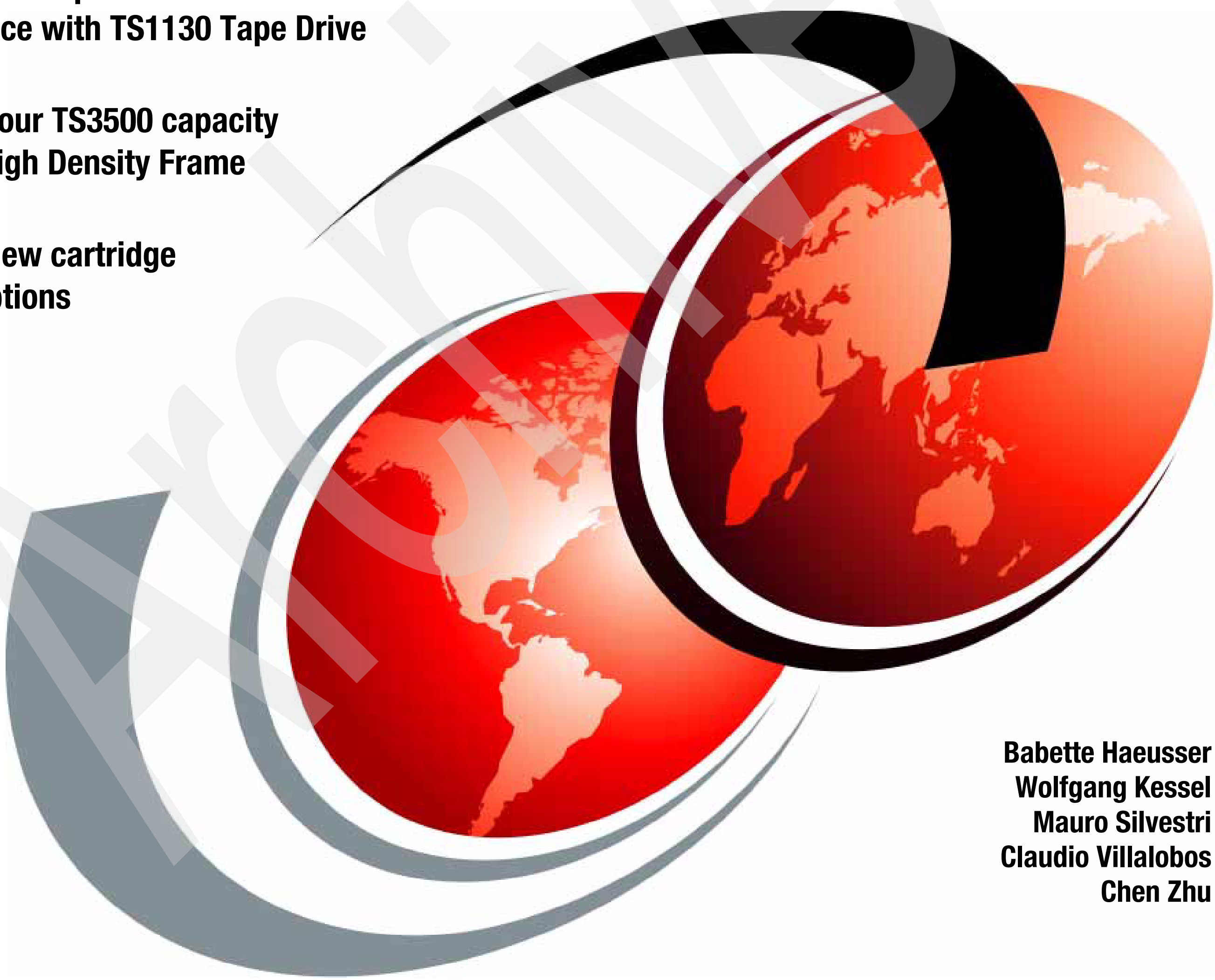
IBM

IBM TS3500 Tape Library with System z Attachment

A Practical Guide to Enterprise Tape Drives and TS3500 Tape Automation

- Improve your tape workload performance with TS1130 Tape Drive
- Increase your TS3500 capacity with the High Density Frame
- Discover new cartridge storage options



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IBM TS3500 Tape Library with System z Attachment A Practical Guide to Enterprise Tape Drives and TS3500 Tape Automation

October 2008

SG24-6789-03

Note: Before using this information and the product it supports, read the information in "Notices" on page xiii.

Fourth Edition (October 2008)

This edition applies to the models and versions of IBM Tape Libraries, Tape Drives, Tape Controllers, and Tape Virtualization solutions available at the time of writing this book. This edition applies to the IBM Virtualization Engine TS7700 up to and including Release 1.4a.

Contents

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Preface

The IBM® System Storage™ TS3500 Tape Library, also known as the IBM System Storage 3584 Tape Library, is designed for medium to large automated tape storage and backup solutions and is part of a whole family of tape libraries for small to large tape automation solutions. Originally designed for IBM Linear Tape Open Ultrium Technology drives, the library was enhanced to also support the IBM System Storage Enterprise Tape Drive 3592 in preparation of System z® server attachment. Together with the IBM System Storage 3953 Tape System, the TS3500 Tape Library attaches to System z servers as well as to Open Systems hosts.

This book is intended for Hardware and Software Planners, System Programmers, Storage Administrators, and anyone involved in planning, implementing, and operating the TS3500 Tape Library in a System z environment. It is also suitable for everyone seeking detailed technical information about the TS3500 Tape Library and the IBM Tape System 3953 that allow attachment to System z hosts.

In this IBM Redbooks® publication, we discuss the enhancements that allow attachment of the IBM System Storage TS3500 Tape Library to System z host systems through the IBM System Storage 3953 Tape System, which consists of the IBM System Storage 3953 Model L05 Library Manager and the Model F05 Frame. The IBM 3953 Tape System significantly broadens the attachment options of the TS3500 Tape Library, which is well established in Open Systems environments, and they allow nearly all platforms to share a single tape library.

The latest version of the IBM Redbooks publication has been updated with the TS1130 Tape Drive (IBM 3592 Model E06/EU6) and Controller and enhancements to the TS3500 Tape Library, such as the High Density Frame that allows storage of up to 1320 cartridges in a single library frame.

When referring to the TS7700 Virtualization Engine, this book includes information relevant up to and including TS7700 Release 1.4a. For more information, refer to:

- *TS7700 R1.4a and lower: IBM Virtualization Engine TS7700: Tape Virtualization for System z Servers*, SG24-7312
- *TS7500 R1.5 and higher: IBM Virtualization Engine TS7740 R1.5 and TS7720: New Virtualization Options for Mainframe Servers*, SG24-7712

The team that wrote this book

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

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Alex Osuna
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Ahmed Almoustafa, Jennifer Bappert, Erika Dawson, Lee Jesionowski, Jon Beard, Harold Koeppel, Steve Wilkins, James Karp, Scott Fry, Dennis Byrne, James Johnson, Arthur Colvig, Dan Watanabe, Stefan Lehmann, Lawrence Fuss, Lloyd Wiebe, Mike Noel, Cory Smith, Jon Beard, Khanh V Ngo, John Newcom, and Jim Fisher
IBM Development and Marketing, Tucson

Antoinette Kaschner and Axel Melber
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Thanks to the authors of the previous editions of this book.

- Authors of the first edition, IBM TS3500 Tape Library with System z Attachment, published in 2005, were:

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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 can also include minor corrections and editorial changes that are not identified.

Summary of Changes
for SG24-6789-03
for IBM TS3500 Tape Library with System z Attachment
as created or updated on October 15, 2008.

October 2008, Fourth Edition

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

New information

New information includes:

- The new TS1130 Tape Drive Model E06 and EU6
- The new high-density frame S24™ for the TS3500 Library
- IPv6 considerations
- TS3500 data gathering

Updated information

Updated information includes:

- Software implementation considerations for TS1130 for z/OS® and JES3
- TS7700 Release 1.4A

March 2008, Third Edition

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

New information

New information includes:

- We added information relative to TS7700 Releases 1.2, 1.3, and 1.4, including:
  - Three Cluster Grid
  - Copy Export
  - Back-end tape encryption by pool
  - Library Request host console command
  - Secure Data Erase
  - Support for TS7700 in the 3494 Tape Library
- We added the new TS3500 feature for a four door I/O station D*xx* frame.

March 2007, Second Edition

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

New information

New information includes:

- This book now includes the latest enhancements of the TS1120 Tape Drive and the TS3500 Tape Library. This includes the Tape Encryption capability of the TS1120 Tape Drive.
- We added information about the IBM System Storage Virtualization Engine™ TS7700 R1.1.
- We included information about sharing and partitioning tape libraries and a new chapter about running a z/OS system.

Changed information

We changed this information:

- We updated and enhanced the software implementation information.
- We updated the operating information.

1

IBM System Storage TS3500 Tape Library and IBM 3953 Tape System

The IBM System Storage TS3500 Tape Library supports the attachment of IBM System z host systems to IBM System Storage TS1130 (IBM 3592-E06/EU6), IBM System Storage TS1120 (IBM 3592-E05), and IBM TotalStorage® 3592 Model J1A installed inside the TS3500. The System z hosts attach using either Enterprise System Connection (ESCON®) or Fiber Connection (FICON®) to one of the following products:

- IBM System Storage TS1120 Model C06 Tape Controller
- IBM TotalStorage 3592 Tape Controller Model J70
- IBM System Storage TS7700 Virtualization Engine (FICON only)
- IBM TotalStorage 3494 Virtual Tape Server (VTS) models B10 and B20

The IBM TS3500 Tape Library is managed on behalf of the System z hosts by an external Library Manager, the IBM 3953 Model L05. This Library Manager, the System z control units, and various switches are housed in a special frame type, the IBM 3953 Model F05 Frame, which is located physically outside the library enclosure. These two components, the Library Manager Model L05 and the 3953-F05 Frame in which it resides, make up the IBM 3953 Tape System. The IBM 3953 Library Manager has common microcode with the Library Manager that is used in the IBM 3494 Tape Library.

Beside the existing TS3500 attachment support for the Open Systems Fibre Channel environments for Linear Tape-Open (LTO) and 3592 drives, the TS3500 together with the IBM 3953 Tape System provides the additional attachment functionality for System z ESCON and FICON environments. Both platforms can be used in an isolated manner, or they can be consolidated into one shared library.

1.1 IBM System Storage TS3500 Tape Library

The TS3500 Tape Library is designed for medium to large automated tape storage and backup solutions and is part of a whole family of tape libraries for small to large automated tape storage and backup solutions. Originally delivered in 2000 as the IBM TotalStorage 3584 Tape Library at the same time as Linear Tape-Open (LTO) Ultrium technology, the TS3500 offers a robust enterprise library solution, which is available for mid-range and high-end Open Systems. Since its introduction, the library has been enhanced to accommodate various drive types and operating platforms, more recently including the attachment of System z (mainframe) hosts and tape controllers.

Previously, mainframe-attached tape drives were housed in the IBM 3494, which is an enterprise library designed for IBM 3490E, IBM 3590, and IBM 3592 Tape Drive technology in both mainframe and Open Systems environments. Since 2005, the TS3500 Tape Library has also been capable of connecting tape drives to host systems with FICON or ESCON attachments using the System z attachment capability covered in this book, as well as any combination of Fibre Channel and Ultra2/Wide Low Voltage Differential (LVD) Small Computer System Interface (SCSI).

The TS3500 was designed and built on the strong foundation of the IBM 3494 robotics and microcode. Physically, the designs look very similar (refer to Figure 1-1), but only approximately three percent of the hardware components are truly common to both machines.

Figure 1-1 Single L frame IBM 3494 (left) and TS3500 (right)

The combination of reliable tape handling with technology and functional enhancements has resulted in an optimal design for a robust enterprise solution and outstanding retrieval performance; typical cartridge move time is less than three seconds. Using IBM 3592 or Linear Tape-Open (LTO) Ultrium high-density cartridge technology, the TS3500 provides a powerful robust tape storage solution for the whole enterprise, yet it is contained in a minimal footprint.

In summary, the TS3500 Tape Library provides:

- A modular, scalable, automated tape library, combining IBM tape and automation for Open Systems and mainframe hosts, using a variety of IBM drive types

- Attachment to IBM System z, IBM System i and i5, IBM System p® and p5, IBM System x™, IBM zSeries®, IBM iSeries®, AS/400, IBM pSeries®, RS/6000®, IBM xSeries®, Netfinity®, Sun™, Hewlett-Packard, and other non-IBM servers
- Connectivity using FICON, ESCON, Fibre Channel, Low Voltage Differential (LVD) SCSI, and High Voltage Differential (HVD) SCSI
- IBM Multi-Path Architecture designed to support redundant control paths, mixed drive configurations, and library sharing among multiple applications

1.2 System z and Open Systems tape consolidation

Attaching System z hosts to the IBM System Storage TS3500 Tape Library requires a number of specific hardware elements. In this section, we highlight basic conceptual differences in the requirements for mainframes and Open Systems hosts, and outline how the TS3500 library has evolved to include support for mainframes.

The tape drives currently supported for System z attachment within the TS3500 are the IBM System Storage TS1130 Model E06 Tape Drive, IBM System Storage TS1120 Model E05 Tape Drive, and IBM TotalStorage 3592 Model J1A Tape Drive, which can also be attached to Open Systems hosts. However, System z attaches to the library differently than Open Systems hosts attach:

- System z hosts attach to controllers, which in turn have a set of drives attached, rather than each drive having a separate attachment to a host channel.
- System z-attached drives must be in a separate TS3500 logical library within the TS3500 Tape Library. Open Systems-attached drives are not supported within this TS3500 logical library.
- The interface between the System z host and the library robotics is managed by a Library Manager, which is physically external to the TS3500 Tape Library. The Library Manager functionality and monitoring capabilities are not available to Open Systems attaching to different partitions of the TS3500 Tape Library.

1.2.1 Channels, adapters, and protocols

The protocol used by System z servers is FICON or ESCON, which is different from the Fibre Channel Protocol (FCP) or SCSI protocol used by Open Systems. Open Systems hosts with FCP host bus adapters (HBAs) cannot be connected to FICON channels even if they are attached through directors that support both protocols.

Each IBM 3592 Tape Drive offers two FCP host attachments. This means that they can be connected to Open Systems hosts, directly or through switches or directors, but without the need for any protocol conversion or gateway/router device. However, System z hosts use a FICON or ESCON controller between the drives and the host channels.

1.2.2 System z tape controllers

System z-attached drives are normally addressed using a front-end controller[1]. FICON or ESCON channels from the host are directly connected, often using a director, to the IBM System Storage TS1120 Model C06 Controller or IBM TotalStorage 3592 Model J70 Tape Controller. The IBM 3592 tape drives attach to the controller using their native FCP adapters. You can connect up to 16 tape drives to a single controller.

[1] This discussion excludes the special case of Linux® logical partitions (LPARs) in System z machines to which FCP drives can be directly attached.

Note: Any drives connected to a System z controller are dedicated for System z use and addressed only through the controller to which they are attached. Even though the IBM 3592 Tape Drive has additional native FCP adapters, they cannot be connected to Open Systems hosts in addition to the mainframe controllers.

You can also view the IBM VTS or the IBM System Storage TS7700 Virtualization Engine in this context as a special type of controller. The VTS is attached directly to the mainframe FICON or ESCON host channels while the TS7700 only supports FICON attachment. Each of those tape virtualization solutions supports connection through a director and emulates a set of physical controllers and attached tape drives. The VTS and the TS7700 have real physical tape drives attached to them, which are managed by them and not visible to the host systems.

1.2.3 IBM TS3500 logical libraries and partitioning

The patented IBM Multi-Path Architecture enables simple SCSI medium changer libraries to be shared by like or unlike host platforms without middleware or a dedicated server acting as a Library Manager. This facility is implemented on a number of IBM libraries, including the TS3500. The Multi-Path Architecture makes sharing possible by letting you partition the library's storage slots and tape drives into TS3500 logical libraries. Servers can then run separate applications for each TS3500 logical library. Unlike hosts that share the library robotics but have the physical library drives and slots divided between them, each host sees the same accessor but has a different view of the physical attributes of the library.

This TS3500 concept of logical libraries is used to segregate the physical devices associated with the tape controllers, VTS, and TS7700 systems from the Open Systems drives. Within a TS3500 Tape Library, there can exist:

- A single mainframe logical library
- A single Open Systems logical library
- Multiple mainframe logical libraries, up to a maximum of four
- Multiple Open Systems logical libraries, up to a maximum of 192
- Multiple TS3500 logical libraries, some for Open Systems hosts and up to four for System z hosts

The System z host always uses its own logical library within the TS3500. The minimum requirement for a TS3500 logical library definition is to contain at least one drive and one cartridge slot. Because you can install up to 192 tape drives in the IBM TS3500 (12 drives in each of 16 frames), you can define up to 192 logical libraries in total. However, the TS3500 supports only a maximum of four System z logical libraries, each of which is managed by one dedicated IBM 3953 Library Manager. For high availability, you can install a secondary Library Manager per System z logical library.

In the TS3500 and 3953 Tape System configuration, a further level of logical partitioning is available in which each TS3500 logical library managed by one dedicated Library Manager can have up to three partitions defined to it (identical to the Library Manager partitions of a 3494).

Note: You can connect an IBM 3953 Library Manager only to one TS3500 logical library.

1.2.4 Library control mechanisms

The IBM 3494 Tape Library is controlled entirely by an integrated Library Manager residing in the IBM 3494 Model L*xx* frame. Open Systems hosts connect directly to the Library Manager through an Ethernet LAN or a direct serial connection using an IBM-supplied device driver. The IBM 3494 Library Manager, the operational focal point of the IBM 3494, provides the support to set up, maintain, configure, and operate the 3494 Tape Library.

In an Open Systems environment, the TS3500 is controlled entirely by the attached host, which uses its own application code and the IBM-supplied device driver to send SCSI Medium Changer commands directly to the library robotics. The host also maintains its own cartridge inventory and does any partitioning at the hardware level, allocating drives and slots to particular partitions in advance as defined by the user.

