under the FO Path, as shown in Example 6-15 on page 247, then you have successfully enabled the data path failover feature for your library. If NA is listed under the FO Path, then the data path failover is not enabled.

Example 6-15 An example of the /proc/scsi/IBMtape file

```
IBMtape version: 1.5.3
IBMtape major number: 253
Attached Tape Devices:
Number  Model       SN                HBA                           FO Path
0       ULT3583-TL  IBM1234567        QLogic Fibre Channel 2200     Primary
1       ULT3583-TL  IBM1234567        QLogic Fibre Channel 2300     Alternate
2       ULT3583-TL  IBM1234567        QLogic Fibre Channel 2300     Alternate
```

Whether you use automatic data path failover or not, you should only configure one data path to each of the drives defined to the IBM Tivoli Storage Manager server.

Defining a path to IBMtape0, if a failure occurs on this path, the IBM device driver will automatically and transparently to the application (for example, IBM Tivoli Storage Manager) fail over to the alternate path (/dev/IBMtape1) without interrupting the current Tivoli Storage Manager operation.

6.11 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 IBM Tivoli Storage Manager server.

There are three severity levels of tape alert messages:

- Informational

  For example, you may 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 may set tape alert messages to ON or OFF by 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 6-16 and Example 6-17 on page 248 are examples of the QUERY TAPEALERTMSG and QUERY ACTLOG commands in UNIX environments.

Example 6-16 QUERY TAPEALERTMSG command output

```
tsm: SERVER1>query tapealertmsg
ANR8960I QUERY TAPEALERTMSG: The display of Tape Alerts from SCSI devices is
Enabled.
```

Archived

Example 6-17 QUERY ACTLOG command output

```
tsm: SERVER1>query actlog begindate=-15 search=TapeAlert

Date/Time               Message
--------------------    ------------------------------------------------------------
03/24/04   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)
03/24/04   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)
03/24/04   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)
```

6.12 Device migration and coexistence

Careful planning is recommended when introducing and mixing new generations of media technology with IBM 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. IBM Tivoli Storage Manager controls the media through the library changer by using SCSI commands, and cannot detect the internal format of a cartridge. IBM 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 IBM Tivoli Storage Manager, you can operate with mixed media types when the library is able to distinguish the different media.

This section provides information about migration and co-existence issues for LTO Ultrium 2, 3, and 4 drives in one library, and with IBM Tivoli Storage Manager. First, we define a few terms.

Mixed media libraries

Mixed media in a IBM 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 coexist in the same library.

Mixed generation devices

A mixed generation device in a IBM 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: IBM Tivoli Storage Manager support for LTO4 is available as of V5.3.5.0 or V5.4.1.0.

6.12.1 Scenarios

In the lifetime of a IBM 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 of 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 6-3 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 IBM Tivoli Storage Manager used. You may 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 the coexistence and migration of the older LTO2 and 3, or even LTO1 and 2.

Table 6-3 LTO migration and co-existence examples

Scenario	Configuration	TSM V5.2.4	TSM V5.3.5 or V5.4.1
1	a) LTO 3 + 4 drives LTO 3 Media ---------- b) LTO 2 + 3 drives, LTO 2 Media	 ---------- 1 logical library 1 devclass	1 logical library 1 devclass
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

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Scenario	Configuration	TSM V5.2.4	TSM V5.3.5 or V5.4.1
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 in Scenario 1:

- Install LTO4 drives in addition to the current LTO3 drives and media.
- Use the equivalent scenario for the older generation, that is, 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 IBM Tivoli Storage Manager V5.2, mixed media types are supported in one library, and thus different generations of tape devices can coexist 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. IBM 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 LTO4 devices.

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Tip: MOUNTLIMIT

For read or write tape mounts, IBM 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 that works for your environment.

Scenario 3

As of IBM 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” on page 250, 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 IBM 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” on page 250.

The same discussion applies using the older generation LTO2 and LTO3 media and drives.

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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 6-29 on page 253).
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 6-29 on page 253).
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 6-29 on page 253).
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 after running the command **`query stgpool`**.

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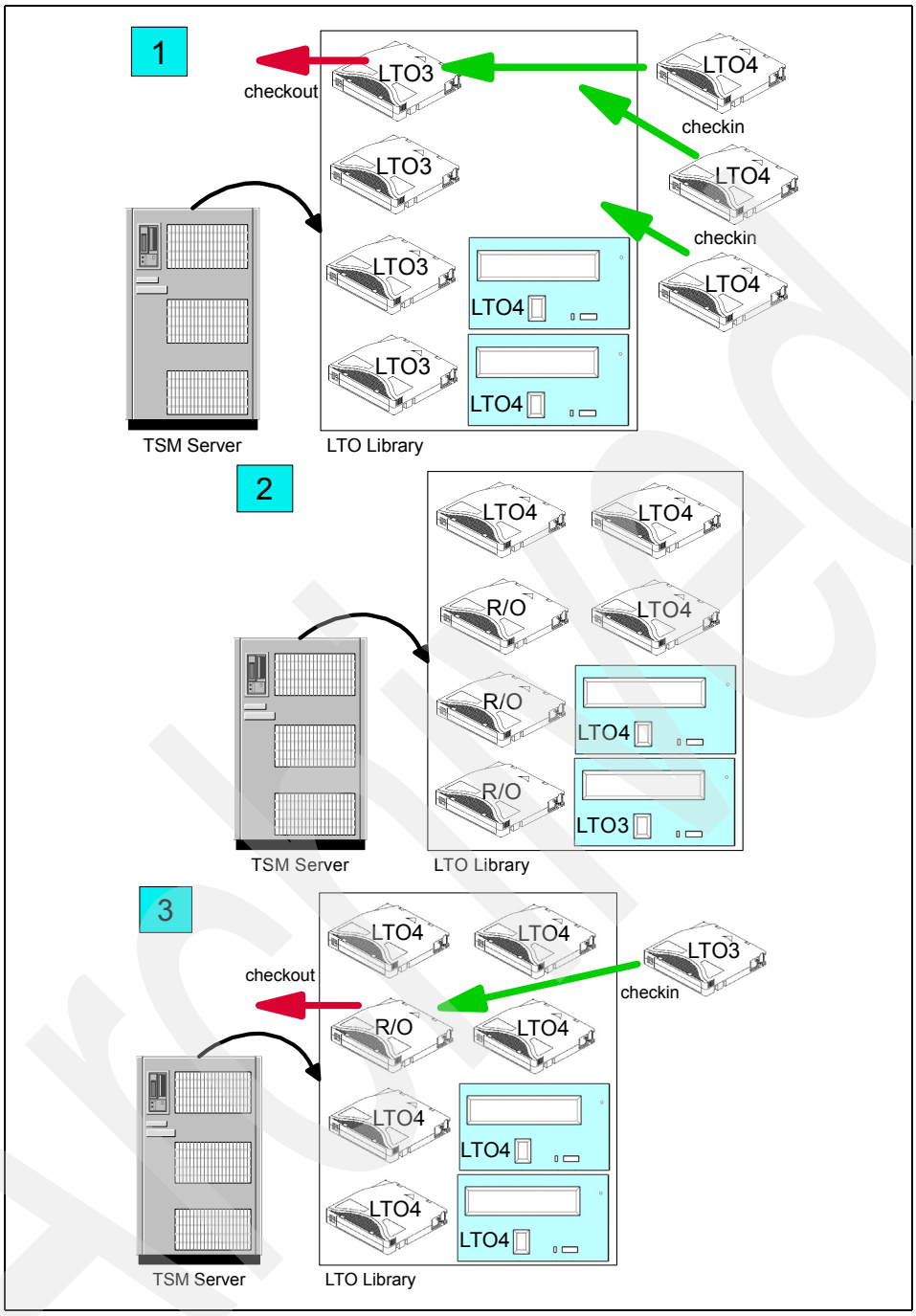


Figure 6-29 Migration scenario 5

The same discussion applies to migrating the older generation LTO2s to LTO3s.

Scenario 6

LTO4 drives can read the LTO2 media. The discussion in “Scenario 5” on page 252 applies here, 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 only affects the storage pools:

1. Define the new LTO library, library path, drives, drive paths, and device classes.
2. Create an LTO sequential storage pool or copy storage pool using the new LTO device class (label 1 in Figure 6-30 on page 255).
3. Modify the NEXTSTGPOOL parameter of the old storage pool to point to the new LTO storage pool (label 2 in Figure 6-30 on page 255).
4. Update the old storage pool ACCESS to READONLY.

   Note: This step 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 that this is a drive-to-drive process).
6. Alternatively, you can execute the **`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 6-30 on page 255).
8. Delete the DRIVE and PATH, and also the LIBRARY and PATH entries for the old library and drives.

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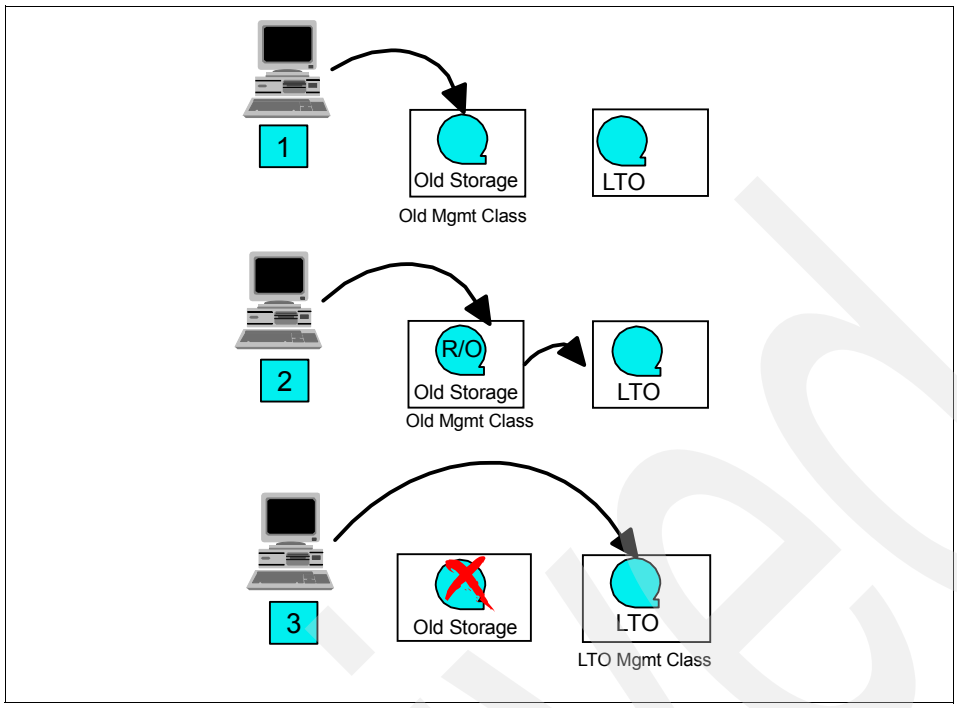


Figure 6-30 Migrating to LTO as sequential primary copy

Disk storage pool as primary copy destination

If you use a disk storage pool as your primary destination that is cascaded to the old storage pool, your final modification affects the primary disk storage pool only.

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 6-31 on page 256), modify the NEXTSTGPOOL parameter of the old storage pool to point to the new LTO storage pool (label 2 in Figure 6-31 on page 256).
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 that 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.

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7. Once the old sequential storage pool is emptied, modify the NEXTSTGPOOL parameter of the disk storage pool to point to the new LTO storage pool (label 3 in Figure 6-31).
8. Delete the DRIVE and PATH, and also the LIBRARY and PATH entries for the old library and drives.

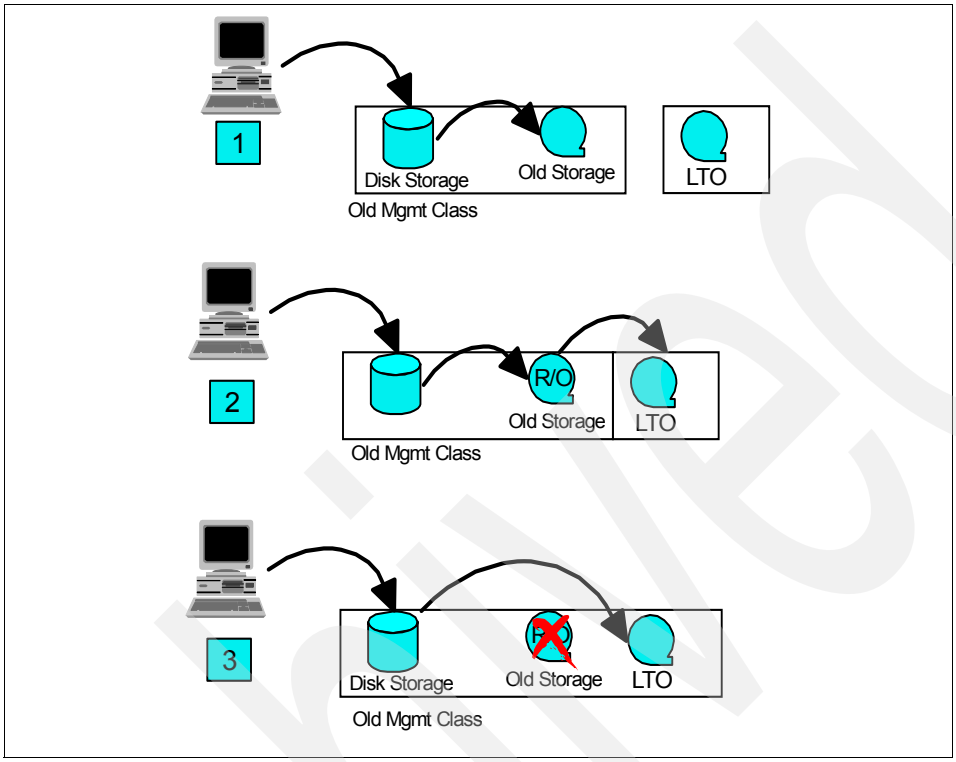


Figure 6-31 Migrating to LTO through disk primary copy

6.13 IBM Tivoli Storage Manager SAN device mapping

In a SAN environment, device IDs can change dynamically due to device or cabling changes. Before V5.2, the IBM 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, IBM Tivoli Storage Manager could access a wrong target device and cause data integrity problems. IBM Tivoli Storage Manager V5.2 introduced a new method to dynamically determine the correct device special file name and makes appropriate changes to the IBM 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 5.3, "Persistent binding" on page 194) in certain environments.

SAN Discovery and Device Mapping are discussed in detail for the IBM Tivoli Storage Manager environment in *Get More Out of Your SAN with IBM Tivoli Storage Manager*, SG24-6687.

6.13.1 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 6.2.3, “Defining the library and drives using the command line” on page 212. Refer to the IBM Tivoli Storage Manager documentation for further details.

Serial number autodetection and validation

Serial number autodetection enables IBM 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 with 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 IBM 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 IBM 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 IBM 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 IBM 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 IBM 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 IBM 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 IBM Tivoli Storage Manager instance, use the following setting:

```
SETOPT SANDISCOVERY ON
```

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7

Implementing other backup software with IBM Open System Tape

In this chapter we give you pointers to implement EMC Legato NetWorker and Symantec (Veritas) NetBackup with Open System Tape drives and libraries. This includes a general overview and points you to the initial setup steps for each of the software products.

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
- For BakBone Netvault
  - http://www.bakbone.com
  - http://www.bakbone.com/support/knowledge_base/default.asp
- For Arkeia
  - http://www.arkeia.com
  - http://www.arkeia.com/support/index.php

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7.1 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.

7.1.1 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 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

7.1.2 NetWorker installation in Windows environment

In this section, we give you guidelines to NetWorker installation for the Windows platform. For a detailed explanation of the installation process, refer to the *Legato NetWorker Installation Guide - Microsoft Windows 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 user ID 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 tape setup for Windows” on page 101.

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.

7.1.3 Networker installation in a Linux environment

Install and configure the tape drives as described in Chapter 4, “Basic IBM tape setup for Linux” on page 159.

Then follow the detailed installation process found in the *Legato NetWorker Installation Guide - Linux Version*. This book can be downloaded in PDF format from the NetWorker Web site at:

http://web1.legato.com/cgi-bin/catalog?sf=Releases

7.2 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: NetBackup gives you data protection for all environments, from desktop to data center to vault.
- Single Solution for All Platforms: NetBackup helps you consolidate and standardize your backup and recovery operations, protecting all major UNIX variants, Windows, Linux, and NetWare systems.
- 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 sites:

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 in meeting 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, go to the following Web site:

http://ftp.support.veritas.com/pub/support/products/NetBackup_Enterprise_Server/285590.pdf

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7.2.1 NetBackup and IBM LTO interoperability

Be sure that NetWorker is supported in your specific environment. You should cross check both the IBM and NetWorker Web sites to verify this interoperability:

http://www-03.ibm.com/servers/storage/tape/lto/lto_isv.html
http://seer.entsupport.symantec.com/docs/278692.htm

To learn more about interfacing with IBM TS3500 ALMS, go to the following Web site:

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.

7.2.2 NetBackup installation in Windows environment

In this section, we give you guidelines to the NetBackup installation for an Windows platform. For a detailed explanation of the installation process, refer to the manuals *Veritas NetBackup 6.0:*

- *Installation Guide for Windows*
- *Media Manager Device Configuration Guide for Unix, Windows and Linux*
- *Media Manager System Administrator Guide for Windows*

See your installation documentation, or go to the Symantec Veritas support Web site:

http://seer.entsupport.symantec.com/docs/279260.htm

You should already have installed and configured the tape drives as described in Chapter 3, “Basic IBM tape setup for Windows” on page 101.

With the IBM TS3000 family of libraries, we recommend using the IBM Ultrium Tape device driver. If this device driver is installed when using other libraries, you must remove the IBM device driver and use the standard Veritas pass through driver.

7.2.3 NetBackup installation in Linux environment

For a detailed explanation of the general UNIX installation process, refer to the manuals *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 go to the Symantec Veritas support Web site:

http://seer.entsupport.symantec.com/docs/279261.htm

You are recommended always to use the Veritas pass through driver.

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7.3 NetVault by BakBone

NetVault by BakBone is an easy-to-use, fully functional, high-performance, and scalable backup and recovery storage management product. NetVault supports a broad range of server and client operating systems in LAN, SAN, and NAS environments. NetVault also supports a wide range of media and devices, including the IBM LTO and 3592 products. NetVault uses industry standard, non-proprietary formats for writing to tape. These are **cpio** for UNIX and Microsoft Tape Format (MTF) for Windows. For easy data interchange and disaster recovery protection, NetVault-produced tapes can be read by any UNIX- or Windows-based system supporting the standard.

In the event of a problem with the library, server hardware, or applications, NetVault tapes can be restored to any machine, regardless of whether the NetVault application is present.

The latest device, library, and operating system-specific information can be obtained from the BakBone Web site at:

http://www.bakbone.com

7.3.1 BakBone NetVault and IBM LTO interoperability

Be sure that BackBone NetVault is supported in your specific environment. You should cross check both the IBM and BakBone Web sites to verify this interoperability:

http://www.bakbone.com/docs/NetVault_Backup_Supported_Platforms_March07.pdf
http://www.bakbone.com/docs/SDL_Drives_2007_Mar15.pdf
http://www.bakbone.com/docs/SDL_Libraries_2007_Apr05.pdf

7.3.2 BackBone NetVault installation in Windows and Linux environments

In this section, we give you guidelines to BakBone NetVault installation for the Windows and Linux platforms. For a detailed explanation of the installation process, refer to the *NetVault: Backup 7.4.x Installation and Upgrade Guide.* A version of this book can be downloaded in PDF format from the BakBone Web site at:

http://www.bakbone.com/docs/NV_Backup_Install_Upgrade_Guide_74x.pdf

Or for up-to date documentation, you should log in with your BakBone user ID at this Web site:

http://www.bakbone.com/Support.aspx?id=124

BakBone uses its device driver to manage the devices. An IBM Ultrium Tape device driver or Windows RSM service are not necessary.

7.4 Arkeia Network Backup

Arkeia greatly simplifies data protection by providing automated backup and recovery. It supports a wide variety of computers, operating systems, and storage devices. Arkeia is easy to install, quick to configure, and conveniently scalable from a simple network to a complex enterprise. Arkeia accommodates full and incremental backups, scheduled or on demand, and preserves directory structure, registry, symbolic links, and special attributes. The system manages file system data, and with extension modules, provides online backup for Oracle® databases.

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Arkeia uses multi-flow technology and client side compression, making it capable of backup speeds that could exceed the network's rated speed. Its unique transaction engine allows multiple backups and restores to be performed simultaneously with total reliability.

In the case of network and system errors, Arkeia is designed to restart, recover, and survive. Arkeia's systems management facility allows prioritization of other processing activities while a backup is in progress, and leverages standard TCP/IP protocol to intelligently monitor network errors. Should a network error occur, Arkeia restarts the backup procedure from the point of interruption.

Arkeia's centralized catalog keeps a full record of all data and metadata managed by the system. It appends the relevant part of the catalog onto each tape. In the event of complete backup server failure, the catalog can be rebuilt and the data recovered by using the fail-safe restore utility.

For more information about the Arkeia product, go to their Web site at:

http://www.arkeia.com

7.4.1 Arkeia and IBM LTO interoperability

Be sure that Arkeia is supported in your specific environment. You should cross check both the IBM and Arkeia Web sites to verify this interoperability:

http://www.arkeia.com/products/arkeianetworkbackup/compatibility.php

7.4.2 Arkeia installation in Windows and Linux environments

In this section, we give you guidelines for Arkeia installation for the Windows and Linux platform. For a detailed explanation of the installation process, refer to the *Arkeia Network Backup - User Manual.* A version of this book can be downloaded in PDF format from the Arkeia Web site:

http://www.arkeia.com/support/documentation/manuals.php

Or for up-to date documentation, you should subscribe to the Arkeia Newsletter at this Web site:

http://www.arkeia.com/support/usermailinglist/index.php

Arkeia uses its device driver to manage the devices. The IBM Ultrium Tape device driver and Windows RSM service are not necessary.

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Part 3

Appendixes

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A

Recommended HBA settings for LTO drives and libraries

This appendix provides the recommended settings for QLogic and Emulex host bus adapters (HBAs) when used with LTO tape drives and libraries.

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Recommended QLogic HBA settings

Table A-1 lists some suggested settings for direct-attached and SAN-attached IBM Linear Tape-Open (LTO) libraries using QLogic Host Bus Adapters (HBAs). Please note that there is no strict set of rules, and any changes made here should be carefully tested in your environment. For more information about recommended HBA settings, refer to the QLogic support Web site, available at:

http://solutions.qlogic.com

Table A-1 QLogic HBA settings

Host Adapter settings	**Setting LTO fabric-attached (switch)**	**LTO direct-attached, with and without SDG**
Host Adapter BIOS	Disabled	Disabled
Frame Size	2048	2048
Loop Reset Delay	5	5
Adapter Hard Loop ID	Disabled	Disabled
Selectable Boot Settings		
Selectable Boot Device	Disabled	Disabled
Current Boot Node Name	0	0
Current Boot LUN Number	0	0
Advanced Adapter Settings		
Execution Throttle	256	256
Fast Command Posting	Enabled	Enabled
>4 Gigabyte (GB) Addressing	Disabled for systems with less than 4 GB of memory	Disabled for systems with less than 4 GB of memory
LUNs per Target	16	16
Enable LIP Reset	No	No
Enable LIP Full Login	Yes	Yes
Enable Target Reset	Yes	Yes
Login Retry Count	180	180
Port Down Retry Count	180	180
Connection Options	1	2
Response Timer	0	0
Interrupt Delay Timer	0	0

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Recommended Emulex HBA settings

Table A-2 lists some suggested settings for direct-attached and SAN-attached IBM Linear Tape-Open (LTO) libraries using Emulex Host Bus Adapters (HBAs). Please note that there is no strict set of rules, and any changes made here should be carefully tested in your environment. For more information about recommended HBA settings, refer to the Emulex support Web site at:

http://www.emulex.com/ts/index.html

Table A-2 Emulex HBA settings

HBA settings	Setting LTO fabric-attached (switch), with and without SAN Data Gateway (SDG)	LTO direct-attached, with and without SDG
Port Driver Installed	Fabric, automap SCSI devices	Arbitrated loop, automap SCSI devices
Boot BIOS Level	Boot BIOS	Boot BIOS
Adapter Controls		
Automatically Map SCSI Devices	Checked (enabled)	Checked (enabled)
Query Name Server for all N-Ports	Checked (enabled)	Checked (enabled)
Allow Multiple Paths to SCSI Targets	Checked (enabled)	Checked (enabled)
Point to Point	Not shown on screen	Not checked (disabled)
Register for State Change	Checked (enabled)	Checked (enabled)
Use Report LUNs	Checked (enabled)	Checked (enabled)
Use Name Server after RSCN		
(Should be checked if using soft zoning on the switch)	Not checked (disabled)	
(Should be checked if using soft zoning on the switch)	Not checked (disabled)	
LUN Mapping	Checked (enabled)	Checked (enabled)
Automatic LUN Mapping	Checked (enabled)	Checked (enabled)
Scan in Device ID Order	Not checked (disabled)	Not checked (disabled)
Enable Class 2 for SCSI Devices	Not checked (disabled)	Not checked (disabled)
Report Unknown SCSI Devices	Checked (enabled)	Checked (enabled)
Look for Disappearing Devices	Not checked (disabled)	Not checked (disabled)
Translate Queue Full to Busy	Not checked (disabled)	Not checked (disabled)
Use Bus Reset Status for Retries	Not checked (disabled)	Not checked (disabled)
Retry Unit Attention	Not checked (disabled)	Not checked (disabled)
Retry PLOGI Open Failures	Not checked (disabled)	Not checked (disabled)

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Maximum Number of LUNs (value > or = to the number of LUNs available to the HBA on any attached target)	(Value > or = to the number of LUNs available to the HBA on any attached target)	(Value > or = to the number of LUNs available to the HBA on any attached target)
Maximum Queue Depth	8	8
Link Timer	30 seconds	30 seconds
Retries	64	64
E_D_TOV	2000 ms	2000 ms
AL_TOV	15 ms	15 ms
Wait Ready Timer	45 seconds	45 seconds
Retry Timer	2000 ms	2000 ms
R_A_TOV	2 seconds	2 seconds
ARB_TOV	1000 ms	1000 ms
Performance Parameters		
Max Interrupt Latency	0	0
Min I/O Completions per Interrupt	0	0
Max I/O Completions per Interruptions	128	128
Link Control Parameters		Tab not available
Topology	Point to point	Not shown
Link Speed	Auto	Not shown

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B

SNMP setup

This appendix describes setting up SNMP on the different IBM System Storage libraries:

- IBM System Storage TS3100 Tape Library and 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.

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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 implements 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 requestors, 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 that 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" (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 has 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.

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 three different receivers, as shown in Figure B-1.

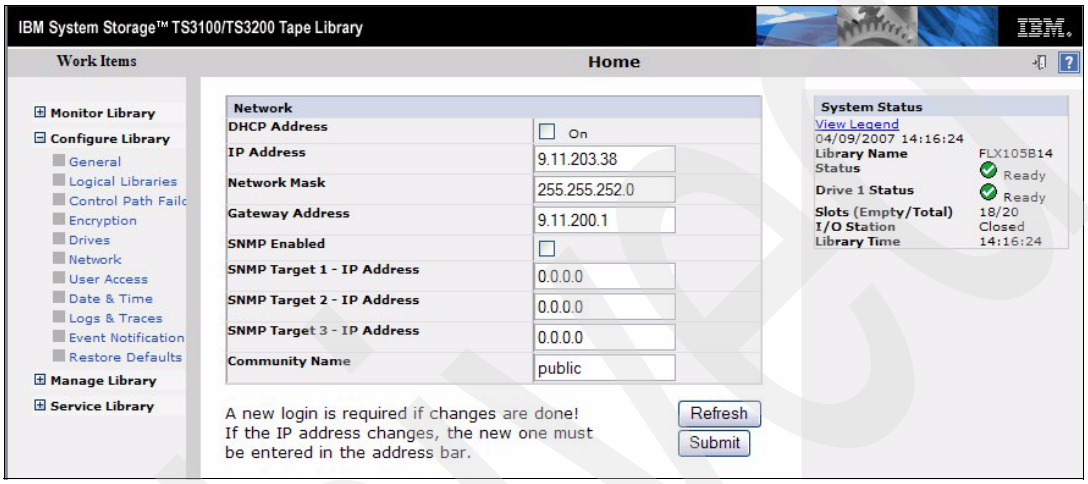


Figure B-1 TS3100/TS3200 SNMP Configuration

To set up direct e-mail notification, select **Configure Library** → **Event Notification**, as shown in Figure B-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.

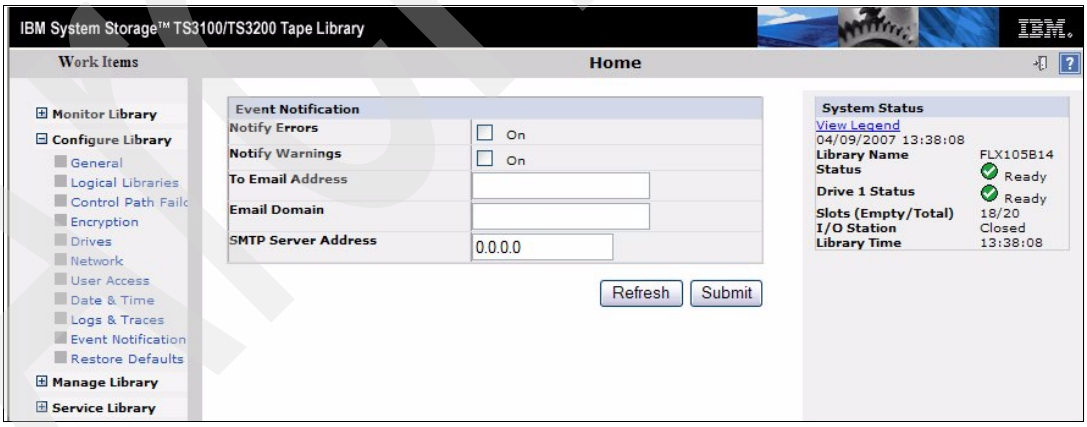


Figure B-2 TS3100/TS3200 Event Notification

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 the 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 for this.

In the Library Tasks view of the Tape Library Specialist (Figure B-3), select **Manage Library** → **Settings** → **SNMP**, and you will see the SNMP configuration window.

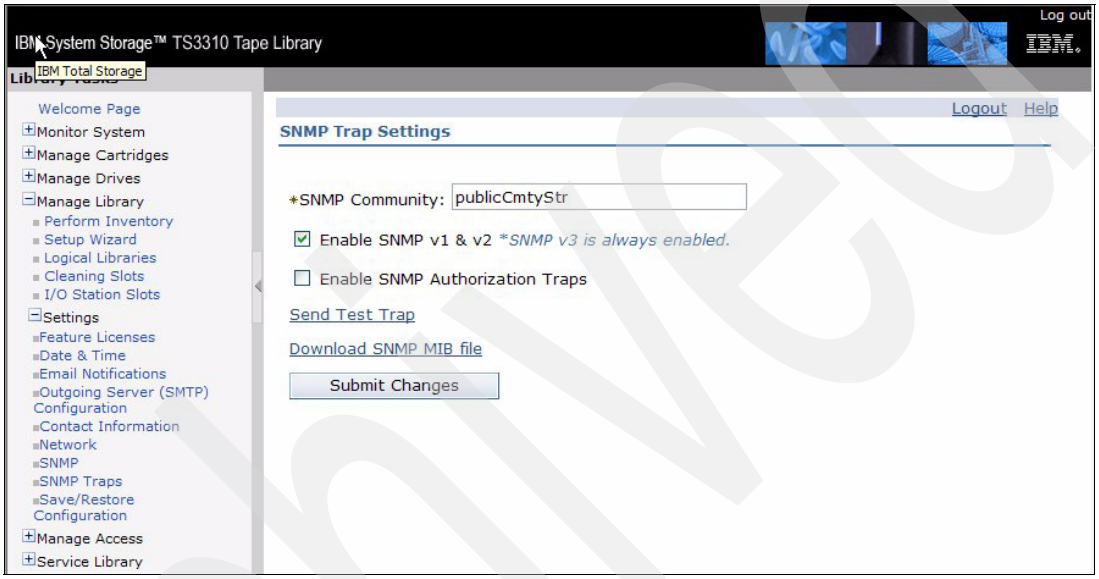


Figure B-3 IBM TS3310 Configure SNMP Trap Settings

Click the **Submit** button to apply the changes. A confirmation window appears. Click **ENTER** to confirm the updates. You can 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 eight 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 windows, the first of which is shown in Figure B-4 on page 275.