System z hosts control the IBM libraries through operating system components in z/OS, z/VM®, and z/VSE™ by issuing the appropriate library control commands. In the IBM 3494, the host sends these commands using the data path to a tape controller that routes them internally to the integrated Library Manager. The TS3500 has no such integrated Library Manager; so for System z attachment, a separate Library Manager, the IBM 3953 Model L05, is provided, which is physically external to the library. Similar, but not identical in function to the Library Manager in the IBM 3494 library, the IBM 3953-L05 provides the appropriate System z library management interface to the TS3500.

1.2.5 IBM TotalStorage 3953 Library Manager and frame

You order the Library Manager for System z attachment to the TS3500 as a separate device type and model number, IBM 3953 Library Manager Model L05. The Library Manager translates requests from the System z hosts into SCSI move medium changer commands to communicate with the TS3500 library. It shares common microcode with the Library Manager used in the IBM 3494 library. It is the same PC used in the IBM 3494; however, the card complement in the PC is different when it is used in an IBM 3494 compared with a TS3500.

The IBM 3953 Library Manager supports attachment of System z hosts to IBM 3592 tape drives inside a TS3500 Tape Library through:

- IBM 3494 VTS Model B10 or B20 and Peer-to-Peer VTS (PtP VTS)
- IBM System Storage TS7700 Virtualization Engine
- IBM System Storage TS1120 Model C06 Tape Controller
- IBM 3592 Tape Controller Model J70

The supported configurations are:

- Up to 16 subsystems per 3953 Tape System (of which two subsystems can be VTSs, TS7700s, or a mixture of both)
- Up to four IBM 3953 Tape Systems per TS3500 Tape Library (a maximum of eight VTSs, TS7700s, or a mixture of both)

Unlike the Library Manager in the IBM 3494, this IBM 3953 Library Manager does not control any Open Systems drives.

You install the Library Manager in an independent frame, the IBM TotalStorage 3953 Tape Frame Model F05. This frame sits outside the TS3500 Tape Library enclosure and can be physically located away from it. The IBM 3953 frame comes as a base frame and an expansion frame. The base frame contains the IBM 3953 Library Managers and up to one tape controller. Each expansion frame can house up to three tape controllers. For one TS3500 logical library, there can be only one IBM 3953 base frame and up to five expansion frames.

1.2.6 Advanced Library Management System

The Advanced Library Management System (ALMS) for the TS3500 library is the next generation of the Multi-Path Architecture. It provides a user-friendly Web interface to facilitate the definition and management of multiple logical libraries.

> **Note:** ALMS is an optional feature for the TS3500 Tape Library in general; however, it is a mandatory feature for the library when you attach a System z host, or when you install the IBM TS3500 Model HA1 (High Availability).

1.3 Basic components for System z attachment to TS3500

Attaching System z to the IBM System Storage TS3500 Tape Library requires a number of specific hardware elements. Here is a summary of equipment that is either required or installed according to client system requirements:

- IBM TotalStorage 3953 Tape Frame Model F05

  A special frame, independent of the TS3500 library, that is used to house the Library Manager, switches, and controllers for mainframe-attached tape:

  – TS3000 System Console

    The IBM System Storage TS3000 System Console (TSSC), formerly known as the TotalStorage Master Console, enables remote monitoring by IBM Engineering of attached units to expedite microcode updates, reduce service times, and enhance local service. It is required for the IBM 3953 and can be ordered as an integrated feature in the IBM 3953-F05 base frame. You can choose to attach an external TotalStorage Master Console that is already installed for other IBM equipment in the same physical location.

  – Keyboard-Video-Mouse (KVM) switch

    A folding keyboard, video monitor, and mouse are provided in the base frame for the operator console of the Library Manager. If a TotalStorage Master Console or a second Library Manager is installed in the base frame, a KVM switch is required, because they all share the same keyboard, mouse, and monitor.

  – Ethernet switches

    Ethernet switches are provided for the internal communications between the Library Manager, tape controllers, IBM 3494 VTSs, TS7700, and the TSSC.

- IBM TotalStorage 3953 Library Manager Model L05

  An industrial PC containing an Intel® processor that provides the mainframe interface to the TS3500.

- IBM System Storage TS3500 models L23, D23, and S24

  The library frames used for cartridge storage and to house IBM 3592 tape drives and library robotics.

- IBM 3592 tape drives

  The physical tape drive used in the TS3500 and 3494 tape libraries.

- IBM System Storage TS7700 Virtualization Engine

  An Enterprise virtual tape solution with a disk Tape Volume Cache (TVC), providing FICON host connectivity and emulating up to 256 virtual tape drive addresses to the host.

- IBM TotalStorage 3494 Virtual Tape Server models B10 and B20

  An Enterprise virtual tape solution with a disk Tape Volume Cache (TVC) that provides FICON or ESCON host connectivity and emulates up to 256 virtual tape drive addresses to the host.

- IBM System Storage TS1120 Model C06 Tape Controller or IBM TotalStorage 3592 Tape Controller Model J70

  They include a RISC processor controller that provides FICON or ESCON host connectivity and that is capable of supporting up to 16 FCP-attached IBM 3592 tape drives.

- Fibre Channel switches

  These switches are required to attach the IBM 3592 tape drives to the controllers. Each controller can support one or, for redundancy, two switches.

Figure 1-2 shows a simple diagram of the overall System z attachment to the TS3500 Tape Library.

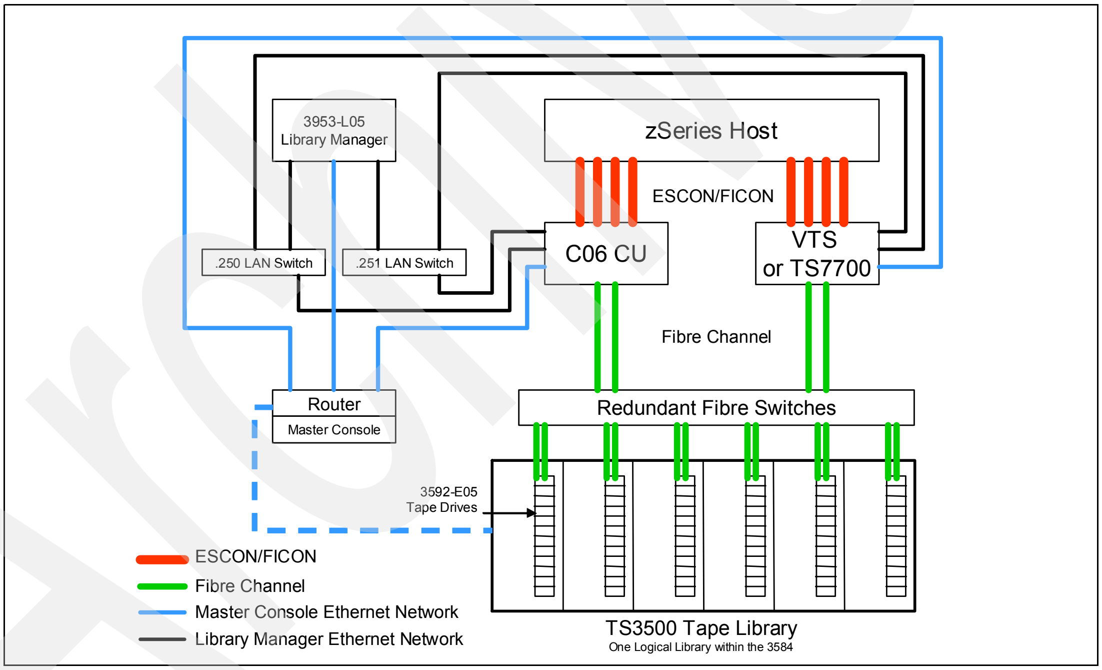


Figure 1-2 System z attachment to the IBM TS3500 library

When a TS7700 is attached to the tape drives installed inside the TS3500 Tape Library, the TS7700-specific equipment is installed inside the IBM 3952 Tape Frame.

An IBM 3952 Tape Frame can contain:

- One TS7740 Node (3957-V06)
- One TS7740 Cache Controller (3956-CC6)
- One or three TS7740 Cache Drawers (3956-CX6)
- Two Ethernet routers
- Dual power

For more details, refer to 5.3, “TS7700 Virtualization Engine” on page 127.

When a VTS is attached to the tape drives installed inside the TS3500 Tape Library, the VTS-specific equipment is installed inside the IBM 3494 Model B10 or Model B20 frame. When a System z-attached tape controller is installed together with drives inside a TS3500 Tape Library, the System z-specific equipment is housed in IBM 3953 Model F05 frames, where the following physical location and installation rules apply:

- An IBM 3953 base frame can contain:
  - One or two IBM 3953-L05 Library Manager PCs
  - Zero or one tape controller
  - Zero or one TotalStorage Master Console
  - Ethernet switches
  - Up to six Fibre Channel switches
  - Keyboard, video monitor, and mouse, with KVM switch if required
  - Single or dual power
- An IBM 3953 expansion frame can contain:
  - Up to three tape controllers
  - Up to six Fibre Channel switches (one or two for each of the controllers)
  - Ethernet switches
  - Power for all components, including support for dual line cords

For more details, refer to Figure 2-9 on page 33 and Figure 2-10 on page 34.

1.4 Conclusion

The IBM System Storage TS3500 Tape Library with IBM 3592 tape drives has been supported in a wide range of Open Systems environments. With the IBM System Storage 3953 Tape Frame Model F05 and Library Manager Model L05, the TS3500 library support has been expanded to include System z enterprise host system environments.

This IBM 3953 tape system brings similar function and capabilities from the proven IBM 3494 Library Manager with a common code maintenance, update, development path, and investment, while providing the enhanced functions and features of the TS3500 Tape Library.

The TS3500 library features include:

- Up to 20% less floor space requirement than the IBM 3494
- An increase in storage density of up to 87% when comparing a single frame of the IBM 3494 Model D22 frame with maximum drives and dual gripper against the TS3500 Model D23 frame with maximum drives
- A single S24 high density frame has the capacity of 2.5 Model D23 frames
- A broad set of application support in both Open Systems and mainframe environments
- Design to incorporate best of breed reliability, availability, and serviceability characteristics

Additionally, use of common microcode in the IBM 3953 Library Manager and the IBM 3494 Tape Library enables enhancements to be synchronously incorporated and maintained in both products.

2

TS3500 Tape Library components and architecture

The TS3500 Tape Library is designed as a highly scalable, automated tape library combining IBM automation technology and high performance IBM tape drives for both System z and Open Systems environments.

In this chapter, we provide a structural overview of the TS3500 Tape Library and a detailed description of the hardware components, which were listed in 1.3, “Basic components for System z attachment to TS3500” on page 6 and followed by an architectural overview.

We discuss the following topics:

- IBM TS3500 Tape Library
- IBM 3953 Model F05 Tape Frame
- System design

For more information about the TS3500 Tape Library and its hardware components, software support, and implementation specifics for Open Systems hosts, refer to *The IBM System Storage Tape Libraries Guide for Open Systems*, SG24-5946.

2.1 IBM System Storage TS3500 Tape Library

The IBM System Storage TS3500 Tape Library is part of a family of tape library storage solutions designed to provide a highly scalable, automated tape library for large environments. The IBM System Storage TS3500 Tape Library addresses the requirement for unattended operation for midrange systems up to System z systems. Each aspect of the subsystem is designed to help optimize access to data and reliability.

2.1.1 TS3500 highlights

The TS3500 supports the IBM TotalStorage Linear-Tape Open (LTO) Ultrium 1, 2, and 3 tape drives, the IBM System Storage TS1040 Tape Drive (IBM LTO Ultrium 4), the IBM TotalStorage 3592 Enterprise Tape Drive Model J1A, and the IBM 3592 Model E tape drives. IBM 3592 Model E tape drives include TS1120 Tape Drive and TS1130 Tape Drive.

IBM LTO Ultrium tape drives are compact storage devices designed to support the highly intensive read and write operations required by today's Open Systems servers. The 3592 tape drives are designed to provide high levels of performance, functionality, and cartridge capacity supporting the 3592 tape format. Write Once Read Many (WORM) media support is included for both LTO and 3592 tape drives.

The 3592 Model E tape drives have the capability to encrypt data on tape cartridges. The TS1130 Tape Drive is encryption-capable by default. Encryption enablement is still optional. Note that in a C06 environment the drive will always be encryption-enabled. On 8 September 2006, this encryption capability became standard on all IBM TS1120 Model E05 tape drives and became a chargeable upgrade feature for IBM TS1120 Model E05 tape drives manufactured prior to 8 September 2006.

Features of the TS3500 include:

- Support for 4 Gbps Fibre Channel drives (Table 2-1 on page 11)
- Library frames that include an enhanced power architecture and frame control assembly
- Support to intermix new frame models with currently installed frames in the TS3500
- Support for High Density (HD) Storage Frame S*x*4 and High Density (HD) technology in a storage-only frame
- Multi-path support that provides the capability for sharing library robotics
- Enhanced automation functionality with the Advanced Library Management System (ALMS)
- Control Path Failover for enhanced availability
- Cartridge Assignment Policy (CAP) to handle the insertion process of media in the TS3500

> **Note:** Manual cartridge assignment using Insert Notification is not supported on a high density library. For any partitioned library, we recommend that Cartridge Assignment Policy is configured to provide automated assignment of all inserted cartridges.

The TS3500 Tape Library is designed to connect to host systems using any combination of Fibre Channel, Ultra2/Wide Low Voltage Differential (LVD) Small Computer System Interface (SCSI), or Ultra/Wide High Voltage Differential (HVD) SCSI interfaces when attaching to an Open Systems host.

The System z requires the IBM TotalStorage 3953 Library Manager Model L05 and Tape Frame Model F05 to allow attachment to the TS3500 Tape Library.

The 3584 Tape Library comes with several tape drive and frame options to meet your needs. Table 2-1 provides an overview of supported tape drives.

Table 2-1 Tape drives that are supported in the TS3500 Tape Library

Type of drive	Speed of connectivity	Native data rate	Native capacity	Other information
TS1040 Tape Drive Model F4A	4 Gbps Fibre	120 MB/s	800 GB	Known as the Ultrium 4 Tape Drive
TS1030 Tape Drive Model F3B	4 Gbps Fibre	80 MB/s	400 GB	Both of these drives are known as the Ultrium 3 Tape Drive
3588 Tape Drive Model F3A	2 Gbps Fibre	80 MB/s	400 GB	
LTO Ultrium 2 Tape Drive	2 Gbps Fibre 160 MB/s (LVD SCSI) 40 MB/s (HVD SCSI)	35 MB/s	200 GB	Known as the Ultrium 2 Tape Drive
LTO Ultrium1 Tape Drive	1 Gbps Fibre 80 MB/s (LVD SCSI) 40 MB/s (HVD SCSI)	15 MB/s	100 GB	Known as the Ultrium 1 Tape Drive
TS1130 Tape Drive	4 Gbps Fibre	160 MB/s	1000 GB[a] 640 GB[b] 128 GB[c]	Known as the 3592 Tape Drive Model E06/EU6
TS1120 Tape Drive	4 Gbps Fibre	100 MB/s	700 GB [a] 500 GB[b] 100 GB[c]	Known as the 3592 Tape Drive Model E05
3592 Tape Drive Model J1A	2 Gbps Fibre	40 MB/s	300 GB[b] 60 GB[c]	Withdrawn from marketing as of September 2006

a. JB/JX cartridge
b. JA/JW cartridge
c. JJ/JR cartridge

2.1.2 TS3500 frame models

The TS3500 Tape Library has a modular design and can consist of one to sixteen frames housing a maximum of 192 tape drives. A library must contain a base frame model (Model L*xx*) to which you can add optional expansion frames (Model D*xx or Sxx*). An optional second accessor is available through the addition of the High Availability (Model HA1) frame. Note that adding the High Availability frame and service bay extends the total length of the library by another two frames.

The left side of Figure 2-1 on page 12 shows an IBM System Storage TS3500 Tape Library configured with the maximum number of 16 frames for data and cartridge storage. The image on the right shows a minimum configuration, which is a single frame TS3500 Tape Library.

Figure 2-1 TS3500 frame configurations

The TS3500 frames come in different models, depending on whether the TS3500 frame is the first frame in the library, which contains the accessor, as well as tape drives and storage cells, and on which type of tape drive is installed in the frame. Model L*xx* and D*xx* frames can be intermixed with each other and installed frame models with the provision that there is only one base frame in each library. Model S24 can be attached to a tape library that has 3592 drives installed inside, and Model S54 can be attached to a tape library that has LTO drives installed inside.

> **Note:** Models L32 and D32 were withdrawn from marketing effective 1 October 2004. models L22/D22 and L52/D52 were withdrawn from marketing effective 29 September 2006.

The following list describes the currently available frame models:

- **TS3500 Tape Library Model L23**: A base frame that contains up to twelve IBM 3592 tape drives and up to 260 IBM TotalStorage 3592 tape cartridges.
- **TS3500 Tape Library Model D23**: *A*n expansion frame that can house up to twelve IBM 3592 tape drives and up to 400 IBM TotalStorage 3592 tape cartridges. You can install up to 15 expansion frames with a base frame.
- **TS3500 Tape Library Model L53**: A base frame that contains up to 12 Ultrium tape drives and up to 287 Linear Tape-Open (LTO) Ultrium tape cartridges.
- **TS3500 Tape Library Model D53**: An expansion frame that contains up to 12 Ultrium tape drives and up to 440 LTO Ultrium tape cartridges. You can install up to 15 expansion frames with a base frame.
- **TS3500 Tape Library Model S24**: A driveless, high-density, storage-only expansion frame for up to 1000 3592 tape cartridges. You can install up to 15 expansion frames with a base frame. Advanced Library Management System (ALMS) is required for any library with a Model S24 frame. This frame can optionally be configured as service bay B.

- **TS3500 Tape Library Model S54**: A driveless, high-density, storage-only expansion frame for up to 1320 Ultrium (LTO) tape cartridges. You can install up to 15 expansion frames with a base frame. Advanced Library Management System (ALMS) is required for any library with a Model S54 frame. This frame can optionally be configured as service bay B.
- **IBM TS3500 Model HA1**: Optional High Availability Frame. In conjunction with service bay features on the TS3500 Tape Library models D23 and D53, this IBM TS3500 Model HA1 supports the installation of a second accessor in the TS3500.