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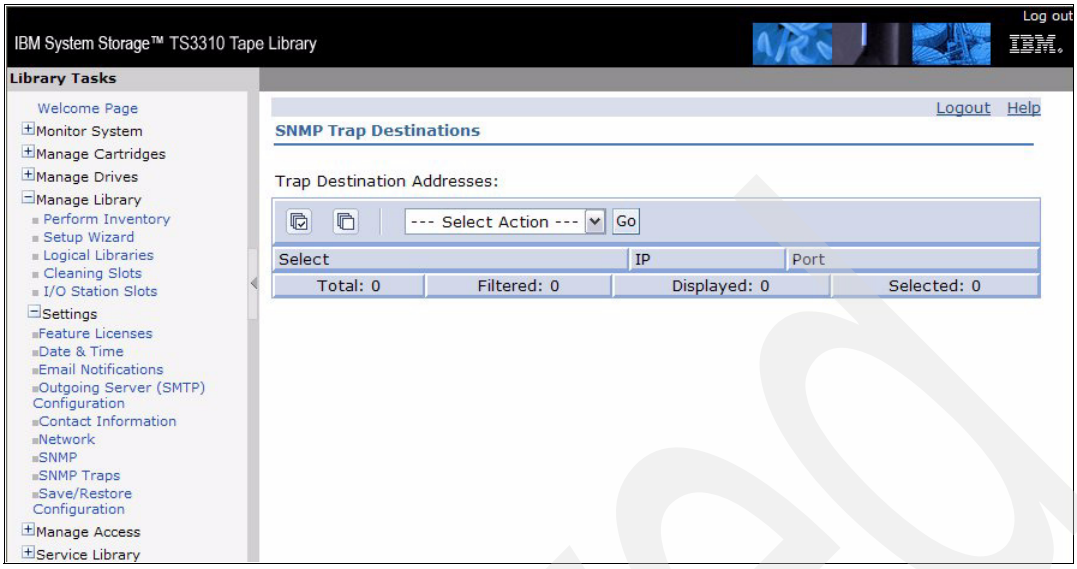


Figure B-4 IBM TS3310 Configure SNMP Trap Destinations

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 B-4, you get a window to add the SNMP server IP address, as shown in Figure B-5. The default port is 162.

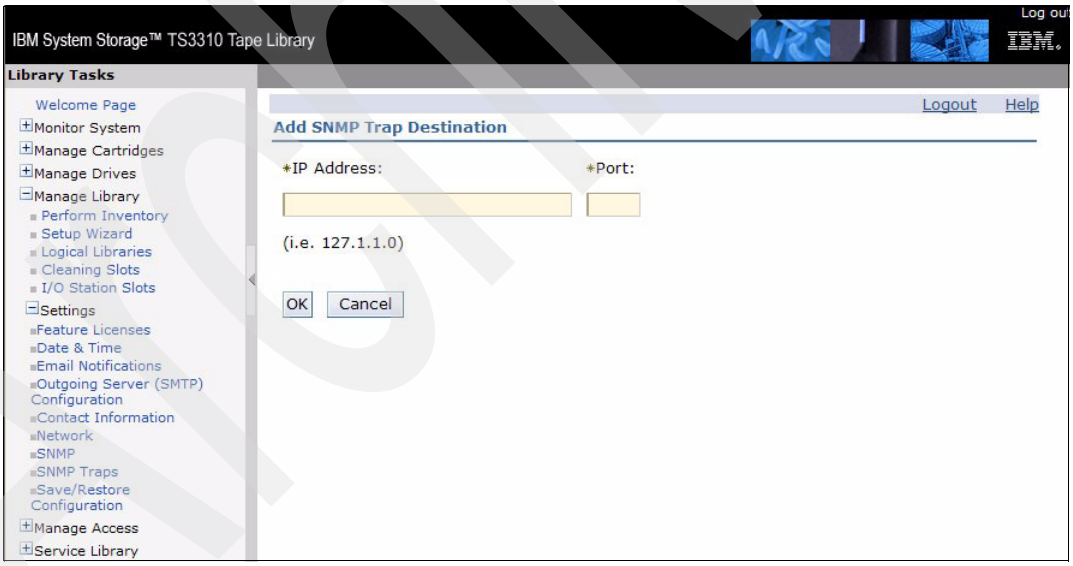


Figure B-5 IBM TS3310 Add SNMP Trap Destination

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**, as shown in Figure B-6. From the drop-down menu, you can enable/disable this functionality, and add or change mail receivers.

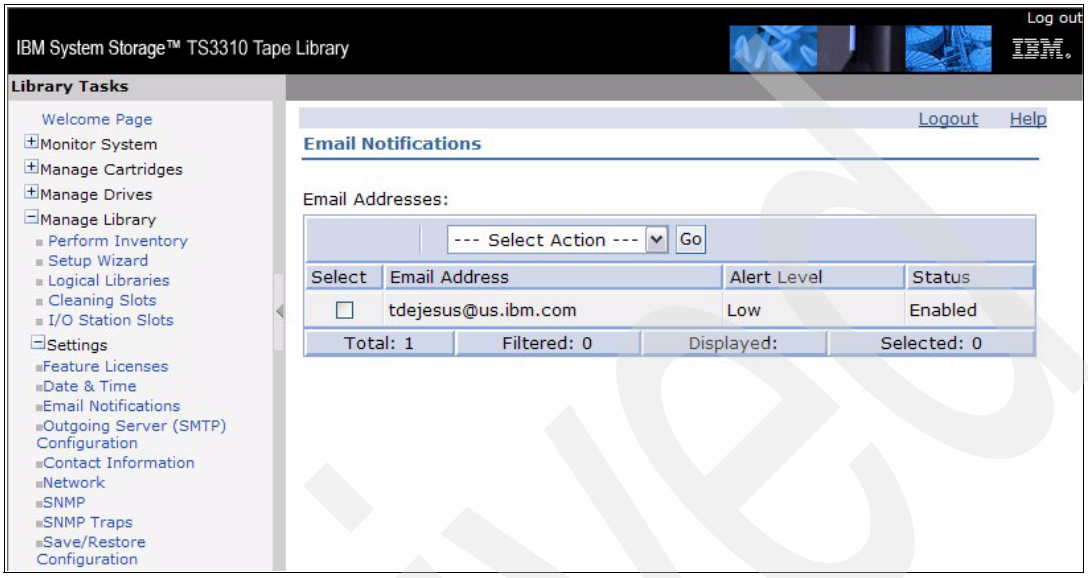


Figure B-6 IBM TS3310 setup Email Notifications

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.

In the Library Tasks column in the Home window (Figure B-7 on page 277), select **Configure Library** → **Notifications**, and select the **SNMP Setting** tab, as shown in Figure B-7 on page 277.

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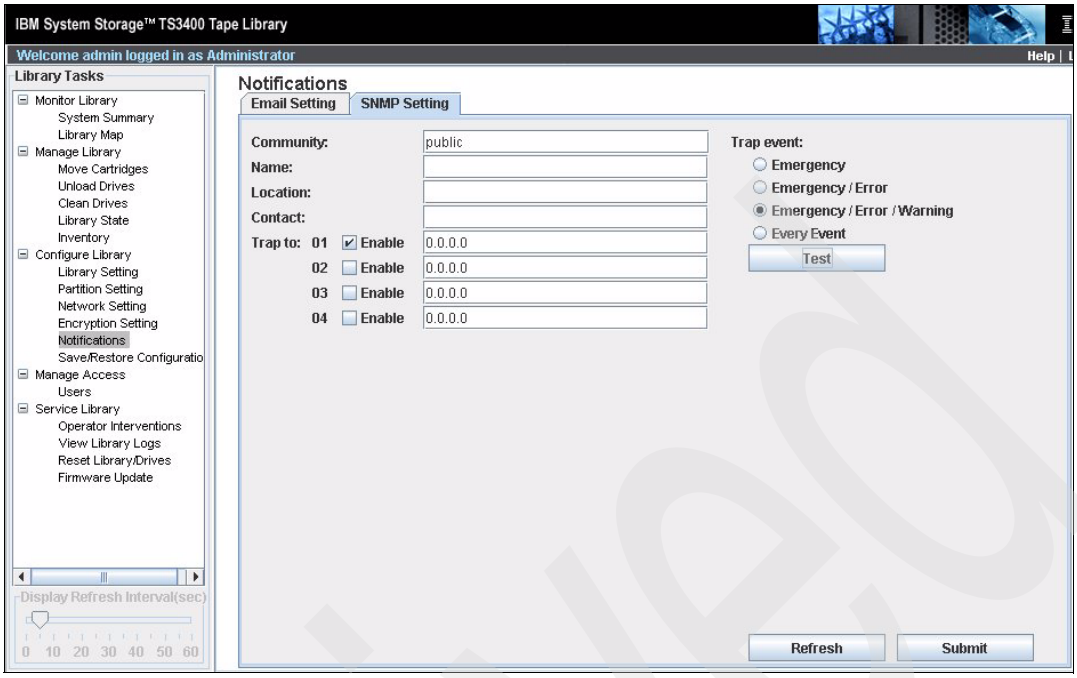


Figure B-7 IBM TS3400 Tape Library Specialist: SNMP Setting

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 e-mail traps directly. Selecting the **Email Setting** tab, ash shown in Figure B-7, you get a very similar window to define an e-mail server, and up to four mail receivers.

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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 V6.0.1 window is shown in Figure B-8, where our tape drive BAVARIA is discovered as a node.

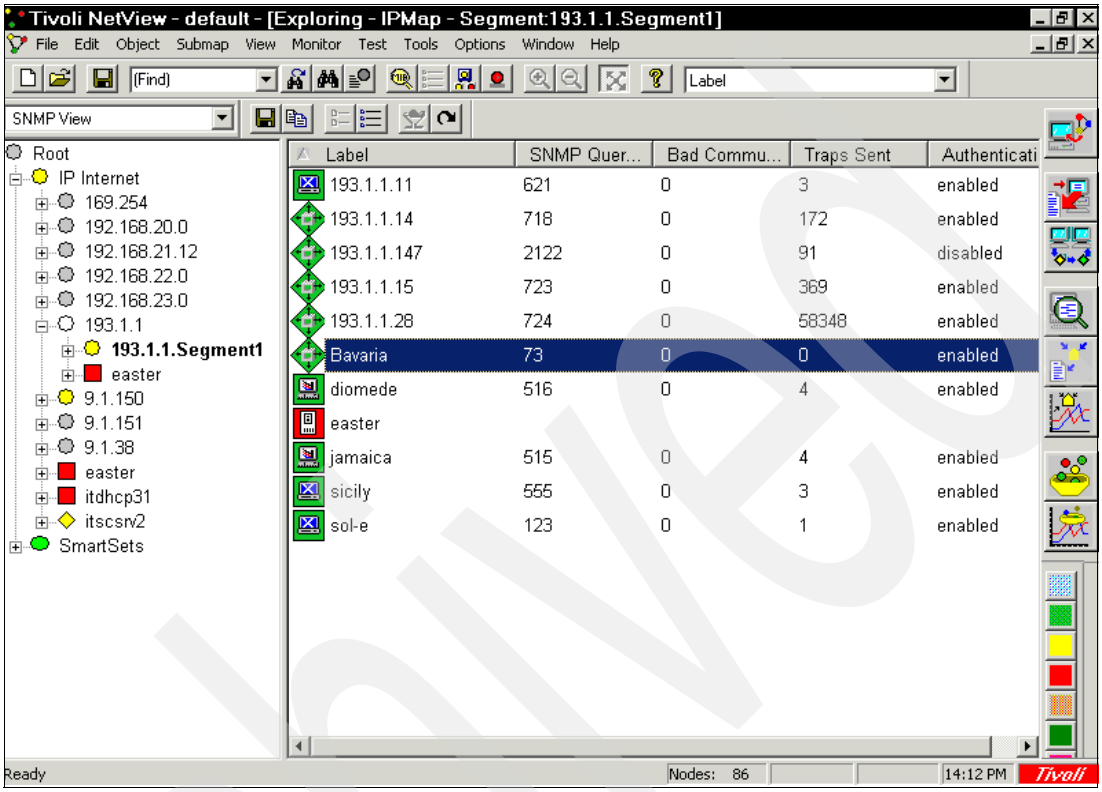


Figure B-8 Tivoli NetView SNMP monitoring

Tip: For more information about NetView, see *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, using 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 the following FTP site:

`ftp://ftp.software.ibm.com/storage/358x/3584/`

Enable SNMP traps using the Operator panel

From the library's Activity Operator panel, click **Menu** and 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 screen displays with the current state of SNMP (Figure B-9). Click **UP** or **DOWN** to specify **Enabled** or **Disabled** for SNMP. The SNMP screen redisplays the new setting. To accept the new setting and return to the previous panel, click **Back**.

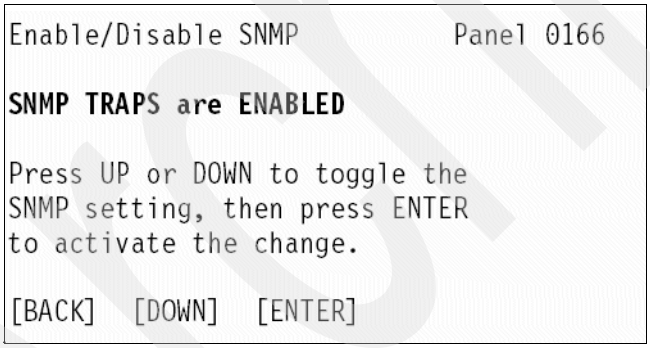


Figure B-9 IBM TS3500 Operator panel: Enable/disable SNMP

Some SNMP monitoring applications only support Version 1 SNMP traps, while others only support Version 2 traps. The IBM 3584 supports both Version 1 and Version 2c.

To send a different version of traps, select **V1/V 2** in the SNMP Menu. 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 B-10), and then click **ENTER**. The screen redisplays with the new version of the trap. To accept the new setting and return to the previous panel, click **Back**.

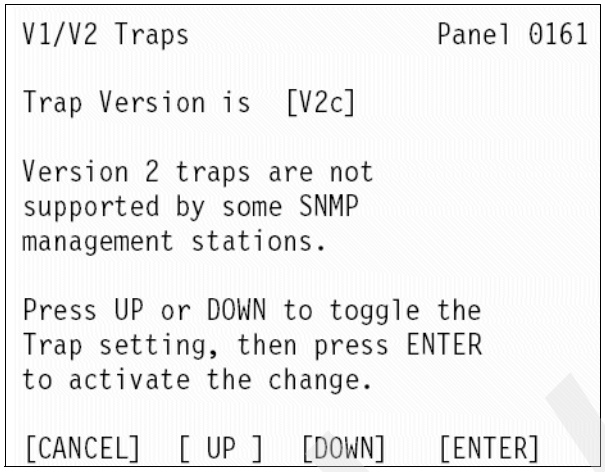


Figure B-10 IBM TS3500 Operator panel: V1/V2 Traps

To view or change the destination IP address of a monitoring station to which SNMP alerts will be sent, choose **Destination IP Addresses** from the SNMP menu. Then click **UP** or **DOWN** to specify the destination IP address that you want to view or change (Figure B-11), and then click **ENTER**. You can have the library send the SNMP traps to up to five different monitoring stations.

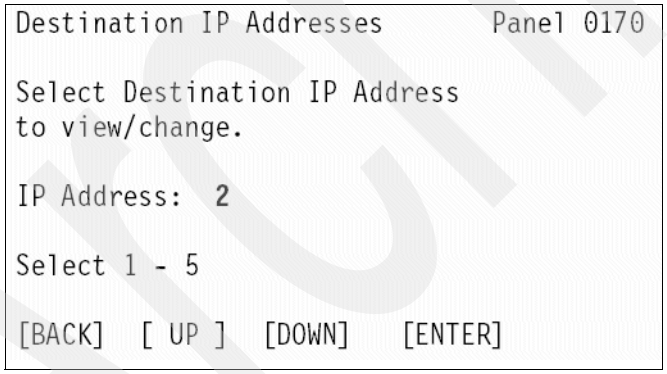


Figure B-11 IBM TS3500 Operator panel: Destination IP address

The Set Destination IP Address screen displays with the current value of the destination IP address that you specified (Figure B-12 on page 281). Click **UP** or **DOWN** to change to the value that you want, and then click **ENTER**. The screen redisplays with the new destination IP address. To accept the new setting and return to the previous screen, click **Back**.