The L*xx* frames also contain an I/O station for 16 cartridges. If both LTO and IBM 3592 tape drives are installed inside the TS3500 Tape Library, the optional second I/O station is required for the second media format. The second I/O station is installed below the first I/O station. The drive type in the L*xx* frame determines which I/O station is in the top position. In an L53 frame, this is the I/O station for LTO cartridges, and in an L23 frame, the I/O station for 3592 cartridges is in the top position.

2.2 TS3500 Tape Library for System z hosts

The TS3500 functions and capabilities in this section are a prerequisite for its attachment to System z hosts through the IBM 3953 Library Manager. A TS3500 Tape Library, which attaches only to System z hosts, contains the following components:

- One IBM System Storage TS3500 Model L23 Frame (base frame)
- Optionally, up to 15 IBM System Storage TS3500 Model D23 frames or 15 IBM System Storage TS3500 Model S24 frames (expansion frames) or up to 15 mixed frames of Model D23 and S24
- IBM TS3500 Model HA1 (optional High Availability frame)
- IBM System Storage 3953 Tape System

For a detailed description of the TS3500 Tape Library and its complete list of features, refer to the *IBM System Storage TS3500 Tape Library Introduction and Planning Guide*, GA32-0559, and to *The IBM System Storage Tape Libraries Guide for Open Systems*, SG24-5946, which describes the TS3500 Tape Library in Open Systems environments.

2.2.1 IBM System Storage TS3500 Base Frame

IBM System Storage TS3500 Base Frame includes Model L23 Frame and Model L53 Frame. TS3500 Tape Library Model L23 is a base frame containing IBM 3592 tape drives and cartridges that attaches to System z or Open Systems hosts, while the TS3500 Tape Library Model L53 is a base frame containing LTO tape drives and cartridges that attaches to Open Systems hosts.

IBM System Storage TS3500 Model L23 Frame

The TS3500 Tape Library Model L23 is a base frame designed for IBM 3592 tape drives and 3592 data cartridges. The frame contains the accessor with dual grippers that can handle both LTO and 3952 cartridges and supports up to 15 expansion frames. The Model L23 base frame has 58 to 260 cartridge slots and supports up to 12 tape drives with an incremental reduction of storage slots for more than four drives or with the additional I/O station installed.

This Model L23 base frame has a smaller footprint than the Model L32. The TS3500 Tape Library Model L23 is designed with an optimized gripper for use with LTO or 3592 tape cartridges. Up to 12 logical libraries (one per tape drive) can be configured for each frame.

Each Model L23 library has a standard 16-slot cartridge I/O station for importing and exporting 3592 tape cartridges to and from the library without requiring an inventory operation. An additional 16-slot cartridge I/O station is optionally available for either LTO or 3592 data cartridges. Libraries containing a mixture of LTO and 3592 drive technologies must have one LTO I/O station and one 3592 I/O station. For bulk loading of tape cartridges, the library door can be opened or D23 frames with optional I/O can also be used.

Each time that you close the library door, a barcode reader mounted on the autochanger is designed to scan the cartridge labels, enabling a re-inventory of the cartridges in the library frame in as little as 60 seconds. A door lock is included to help restrict physical access to cartridges in the library.

For models L23, D23, L53, and D53, each base frame and expansion frame that contains drives has its own enhanced frame control assembly, which receives ac power from two client-supplied outlets and provides dc power to all tape drives within the frame, as well as to the accessor. Like the frame control assembly, the enhanced frame control assembly and tape drives have their own cooling, but they must have free airflow. Do not stack cartridges, books, or other materials on the top of the library.

For libraries that include a second accessor and the high-availability Model HA1, at least one D23 or D53 frame (not a service bay) must be equipped with an enhanced frame control assembly (feature code (FC) 1451).

Figure 2-2 and Figure 2-3 on page 15 show interior and exterior views of the Model L23 Frame and note the features and enhancements of the L23 frame.

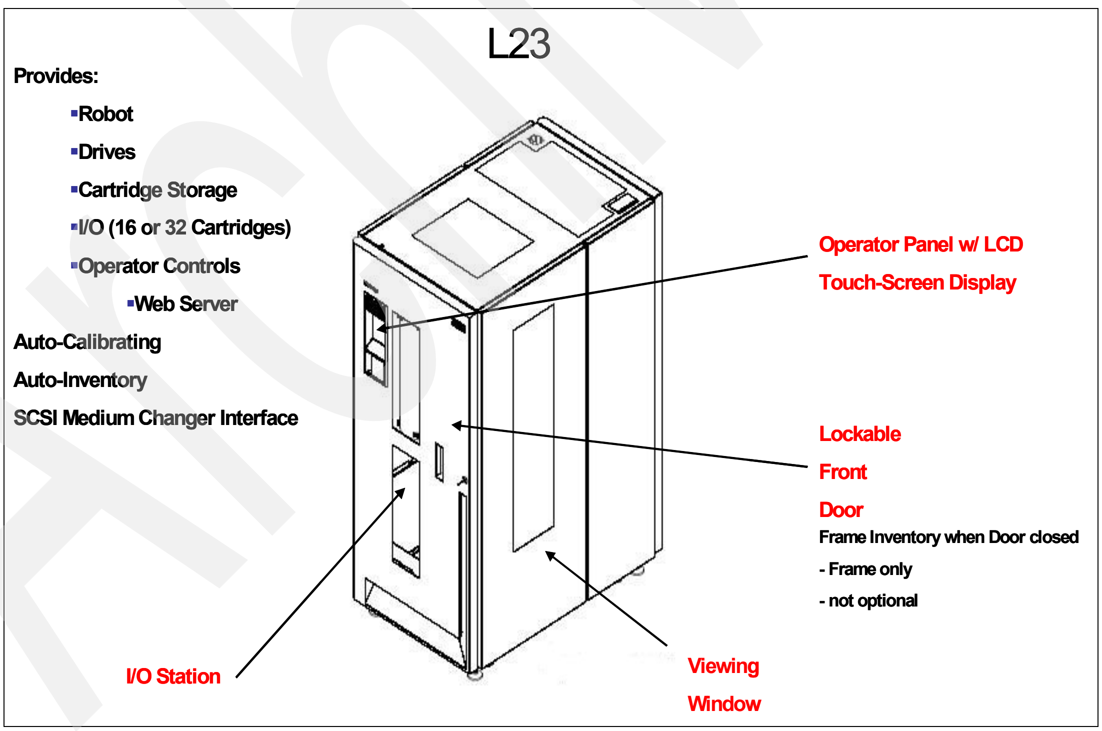


Figure 2-2 TS3500 Model L23 Frame exterior view

Architectural characteristics include:

- Enhanced frame controller assembly. There are two power supplies in each frame, which supply power to the drives and the library.
- Dual Ethernet interfaces: one Ethernet interface for the Web user interface and the other Ethernet interface dedicated to the connection to the TS3000 System Console (TSSC), previously known as the TotalStorage Master Console.

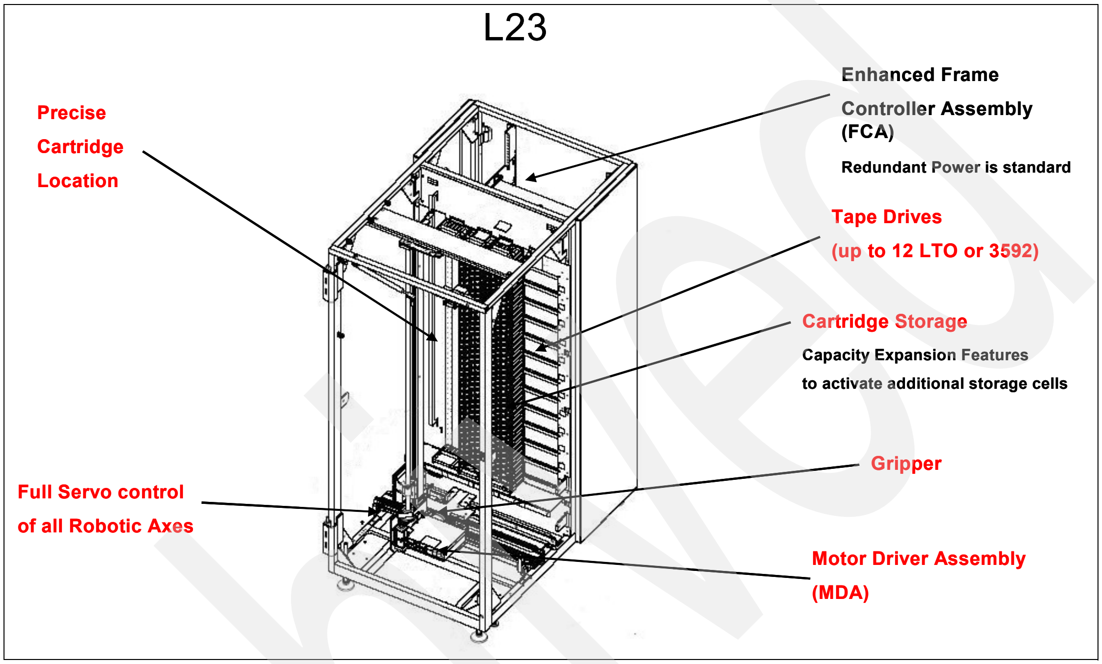


Figure 2-3 TS3500 Model L23 Frame interior view

IBM System Storage TS3500 Model L53 Frame

The TS3500 Tape Library Model L53 is a base frame designed for IBM TS1040 or other LTO Ultrium Fibre Channel tape drives and LTO data cartridges. The Model L53 base frame has 64 to 287 cartridge slots and support for up to 12 tape drives with an incremental reduction of storage slots for more than four drives or with the additional I/O station installed. This model has a smaller footprint than the Model L32.

The TS3500 Tape Library Model L53 is designed with an optimized dual gripper for use with LTO or 3592 tape cartridges. Data capacity for the Model L53 depends on the types of LTO Ultrium cartridges, which can provide up to 460 TB of physical capacity (at 2:1 compression) using LTO data compression (LTO-DC) with Ultrium 4 data cartridges. Up to 12 logical libraries (one per tape drive) can be configured for each frame.

Each Model L53 library has a standard 16-slot cartridge I/O station for importing and exporting LTO tape cartridges to and from the library without requiring another inventory. An additional 16-slot cartridge I/O station is optionally available for either LTO or 3592 data cartridges. Libraries containing a mixture of LTO and 3592 drive technologies must have one LTO I/O station and one 3592 I/O station.

For bulk loading of tape cartridges, you can open the library door or use D53 frames with optional I/O. Each time that you close the library door, a barcode reader mounted on the autochanger is designed to scan the cartridge labels, which enables another inventory of the cartridges in the library frame in as little as 60 seconds. A door lock is included to help restrict physical access to cartridges in the library. The exterior of the frame looks like the TS3500 Tape Library Model L23; refer to Figure 2-2 on page 14 for reference.

Architectural enhancements include:

- Enhanced frame controller assembly. There are two power supplies in each frame, which supply power to the drives and the library.
- Dual Ethernet interfaces: one Ethernet interface for the Web user interface and the other Ethernet interface dedicated for the connection to the TS3000 System Console (TSSC), previously known as the TotalStorage Master Console.

2.2.2 IBM System Storage TS3500 Drive Frame

IBM System Storage TS3500 Drive Frame includes the Model D23 Frame and the Model D53 Frame. TS3500 Tape Library Model D23 is an expansion frame that can contain IBM 3592 drives and cartridges and attaches to System z or Open Systems hosts, while the TS3500 Tape Library Model D53 is an expansion frame that can contain LTO tape drives and attaches to Open Systems hosts.

IBM System Storage TS3500 Model D23 Frame

The TS3500 Tape Library Model D23 expansion frame shown in Figure 2-4 on page 17 is designed for TS1130 (3592-E06 and 3592-EU6), TS1120 (3592-E05), and 3592-J1A tape drives and 3592 data cartridges. You can add up to 15 Model D23 expansion frames to the TS3500 Model L22, L23, L32, L52, or L53 base frame to increase 3592 cartridge storage or drive capacity. Each Model D23 supports up to 400 3592 cartridge slots and up to 12 3592 tape drives with an incremental reduction of storage slots for each installed set of four tape drives. Each frame can have up to 12 logical libraries or 12 control paths (one per tape drive).

A Model D23 can be ordered from the plant with FC1656, which provides installed I/O stations that are comprised of four independently accessible I/O station doors with a total of 64 slots (16 in each I/O station door). A maximum of three D23 I/O frames are allowed in any TS3500 library string. This increases the maximum I/O slot capacity from 32 to 224. There is a loss of storage capacity of 160 cartridges for each Model D23 with optional I/O capability.

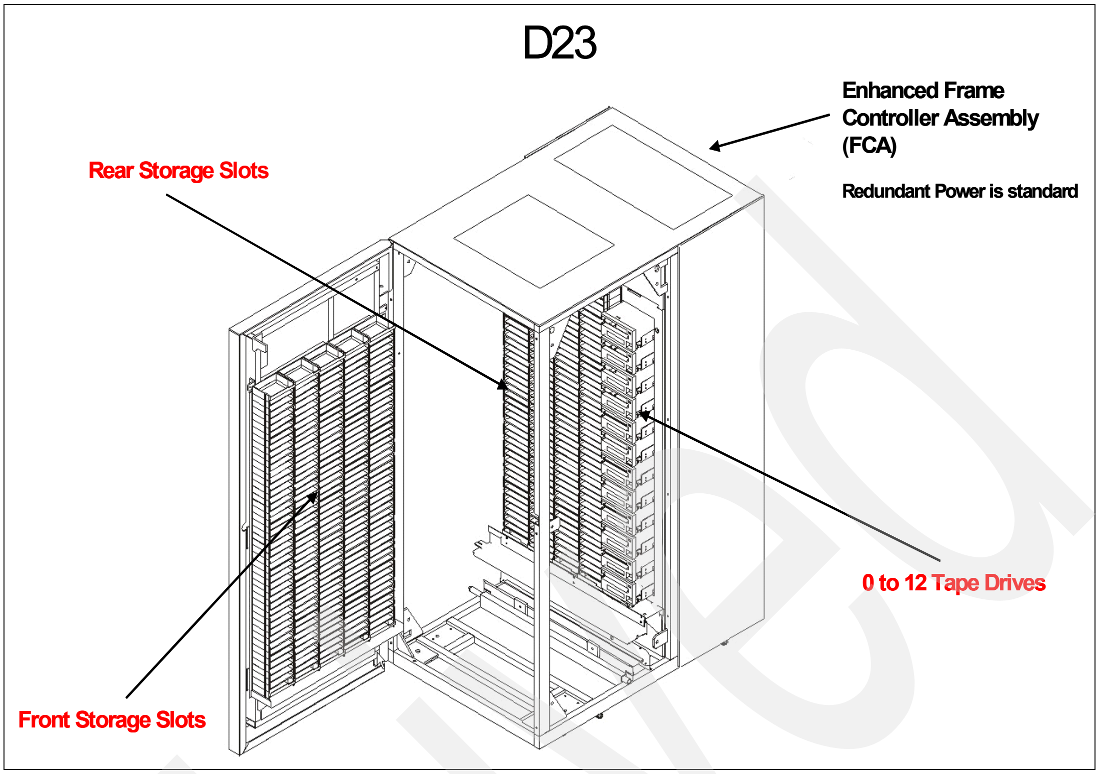


Figure 2-4 TS3500 Model D23 Frame

IBM System Storage TS3500 Model D53 Frame

The TS3500 Tape Library Model D53 expansion frame is designed for IBM TS1040 LTO Ultrium Fibre Channel (FC) tape drives and LTO data cartridges. You can add up to 15 Model D53 expansion frames to the TS3500 Tape Library Model L22, L23, L32, L52, or L53 base frame to increase LTO cartridge storage or drive capacity.

Each Model D53 supports up to 440 LTO cartridge slots and up to 12 IBM LTO Ultrium 4 tape drives with an incremental reduction of storage slots for each installed set of four tape drives. Each frame can have up to 12 logical libraries or 12 control paths (one per tape drive).

You can order a Model D53 from the plant with FC1655, which provides installed I/O stations that are comprised of four independently accessible I/O station doors with a total of 64 slots (16 in each I/O station door). A maximum of three D53 I/O frames are allowed in any TS3500 library string.

This increases the maximum I/O slot capacity from 32 to 224. There is a loss of storage capacity of 176 cartridges for each D53 with optional I/O capability. The exterior of the frame is like the exterior of the TS3500 Tape Library Model D23. Refer to Figure 2-4 for reference.

2.2.3 IBM System Storage TS3500 Storage Frame

IBM System Storage TS3500 storage only frame includes the Model S24 Frame and the Model S54 Frame. The TS3500 Tape Library Model S24 and S54 frames are High Density (HD) storage only expansion frames compatible with existing TS3500 strings.

The Advanced Library Management System (ALMS) is required for support of HD frames, even in an Open Systems only library.

The TS3500 Tape Library Model S24 expansion frame is designed for 3592 data cartridges. You can add up to 15 Model S24 expansion frames to the TS3500 Model L22 or L23 base frame to increase 3592 cartridge storage. Each Model S24 Frame supports up to 1000 IBM 3592 cartridge slots.

The TS3500 Tape Library Model S54 expansion frame is designed for LTO data cartridges. You can add up to 15 Model S54 expansion frames to the TS3500 Tape Library Model L32, L52, or L53 base frame to increase LTO cartridge storage. Each Model S54 Frame supports up to 1320 LTO cartridge slots.