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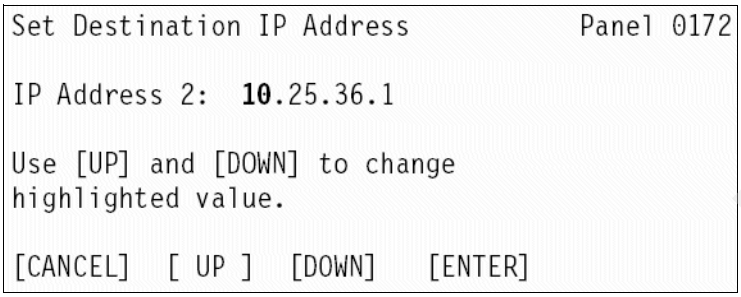


Figure B-12 IBM TS3500 Operator panel: Set destination IP address

To view or change the community name, click **UP** or **DOWN** to highlight **Community Name** and click **ENTER**. The Community Name screen displays with the current password (Figure B-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.

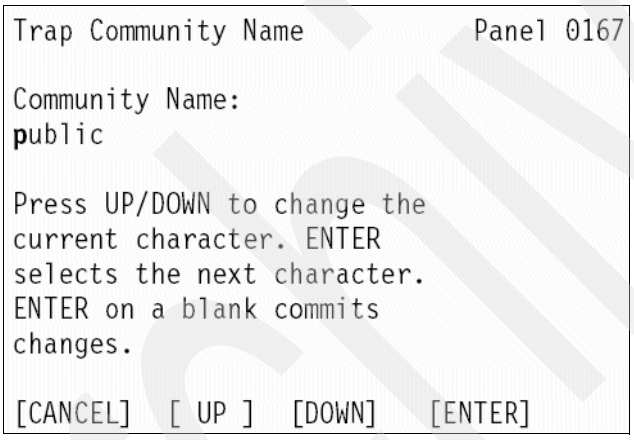


Figure B-13 IBM TS3500 Operator panel: Set community name

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 about SNMP traps, see the *IBM System Storage TS3500 Tape Library Operator Guide*, GA32-0560.

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Enable SNMP Traps using Tape Library Specialist

In the Web Tape Library Specialist, select **Access** → **SNMP Settings**. Select the trap version, either SNMP V1 or SNMP V2c (see Figure B-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. If enabled, the SNMP server can request information from the library using the get/get-response mechanism.

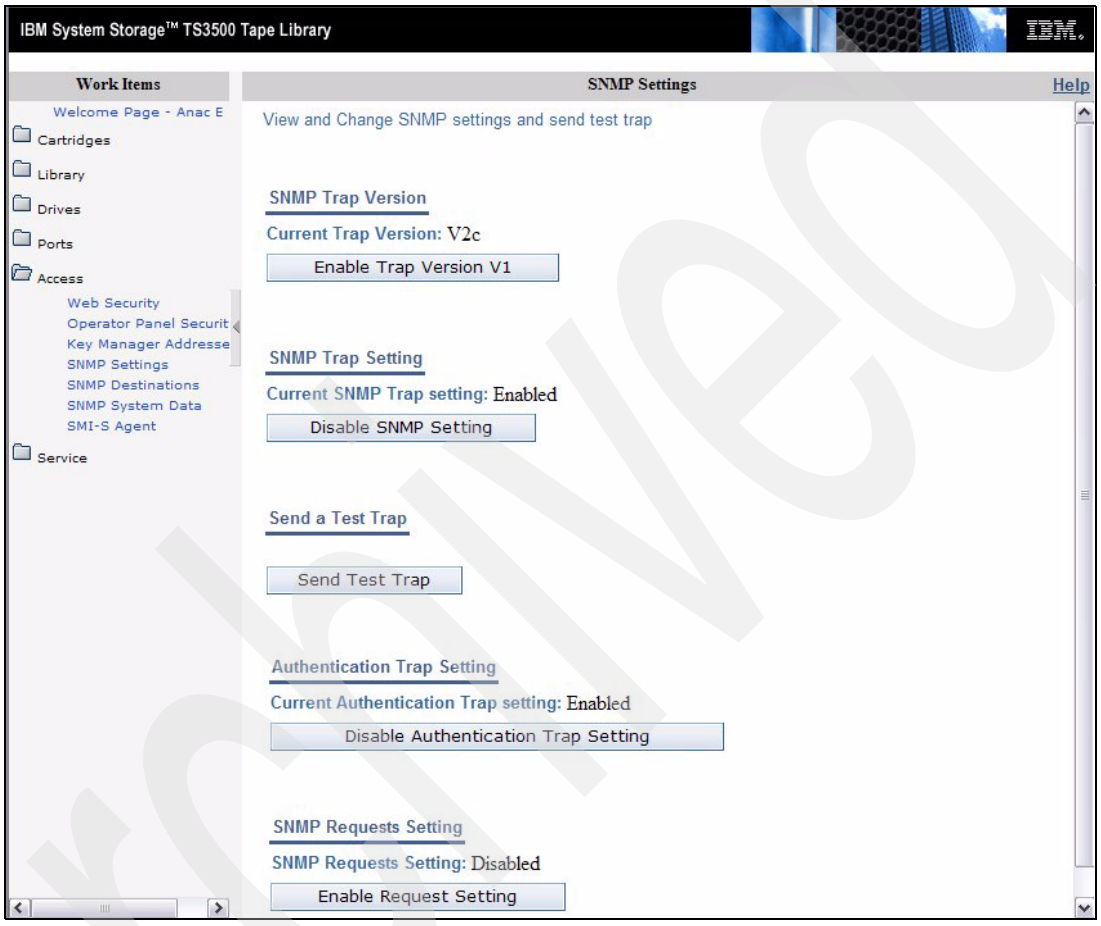


Figure B-14 IBM TS3500 Tape Library Specialist: Enabling SNMP

Next, enter the destination SNMP monitoring server. Up to five SNMP monitoring servers can be defined. Select **SNMP Destinations** in 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, as shown in Figure B-15 on page 283.

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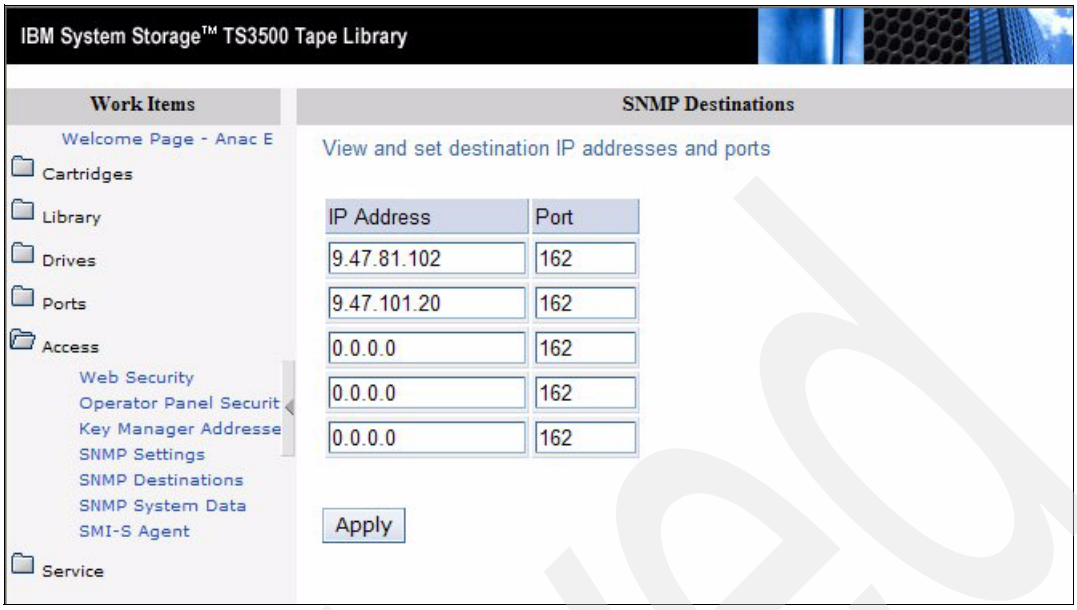


Figure B-15 IBM TS3500 Tape Library Specialist: SNMP destinations

You must also establish the SNMP System data, as shown in Figure B-16. Fill in the required information and **Apply**.

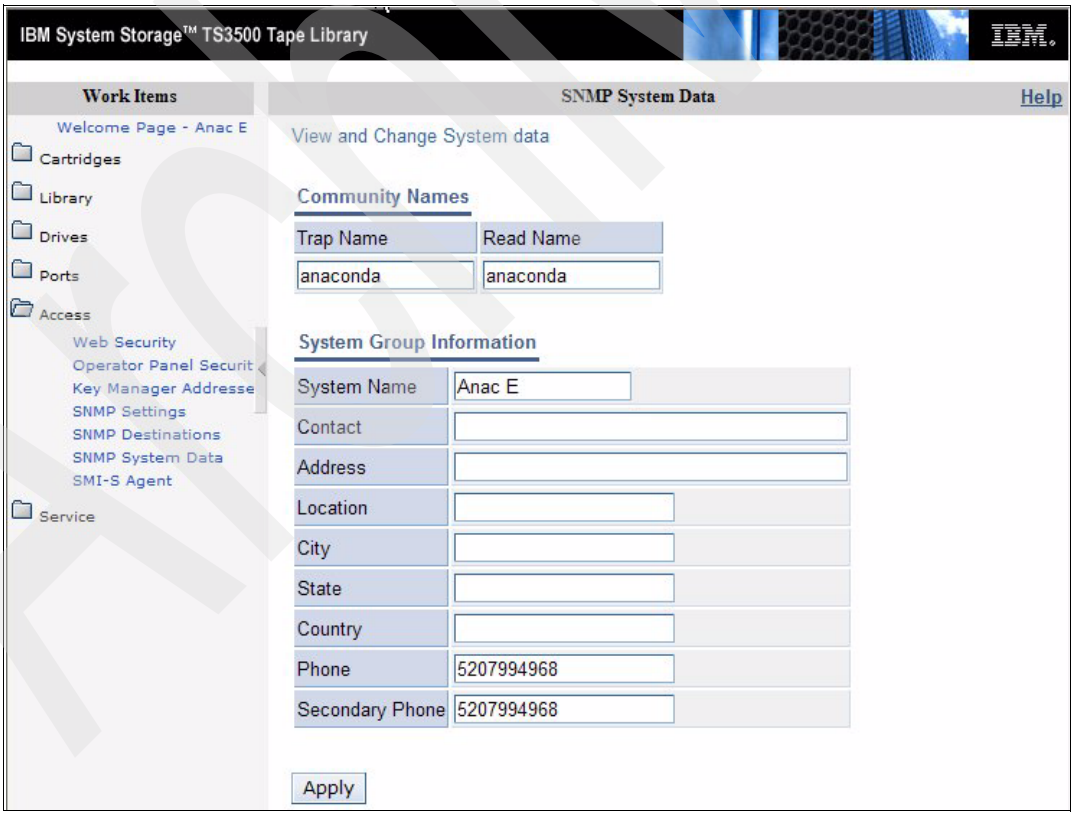


Figure B-16 IBM TS3500 SNMP System data

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 (such as 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 about 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, go to the following 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 B-17).

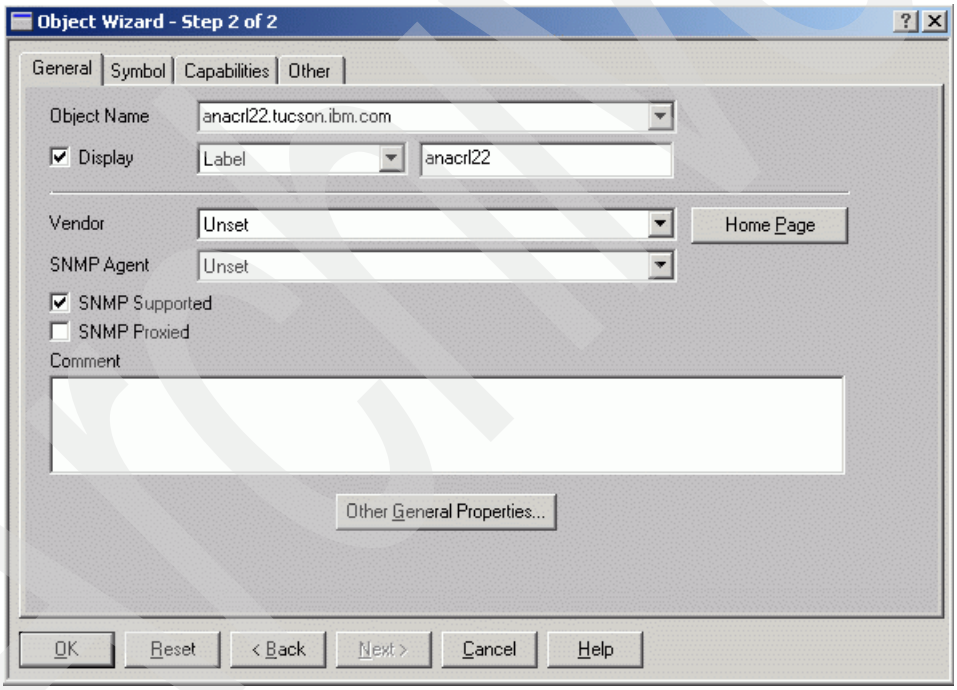


Figure B-17 Tivoli NetView: Create new Object

2. Select the **Other** tab and specify the Hostname, the IP Address of the IBM TS3500, and the Subnet Mask (see Figure B-18 on page 285). Before you can create this new object, you have to verify the connection. Click the **Verify** icon for that purpose.

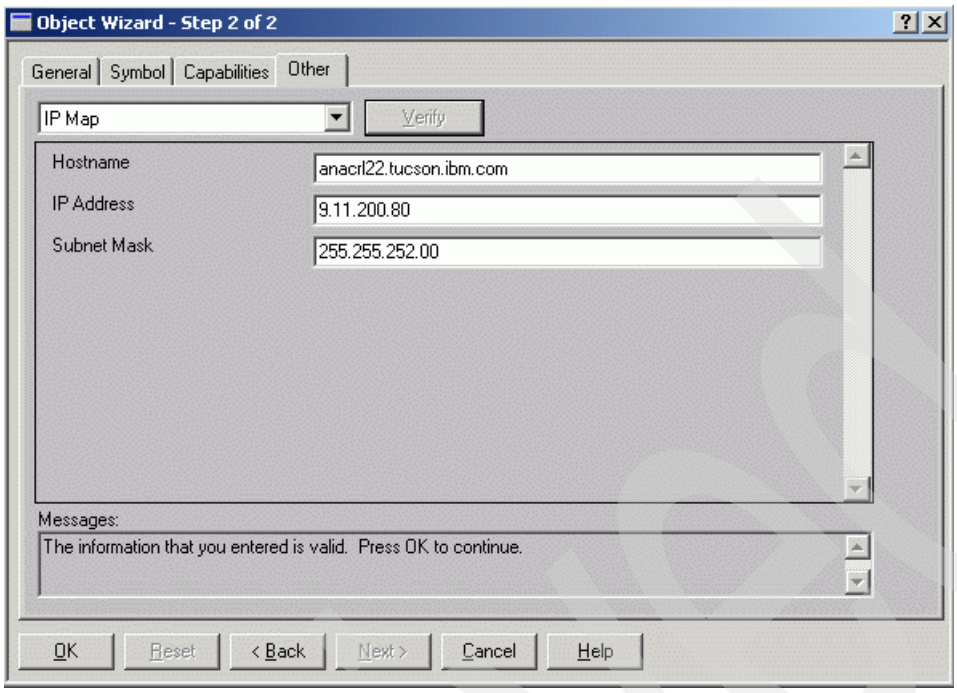


Figure B-18 NetView: Create new object

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 B-19 for an illustration of several libraries with different statuses.

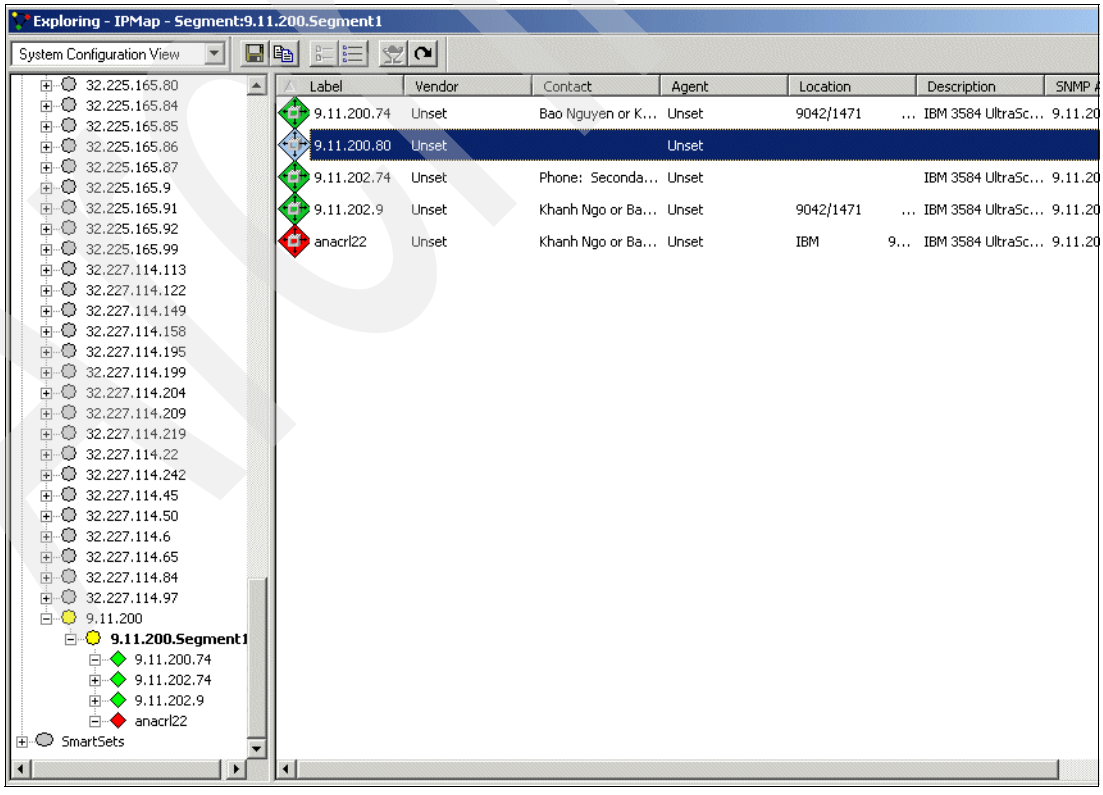


Figure B-19 NetView: Browse network segment

4. 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 B-20).

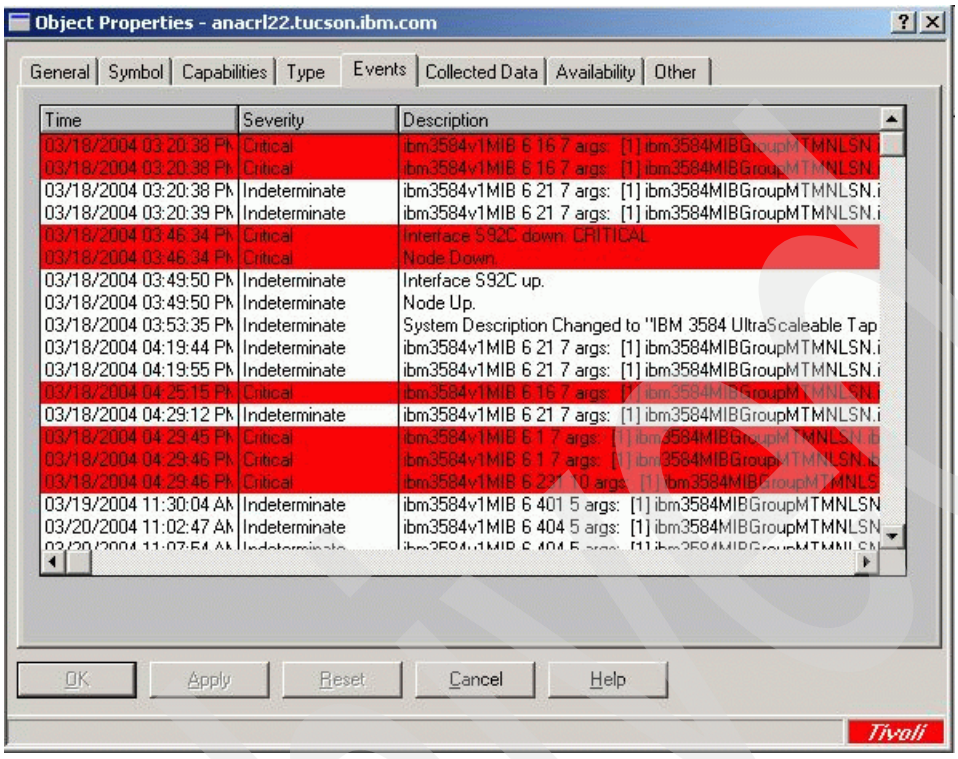


Figure B-20 NetView - SNMP Traps

5. 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 B-21).

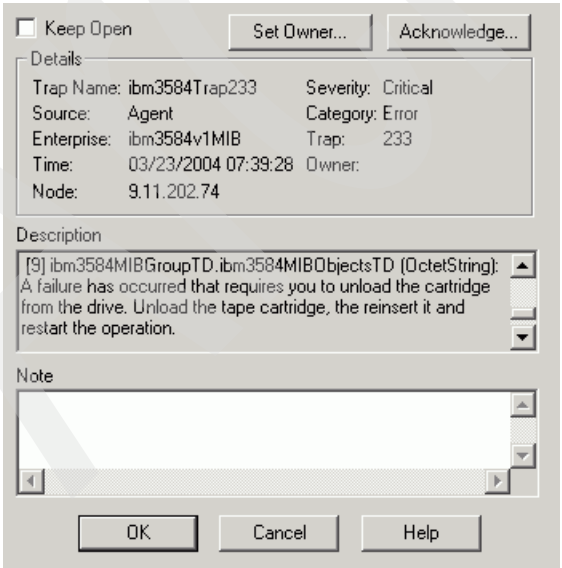


Figure B-21 NetView - Detailed description of 3584 SNMP Trap

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 B-14 on page 282.

You can now use SNMP to monitor your library. Here are some examples created with Tivoli NetView:

- To learn 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 B-22).

.

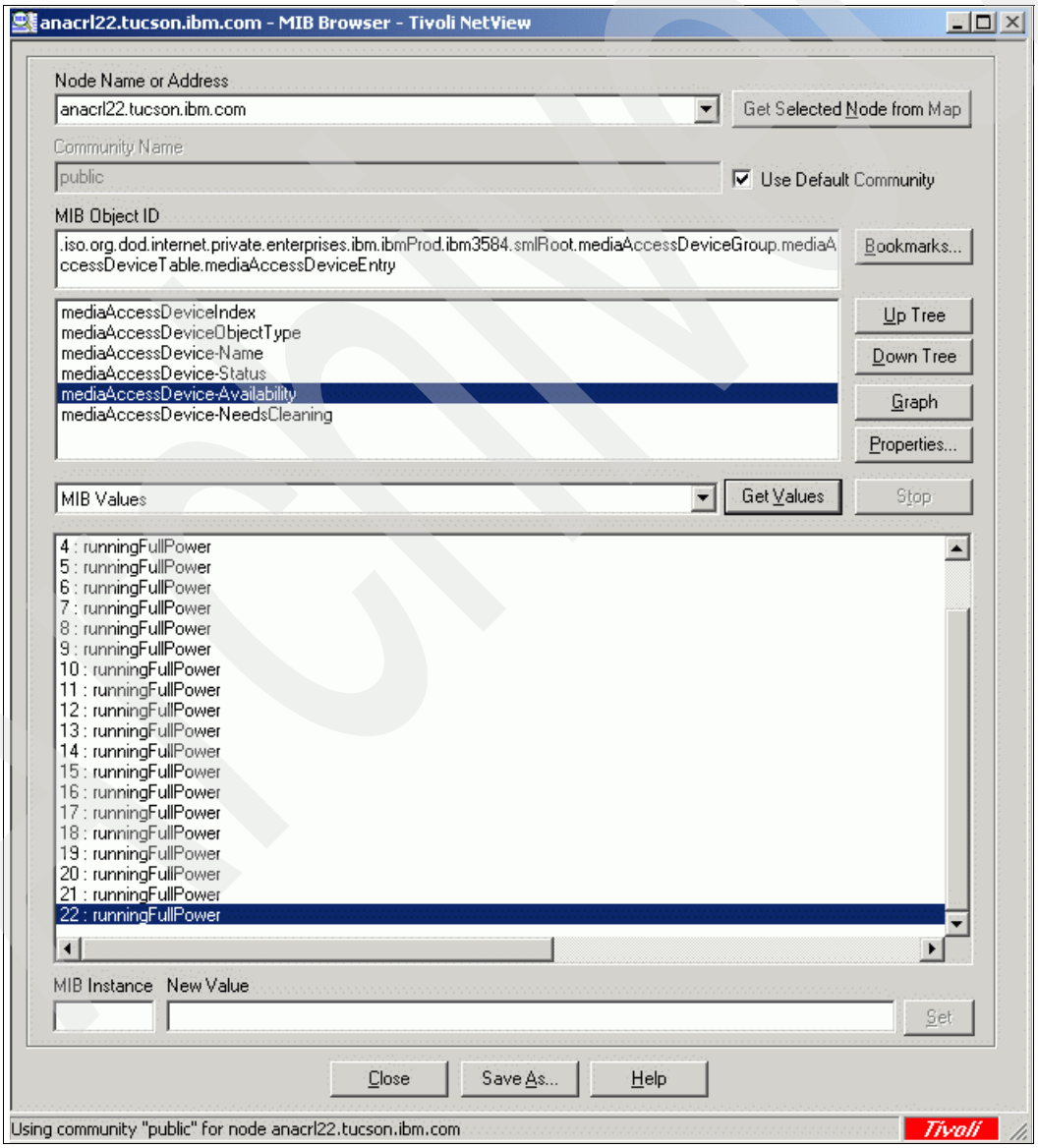


Figure B-22 SNMP Request: Drive status

- 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 B-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 B-24 on page 289) for the status and the volser of all the cartridges.

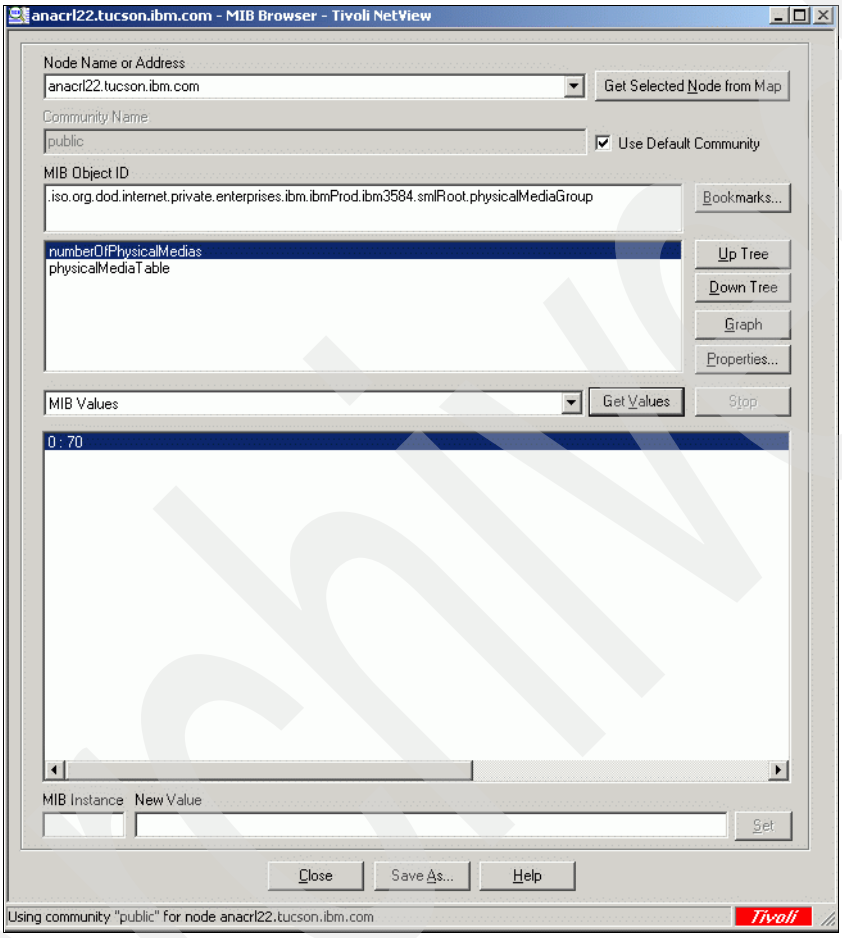


Figure B-23 SNMP Request: Number of all physical cartridges

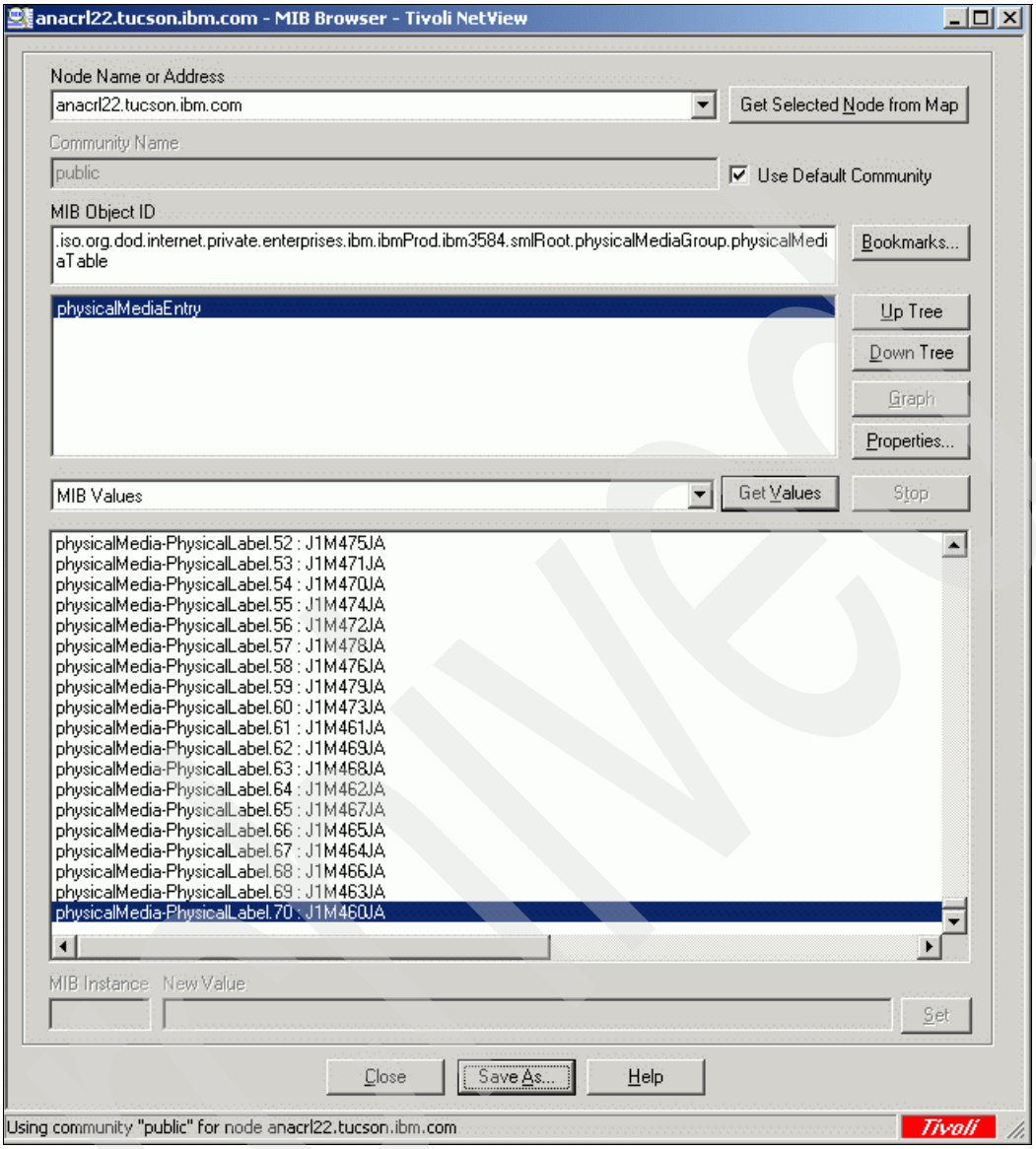


Figure B-24 SNMP Request: List of all physical media

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.

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C

Additional information

This appendix provides some additional information that is useful when implementing IBM LTO tape drives and libraries.

The topics are:

- Some performance considerations for tape devices
- IBM Tivoli Storage Manager tape drive and library commonly used commands
- EMC Legato NetWorker autochanger maintenance commands
- Using `ntutil` and `IBMtapeutil` to verify correct device attachment
- Troubleshooting considerations

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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
- The application itself (for example, database)
- Connection to the tape drives
  - Type of HBAs: 1 GBit, 2 Gbit, or 4Gbit
  - 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? Therefore, look at each link separately.