Currently, up to 6887 slots are supported per single TS3500 library. Therefore, the limit of 15 active expansion frames is reduced as listed in Table 2-2. IBM plans to provide support for greater than 6887 cartridges in a future release as has been previewed.[1]

Table 2-2 TS3500 active frames

Number of active S24 frames	Number of active S54 frames	Limit of total active expansion frames
1	0	13 (reduce by 2)
0	1	13 (reduce by 2)
2	0	12 (reduce by 3)
0	2	11 (reduce by 4)
3	0	10 (reduce by 5)
0	3	9 (reduce by 6)
4	0	9 (reduce by 6)
0	4	7 (reduce by 8)
5	0	7 (reduce by 8)
0	5	5 (reduce by 10)
6	0	6 (reduce by 9)
0	6	not supported
7	0	not supported

High Density (HD) technology

The depth of a cartridge location in a HD frame is known as the *tier*. The cartridge immediately accessible in the HD slot is a Tier 1 cartridge. Behind that is Tier 2 and so on. The maximum tier in an LTO HD slot is Tier 5. The maximum tier in a 3592 HD slot is Tier 4, because the 3592 cartridge is slightly longer than the LTO cartridge. The single-deep slots on the door-side of HD frames and in non-HD frames are referred to as *Tier 0 slots*.

Figure 2-5 on page 19 shows a graphical exterior view of an S24 frame. An S54 frame has the same exterior view; the difference is that an S54 frame has the Tier 5 slot inside.

[1] Previews provide insight into IBM plans and direction. Specific availability dates, ordering information, and terms and conditions will be provided when the product functionality is announced.

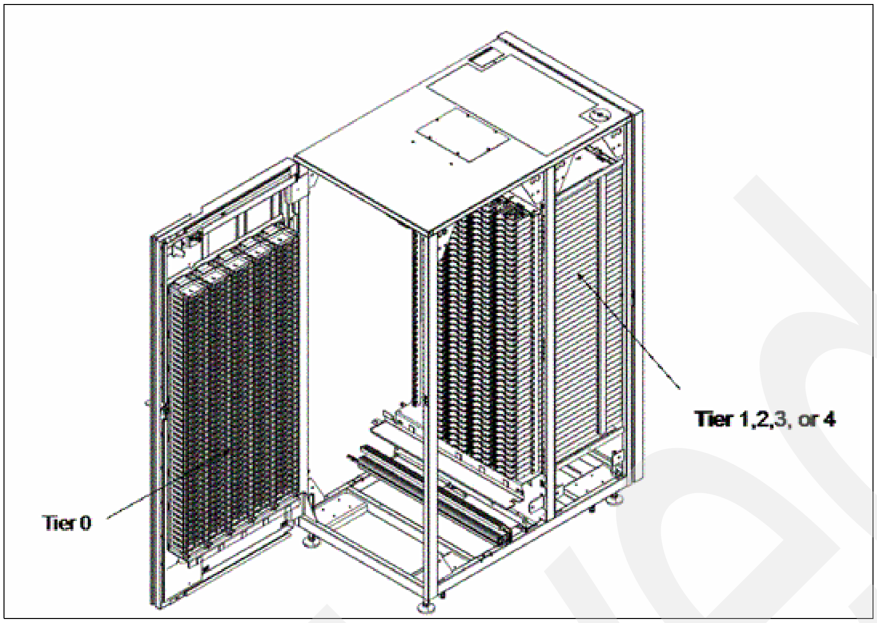


Figure 2-5 TS3500 Model S24 Frame

Figure 2-6 shows the side view of HD frame.

The S24 frame supports up to a total of five tiers (Tier 0 to Tier 4) with up to 200 IBM 3592 cartridge slots for each tier. The S54 frame supports up to a total of six tiers (Tier 0 to Tier 5) with up to 220 IBM LTO cartridge slots for each tier.

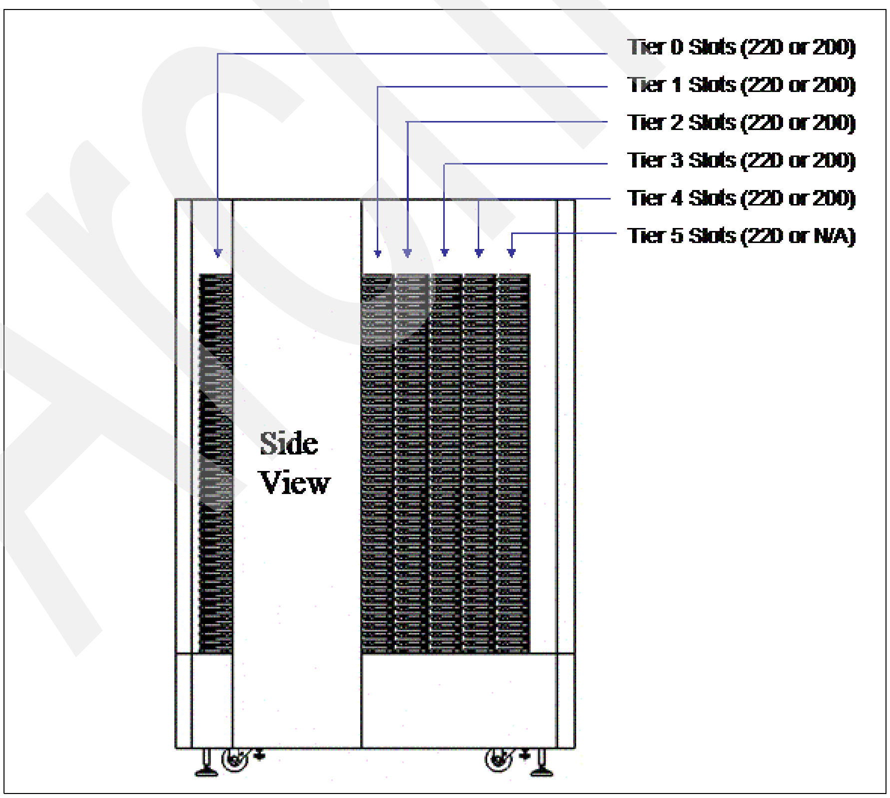


Figure 2-6 TS3500 Model Sxx Frame side view

LED lighting

New internal LED lighting as shown in Figure 2-7 has been added to the HD frame, because the window at the top of the frame has been removed.

Figure 2-7 Internal LED lighting

Library configurations supported by HD frames

When installing HD frames in a TS3500, these configuration rules apply:

- HD frames are supported in mixed media, LTO media-only, and 3592 media-only libraries without High Availability (HA) frames.
- HD frames are supported as active frames in HA LTO-only or 3592-only libraries.
- HD frames are supported as Service Bay B in HA LTO-only or 3592-only libraries.
- HD frames are *not* supported as active frames in an HA mixed media library.
- HD frames are *not* supported as Service Bay B in an HA mixed media library.

2.2.4 Frame capacity

This section introduces the quantity of LTO Ultrium tape cartridges and 3592 tape cartridges that the TS3500 Tape Library supports, depending on whether the Capacity on Demand feature or Capacity Expansion feature is installed, the upper and lower I/O stations are used, and a specified quantity of drives are installed.

Capacity of Model L23 and D23 frames

In this section, we show the types of eligible Capacity on Demand features and the quantities of drives, I/O slots, and storage slots for L23 and D23. Refer to Table 2-3 on page 21 for reference.

Table 2-3 Quantity of storage cells in TS3500 models L23 and D23

Type of frame	Capacity on Demand[1] feature	Number of drives installed	Number of I/O station slots	Number of storage slots
L23	Entry	0 to 12	16	58
L23	Intermediate	0 to 12	16	117
L23	Full	0 to 4	16	260
L23	Full	5 to 8	16	248
L23	Full	9 to 12	16	237
L23	Full	0 to 4	32	222
L23	Full	5 to 8	32	210
L23	Full	9 to 12	32	199
D23	N/A	0	N/A	400
D23	N/A	1 to 4	N/A	383
D23	N/A	5 to 8	N/A	371
D23	N/A	9 to 12	N/A	360

1. The initial (entry) capacity is enabled to use 58 cartridge slots for 3592 tape cartridges. If you add the Intermediate Capacity or Full Capacity feature, you can enable additional storage elements. Refer to the *IBM TotalStorage TS3500 Tape Library Introduction and Planning Guide*, GA32-0559-03, for more details.

Capacity of Model L53 and D53 frames

In this section, we show the types of eligible Capacity on Demand features and the quantities of drives, I/O slots, and storage slots for Model L53 and D53 frames. Refer to Table 2-4 on page 22 for reference.

Table 2-4 Quantity of storage slots in Model L53 and D53 frames

Type of frame	Capacity on Demand[1] feature	Number of drives installed	Number of I/O station slots	Number of storage slots
L53	Entry	0 to 12	16	64
L53	Intermediate	0 to 12	16	129
L53	Full	0 to 4	16	287
L53	Full	5 to 8	16	273
L53	Full	9 to 12	16	261
L53	Full	0 to 4	32	245
L53	Full	5 to 8	32	231
L53	Full	9 to 12	32	219
D53	N/A	0	N/A	440
D53	N/A	1 to 4	N/A	422
D53	N/A	5 to 8	N/A	408
D53	N/A	9 to 12	N/A	396

1. The initial (entry) capacity is enabled to use 58 cartridge slots for 3592 tape cartridges. If you add the Intermediate Capacity or Full Capacity feature, you can enable additional storage elements. Refer to the *IBM TotalStorage TS3500 Tape Library Introduction and Planning Guide*, GA32-0559-03, for more details.

Capacity of Model S24 Frame

In this section, we show the quantity of cartridge storage slots available in the Model S24 Frame depending on the amount of licensed capacity. The quantity of storage slots available depends on the total licensed capacity of the frame.

Table 2-5 Quantity of cartridge storage slots in the Model S24 Frame

Type of frame	Available capacity	Quantity of storage slots[a]
S24	Base (Tiers 0, 1, and 2)	600
S24	Full (Tiers 0, 1, 2, 3, and 4)[b]	1000

a. The actual number of slots available for storage is slightly lower, because some slots must remain available for when a shuffle operation is required to access cartridges.
b. Base capacity for a Model S24 frame consists of the storage slots available in Tiers 0, 1, and 2. In order to use the additional capacity of Tiers 3 and 4, it is necessary to purchase license keys for each HD frame on which you want to use Tiers 3 and 4.

Capacity of Model S54 Frame

In this section, we show the quantity of cartridge storage slots available in the Model S54 Frame, depending on the amount of licensed capacity. The quantity of storage slots available depends on the total licensed capacity of the frame. Refer to Table 2-6 on page 23.

Table 2-6 Quantity of cartridge storage slots in the Model S54 frame

Type of Frame	Available Capacity	Quantity of Storage Slots[a]
S54	Base (Tiers 0, 1, and 2	660
S54	Full (Tiers 0, 1, 2, 3, 4, and 5)[b]	1320

a. The actual number of slots available for storage is slightly lower because some slots must remain available for when a shuffle operation is required to access cartridges.
b. Base capacity for a Model S54 frame consists of the storage slots available in Tiers 0, 1, and 2. In order to use the additional capacity of Tiers 3, 4 and 5, it is necessary to purchase license keys.

Capacity on Demand for HD frames

HD frames support HD Capacity on Demand (CoD), so that you have the ability to add slot capacity nondisruptively to S*x*4 frames. FC1645 provides on demand activation of an additional 400 slots of capacity (Tiers 3 and 4) for Model S24, and FC1646 provides on demand activation of an additional 660 slots of capacity (Tiers 3, 4, and 5) for Model S54.

For a list of TS3500 feature codes that are required to attach System z hosts, refer to Appendix G, “Feature codes” on page 511.

Table 2-7 gives the capacities of the supported frames.

Table 2-7 Frames that are supported in the 3584 Tape Library

Models	Drives in frames	Maximum cartridges[a]	Maximum capacity without compression
L52, D52, L53, and D53	Ultrium tape drives	6887	5509 TB
L32 and D32	Ultrium tape drives	6881	5509 TB
L22, D22, L23, and D23	3592 tape drives	6260	6260 TB (TS1130) 4382 TB (TS1120) 1878 TB (J1A)
L23 and S24	3592 tape drives	15 110 (3592 cartridge)[b]	15 110 TB (TS1130) 10 577 TB (TS1120) 4533 TB (J1A)
L53 and S54	Ultrium tape drives	19 889 (LTO cartridge)[c]	15 911 TB

a. Support for more than 6887 cartridges available after General Availability
b. Assuming a reserve of 1% of the slots per S24 frame for sufficient shuffle locations
c. Assuming a reserve of 1% of the slots per S54 frame for sufficient shuffle locations

2.2.5 High Availability frames

The IBM 3494 supports a High Availability Frame Option. It is specified by the single model type IBM 3494 Model HA1. This single model delivers two frames: one left garage frame and a right frame, which is functionally identical to the IBM 3494 installed L frame. Thus, the IBM 3494-HA1 provides not only a redundant robotic accessor, but also a redundant Library Manager. In the case of a failure, the library will swap and use the alternate Library Manager and accessor. You have the option to have both accessors active during normal processing, or to keep one accessor in standby mode.

The TS3500 Tape Library also supports a High Availability Option, but it is not functionally equivalent to the IBM 3494 in a System z environment. Essentially, it provides two additional frames, and dual accessors, both of which are always active. It is specified by including two additional model types on the TS3500:

- IBM TS3500 Model HA1, which provides only one frame that serves as the left garage frame or “Service Bay A” for the original accessor that came with the TS3500 Model L23. Like the IBM 3494 HA1, it does not contain any tape drives or storage cells for client data cartridges.
- An additional TS3500 Model D23 or S24 frame is required as the right unit or “Service Bay B” for the second accessor. The *service bay* is a regular library frame without any drives, power supplies, or node cards. Storage slots within the service bay are used only to test service actions. This frame has a special feature code, FC1440, which provides the second accessor and signifies its use as a service bay. The strength of this design is in the ease of installing additional frames in the library when required. If you need to add one or more D23 or S24 expansion frames, your IBM Systems Service Representative (IBM SSR) can convert service bay B to an expansion frame, add the new frame or frames to the right, and convert the last frame on the right to service bay B. To convert the existing service bay to an expansion frame, the SSR removes the test slots and replaces them with storage slots.

However, the High Availability units for the TS3500 do not provide a redundant Library Manager; they only provide dual accessors.

As part of the System z attachment frames (3953 Model F05), you can configure a second Library Manager for redundancy, which, together with the TS3500 High Availability Frame Option, provides the same redundancy as the IBM 3494 for System z configurations.

2.2.6 IBM 3953 Tape System

The IBM 3953 Tape System consists of the IBM 3953 Tape Frame Model F05 and the IBM 3953 Library Manager Model L05. It is required for the attachment of System z hosts to the TS3500 Tape Library.

The 3953 F05 Tape Frame is an independent frame used to house the 3953 L05 Library Manager and other components and provides an interface between the TS3500 Tape Library and System z hosts. The System z hosts attach through either ESCON or FICON to one of the following products:

- IBM System Storage TS1120 Tape Controller (or 3592-J70)
- IBM System Storage TS7700 Virtualization Engine (FICON only)
- IBM TotalStorage 3494 Virtual Tape Server (VTS) Model B10 or B20

We explain the IBM 3953 Tape Frame Model F05 and the IBM 3953 Library Manager Model L05 in detail in 2.3, “IBM TotalStorage 3953 Tape Frame Model F05” on page 31 and 2.4, “IBM TotalStorage 3953 Library Manager Model L05” on page 39.

2.2.7 TS3500 features for library management

The TS3500 has distinctive features and functions that help in managing and operating Open Systems-attached drives and that are also required when attaching System z hosts to drives installed inside the TS3500. These features and functions are considerably different than the previous methods of operation, communication, and management in the IBM 3494 Tape Library. For a comparison of the TS3500 and IBM 3494 operational characteristics and differences, refer to 7.6.3, “Mapping 3494 operation modes to TS3500 operation modes” on page 196.

Multi-path support

The Multi-Path Architecture of the TS3500 Tape Library is designed to provide the capability for sharing library robotics by partitioning the library into up to 192 logical libraries (up to the number of drives installed). Each TS3500 logical library has its own separate and distinct drives, storage slots, and control paths. I/O slots are shared on a first-come-first-served basis. This virtualization of the library accessor makes it appear that there are more physical libraries than actually exist and allows homogeneous (similar) and heterogeneous (dissimilar) applications to share the library robotics independently of each other. Cartridges, under library control, cannot be shared or moved among logical libraries. An example of heterogeneous sharing is a Microsoft® Windows® 2000 Server application using the drive and storage slots of one TS3500 logical library, while a UNIX® application uses the drive and slots of another TS3500 logical library. You can also use logical libraries for separating different generations of Ultrium tape drives and cartridges, or 3592 tape drives and cartridges, for applications that do not support mixing the drives in the same TS3500 logical library.

For System z attachment, the configuration rules for logical partitioning are different than the rules for Open Systems hosts whose drives in the TS3500 attach directly to the host. Each 3953 Library Manager (required for System z hosts) attached to the TS3500 must be defined as a separate TS3500 logical library (with its own separate and distinct drives, storage slots, and control paths) in the TS3500 Tape Library. The TS3500 can have multiple 3953 Library Managers (up to four), but each 3953 Library Manager must be defined as a separate TS3500 logical library. Therefore, a TS3500 library that is used exclusively for System z can have a maximum of four TS3500 logical libraries, each with its own set of tape drives and storage slots.

Furthermore, each of these 3953 logical Library Manager partitions can have up to three logical libraries defined to it (identical to logical libraries of a 3494), two of which can be TS7700 Virtualization Engines, VTSs, or a mixture of both. This capability is possible by the 3953 Library Manager supporting the configuration of 16 subsystems per 3953 Tape System. A subsystem is a VTS or TS1120 Model C06 Controller or J70 Controller. If there are two VTSs defined, the remaining 14 subsystems can be fourteen 3592 Model C06 or 3592-J70 Tape Controllers dedicated to native drive attachment (native library).

This configuration of logical Library Manager partitions and further subsystem attachment allows a TS3500 Tape Library that is fully configured with four 3953 Tape Systems to house up to eight TS7700 Virtualization Engines, VTSs, or a mixture of both. For more information, refer to Chapter 6, “Basic concepts of sharing and partitioning” on page 149, which deals exclusively with the concepts of sharing and partitioning.

Drive and cartridge location

In the IBM 3494, tape drives attached to the same tape controller are also installed within the same frame as the controller or in two adjacent frames, one of which contains the controller. Tape drives dedicated to a Virtual Tape Server or TS7700 were also installed in their own, unique frames and cannot share these frames with other drives attached to other tape controllers or to Open Systems hosts.