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 results only.

Linux

The Linux command **dd** can be used to get a baseline performance level. You may test the performance of your disk subsystem first by writing and reading from the disk to /dev/zero. Then you may want to test the performance from the server to the tape by writing and reading from tape to /dev/zero. Finally, you write files from the disk to the tape.

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 may use **dd** in conjunction with **time** to measure the time.

We suggest that you write or read at least 1 GB; therefore, use **bs=262144 count=4096**.

First, test the file system performance with:

```
time dd if=<filename> of=/dev/null bs=262144
```

Substitute <filename> with a large file that you have created or that is already available.

Then test the tape performance with:

```
time dd if=/dev/zero of=/dev/IBMtapex bs=262144
```

And with:

```
time dd if=filename of=/dev/IBMtape0 bs=262144
```

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Windows

With NTUTIL in batch mode, you can test the native performance of the tape drives. For this task, you have to generate a batch file with the content shown in Example C-1.

Example: C-1 Sample NTUTIL batch file to test tape drive performance

```
command open RW
command set_device_parameters compression = 0
command set_media_parameters block_size = 262144
set block_size = 262144
command write records = 4096
command write_filemark 2
```

With this example, we are writing 1 GB data (4096 x 256 KB) from the cache to the tape using blocksize 256 k. Compression is set to off. We are using an Ultrium 1 drive.

Save this file as ntutil.in in the directory where you open NTUTIL. Set the device special file, as described in 3.4, “Testing the library with NTUTIL” on page 114. Load a scratch tape to the tape drives that you want to test (use NTUTIL, StorWatch, or do it manually). Then go back to the main menu (see Example C-2) and select 2.

Example: C-2 NTUTIL main menu

```
NTutil - Copyright (c) 1997-2003 IBM Corporation

Main Menu:
Microsoft Windows 2000 version
==========

  1: Manual test
  2: Batch  test
  9: Exit ntutil

Enter selection:2
```

This runs the batch job in the file ntutil.in and generates output in ntutil.out. In our case, the batch job opens the tape drive, disables compression, and writes 4096 times 256 KB random blocks to the drive. After the job is finished, view the output file ntutil.out. At the end of the file, you see the calculated performance (see Example C-3).

Example: C-3 ntutil.out

```
Batch test begin at time Sat Mar 22 20:48:44 2003

Test tool version 5.0.4.7
command line library mode off
20:48:44 Line     1 >>> command open RW
special file (\\.\tape1) will be opened
20:48:44 Line     2 >>> command set_device_parameters compression = 0
execute set_device_parameters compression = OFF
20:48:44 Line     3 >>> command set_media_parameters block_size = 262144
execute set_media_parameters block_size = 262144
20:48:44 Line     4 >>> set block_size = 262144
20:48:44 Line     5 >>> command write records = 4096
attempt write 262144, actual write 262144 bytes, data = 4707372
 attempt write 262144, actual write 262144 bytes, data = 4707372
 attempt write 262144, actual write 262144 bytes, data = 4707372
 attempt write 262144, actual write 262144 bytes, data = 4707372
 attempt write 262144, actual write 262144 bytes, data = 4707372
```

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```
 attempt write 262144, actual write 262144 bytes, data = 4707372
.
.
attempt write 262144, actual write 262144 bytes, data = 4707372
 attempt write 262144, actual write 262144 bytes, data = 4707372
 attempt write 262144, actual write 262144 bytes, data = 4707372
 20:49:20 Line     6 >>> command write_filemark 2
20:49:21 Line     7 >>>
Total elapsed time in seconds =    37.00
Bytes transferred = 1073741824.000000
Data rate = 29020049.30 bytes/second
Batch test end rc=0 at time Sat Mar 22 20:49:21 2003
```

During this test, it may 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 **portperfshow** command to show the performance of the attached devices. Example C-4 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/s, with the values updated automatically every second.

Example: C-4 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
```

IBM Tivoli Storage Manager tape and tape library commands

The commands seen in Table C-1 are commonly used Tivoli Storage Manager tape and tape library commands.

Table C-1 Commonly used Tivoli Storage Manager tape commands

Command	Description
QUERY LIBRARY	Obtains information about the library.
QUERY DRIVE	Obtains information about tape drives.
QUERY DEVCLASS	Obtains information about device classes.
QUERY LIBVOLUME	Find volumes (scratch and private).
QUERY VOLUME	Find private volumes.
QUERY VOLUME ACCESS=READONLY	Find volumes in read only status.

Command	Description
CHECKIN LIBVOLUME	Check in volumes to the library.
CHECKOUT LIBVOLUME	Check out volumes to the library.
LABEL LIBVOLUME	Write TSM labels on cartridges.
AUDIT LIBRARY	Check the consistency of the library inventory.
REPLY nnn	Reply to console requests.
QUERY PATH	Obtains information about library and device paths.

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 C-2).

Table C-2 NetWorker autochangers maintenance commands

Command	Description
lusbinfo	Prints out SCSI information.
lusdebug	Sets the library debugging level.
lrescan	Rescans for devices.
lreset	Resets the SCSI bus.
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 device attachment with tapeutil or ntutil

Before you start to use your devices for production work with your applications, or if you encounter difficulties with your devices, you may 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 tape setup for Windows” on page 101 and Chapter 4, “Basic IBM tape setup for Linux” on page 159.

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Also, you should have already determined which operating system device name corresponds to which tape drive in the library. You could create a list like Table C-3.

Table C-3 Library device table

Device name	WWN	Tape drive in the library	SCSI element address
\\.\tape0	5005076300410801	Drive 1	257
\\.\tape1	5005076300410802	Drive 2	258
\\.\tape2	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.

Linux tape and medium changer device attachment test

The following procedure tests the attachment of a medium changer device and a tape drive to a Linux system. The procedure assumes that the medium changer is attached at /dev/IBMchanger0 and the tape device is attached at /dev/IBMtape0 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 by running **`ls /dev/IBM*`** (Example C-5).

Example: C-5 List tape drives

```
# ls /dev/IBM*
/dev/IBMchanger0  /dev/IBMtape0  /dev/IBMtape0n  /dev/IBMtape1  /dev/IBMtape1n
```

2. Start **`IBMtapeutil`**. The main menu will be displayed (Example C-6).

Example: C-6 IBMtapeutil for Linux

```
IBMtapeutil for Linux, Version 1.2., Sept 19, 2003
=========================================
        1. Tape
        2. Changer
        3. Quit
=========================================
```

3. Select 2: Changer.
4. Select 1: Open a Device.
5. Enter /dev/IBMchanger0 for the device name (Example C-7).

Example: C-7 tapeutil changer menu

```
Enter device name (<enter> for /dev/IBMchanger0): /dev/IBMchanger0
Opening device...

Hit <enter> to continue...

------------------------- General Commands: -----------------------------
    1. Open a Device                 7. Request Sense
    2. Close a Device                8. Log Sense Page
    3. Inquiry                       9. Mode Sense Page
    4. Test Unit Ready              10. Switch Tape/Changer Device
    5. Reserve Device               11. Create Special Files
    6. Release Device               12. Query Driver Version
```

```
    Q. Quit IBMtapeutil
------------------------ Medium Changer Commands: ----------------------
   60. Element Information          65. Load/Unload Medium
   61. Position To Element          66. Initialize Element Status
   62. Element Inventory            67. Prevent/Allow Medium Removal
   63. Exchange Medium              68. Initialize Element Status Range
   64. Move Medium                  69. Read Device Identifiers
------------------------- Service Aid Commands: ------------------------
   70. Dump Device                  72. Load Ucode
   71. Force Dump                   73. Reset Drive
-------------------------------------------------------------------------
   99. Back To Main Menu
```

6. Select 3: Inquiry. Press Enter when prompted for an inquiry page. This concludes a very basic test of the device, SCSI connection, and the device driver. You may stop the test here or continue to perform a more complete test.
7. Select 62: Element Inventory.
8. From the output of the previous step, select a writable scratch cartridge and determine its element ID (see also “Using tapeutil element inventory (Linux)” on page 300). Also, select the element ID of the tape drive that your are working with; refer to Table C-3 on page 296.
9. Select 64: Move Medium, and then supply the address of the cartridge, followed by the address of the tape drive that you want to test. Use the element address from Table C-3 on page 296. Verify that the cartridge moved.
10. Close the medium changer (option 2) and return to the main menu (99).
11. Select 1: Tape from the main menu.

Example: C-8 tapeutil tape main menu

```
------------------------- General Commands: -----------------------------
    1. Open a Device                 7. Request Sense
    2. Close a Device                8. Log Sense Page
    3. Inquiry                       9. Mode Sense Page
    4. Test Unit Ready              10. Switch Tape/Changer Device
    5. Reserve Device               11. Create Special Files
    6. Release Device               12. Query Driver Version
    Q. Quit IBMtapeutil
-------------------------- Tape Commands: -------------------------------
   20. Rewind                       33. Set Block Size
   21. Forward Space Filemarks      34. Retension Tape
   22. Backward Space Filemarks     35. Query/Set Tape Position
   23. Forward Space Records        36. Query Tape Status
   24. Backward Space Records       37. Load Tape
   25. FSFM                         38. Unload Tape
   26. BSFM                         39. Lock Tape Drive Door
   27. Space to End of Data         40. Unlock Tape Drive Door
   28. Read and Write Tests         41. Take Tape Offline
   29. Write Filemarks              42. Enable/Disable Compression
   30. Read or Write Files          43. Flush Driver's Buffer
   31. Erase                        44. Self Test
   32. Reset Drive                  45. Display Message
-------------------------- IBMtape Commands: ----------------------------
   46. Query Sense                  52. Locate Tape Position
   47. Query Inquiry                53. Read Tape Position
   48. Query/Set Tape Parameters    54. Query Mtdevice Number
   49. Query/Set Tape Position      55. Synchronize Buffers
   50. Query/Set MT/ST Mode         56. List Tape Filemarks
   51. Report Density Support
```

```
-------------------------- Service Aid Commands: ------------------------
   70. Dump Device                   72. Load Ucode
   71. Force Dump                    73. Reset Drive
--------------------------------------------------------------------------
   99. Back To Main Menu
```

12. On the Tape menu, select 1: Open a device.
13. Enter `/dev/IBMtape0` (or the device name of the drive you want to test referring to Table C-3 on page 296) when prompted for the device name.
14. Select 1: Read/Write.
15. Select 4: Test Unit Ready and wait until no error occurs and the tape drive is ready (see Example C-9).

Example: C-9 Test unit ready

```
Enter Selection for /dev/IBMtape0: 4

Issuing test unit ready...
Unit ready.

Hit <enter> to continue...
```

If your drive is not ready after one minute, then do a visual check to see if the cartridge is loaded on the right drive. If not, then your library device table (Table C-3 on page 296) may be wrong and you will have to figure out it by iteration. Close your device by selecting 2, try to open a different device name, and start again at step 12.

Repeat steps 12 to 15 until you find a device that is ready, then update your library device table (Table C-3 on page 296).

16. Select 28: Read and Write Tests.
17. Select 1: Read/Write. Press the Enter key three times to accept the defaults and run the test.
18. Select 38: Unload Tape. Wait until the medium is unloaded.
19. Then close the tape device with option 2 and go back to the main menu with 99.
20. Select 2: Changer
21. Select 1: Open a Device.
22. Select /dev/IBMchanger0 for the device name.
23. Select 62: Move Medium, and 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.
24. Select 2: Close a Device.
25. Select Q: Quit Program.

Windows tape and medium changer device attachment test

The following procedure tests the attachment of a medium changer device and a tape device to a Windows system. The procedure assumes that your media changer is configured at Changer0, and the tape drive is attached at Tape0.

It also assumes that there is no cartridge in any drive.

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You also need an unassigned cartridge available for loading in at least one of the slots:

1. Open a terminal session.
2. Start **ntutil**. The ntutil menu will be displayed (as in Example 3-2 on page 115).
3. Select 1: Manual test.
4. Select 8: Library Mode
5. List all available devices with 88: List registered devices, as shown in Example C-10.

Example: C-10 List registered devices

```
enter selection: 88
Device found: Changer0 @"Scsi Port 3\Scsi Bus 1\Target Id 0\Logical Unit Id 1"
Device found: Tape0 @"Scsi Port 3\Scsi Bus 1\Target Id 0\Logical Unit Id 2"
Device found: Tape1 @"Scsi Port 3\Scsi Bus 1\Target Id 0\Logical Unit Id 4"
Total elapsed time in seconds =     0.00
Return to continue:
```

6. Select 1: Set the device special file (Example C-11).
   a. Enter the special file name for the tape (tape0).
   b. Enter the special file name for the changer (changer0).

Example: C-11 ntutil: Set special file name

```
enter selection: 1
Enter device special file (tape path) name or return for no change: tape0
Enter device special file (changer path) name, or "def" for
default lun1 changer or return for no change: changer0
Total elapsed time in seconds =    41.00
Return to continue:
```

   If you are testing other tape drives, then you have to enter the appropriate special file name.

7. Select 20: Open to open the tape and the changer.
8. Select 14: Additional ioctls calls and then 2: Library 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 that you are working with (refer to Table C-3 on page 296).
10. Select 11: Move Medium, then select 2 (SE = Storage Element) or 3 (IEE = Import / Export Element), depending on where your cartridge is stored. Supply the address of the cartridge. As the destination type, select 4 (DTE = Data Transfer Element = Tape Drive), followed by the address of the tape drive, as seen in Example C-12. Verify that the cartridge moved.

Example: C-12 Move medium

```
enter selection: 11
source type [moving from]: 2 = SE, 3 = IEE, 4 = DTE:2
source address moving from: 4120
destination type [moving to]: 2 = SE, 3 = IEE, 4 = DTE:4
destination address moving to: 258
```

Archived

11. Select 39: Test Unit Ready until no error occurs.

    If your drive is not ready after one minute, check to see if the cartridge actually loaded in the right drive. If not, then your library device table (Table C-3 on page 296) may be wrong and you will have to figure out it by iteration. Close your device by selecting 2 and try to open a different device name by selecting a different device special file name. Open it and try it again with 39: Test Unit Ready.

    Repeat these steps until you find a device that is ready, then update your library device table (Table C-3 on page 296).

12. Select 87: Read and Write Tests.
13. Select 33: Unload Tape. Wait until the medium is unloaded.
14. Select 11: Move Medium, and 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.
15. Select 2: Close a Device.
16. Select Q: Quit Program or start again at step 6 with a different tape drive.

Using tapeutil element inventory (Linux)

When you select option 62 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 C-13.

Example: C-13 Tapeutil element inventory: import/export station

```
Enter Selection for /dev/IBMchanger0: 62

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,  Length 36

           0 1  2 3  4 5  6 7  8 9  A B  C D  E F   0123456789ABCDEF
    0000 - 0000 0000 0000 0000 0000 0000 0000 0000  [................]
    0010 - 0000 0000 0000 0000 0000 0000 0000 0000  [................]
    0020 - 0000 0000                                [....            ]


Import/Export Station Address 16
  Import/Export State ............. Abnormal
  ASC/ASCQ ........................ 8302
  Media Present ................... No
  Import Enabled .................. Yes
  Export Enabled .................. Yes
  Robot Access Allowed ............ No
  Source Element Address Valid ... No
  Media Inverted .................. No

Volume Tag,  Length 36

           0 1  2 3  4 5  6 7  8 9  A B  C D  E F   0123456789ABCDEF
    0000 - 0000 0000 0000 0000 0000 0000 0000 0000  [................]
```

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```
    0010 - 0000 0000 0000 0000 0000 0000 0000 0000  [................]
    0020 - 0000 0000                                [....            ]


Hit <enter> to continue...