When installing IBM 3592 tape drives inside a TS3500 Tape Library, the only requirement is that you must install the drives and their data cartridges in either Model L22 or L23 frames, Model D22 or D23 frames, or both. Within these frames, you can intermix IBM 3592 drives attached to Open Systems, different tape controllers, and different VTS systems. The drives are still dedicated to logical libraries in the TS3500, but the frames are not dedicated to controllers or host platforms. We discuss logical libraries in the TS3500 in more detail in 6.2.2, “TS3500 logical library” on page 152.

Cartridges are located in the frames where the appropriate drives that can process them also are located. The TS3500 Tape Library without the HD frame operates in *fixed home cell mode*, which means that the cartridges are returned to their home cell. The TS3500 Tape Library with the HD frame operates in *floating home cell mode*.

Control path drives

In the TS3500 Tape Library, a *control path* is a logical path into the library, using the physical channel path to the tape drives, through which a server sends SCSI move medium commands to control the logical library. The control path is set up as Logical Unit Number 1 (LUN 1) on a drive; LUN 0 addresses the System z-attached drive. Obviously, whether you use an Open Systems server or a System z server, there must be at least one drive defined as a control path drive for each logical library. Additional control paths reduce the risk that failure in one control path will cause the entire logical library to become unavailable.

For each subsystem (a TS1120 Model C06 Controller, 3592-J70 Controller, TS7700 Virtualization Engine, or a VTS), you must define four drives as control path drives. A tape controller can have fewer than four control path drives if it has fewer than four drives installed.

Control Path Failover

Two types of path failover capabilities exist: Control Path Failover (CPF) and Data Path Failover (DPF). Control refers to the command set that controls the library (the SCSI Medium Changer command set on LUN 1 of the tape drives). Data refers to the command set that carries the client data to and from the tape drives (the SCSI-3 Stream Commands (SSC) device on LUN 0 of the tape drives). *Path failover* means the same thing in both types. Where there is redundancy in the path from the application to the intended target (the library accessor or the drive mechanism), the device driver transparently fails over to another path in response to a break in the active path.

Both types of failover include host-side failover when configured with multiple host bus adapter (HBA) ports in a switch, but CPF includes target-side failover through the control paths that are enabled on more than one tape drive. DPF includes target-side failover for 3592 tape drives only by using the dual-ported interface of the drive.

You can use CPF for enhanced availability. This optional feature is designed to provide automatic control path failover to a preconfigured redundant control path in the event of a loss of a host adapter or control path drive without stopping the current job in progress. Today, IBM provides support under AIX®, Solaris™, Windows, Hewlett-Packard Unix (HP-UX), and Linux when you use the IBM device driver. Additional operating system support will be provided in the future for installed CPF users.

For an IBM 3953 Library Manager partition, CPF is free for that logical library. The driver automatically uses CPF. However, CPF is not free for non-3953 logical libraries. For these partitions, you must purchase CPF.

Data Path Failover and Load Balancing

Data Path Failover (DPF) and Load Balancing exclusively support native Fibre Channel Ultrium tape drives and 3592 tape drives in the TS3500 Tape Library using the IBM device driver. Today, IBM provides support for AIX, Linux, and Solaris. Additional operating system support will be provided in the future for installed DPF users.

DPF is not applicable when attaching System z hosts to TS3500 tape libraries, because the tape controllers function as the interface between the tape drive and the host, and therefore, the host does not attach directly to the native Fibre Channel (FC) drive.

Advanced Library Management System

This section gives an overview of the Advanced Library Management System (ALMS), which virtualizes the locations of cartridges in the 3584 Tape Library. Logical libraries can then consist of unique drives and ranges of volume serial numbers instead of fixed locations.

ALMS is an extension of the IBM patented Multi-Path Architecture. With ALMS, the TS3500 Tape Library is the industry's first standards-based tape library to virtualize the locations of cartridges (called SCSI element addresses) while maintaining native storage-attached network (SAN) attachment for the tape drives. ALMS enables logical libraries to consist of unique drives and ranges of volume serial (VOLSER) numbers, instead of fixed locations.

When you enable ALMS with its license key, you can assign tape drives to any logical library by using the Tape Library Specialist Web interface. Logical libraries can also be added, deleted, or easily changed without disruption. Storage capacity can be changed without impact to host applications.

An optional feature in Open Systems environments, ALMS offers dynamic management of cartridges, cartridge storage slots, tape drives, and logical libraries. It enables the TS3500 Tape Library to achieve unprecedented levels of integration for functionality through dynamic partitioning, storage slot pooling, and flexible drive assignment. ALMS eliminates downtime when you add Capacity On Demand (COD) storage, add or remove logical libraries, or change logical library storage allocation. ALMS also reduces downtime when you add expansion frames, add or remove tape drives, or change logical drive allocation.

> **Note:** ALMS is required for the attachment of System z hosts with the IBM 3953 Tape System. ALMS is also required if HD frames are installed in the TS3500 library.

Capabilities of ALMS include:

- Dynamic Partitioning (storage slot pooling and flexible drive assignment)
- The ability to add or remove storage capacity with minimal or no disruption to host applications
- The capability to configure drive or L frame storage capacity without taking the library offline
- Virtual I/O slots to automatically manage the movement of cartridges between I/O slots and storage slots

For ALMS feature preinstallation planning, refer to 7.1.1, "Plan your hardware configuration" on page 170.

Storage slot pooling

With ALMS enabled on the TS3500, all storage slots are pooled (available on a first-come, first-served basis) to each logical library based on cartridge insert operations. They are a shared resource, which means that changes to the capacity allocation for each logical library can occur without downtime or administrator involvement. The minimum logical library simply has a name and can be thought of as a file folder that has no content. You can place drives in the file folder by using the Drive Assignment panel of the Tape Library Specialist Web interface. 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 of static partitioning to dynamic partitioning (requires Web enablement of ALMS)
- Cartridge Assignment Policy (automatic at the time of insertion)
- Software application move from the I/O station (based on the source application that issued the command), which is possible only on Open Systems environments.
- Manual assignment by an operator using the Tape Library Specialist Web interface

Flexible drive assignment

ALMS allows the assignment of drives through the Web interface and the capability of sharing the drive between multiple hosts and unassigning and reassigning drives from one logical library to another.

> **Note:** This flexible drive assignment is not supported in System z environments. Do not attempt to reassign System z-attached drives. In a System z environment, tape drives are attached to a tape controller, TS7700 Virtualization Engine, or VTS, and they cannot be dynamically reassigned to other logical libraries.

Transparent addition or removal of storage capacity

With ALMS, you can change the total logical library capacity (quantity of addressable storage slots). The change is transparent to each host application, because the value in the Maximum Number of Cartridges field in the Tape Library Specialist Web interface is not impacted by changes to the quantity of storage slots. The additional storage slots are simply new candidates to which to move cartridges upon insertion.

Configuration of storage capacity without disruption

With ALMS enabled, no downtime is required when you enable Intermediate Capacity On Demand or Full Capacity On Demand for L frame models in the TS3500.

Cartridge Assignment Policy in the TS3500

As a means of identifying cartridges that are assigned to logical libraries, the TS3500 Tape Library supports a *Cartridge Assignment Policy* (CAP). The policy is based on the volume serial (VOLSER) label that is affixed to a cartridge, which an operator might have previously assigned to a logical library.

The Cartridge Assignment Policy is media-type specific. 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 (L2, L3, JA, and so forth). Therefore, two identical labels (except for the media-type indicator) can be assigned to two different logical libraries, for example, libraries that contain Ultrium or IBM 3592 tape drives.

When an unassigned cartridge is present in the I/O station, the library reads its VOLSER label and automatically assigns it to the logical library that is specified in the range of VOLSERs that was previously selected by the operator. Similarly, if you open and close the library's front door, the library automatically performs an inventory, and, if it detects a newly inserted, unassigned cartridge, it assigns the cartridge to the logical library of the VOLSER range that was previously selected by the operator.

For unassigned cartridges that do not fall within a Cartridge Assignment Policy, you can assign those cartridges by using one of these methods:

- If the unassigned cartridge is in the I/O station and Insert Notification is disabled, the assignment is done automatically on a first-come, first-served basis.
- If the unassigned cartridge is in the I/O station and Insert Notification is enabled, you can assign the cartridge to a logical library by using the Insert Notification process on the library's Operator Panel, or you can keep the cartridge as unassigned and assign it later by using the TS3500 Tape Library Specialist Web interface.
- Create a new VOLSER range, then perform a manual inventory to assign those cartridges through the Cartridge Assignment Policy.
- Use the TotalStorage Tape Library Specialist Web interface to assign the cartridges manually.

For more information about creating a new VOLSER range, performing a manual inventory, assigning cartridges manually, or assigning cartridges to a logical library, refer to Chapter 13, "Operation" on page 379.

Insert Notification

Manual cartridge assignment using Insert Notification is not supported on a high density library. For any partitioned library, we recommend that Cartridge Assignment Policy is configured to provide automated assignment of all inserted cartridges.

Virtual I/O

Virtual I/O (VIO) provides the ability to enhance the number of available I/O slots in the TS3500 Tape Library. The TS3500 has input/output (I/O) stations and I/O slots that allow you to insert and eject up to 32 cartridges at any given time. The I/O slots are also known as *import/export elements* (*IEEs*). Virtual I/O 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 Open Systems hosts as I/O slots are called *virtual import/export elements* (*VIEEs*). With Virtual I/O slots, when cartridges are inserted into the I/O station, the library works 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.

Support for Virtual I/O slots is provided at the latest released level of library microcode and will be enabled by default when ALMS is enabled. For existing clients, who have a TS3500 library with ALMS already enabled, a newer level of library microcode that supports Virtual I/O slots will be required, and virtual I/O slots will need to be manually enabled.

2.2.8 Remote support

Remote support for the TS3500 tape Library is available through the Call Home feature, which can help improve availability of the library. When a failure occurs on the drive or the library, Call Home can use either a modem or the TotalStorage System Console (TSSC) to send information to an IBM support center about the nature of the problem and suggested fixes. Call Home can also periodically send support information (such as configuration, library and drive code versions, and error logs).

Call Home has three capabilities:

- **Problem Call Home**: The TS3500 Tape Library or one of its drives detects a problem and the library performs a Call Home operation to create a Problem Management Record (PMR) in the IBM Remote Technical Assistance Information Network (RETAIN®). This PMR is a single page of text data that enables the IBM Support Center personnel or the IBM service support representative (SSR) to access an action plan and a list of parts called *field-replaceable units (FRUs)*. When servicing the library, the IBM SSR can issue a test Call Home operation to RETAIN from the library's Operator Panel. The library allows the IBM SSR to include drive dumps in the test Call Home for analysis, rather than collecting dumps by using CE-Tool and transmitting them through an IBM messaging system. In this way, Support Center personnel can access a dump through the Call Home database.
- **Heartbeat Call Home**: On a scheduled basis (once a week or one hour after a code update has completed), the library sends home (to IBM) the following files: a Machine Reported Product Data (MRPD) file, a library error log file, and a drive error log file. The MRPD file contains information about the machine (library), including the number of frames and drives, the model and serial number of each frame, the type and serial number of each drive, the code version of the library and each drive, and any machine-detectable features, such as additional I/O stations, capacity expansion, and so forth.
- **Data Call Home:** When a Problem Call Home or a Heartbeat Call Home is initiated, the library also sends data files that might be helpful to Support Center personnel. In the case of a Heartbeat Call Home, the library also sends the library error log and drive error log. In the case of a Problem Call Home, the library sends any trace files that might be related to the problem.

Remote support through a modem

Feature codes FC2710 and FC2712 provide the capability of the remote functions just described through a modem.

Remote support through a TS3000 System Console

Where there is a TS3000 System Console (TSSC) present for a System z-attached TS3500 Tape Library, you can use it optionally to manage the Call Home facility on behalf of the library in addition to the other managed units. Using the TSSC avoids the need for a dedicated analog phone line for the library's Call Home modem.

To perform a Call Home operation through the TSSC, the TS3500 sends Call Home information across a private Ethernet connection to the TSSC, which then performs the Call Home operation and sends the information to the IBM Remote Technical Assistance Information Network (RETAIN). For remote support through the TSSC, the TS3500 Tape Library needs a minimum of two Ethernet ports: one Ethernet port for the Web User interface and one Ethernet port for attachment to the TSSC. Frame models L23 and D23 facilitate this requirement by providing dual Ethernet interfaces in the Media Change Assembly of the frame.

There is a benefit to calling home using the TSSC as opposed to using the remote support features, because you need to provide fewer analog phone lines. In addition, in certain error scenarios, calling home using the TSSC provides enhancements to first time data capture. As an example, a situation might occur where a VTS tries to move a specific cartridge into a drive, but then finds that the wrong cartridge appears to have been loaded. In this scenario, the library and drive do not see any problem so they do not call home. But the VTS knows something went wrong, and it calls home using the TSSC. As part of the call, the VTS notifies the TSSC of all of the devices that are associated with the failure. If the TS3500 is connected to the TSSC, as a result of the VTS call, the TSSC can automatically pull library and drive information covering the same time period.

For further information about the TSSC and its attachment options, refer to 2.3.5, “IBM System Storage TS3000 System Console” on page 37.

2.3 IBM TotalStorage 3953 Tape Frame Model F05

The IBM 3953 TotalStorage Tape Frame is an independent frame that allows the attachment of System z host systems to IBM 3592 tape drives (models J1A, TS1120, or TS1130) in an IBM System Storage TS3500 Tape Library through IBM System Storage TS1120 Model C06 Controllers, 3592 Model J70 Tape Controllers, TS7700 Virtualization Engine, or VTS systems. The IBM 3953 TotalStorage Tape Frame is controlled by the IBM 3953 Model L05 Library Manager.

> **Note:** The 3592-J70 Tape Controller was withdrawn from marketing effective 29 September 2006, but it is still supported in the current 3953 Tape System configuration as described for the TS1120 Model C06 Tape Controller in this section.

Figure 2-8 shows the front view of an IBM 3953-F05 Frame.

Figure 2-8 IBM 3953 Tape Frame Model F05

The IBM 3953 Tape Frame is available in two versions:

- Base frame:

  IBM 3953 Model F05 base frame is the first 3953 frame in a configuration. It houses one Library Manager or optionally two Library Managers for redundancy, multiple Ethernet switches, up to six Fibre Channel switches when an IBM System Storage TS1120 Model C06 Controller, IBM 3592 Model J70, TS7700 Virtualization Engines, or VTSs are installed, one KVM Switch (which allows the operator to use the keyboard and monitor with either the Library Manager or the TSSC), monitor, and keyboard. It can house one TS1120 Model C06 Controller and the TSSC, if installed.

- Expansion frame:

  IBM 3953 Model F05 expansion frame can be used to install additional TS1120 Model C06 Controllers or IBM 3592-J70 Controllers. A single expansion frame can house up to three TS1120 Model C06 Controllers or 3592-J70 Controllers or up to two Ethernet switches, and up to six Fibre Channel switches.

Both the base frame and the expansion frame have the same Model type, F05, but they are differentiated by having a descriptive feature code.

There can be up to six frames in total associated with one 3953 Tape System and one TS3500 logical library. You do not need to physically install the 3953 frames adjacent to the TS3500 library frames. The first frame in the 3953 Tape System must be a base frame, and it houses the Library Manager.

The Library Manager controls all or part of the TS3500 Tape Library according to how the logical libraries are set up; for example, you can divide the physical library between Open Systems hosts, as well as System z servers. One Library Manager controls one logical library, but there can be up to four Library Manager-controlled logical libraries in one TS3500 Tape Library, as well as a number of Open Systems-controlled logical libraries. We describe the IBM 3953 Library Manager in detail in 2.4, “IBM TotalStorage 3953 Library Manager Model L05” on page 39.

2.3.1 IBM 3953 Model F05 base frame

The base frame is signified by adding a special feature code, FC5505, Base User Interface, which designates it as a base frame and provides:

- Two Ethernet switches
- A keyboard, mouse, and video monitor
- The mounting hardware for one Library Manager

Note that you must order the Library Manager separately in addition to the frame.

As illustrated on the left side of Figure 2-9 on page 33, which shows the maximum configuration, the base frame can house:

- One or two IBM 3953 Library Manager Model L05s
- Zero or one IBM System Storage TS1120 Model C06 Tape Controller (or J70)
- Zero or one IBM TS3000 System Console
- Keyboard, monitor, mouse, and KVM switch
- Two Ethernet switches, which are required for internal communications
- Up to six Fibre Channel switches to attach the tape drives to the controller, TS7700 Virtualization Engines, or VTSs (one or two for the controller and two each for the TS7700 Virtualization Engines or VTSs)
- One Ethernet router for communication among the IBM 3953 Library Manager, IBM 3592 Controller, and the TS3000 System Console
- Power for all components including support for dual line cords

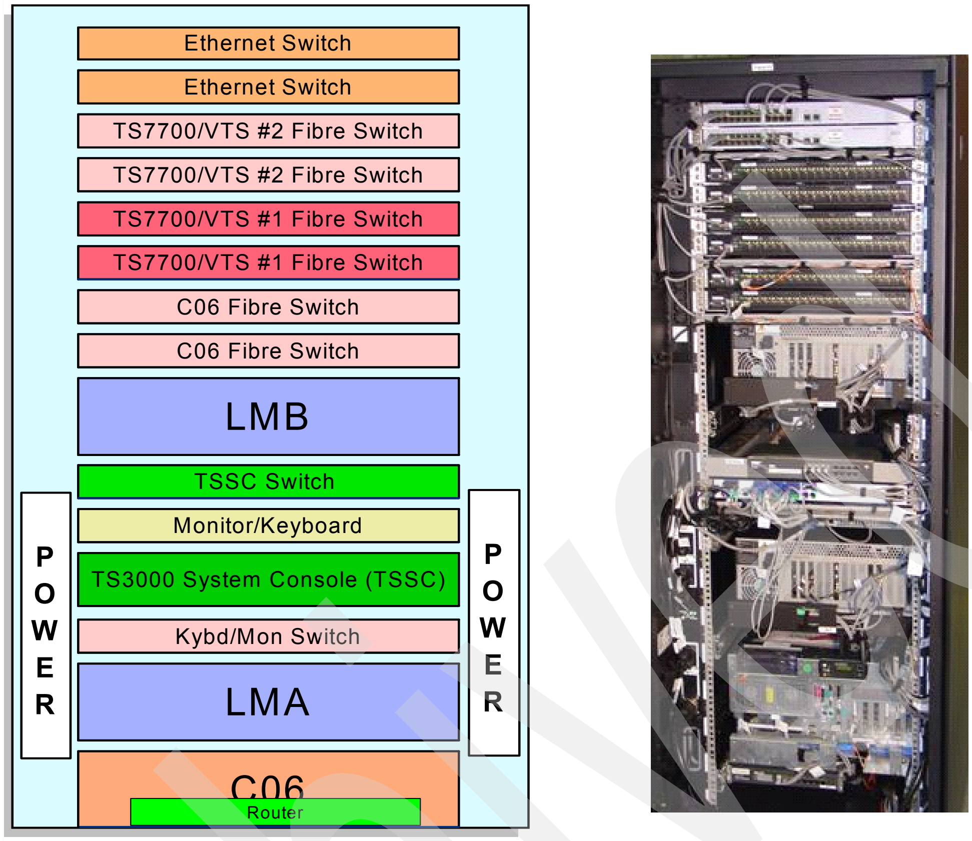


Figure 2-9 Components housed in the IBM 3953 Model F05 base frame

The picture shown on the right in Figure 2-9 shows the rear view of a fully equipped Model F05 base tape frame.

2.3.2 Model F05 expansion frame

You signify the expansion frame by adding a special feature code, FC5506, Expansion Connectivity, to the IBM 3953-F05. This designates the tape frame as an expansion frame and provides two Ethernet 8-port routers and the capability of installing up to three IBM System Storage TS1120 Model C06 or 3592-J70 Tape Controllers.

The maximum configuration of an expansion frame as shown on the left in Figure 2-10 on page 34 can contain up to:

- Three TS1120 Model C06 or 3592-J70 Tape Controllers
- Two Ethernet routers for communication among the IBM 3953 Library Manager, tape controllers, and the TotalStorage System Console
- Up to six Fibre Channel switches for connecting the IBM 3592 tape drives (3592-J1A, TS1120, or TS1130) to the tape controllers (up to two for each controller)
- Power for all components including support for dual line cords

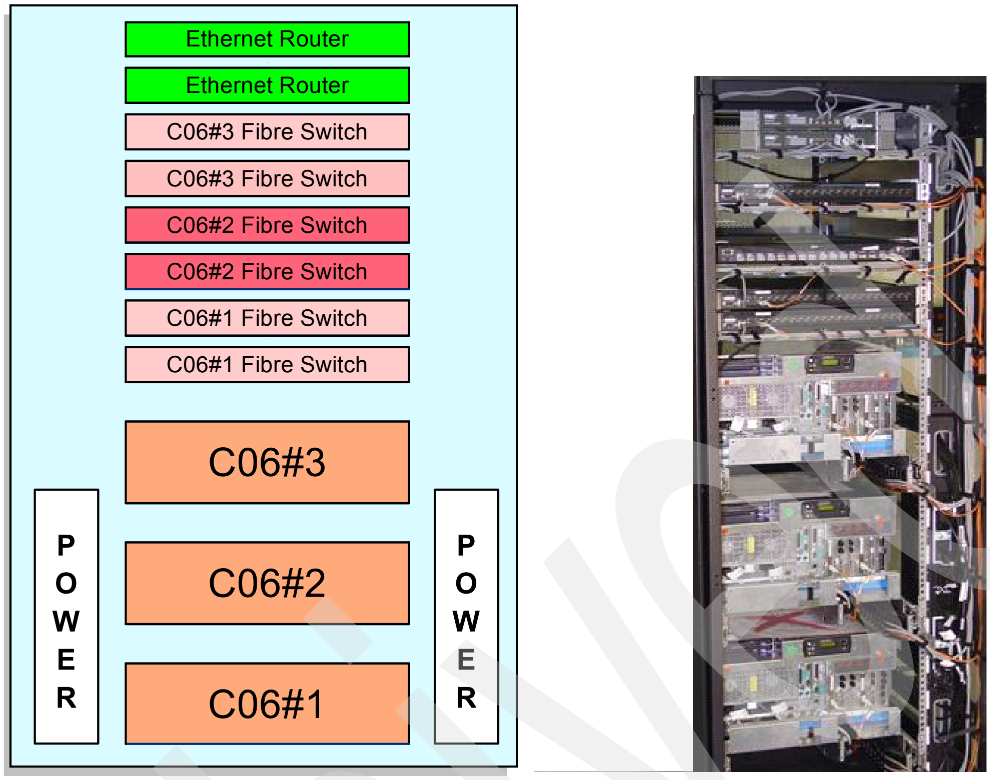


Figure 2-10 Components housed in the IBM 3953 Model F05 expansion frame

The photograph shown on the right in Figure 2-10 shows the rear view of a Model F05 expansion frame equipped with three TS1120 Model C06 Controllers. C06#1 has two Fibre Channel switches installed, and C06#2 and C06#3 each have one Fibre Channel switch installed.

Two 8-port routers in the top of the frame interface with the internal local area networks (LANs). The top router is designated as the 250 LAN Network. The lower router is designated as the 251 LAN Network as described in 2.5.4, “Ethernet network topology” on page 48.

You can install up to five IBM 3953-F05 expansion frames in addition to the base frame. The complete system can contain up to 16 controllers: one controller in the base frame and three controllers in each of five expansion frames, as illustrated in Figure 2-11 on page 35.

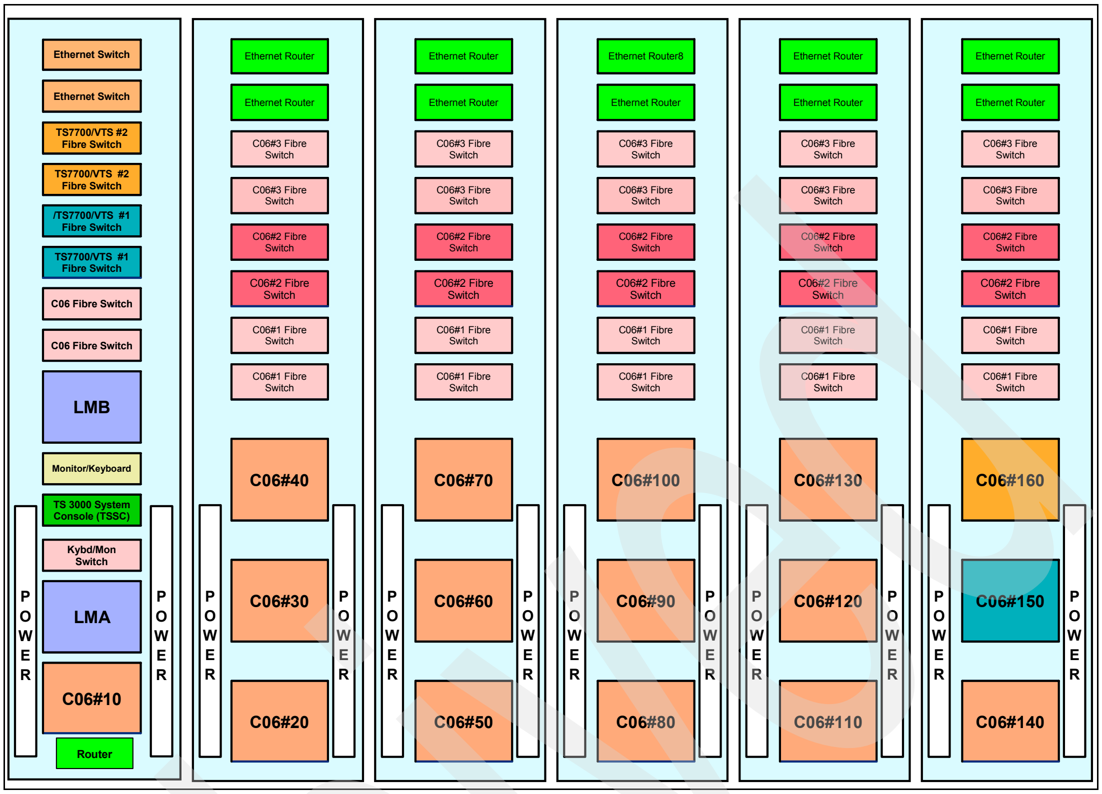


Figure 2-11 Maximum IBM 3953 configuration with 16 TS1120 Model C06 Tape Controllers

2.3.3 Tape controllers

In Figure 2-11, note that the two TS7700/VTS Fibre Channel switches installed in the base frame for attachment of TS7700/VTS#1 and TS7700/VTS#2 are the same color as the tape controllers C06#15 and C06#16. The color shading coding indicates that if you have TS7700 Virtualization Engines or VTSs attached to the subsystem, they also count as controllers; so, for example, if you have the maximum two VTSs in the subsystem, in addition, you can only have up to 14 TS1120 Model C06 Controllers.

A TS7700 Virtualization Engine is installed in a dedicated IBM 3952 Tape Frame, which is a multipurpose frame that can contain components of various tape offerings. In a TS7700 Virtualization Engine configuration, you use the IBM 3952 Tape Frame for the installation of the TS7740 Node, the TS7740 Cache Controller, and the TS7740 Cache Modules. Two Ethernet routers provide the infrastructure for the TS7700 Virtualization Engine to communicate with the IBM 3953 Library Manager through an internal Ethernet network.

A VTS that is attached to a TS3500/3953 Tape Library configuration resides inside the same dedicated frame (IBM 3494 Model B10 or B20) in which it resides when it is installed in an IBM 3494 Tape Library. The VTS communicates with the IBM 3953 Library Manager through an internal Ethernet network.

The TS1120 Model C06 Tape Controllers are installed in each IBM 3953 frame from the bottom upward. The IBM SSR configures the control unit based on the frame in which it is installed (Frame 1 through 6 where Frame 1 is the Base Frame) and then based on the position within this frame (either bottom, middle, or top). The last digits (10, 20, 30, ... 140) of the IP addresses for the internal LAN are then derived from this configuration.

Note that you do not have to fully configure each frame with TS1120 Model C06 Controllers before you add an additional expansion frame. The IP addresses for each position in an expansion frame are reserved. The base TS1120 Model C06 Controller in an expansion frame must be one of 20, 50, 80, 110, or 140. If a TS1120 Model C06 Controller is not installed, the reserved IP address is skipped. If the first expansion frame only has two TS1120 Model C06 Controllers, their IP addresses are 192.168.25*x*.020 and 192.168.25*x*.30. The IP address 192.168.25*x*.40 is reserved. The second expansion frame's bottom TS1120 Model C06 Controller IP address is 192.168.25*x*.50. Leaving C06 slots empty does not give you any performance degradation or benefits.

2.3.4 Fibre Channel switches

The Fibre Channel switches in the base frame provide the following functions:

- To route data between the tape controllers in the base frame and its associated tape drives
- To route data between any attached TS7700 Virtualization Engine or VTS and its associated tape drives

An Ethernet connection transmits diagnostic information from the Fibre Channel switch to its associated tape controller, TS7700 Virtualization Engine, or VTS.

The base frame can house up to six Fibre Channel switches. Each TS7700 Virtualization Engine or VTS must have two Fibre Channel switches. There must be at least one Fibre Channel switch per tape controller; however, two Fibre Channel switches can be associated with each controller for increased reliability. If only one Fibre Channel switch is used with a tape controller, the switch is installed in the lower position of the two positions in the frame and is connected to the 251 24-port Ethernet switch. The upper position of the two positions remains empty to allow for future expansion.

The Fibre Channel switches in the expansion frame route data between the tape controllers in the expansion frame and their associated tape drives. An Ethernet connection transmits diagnostic information from the Fibre Channel switch to its associated controller. The expansion frame can house up to six Fibre Channel switches.

The following feature codes (FCs) are available when installing a TS1120 Model C06 Tape Controller in a 3953 Tape Frame. For features for the 3592-J70 Controller, refer to *IBM System Storage TS1120 Tape and Controller, Introduction and Planning Guide*, GA32-0555. The FCs are:

- **2 Gb Fibre Channel switch, FC3487**: This feature provides a 2 Gb Fibre Channel switch for the attachment of up to sixteen 3592 tape drives.
- **4 Gb Fibre Channel switch, FC3488**: This feature provides a 4 Gb Fibre Channel switch for the attachment of up to sixteen 3592 tape drives to a TS1120 Model C06 Controller. Maximum of two 4 Gb Fibre Channel switches for each TS1120 Model C06 Controller.

> **Note:** When attaching a TS7700 Virtualization Engine to a 3953-F05, two FC3488s (4 Gb Fibre Channel switches) are required for each TS7740 attachment.

- **Fibre Channel switch Mount Kit, FC4888**: This feature provides the mounting hardware for up to 2 of the 2 Gb or 4 Gb Fibre Channel switches in a 3953-F05 tape frame that contains one or more TS1120 Model C06 Tape Controllers.

- **Client-supplied 2 Gb Fibre Channel switch, FC4889**: This feature allows a 2 Gb Fibre Channel switch provided by the client to attach to the 3592 tape drives. We recommend two Fibre Channel switches for each controller for redundancy, but only one Fibre Channel switch is required. However, if only one switch is installed per controller, the switch must be installed in the lower position of the two positions. You can order this feature in any quantity from one to six 2 Gb Fibre Channel switches for each frame. You must order one FC4888, Fibre Channel switch Mount Kit, for each TS1120 Model C06 Controller for which FC4889 will be ordered.
- **Client-supplied 4 Gb Fibre Channel switch, FC4897**: This feature allows a 4 Gb Fibre Channel switch provided by the client to attach to the 3592 tape drives. We recommend two Fibre Channel switches for each controller for redundancy, but only one Fibre Channel switch is required. However, if only one switch is installed per controller, the switch must be installed in the lower position of the two positions. You can order this feature in any quantity from one to six 4 Gb Fibre Channel switches for each frame. You must order one FC4888, Fibre Channel switch Mount Kit, for each TS1120 Model C06 Controller for which FC4897 will be ordered.

2.3.5 IBM System Storage TS3000 System Console

IBM System Storage TS3000 System Console (TSSC) is the current version of what was previously known as the TotalStorage Master Console (TSMC). Attachment to the TSSC is an installation requirement for any TS7700 Virtualization Engine, VTS, TS1120 Model C06 Controller, or 3592-J70 Controller attached to a TS3500 Tape Library. Attachment to the TSSC is also required for the Library Manager. The TSSC can provide remote support for as many as 43 attached tape systems using feature-provided switches and Ethernet cabling.

The IBM 3953 Library Manager is enhanced to support the TSSC and can join the dedicated LAN. The TSSC attaches to each installed IBM 3953 Model L05 Library Manager, TS1120 Model C06 Controller or 3592-J70 Controller, TS7740 Node (3957-V06), IBM 3494 B10 or B20 VTS, and also to the TS3500 Tape Library. The TSSC monitors these components for early detection of unusual conditions. Error information is sent automatically to IBM RETAIN (remote support).

Remote support capabilities

The Master Console support includes:

- Call Home problem reporting capability with staged, error-specific data gathering for support (using a modem)
- Call In capability with authenticated access (using a modem), including file transfer and multiple connections with attached systems
- Simultaneous Call Home and Call In capabilities using dual modems (Stand-alone Master Console only)
- Automatic wellness checking for attached systems
- Ability to defer disposition code 2 Call Home activity to specific business hours
- Automatic archival of log files for most attached tape systems for subsequent support reference
- Automatic download and storage of new tape drive code images through a modem connection with IBM RETAIN

Additionally, the TSSC provides a convenient focal point for local service activities within the data center. It provides the following local service tool applications:

- Ability to Telnet to multiple tape systems and simultaneously perform multiple service tasks from the TSSC
- Graphic user interface for tape system and tape drive service diagnostic utilities
- Ability to broadcast control unit and tape drive code images to tape systems for subsequent activation from the TSSC
- Diagnostic tools for verifying communications with tape systems and IBM RETAIN
- Graphic user interface for configuring, backing up, and restoring Master Console settings
- One-time authentication for logging in to multiple attached subsystems

FC2730 for the IBM TotalStorage 3953 Tape Frame Model F05 provides the enhanced rack-mountable TS3000 System Console, an Ethernet switch, a cable, and connectors for connection of one machine to an IBM-supplied modem to enable remote enhanced service. This feature is an enhanced replacement of the IBM TotalStorage Master Console for Service (FC2718). FC5505 on the IBM 3953 Model F05 Frame, as well as FC5511 or FC5510, is required. FC2720 provides the TS300 desktop model.

Attached subsystems

The same TSSC can be shared among the following units, up to a maximum of 43 units:

- IBM TS7740 Node (3957-V06) installed in an IBM 3952 Tape Frame
- IBM 3494 B10, B18, B20, HA1, L10, L12, L14, L22, or L23 frames
- VTC in an IBM 3494-CX1 Frame
- IBM 3592-J70 Tape Controller
- TS1120 Model C06 Controller
- IBM 3953 Library Manager
- TS3500 Tape Library

Existing TotalStorage System Console

If you already have a TSSC attached to your tape system, it is possible to connect it to your IBM 3953 Tape System, but you are not able to use the keyboard, video, and KVM switch inside the IBM 3953 base frame, because the existing TSSC is located outside the IBM 3953 Frame.

FC2714, Console Expansion, allows you to attach the IBM Model L05 Library Manager to an existing TSSC. The feature provides an attachment cable and mounting hardware for connection of an existing TSSC mounted externally to the base frame. This feature also supplies a rack-mountable 16-port TSSC Ethernet switch. This feature is only available for a base frame and can be ordered in place of FC2720, TS3000 System Console.

TS3000 System Console configuration

The TSSC attaches to all installed IBM 3953-L05 Library Managers, TS1120 Model C06 Controllers, 3592-J70 Controllers, IBM TS7740 Node (3957-V06), IBM 3494-B10 and B20 VTSs, and the TS3500 Tape Library. The TSSC monitors these components for early detection of unusual conditions, and it transmits error information to IBM RETAIN.