Import/Export Station Address 17
  Import/Export State ............ Abnormal
  ASC/ASCQ ....................... 8302
  Media Present .................. No
  Import Enabled ................. Yes
  Export Enabled ................. Yes
  Robot Access Allowed ........... No
  Source Element Address Valid ... No
  Media Inverted ................. No

Volume Tag,  Length 36

           0 1  2 3  4 5  6 7  8 9  A B  C D  E F   0123456789ABCDEF
    0000 - 0000 0000 0000 0000 0000 0000 0000 0000  [................]
    0010 - 0000 0000 0000 0000 0000 0000 0000 0000  [................]
    0020 - 0000 0000                                [....            ]
```

Scroll down to continue the listing of the rest of the import/export slots. Next, the drives are listed (Example C-14).

Example: C-14 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,  Length 36

           0 1  2 3  4 5  6 7  8 9  A B  C D  E F   0123456789ABCDEF
    0000 - 0000 0000 0000 0000 0000 0000 0000 0000  [................]
    0010 - 0000 0000 0000 0000 0000 0000 0000 0000  [................]
    0020 - 0000 0000                                [....            ]


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,  Length 36
```

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```
          0 1  2 3  4 5  6 7  8 9  A B  C D  E F   0123456789ABCDEF
    0000 - 0000 0000 0000 0000 0000 0000 0000 0000  [................]
    0010 - 0000 0000 0000 0000 0000 0000 0000 0000  [................]
    0020 - 0000 0000                                [....            ]
```

Finally, the individual storage slots are listed (Example C-15).

Example: C-15 Tapeutil element inventory: storage slots

```
Slot Address 4097
  Slot State ..................... Abnormal
  ASC/ASCQ ....................... 8302
  Media Present .................. No
  Robot Access Allowed ........... No
  Source Element Address Valid ... No
  Media Inverted ................. No

Volume Tag,  Length 36

          0 1  2 3  4 5  6 7  8 9  A B  C D  E F   0123456789ABCDEF
    0000 - 0000 0000 0000 0000 0000 0000 0000 0000  [................]
    0010 - 0000 0000 0000 0000 0000 0000 0000 0000  [................]
    0020 - 0000 0000                                [....            ]
..
..
..
Slot Address 4102
  Slot State ..................... Normal
  ASC/ASCQ ....................... 0000
  Media Present .................. Yes
  Robot Access Allowed ........... Yes
  Source Element Address ......... 4102
  Media Inverted ................. No

Volume Tag,  Length 36

          0 1  2 3  4 5  6 7  8 9  A B  C D  E F   0123456789ABCDEF
    0000 - 4142 4139 3230 4C31 0000 0000 0000 0000  [ABA920L1........]
    0010 - 0000 0000 0000 0000 0000 0000 0000 0000  [................]
    0020 - 0000 0000                                [....            ]
```

You can see that slot 4102 is occupied, since Media Present is set to Yes and the Volume Tag (Barcode label) contains ABA9201L1, indicating that this tape cartridge is located in this slot. Slot 4097 is empty, since Media Present is set to No. Therefore, when selecting option 1: Move Medium, assuming we knew the tape in slot 4102 was not already used by an application, we could specify source address 4102 and destination address 256. This would load that tape into the tape drive. To unload the media (after selecting 33: Unload Tape), we would move the medium from 256 back to 4102.

Using NTUTIL element inventory (Windows)

When you select option 14: Additional ioctls calls and then 2: Library Inventory in NTUTIL, you will receive a list of each element in the library and its status. First, the drives are listed, followed by each of the slots in the storages cells and the import/export station, as shown in Example C-16 on page 303. Some of the listing has been deleted for brevity.

Archived

Example: C-16 NTUTIL element inventory

```
DATA TRANSFER ELEMENTS -- DRIVES

Element address = 258
Accessible = 1
Lun flag = 0
Lun = 0
Full = 0
Svalid = 0
Source Address= 0
SCSI flag = 1
SCSI ID = 10
Barcode =
Barcode length = 0

Element address = 259
Accessible = 1
Lun flag = 0
Lun = 0
Full = 0
Svalid = 0
Source Address= 0
SCSI flag = 1
SCSI ID = 11
Barcode =
Barcode length = 0


STORAGE ELEMENTS

Element address = 4120
Accessible = 1
Full = 0
Svalid = 0
Source Address= 0
Barcode =
Barcode length = 0

Element address = 4121
Accessible = 1
Full = 0
Svalid = 0
Source Address= 0
Barcode =
Barcode length = 0
..................................... Storage element output deleted
IMPORT/EXPORT ELEMENTS

Element address = 16
Accessible = 1
Full = 0
Svalid = 0
Source Address= 0
Barcode =
Barcode length = 0
Element address = 17
Accessible = 1
Full = 1
Svalid = 0
Source Address= 0
```

Archived

```
Barcode = H00512L1
Barcode length = 8
.... ............................. Import/Export element output deleted
```

You can see that slot 17 is occupied, since Full is set to 1 and the Barcode contains H00512L1, indicating that this tape cartridge is located in this slot. All other slots are empty, since Full is set to 0. Therefore, when selecting option 11: Move Medium, assuming we knew the tape in slot 17 was not already used by an application, we could specify source address 17 and destination address 258. This would load that tape into the tape drive. To unload the media (after selecting 33: Unload Tape), we would move the medium from 258 back to 17.

Troubleshooting

In this section, we present an approach to troubleshooting problems with LTO drives and libraries.

Collect 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. Here are the elements to save; the following are details of how to save each element.

- Save the Library logs.
- Save the Drive logs (Drive dump).
- Force a Drive dump and save the Drive dump again.
- Save your application log.
- Save the operating system error log.

Save the Library logs on Windows with ntutil

To save the Library logs on Windows with ntutil:

1. Start NTUTIL.
2. Select 1: Manual test.
3. Select 8: Library Mode.
4. Select 1: Set device special file.
5. Open the device with Option 20.
6. Select 81: Read Dump and choose 1 for library.
7. Save the dump to local disk (Example C-17).

Example: C-17 NTUTIL save library logs

```
enter selection: 81
Drive = 0, Library = 1: 1
Enter dump name (1 to 8 characters) or return for default dump0001: libdump
analyze() called with  rc 1 err 0 (ERROR_SUCCESS) data 0
Total elapsed time in seconds =    37.00
Return to continue:
```

Save the Library logs on LINUX with tapeutil

To save the Library logs on LINUX with tapeutil:

- Start **IBMtapeutil**.
- Select 2: Changer.
- Select 1: Open a Device.
- Enter the changer device name.

- Select 70: Dump Device.
- Save the dump to local disk (Example C-18).

Example: C-18 Tapeutil save library logs

```
Enter Selection for /dev/IBMchanger0: 70

Enter destination filename (<enter> for dump0001.dmp): lib_dump.dmp

Issuing read dump...
Total dump data length is 3840.
Total number of transfers is 1.
Transfering dump data...
Current transfer number is 1.
Wrote 3840 bytes.
Total dump data length is 3840.
Total number of transfers is 1.
Transfering dump data...
Current transfer number is 1.
Wrote 3840 bytes.

Hit <enter> to continue...
```

Save the Library logs with the IBM System Storage Tape 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 you are 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 C-1 through Figure C-5 on page 307). Generally, there are separate selections for drive and library logs.

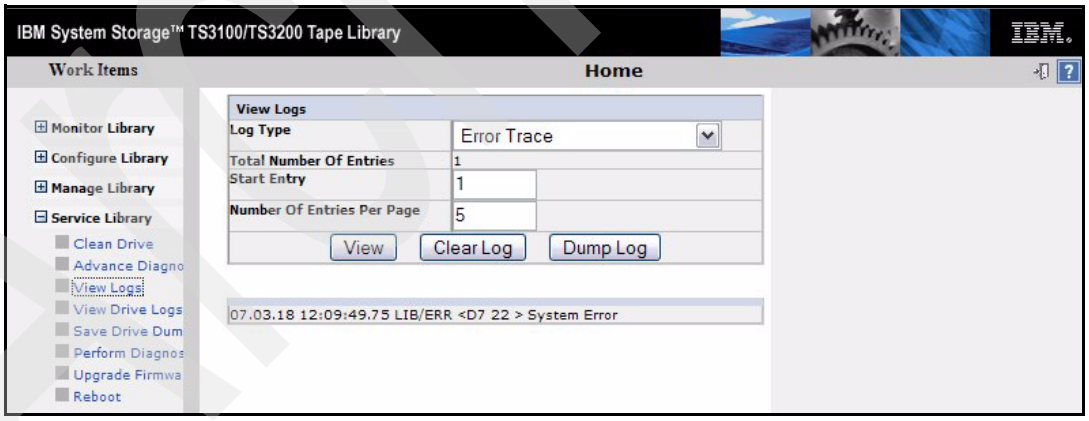


Figure C-1 IBM TS3100/TS3200 Tape Specialist download library logs

We see that we can capture the logs by individual drives or by the different logical libraries.

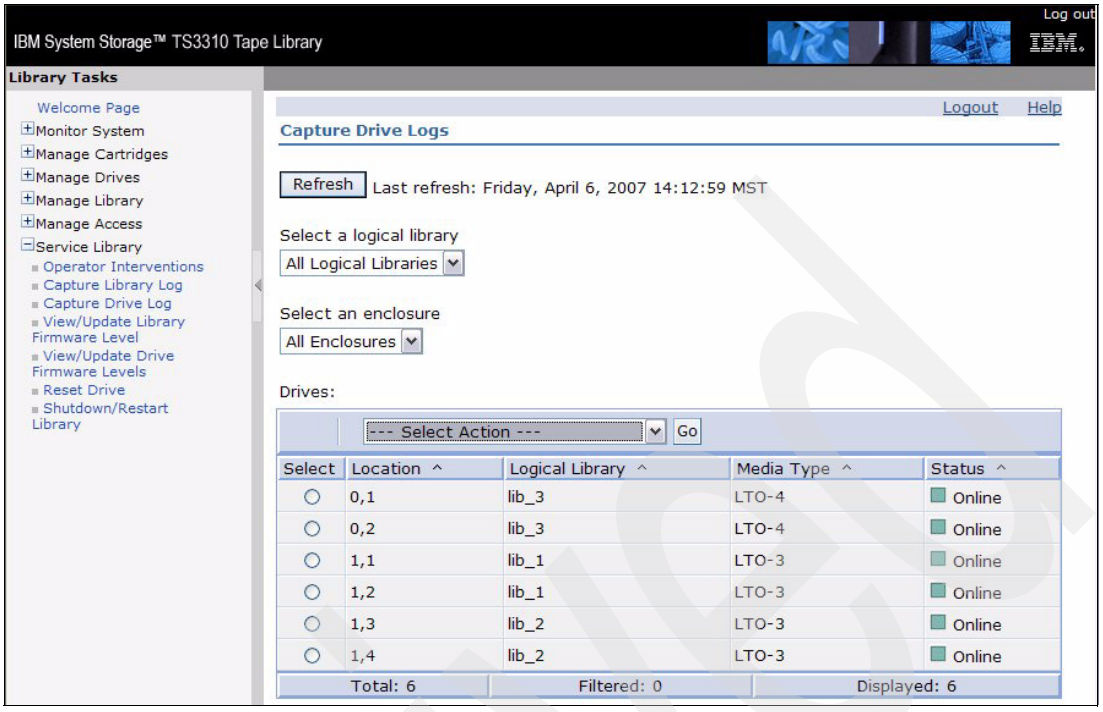


Figure C-2 IBM TS3310 Tape Specialist download drive logs

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 may have slightly different description and selections from the *Library Tasks* menu.

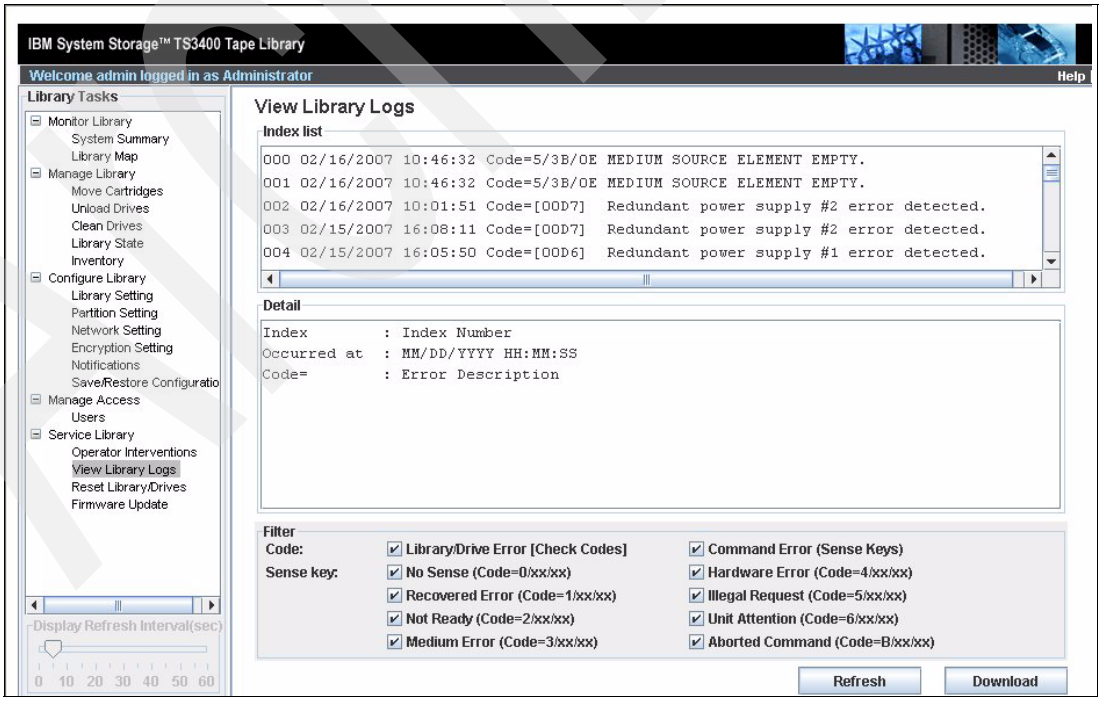


Figure C-3 IBM TS3400 Tape Specialist view and download library logs

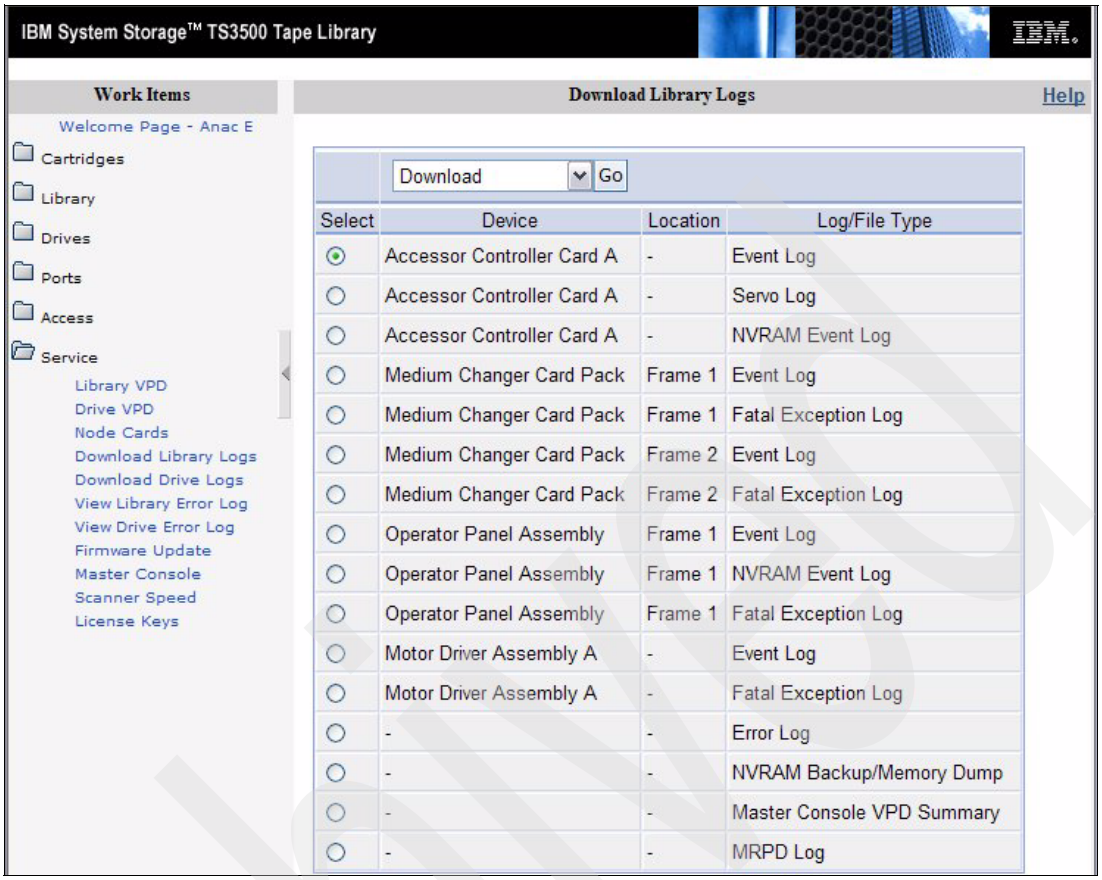


Figure C-4 IBM TS3500 Tape Specialist download library logs

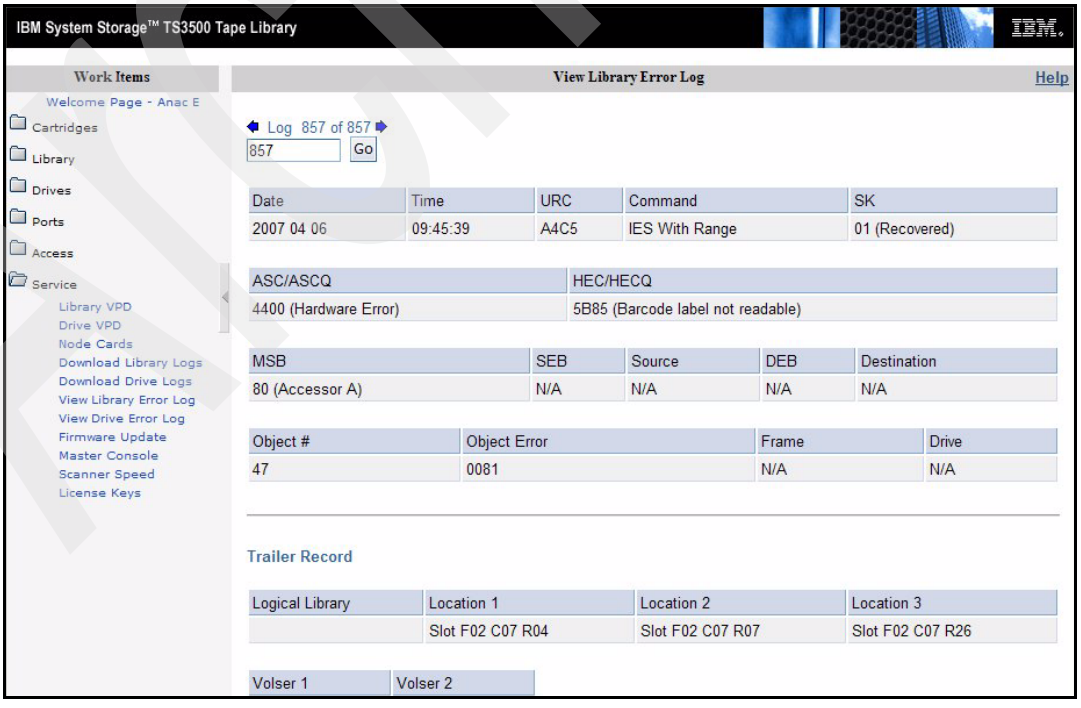


Figure C-5 IBM TS3500 Tape Specialist view library error log

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 C-4 on page 307, and that there are selections for just viewing the logs, as shown in Figure C-5 on page 307.

Save the drive logs on Windows with NTUTIL

To save the drive logs on Windows with NTUTIL:

1. Start NTUTIL.
2. Select 1: Manual test.
3. Enter 1: Set device special file.
4. Open the device with option 20.
5. Select 81: Read Dump and choose 0 for the drive.
6. Save the dump to local disk (Example C-19).

Example: C-19 ntutil save drive logs

```
enter selection: 81
Drive = 0, Library = 1: 0
Enter dump name (1 to 8 characters) or return for default dump0001: before_drive
0
execute_command_read_dump, invalid dump_name statement at (dump_name = before_dr
ive0 device = 0 result rc != -1)
batch file syntax error, line 0
NTUTIL error unable to execute_command
Total elapsed time in seconds =    19.00
Return to continue:
```

Save the drive logs on Linux with tapeutil

To save the drive logs on Linux with tapeutil:

1. Start **IBMtapeutil**.
2. Select 1: Tape.
3. Select 1: Open a Device.
4. Enter a tape device name.
5. Select 70: Dump Device.
6. Save the dump to local disk (Example C-20 on page 309).

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Example: C-20 tapeutil save drive logs

```
Enter Selection for /dev/IBMtape0: 70

Enter destination filename (<enter> for dump0001.dmp): tape_before.dmp

Issuing read dump...
Querying tape parameters...
Total dump data length is 307740.
Total number of transfers is 5.
Transfering dump data...
Current transfer number is 1.
Wrote 65536 bytes.
Current transfer number is 2.
Wrote 65536 bytes.
Current transfer number is 3.
Wrote 65536 bytes.
Current transfer number is 4.
Wrote 65536 bytes.
Current transfer number is 5.
Wrote 45596 bytes.

Hit <enter> to continue...
```

Force a drive dump and save the dump again on Windows

To force a drive dump and save the dump again on Windows:

1. Start NTUTIL.
2. Select 80: Force Dump (Example C-21).

Example: C-21 ntutil force dump

```
enter selection: 80
analyze() called with  rc 1 err 0 (ERROR_SUCCESS) data 0
Total elapsed time in seconds =     0.00
Return to continue:
```

3. Select 81: Read Dump and choose 0 for the drive.
4. Save the dump to a local disk (for example, after_drivex).

Force a drive dump and save the dump again on Linux

To force a drive dump and save the dump again on Linux:

1. Run **tapeutil**.
2. Select 71: Force Dump (Example C-22).

Example: C-22 tapeutilForce dump

```
Enter Selection for /dev/IBMtape0: 71

Issuing force dump...

Hit <enter> to continue...
```

3. Select 70: Dump Device.
4. Save the dump to a local disk (for example, after_drivex).

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Save your application logs

To save your application logs:

- For Tivoli Storage Manager, save the server activity log.
- For NetWorker, save the Daemon logs in /nsr/log/daemon.log.

Save the operating system error log

To save the operating system error log:

- Copy the Event log for Windows machines.
- For Linux, copy the messages and IBMtape.errorlog logs. Both are located in /var/log.

Provide all those logs to the IBM Support Center. You should also provide general information about your system, such as:

- Exact machine type
- Exact operating system version
- Installed adapter (SCSI/FC, Adaptec, Emulex, and so on)
- Adapter microcode, firmware level, bios level, and configuration

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 following command:

```
AUDIT LIBRARY library_name checklabel=barcode
```

The IBM Ultrium Tape Library Specialist

If you have problems connecting to your library using the IBM Ultrium Tape Library Specialist, try changing the library network settings to 10 Mb / Half Duplex.

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Related publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this book.

IBM Redbooks publications

For information about ordering these publications, see “How to get IBM Redbooks publications” on page 315. Note that some of the documents referenced here may be available in softcopy only.

- *Designing an IBM Storage Area Network*, SG24-5758
- *Designing and Optimizing an IBM Storage Area Network*, SG24-6419
- *Get More Out of Your SAN with IBM Tivoli Storage Manager*, SG24-6687
- *Getting Started with zSeries Fibre Channel Protocol*, REDP-0205
- *IBM SAN Survival Guide*, SG24-6143
- *IBM Tivoli Storage Management Concepts*, SG24-4877
- *IBM Tivoli Storage Manager Implementation Guide*, SG24-5416
- *IBM Tivoli Storage Manager Version 5.3 Technical Guide*, SG24-6638
- *IBM TotalStorage Enterprise Tape 3592: Presentation Guide*, REDP-3749
- *IBM System Storage: Implementing an IBM SAN*, SG24-6116
- *IBM System Storage Tape Library Guide for Open Systems*, SG24-5946
- *Implementing IBM Tape in UNIX Systems*, SG24-6502
- *Introduction to Storage Area Networks*, SG24-5470
- *Tivoli NetView 6.01 and Friends*, SG24-6019

Other publications

These publications are also relevant as further information sources:

- *IBM SAN Data Gateway Router 2108 Model R03 Installation and User's Guide*, SC26-7355
- *IBM Storage Area Network Data Gateway Installation and User's Guide*, SC26-7304
- *IBM Storage Area Network Data Gateway Module Setup, Operator and Service Guide,* GA32-0436
- *IBM Tivoli Storage Manager for Linux Administrator's Guide V5.3*, GC23-4690
- *IBM Tivoli Storage Manager for Linux Administrator's Reference Guide v5.3*, GC23-4691
- *IBM Tivoli Storage Manager for Linux Installation Guide V5.3*, GC32-1599
- *IBM Tivoli Storage Manager for Linux Quick Start V5.2*, GC23-4692
- *IBM Tivoli Storage Manager for Linux Storage Agent Users Guide V5.3*, GC23-4693
- *IBM Tivoli Storage Manager for SAN for AIX Storage Agent User's Guide V5.3,* GC32-0771

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- *IBM Tivoli Storage Manager for Windows Adminstrator's Guide V5.3*, GC32-0782
- *IBM Tivoli Storage Manager for Windows Quick Start V5.2*, GC32-0784
- *IBM Tivoli Storage Manager for Windows Storage Agent Users Guide V5.3*, GC32-0785
- *IBM Tivoli Storage Manager for Windows Installation Guide V5.3,* GC32-1602
- *IBM TotalStorage 3580 Tape Drive Setup, Operator, and Service Guide*, GC26-7708
- *IBM TotalStorage 3581 Tape Autoloader Models L28/L38/L3H and F28/F38/F3H Setup, Operator and Service Guide*, GA32-0470
- *IBM TotalStorage 3582 Tape Library Setup, Operator, and Service Guide*, GA32-0458
- *IBM TotalStorage 3583 Tape Library 3583 Setup and Operator Guide for Multi-Path Libraries*, GA32-0411
- *IBM TotalStorage 3953 Tape Frame Model F05 and Library Manager Model L05 Introduction and Planning Guide*, GA32-0472
- *IBM TotalStorage Enterprise Tape System 3592 Introduction and Planning Guide*, GA32-0464
- *IBM TotalStorage SMI-S Agent for Tape Installation Guide*, GC35-0512
- *IBM TotalStorage Tape Device Drivers Installation and User's Guide*, GC35-0154
- *IBM TotalStorage Tape Device Drivers Programming Reference,* GC35-0346
- *IBM TotalStorage UltraScalable Tape Library 3584 Introduction and Planning Guide*, GA32-0469
- *IBM Total Storage UltraScalable Tape Library 3584 Operator Guide*, GA32-0468
- *IBM TotalStorage UltraScalable Tape Library 3584 SCSI Reference*, GA32-0454
- *IBM TotalStorage Ultrium Device Drivers Programming Reference*, GC35-0483
- *IBM TotalStorage Ultrium Tape Autoloader 3581 Setup, Operator and Service Guide*, GA32-0461
- *IBM Tape Device Drivers Installation and User' Guide*, GC27-2130

Online resources

These Web sites and URLs are also relevant as further information sources:

- Adaptec

  http://www.adaptec.com
- Adaptec - Support

  http://www.adaptec.com/worldwide/support/suppbyproduct.jsp?fromPage=driverindex&cat=%2fTechnology%2fSCSI+Host+Adapters
- Arkeia home page

  http://www.arkeia.com/
- BakBone home page

  http://www.bakbone.com/
- Devfs (Device File System) FAQ

  http://www.atnf.csiro.au/~rgooch/linux/docs/devfs.html
- EMC^2 Legato - Compatibility Guides

  http://www.legato.com/support/websupport/compat_guides

- Emulex home page

  http://www.emulex.com
- IBM 3580 Tape Drive: Interoperability matrix- IBM TotalStorage Tape Storage Systems

  http://www.ibm.com/servers/storage/tape/3580/interop.html
- 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 3584 drive and library firmware

  ftp://ftp.software.ibm.com/storage/358x/3584
- IBM 3584 Tape Library: Interoperability matrix - IBM TotalStorage Tape Storage Systems

  http://www.ibm.com/servers/storage/tape/3584/interop.html
- IBM eServer: I/O connectivity on zSeries mainframe servers

  http://www-1.ibm.com/servers/eserver/zseries/connectivity
- IBM Software - IBM Tivoli Storage Manager - Support

  http://www-306.ibm.com/software/sysmgmt/products/support/IBMTivoliStorageManager.html
- IBM Software Support: Tivoli: IBM Tivoli Storage Manager Supported Devices for AIX HPUX SUN WIN

  http://www-306.ibm.com/software/sysmgmt/products/support/IBM_TSM_Supported_Devices_for_AIXHPSUNWIN.html
- IBM Storage Media: Overview - IBM TotalStorage

  http://www-1.ibm.com/servers/storage/media
- IBM Support & downloads - United States

  http://www.ibm.com/support
- IBM Tape Storage Systems: Resource Library - IBM TotalStorage

  http://www-03.ibm.com/systems/storage/tape/library.html
- IBM Tivoli Storage Manager - NDMP backup for Network Attached Storage

  http://www-306.ibm.com/software/tivoli/products/storage-mgr/network-data-mgt-protocol.html
- IBM Tivoli Storage Manager - Product overview

  http://www-306.ibm.com/software/tivoli/products/storage-mgr
- IBM Tivoli Storage Manager - Related products

  http://www-306.ibm.com/software/tivoli/products/storage-mgr/product-links.html
- IBM Tivoli Storage Manager for Storage Area Networks - Product overview

  http://www-306.ibm.com/software/tivoli/products/storage-mgr-san
- IBM System Storage support: Tape & optical storage

  http://www-304.ibm.com/jct01004c/systems/support/supportsite.wss/allproducts?brandind=5000034&taskind=1
- *IBM TotalStorage UltraScalable Tape Library 3584 Advanced Library Management System Technology White Paper*, found at:

  http://www-1.ibm.com/servers/storage/tape/whitepapers/pdf/advanced_library_management_system.pdf

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- Index of ftp://index.storsys.ibm.com/358x/3581

  ftp://index.storsys.ibm.com/358x/3581
- Index of ftp://ftp.software.ibm.com/storage/358x/3583

  ftp://ftp.software.ibm.com/storage/358x/3583
- Index of ftp://ftp.software.ibm.com/storage/devdrvr/Doc

  ftp://ftp.software.ibm.com/storage/devdrvr/Doc
- Index of ftp://ftp.software.ibm.com/storage/devdrvr/Linux

  ftp://ftp.software.ibm.com/storage/devdrvr/Linux
- Index of ftp://ftp.software.ibm.com/storage/devdrvr/Windows/Win2000

  ftp://ftp.software.ibm.com/storage/devdrvr/Windows/Win2000
- Index of ftp://ftp.software.ibm.com/storage/devdrvr/Windows/Win2003

  ftp://ftp.software.ibm.com/storage/devdrvr/Windows/Win2003
- Index of ftp://ftp.software.ibm.com/storage/san/2108

  ftp://ftp.software.ibm.com/storage/san/2108
- Index of ftp://metalab.unc.edu/pub/Linux/system/backup

  ftp://metalab.unc.edu/pub/Linux/system/backup
- ISV Support Matrix for LTO

  http://www-03.ibm.com/systems/storage/product/
- java.com

  http://java.com/en
- Kernel Rebuild Guide

  http://www.digitalhermit.com/linux/Kernel-Build-HOWTO.html
- Legato home page

  http://software.emc.com/
- The Linear Tape-Open Technology Organization Web site provides information about the technology, formats, and licensing

  http://www.lto-technology.com/
- Linear Tape-Open Web site

  http://www.lto.org
- The Linux SCSI Generic (sg) Driver

  http://www.torque.net/sg
- Network Appliances home page

  http://www.netapp.com/
- The PCI Utilities

  http://mj.ucw.cz/pciutils.shtml
- QLogic home page

  http://www.qlogic.com
- QLogic Support

  http://www.qlogic.com/support
- QLogic Support: OEM Download driver

  http://www.qlogic.com/support/ibm_page.html

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- RFC 1157: A Simple Network Management Protocol (SNMP)

  ftp://ftp.isi.edu/in-notes/rfc1157.txt

- rscan-scsi-bus.sh script

  http://www.garloff.de/kurt/linux/rescan-scsi-bus.sh

- *SANBlade Manager User's Guide Management Application for SANBlade Host Bus Adapters* for your specific HBA, found at:

  http://www.qlogic.com/support/drivers_software.asp

- scsidev utility for Linux

  http://www.garloff.de/kurt/linux/scsidev

- SCSI Media Changer and Backup Device Control System

  http://mtx.sourceforge.net

- Solaris documentation

  http://docs.sun.com/

- Tivoli - Support - Information Center

  http://publib.boulder.ibm.com/tividd/td/tdprodlist.html
  http://publib.boulder.ibm.com/infocenter/tivihelp/index.jsp

- Ultrium 3580 Drive firmware information

  http://www-1.ibm.com/support/docview.wss?rs=543&org=ssg&doc=S4000055&loc=en-us

- Ultrium device driver downloads

  ftp://ftp.software.ibm.com/storage/devdrvr

- This Web site describes the media available from IBM

  http://www.ibm.com/storage/media

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Part 2 documents how to use these products with popular data backup applications, including IBM Tivoli Storage Manager, BakBone NetVault, Arkeia, and EMC Legato NetWorker.

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SG24-6268-04 ISBN 0738488917