When attaching System z to the TS3500, it is mandatory to have a TSSC available. There are two ways to have a TSSC available:

- Integrate it into the IBM 3953-F05 Frame as FC2720, which provides the TS3000 System Console, a 16-port Ethernet switch, and a cable and connectors for connection of one subsystem. You then need to add the KVM switch, because you only have one monitor, keyboard, and mouse, which are shared with the Library Manager operator interface. The frame must also have FC5505 to indicate that it is a base frame and one of the KVM switch installation feature codes, either FC5510 or FC5511. The KVM switch is required for the integrated TSSC so that it can share the use of the operator interface with the Library Manager.
- Use an external TSSC by adding the console expansion FC2714 to the IBM 3953-F05 base frame, which provides an attachment cable for a client-supplied TSSC that is external to the base frame. This feature also supplies a rack-mountable 16-port Ethernet switch. This feature is only available for a base frame, and you order it in place of FC2720. The frame must also have FC5505 to indicate that it is a base frame, but no KVM switch is required, because the external TSSC has its own dedicated monitor, keyboard, and mouse and can support the attachment of up to 43 units.

2.3.6 Ethernet routers

Ethernet routers are installed in both the IBM 3953 base and the expansion frames.

The 8-port Ethernet router in the base frame

The 8-port tape controller Ethernet router is placed in the bottom of the base frame and connects the controller to the TSSC and one of the 24-port Ethernet switches.

The 8-port Ethernet router in the expansion frame

In the expansion frame, the routers are located in the top of the frame. The two 8-port Ethernet routers communicate between the tape controllers in the expansion frame and the IBM 3953-L05 Library Managers in the base frame and route diagnostic information from the Fibre Channel switches in the expansion frame to their associated tape controllers. FC5506, Expansion Connectivity, installs both 8-port Ethernet routers in the expansion frame.

2.4 IBM TotalStorage 3953 Library Manager Model L05

The IBM 3953 Library Manager controls the System z part of the TS3500 Tape Library in the same way that the integrated Library Manager controls the IBM 3494 Tape Library. It is housed outside the TS3500 Tape Library in the IBM 3953-F05 base frame. It provides the appropriate interface between the TS3500 Tape Library and the System z host.

The front view of an IBM 3953 Model F05 Frame is in the middle of Figure 2-12 on page 40.

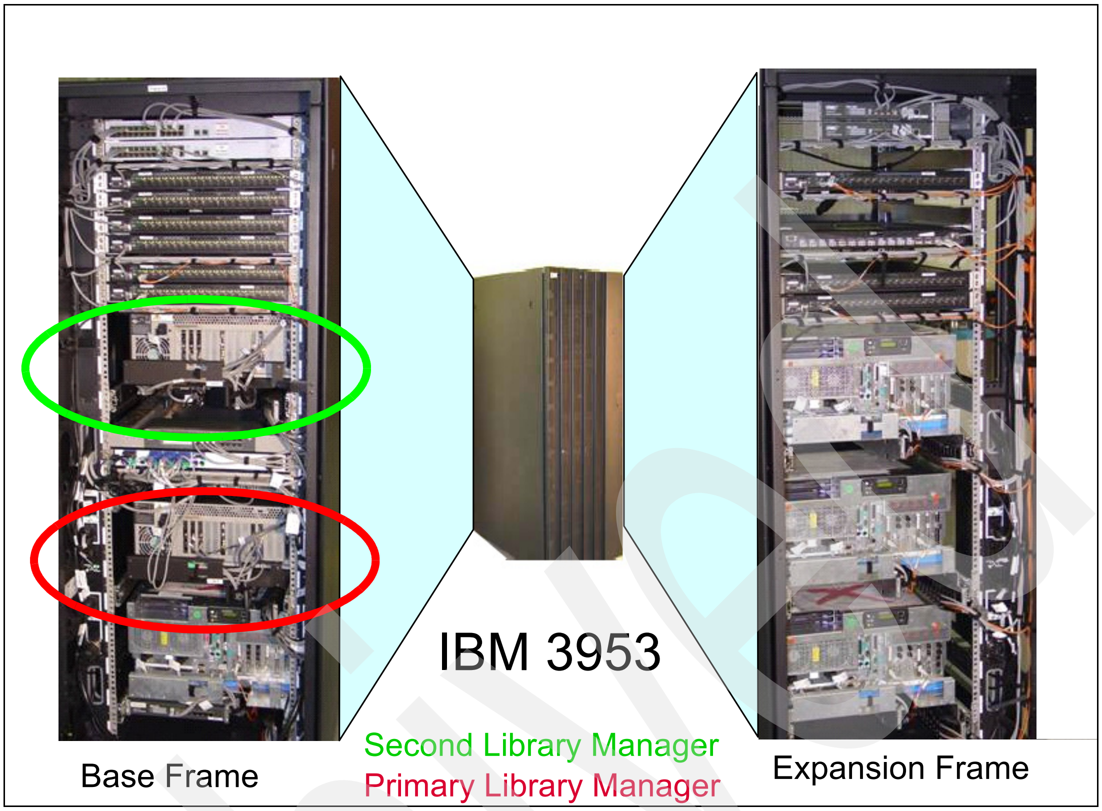


Figure 2-12 IBM 3953 Frame front and rear views

The IBM 3953 Library Manager has common microcode with the Library Manager used in the IBM 3494 Tape Library. The IBM 3953 Library Manager uses the same hardware as the IBM 3494 Library Manager. However, the card complement in the PC is different when it is used within an IBM 3494 Tape Library than when it is used with a TS3500 Tape Library. It includes:

- 1.26 GHz processor
- 512 MB RAM
- Two 80 GB hard drives
- Mirroring card
- Three Ethernet cards

The IBM 3953 Library Manager automates the storage, retrieval, and control of cartridges in defined logical libraries in the TS3500 Tape Library. It also provides the operator with error recovery, operational status, and several service options. You can install either one or two IBM 3953-L05 Library Managers in the base frame. The second 3953-L05 Library Manager, if installed, increases system reliability by acting as a standby for the first.

The following IBM 3953 Library Manager configuration rules apply:

- IBM 3953 Model L05 can be connected to only a single TS3500 logical library.
- The TS3500 Tape Library can have up to four IBM 3953s attached to it. However, each IBM 3953 must have its own logical library.
- Each IBM 3953 Model L05 can manage up to two TS7700 Virtualization Engines or two VTSs, or a mixture of both, which means that up to eight TS7700 Virtualization Engines or VTSs can be attached to one physical TS3500 Tape Library.

- Not all the drives in a frame must be associated with a single TS7700 Virtualization Engine, VTS, or controller. For instance, a frame of 12 drives can have six drives attached to a TS7700 Virtualization Engine and six drives attached to a TS1120 Model C06 Controller. Also, all the drives attached to a TS7700 Virtualization Engine, VTS, or TS1120 Model C06 Controller do not necessarily need to reside in the same frame.

> **Note:** It is a good practice to have TS7700 Virtualization Engine or VTS drives installed in two separate frames to increase availability.

- The maximum number of subsystems per IBM 3953 is 16. Each controller, TS7700 Virtualization Engine, or VTS counts as one subsystem.

2.4.1 Display and controls

The IBM 3953 base frame contains a display and keyboard that are used as the operator station. The operator uses this interface to interact with the IBM 3953 Library Manager and with the TS3000 System Console (TSSC). The display consists of a color flat-panel monitor. The monitor incorporates a standby function for power conservation and increased reliability purposes. Pressing any key on the keyboard activates the display if it is standby. The keyboard incorporates a trackpoint pointing device located near the center of the keyboard. The monitor is able to fold down flat against the keyboard. The shelf containing the monitor and keyboard can be retracted into the base frame when the monitor is folded down.

The display and keyboard are provided automatically when you specify FC5505, Base User Interface. However, if you install a second Library Manager or a TSSC in the base frame, you must also specify the KVM switch so that these units can all share the same operator station. The operator cannot access the IBM 3953-L05 Library Managers and the TSSC simultaneously with the display and keyboard but must select one at a time. Refer to the *IBM TotalStorage 3953-L05 Library Manager Operator Guide*, GA32-0558, for more information.

2.4.2 Licensed Internal Code

Microcode for IBM 3953 Library Manager is the same as the microcode used in the IBM 3494 Library Manager. Several library-related functions are not required with IBM 3953 Library Manager, because TS3500 library hardware handles them. For example, barcode interface code, library inventory code, or code that generates accessor motion commands is not used in the IBM 3953 Library Manager.

The Operator Panel is reduced but looks similar to the IBM 3494. On the Operator Panel, approximately 67% looks the same, 18% has been changed, and 5% is no longer required. Similarly in the Service panels, 50% is removed; for example, the accessor-related and I/O station-related menus are not included, because they are handled through the IBM TS3500 Tape Library.

The IBM 3953 Library Manager creates and maintains a database that contains:

- The configuration of the Library Manager
- The inventory of the physical cartridge volumes and logical volumes that a S7700 Virtualization Engine or VTS manages, also information about their use and current status
- The status of each physical tape drive and IBM 3490 virtual device

As operations progress, the IBM 3953-L05 Library Manager updates the database dynamically on the disk drive to reflect the current system status.

2.4.3 Dual Library Managers

You have the option of installing an extra IBM 3953 Model L05 Library Manager in the base frame for improved reliability in the event of a Library Manager failure. The second Library Manager provides the same functionality as the dual Library Managers on the IBM 3494 library, except for the control of a second accessor. The second IBM 3953 Library Manager can be used without regard to the number of accessors in the TS3500 Tape Library.

You can also install dual accessors in the TS3500. However, the two redundancy features (dual Library Managers and dual accessors) do not have to be installed together to allow more flexible configurations; you can install two Library Managers and one accessor, or two accessors and one Library Manager. This flexibility might be applicable, for example, in a TS7700 Dual Cluster Grid configuration where a client might prefer to have dual Library Managers at one or both sites, but might think that dual accessors on each library are not required.

Figure 2-13 shows the internal connections with two Library Managers installed in the subsystem.

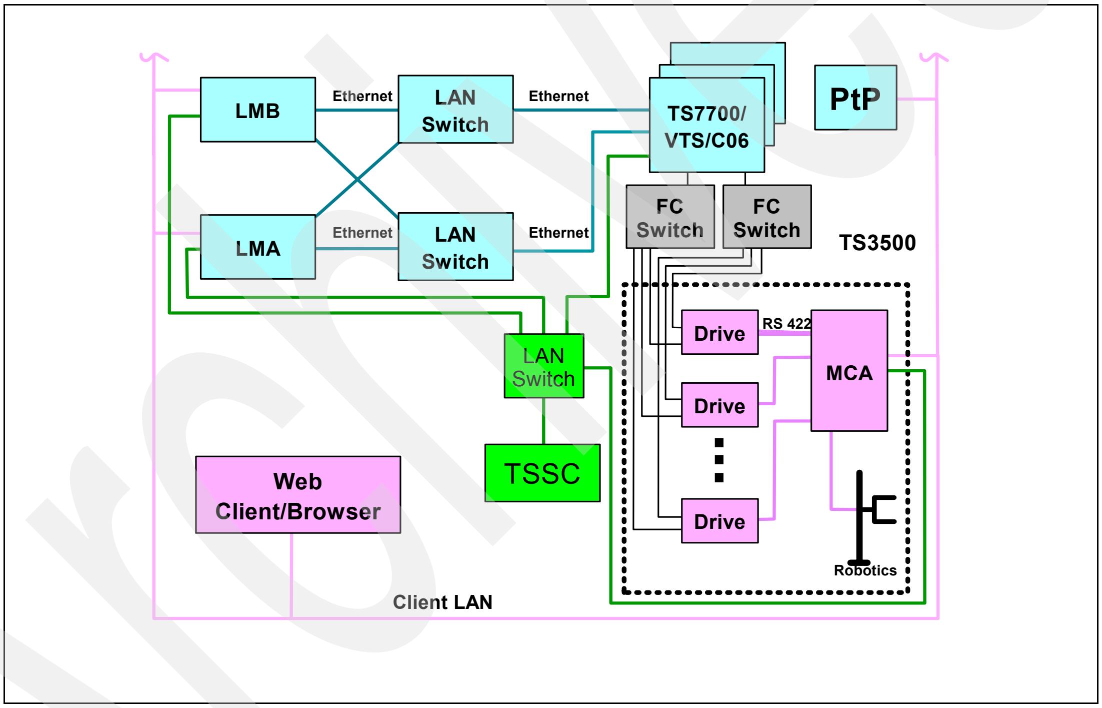


Figure 2-13 Dual Library Manager configuration

During normal operation with no failed or degraded components, the lower Library Manager in the base frame (Library Manager A, or LMA, shown in its position in the base frame in Figure 2-12 on page 40) is the active Library Manager by default. The status of the active Library Manager is changeable. The active Library Manager processes host requests received through either the “251” or the “250” Ethernet network from attached VTSs and controllers. The active Library Manager also updates its library database as required based on library activity.

The upper Library Manager in the base frame during normal operations is the standby Library Manager (Library Manager B, or LMB, shown in its position in the base frame in Figure 2-13) by default. It maintains a copy of the active library database. The standby database is updated to match the active database through the “250” Ethernet network during normal operation. The “250” Ethernet network also passes heartbeat messages from the active to the standby Library Manager. These heartbeat messages inform the standby Library Manager that the active Library Manager is functioning normally.

A loss of the heartbeat messages indicates that the active Library Manager has failed. When this occurs, the standby Library Manager automatically becomes the active Library Manager, continuing library operations. The operator can also switch the active Library Manager to standby from the base frame operator station if desired or required (refer to the *IBM TotalStorage 3953 Library Manager Model L05 Operator Guide*, GA32-0558, for more information).

For dual Library Manager support, there is a nonvolatile random access memory (NVRAM) card; this card is installed in the base frame but is not illustrated. The memory on the card stores information regarding the validity of the databases in each Library Manager. The Library Managers use this information during their initialization to determine whether one or both of them is capable of becoming the active Library Manager. If a Library Manager’s database is valid as determined from the information on the NVRAM card, it is capable of becoming the active Library Manager.

For example, assume that both Library Managers are operating and Library Manager A is the active Library Manager. The information stored on the NVRAM card indicates that the database for each Library Manager is valid. If both Library Managers are shut down at the same time, the information stored on the NVRAM card indicates that either Library Manager is capable of becoming the active Library Manager. Assume now that both Library Managers are shut down, and that both Library Managers have valid databases. If only Library Manager B is initialized, it becomes the active Library Manager. Library Manager B modifies the information on the NVRAM card to indicate that Library Manager A’s database is no longer valid, because it is now out-of-date. This action prevents Library Manager A from becoming the active Library Manager until its database is made equivalent to Library Manager B’s database. When the databases are equal, the information on the NVRAM card is updated to indicate that the databases of both Library Managers are now valid.

2.4.4 Features for redundant IBM 3953 Model L05

A second Library Manager option is available to provide redundancy and improve reliability in the event of a Library Manager failure. During normal operation, the first Library Manager is the active Library Manager by default, and the second Library Manager is the standby (refer to 2.4.3, “Dual Library Managers” on page 42).

You must specify the High Availability Option for dual accessors (described in 2.2.5, “High Availability frames” on page 23), as well as a second IBM 3953 Library Manager Model L05, in order to provide the same redundancy as the IBM 3494 for System z configurations.

You specify the second Library Manager by including an additional Model L05 with these installation features on the IBM 3953:

- Installation features required on the IBM 3953-F05 base frame are:
  - Plant installation FC5065 if the second Library Manager is part of the original base frame order
  - Field install FC5067 if the second Library Manager is added later to an already installed base frame
  - Field merge FC5066 if a client-supplied Library Manager is to be added to a new base frame

- A second IBM 3953-L05 Library Manager with the following feature codes:
  - Plant installation FC9065 if the second Library Manager is part of the original base frame order
  - Field merge FC9066 if a new Library Manager is added later to an already installed base frame

Note that these features are not valid for the expansion frames.

2.4.5 Environmental specifications

Table 2-8 lists the physical specifications and dimensions of the IBM 3953 models.

Table 2-8 IBM 3953 physical specifications

Specifications	Model F05 Frame	Model L05 Library Manager
Width	1102 mm (43.4 inches)	431.8 mm (17.0 inches)
Depth	644 mm (25.4 inches)	495.3 mm (19.50 inches)
Height	1804 mm (71.0 inches)	177.8 mm (7.0 inches)
Weight	282 kg (620.4 lbs.)	21 kg (46.2 lbs.)

Table 2-9 shows the operating characteristics of the IBM 3953 models.

Table 2-9 IBM 3953 operating characteristics

Specifications	Model F05 Frame	Model L05 Library Manager
Temperature	16° to 32°C (60.8° to 89.6°F)	16° to 32°C (60.8° to 89.6°F)
Relative humidity	20% to 80% non-condensing	20% to 80% non-condensing
Wet bulb (caloric value)	23°C (73.4°F)	23°C (73.4°F)
Electrical power	1.5 kVA	0.9 kVA
Maximum acoustical noise sound power levels LwAd in bels	7.4/7.4	N/A
Heat output	250 watts, 875 BTU/hr.	330 watts, 1160 BTU/hr.

Note also that each Fibre Channel switch weighs 8.2 kg (18 lbs.) and has a heat output of 100 kw, 350 BTU/hr. maximum, and an electrical power requirement of 0.125 kVA.

2.5 IBM TS3500 and IBM 3953 system design

You can use the TS3500 Tape Library for both System z and Open Systems host attachments. Using the Multi-Path Architecture and Advanced Library Management System functions in the TS3500, you can partition the library into logical libraries. Refer to Chapter 6, “Basic concepts of sharing and partitioning” on page 149. Each host sees only the drives and cartridges belonging to it, but it shares the library robotic accessors and the storage slots with other unlike hosts. The System z host uses drives in its own dedicated logical library, and ALMS is required, even if the library has only a single System z-attached logical library allocated.

2.5.1 Architectural overview

In Figure 2-14, we show an architectural overview of an IBM 3953 Library Manager with one System z-attached TS7700 Virtualization Engine, one System z-attached VTS system, and one System z-attached TS1120 Model C06 Tape Controller attached to one TS3500 logical library.

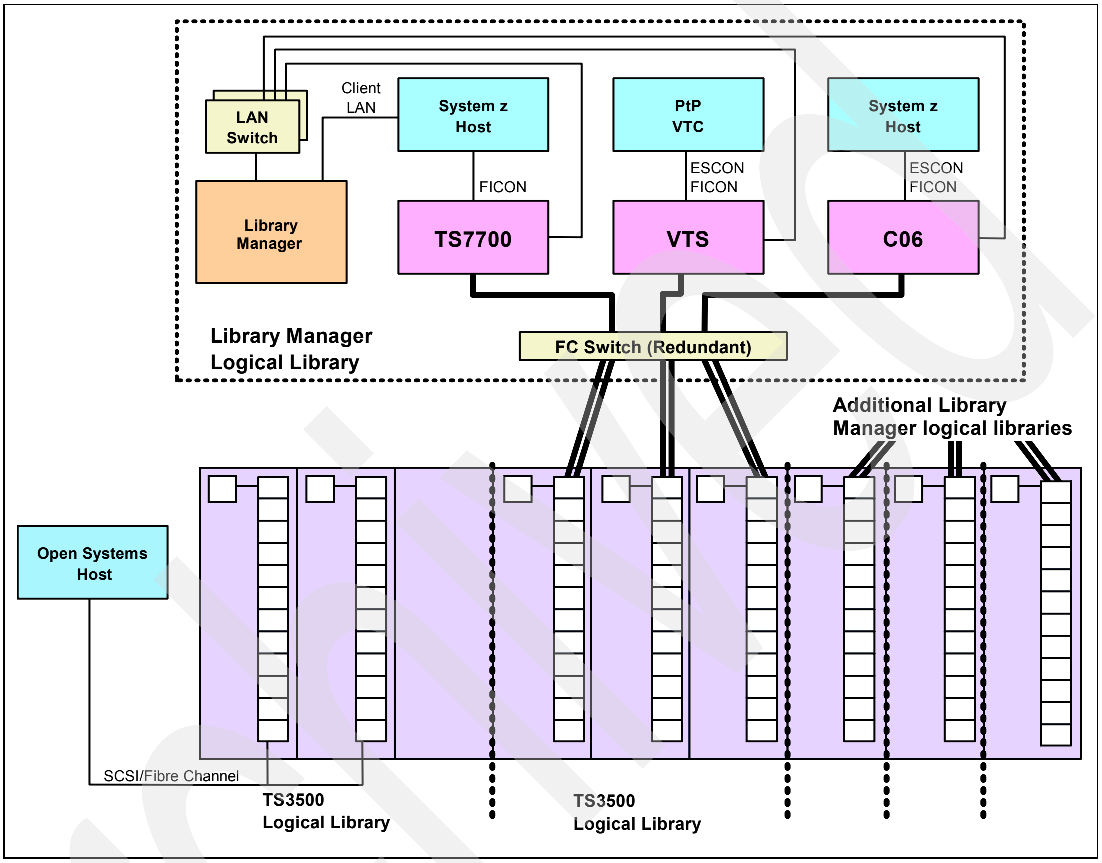


Figure 2-14 TS3500 and 3953 architectural overview

In Figure 2-14, we see that the TS7700 Virtualization Engine, the VTS system, and the TS1120 Model C06 Tape Controller in the host logical library are all controlled by one or a pair of Library Managers. In addition to this TS3500 logical library, the TS3500 has defined another logical library for Open Systems with SCSI-attached drives, which are controlled directly by the Open Systems host. Up to three additional Library Manager logical libraries can exist within the same physical TS3500 Tape Library. A single TS3500 logical library controlled by a Library Manager within a TS3500 Tape Library is in a way comparable to what a Library Manager inside an IBM 3494 supports. You can install the following subsystems inside one Library Manager logical library in a TS3500 Tape Library:

- Up to a total of two virtualization solutions:
  - Up to two VTS models B10 or B20
  - Up to two TS7700 Virtualization Engines
- Up to 16 TS1120 Model C06 (or 3592 Model J70) Controllers, depending on the number of TS7700 Virtualization Engines or VTS systems attached to the same IBM 3953:
  - Up to 14 with two TS7700 Virtualization Engines or VTSs
  - Up to 15 with one TS7700 Virtualization Engine VTS
  - Up to 16 with no TS7700 Virtualization Engine or VTS

Figure 2-15 shows an overview of the basic connections among the components.

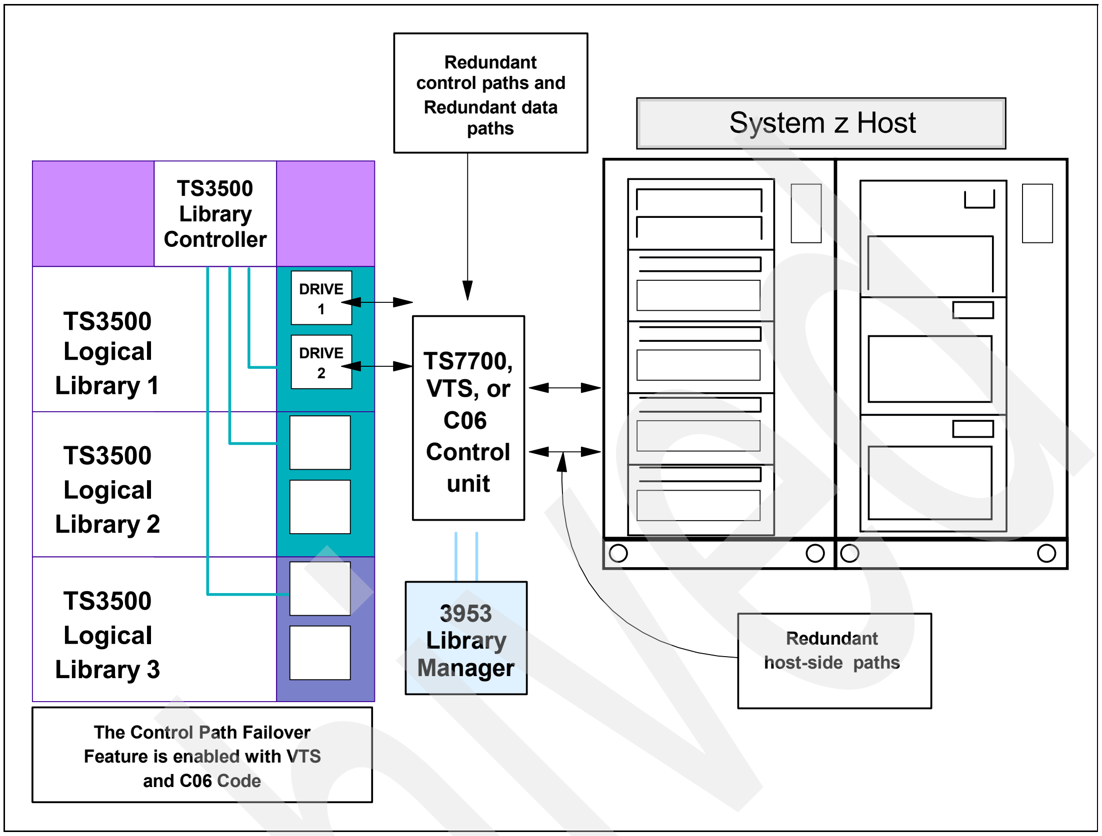


Figure 2-15 TS3500 Tape Library connections

As shown in Figure 2-15, the System z components are contained in their own logical library within the TS3500, using the Multi-path capability of the library. The hosts connect to the TS3500 Tape Library only through the TS1120 Model C06 Controller, the TS7700 Virtualization Engine, or through the IBM VTS Model B10 or B20. The supported connection types are ESCON or FICON except for the TS7700 Virtualization Engine, which supports only FICON connections.

One IBM 3953 Model L05 Library Manager (or a pair of separate Library Managers), which manages the TS3500 logical library on behalf of the System z host, is provided. The IBM 3953-L05 is similar in function to the Library Manager in the IBM 3494 Tape Library.

The controllers, TS7700 Virtualization Engines, and VTSs in the subsystem communicate with the IBM 3953 Model L05 Library Manager or the pair of Library Managers, which control the library on behalf of the System z hosts. The Library Managers send simple SCSI commands to the TS3500 library robotics using the controller, TS7700 Virtualization Engine, or VTS path to the logical unit number 1 (LUN 1) address of the drives.

2.5.2 Communication paths

The means of communication between the System z host and the Library Manager, in either the IBM 3494 library or the TS3500 library, is through a controller, a TS7700 Virtualization Engine, or a VTS. The ESCON or FICON connections from the System z host to the controllers, TS7700 Virtualization Engine (FICON only), or VTSs are used for both data and library commands. There is no requirement for a separate channel or communication link to the Library Manager from each attached System z host, because existing channels to the tape subsystems are used to pass commands to the Library Manager.

Figure 2-16 summarizes the communication paths among the TS1120-E05 drives, the TS3500 Tape Library, and the System z hosts.

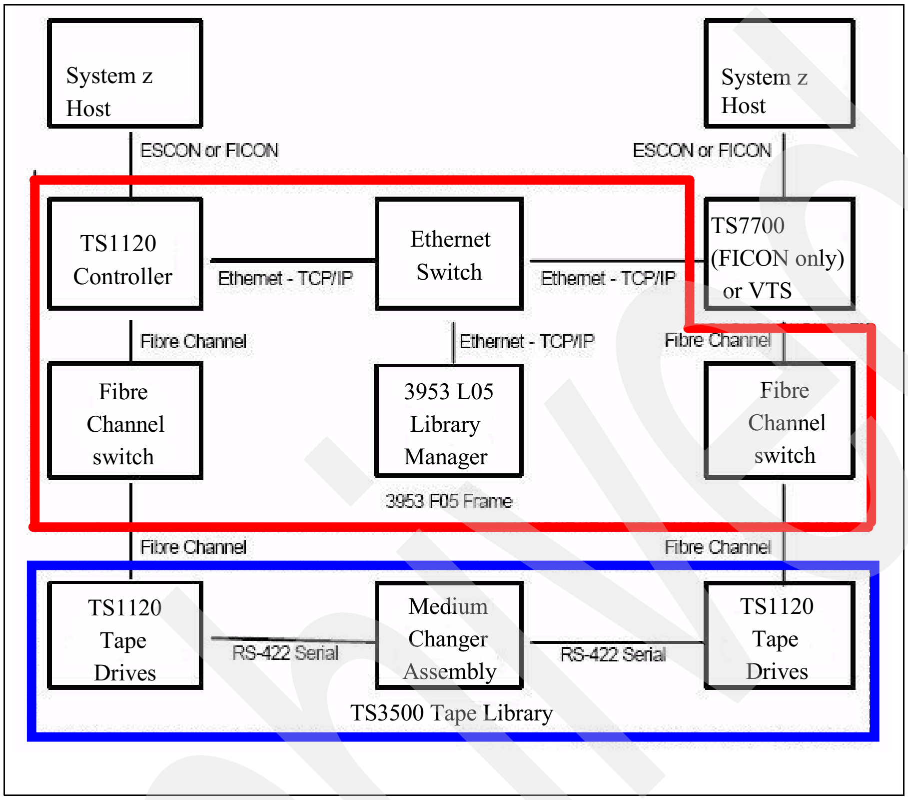


Figure 2-16 Communication paths

The bold frame in the middle of Figure 2-16 includes the components installed in the IBM 3953 base frame, and the bold frame at the bottom of Figure 2-16 includes the components installed in the TS3500 Tape Library.

The IBM 3953 Library Manager translates the library commands received from the host into SCSI move medium commands. It then sends them back through the TS1120 Model C06 Controller or IBM 3592-J70 Controller, TS7700 Virtualization Engines, or VTSs and on to the Medium Changer Assembly (MCA) in the library using LUN 1 of an attached drive. In order to use a drive for this communication, you must define the drive as a control path drive (refer to "Control path drives" on page 26); define the drive as a control path drive when you set up the drives using the TS3500 Operator Panel or the Web interface. Obviously, whether you use Open Systems or System z, you must have at least one drive defined as a control path drive for each logical library. Four control path drives are required per subsystem (J70, TS7700, or VTS), unless the subsystem has fewer than four drives installed.

When a drive is ready for transfer of the data, the Library Manager communicates this drive readiness to the host. The host then begins the data transfer to the controller and onto the tape drive, which is addressed using LUN 0.

2.5.3 Control path drives

In the TS3500, a *control path* is a logical path into the library through which a server sends SCSI move medium commands to control the logical library.

Setting up control path drives is part of hardware installation and implementation; it is not addressed when the system is specified. Any attached drive can be defined as a control path drive. For the procedure to enable, disable, or modify control paths, refer to the *IBM System Storage TS3500 Tape Library Operator Guide*, GA32-0560.

For Open Systems hosts, the library has an optional control path failover (CPF) hardware feature, FC1680. This feature code enables the IBM device driver to resend the command to an alternate control path defined for the same logical library; this failover is transparent to any attached host application. In the TS3500 Open Systems partitions, the internal microcode checks the installed features before attempting control path failover. This feature works only if the hardware feature and supported IBM device drivers are installed.

In the TS3500 System z architecture, the control path failover is actually handled by the device driver on the host, tape controller, TS7700 Virtualization Engine, or VTS. For Open Systems, the key is entered at the TS3500, then the host driver checks for this key when deciding to use control path failover. For System z, the driver in the tape controller, TS7700 Virtualization Engine, or VTS automatically uses CPF without looking for a key from the TS3500 library.

Note: You do not have to order FC1680 for System z attachment.

2.5.4 Ethernet network topology

The communication between the IBM 3953 Library Manager and the tape controllers is through an internal LAN. The Ethernet connections are supported with an IBM-supplied standard length cable of 31 m (100 ft) between the frames as shown in Figure 2-17 on page 49. You can, however, provide your own longer cable.

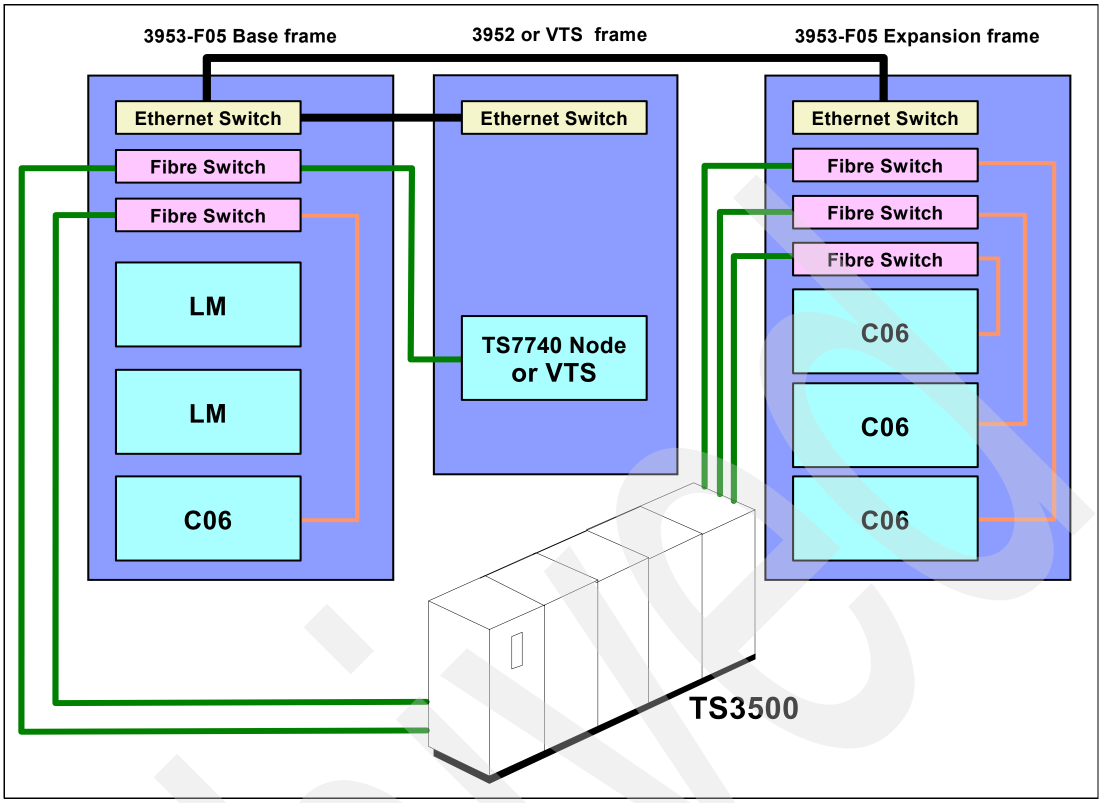


Figure 2-17 IBM 3953 Ethernet connection

Use Ethernet attachments for the following functions:

- Transfer library information and commands among the IBM 3953 Model L05, the TS7740 nodes, the VTSs, and the IBM 3592 Model J70 Controllers
- Allow the two IBM 3953 Model L05 Library Managers to exchange database information
- Send "heartbeat" diagnostic information from the IBM 3953-L05 Library Managers, the TS7740 nodes, the VTSs, the tape controllers, and the TS3500 Tape Library to the TSSC
- Connect the IBM 3953-L05 Library Managers, the tape controllers, the TS7740 nodes, the VTCs in a Peer-to-Peer VTS configuration, and the TS3500 Tape Library to a client LAN (these connections are used by the Specialist to allow system monitoring through a Web browser)

The Ethernet network topology consists primarily of four networks. Two of these networks are parallel. They provide redundancy and prevent a single network from becoming a single point of failure. The third network serves as the TSSC network. The fourth network is the client's intranet, which we do not discuss here. We describe the other three networks next.

192.168.250.*xxx* network

This network provides:

- The primary (preferred) path between the IBM 3953-L05 Library Managers (if there are two installed) for library database information exchange
- The secondary (alternate) path connecting the IBM 3953-L05 Library Managers, the tape controllers, the TS7740 nodes, and the VTSs

The 250 8-port Ethernet router expands this network to the expansion frame.

192.168.251.*xxx* network

This network provides:

- The primary (preferred) path connecting the 3953 Library Manager and its subsystems (the tape controllers, TS7740 nodes, and the VTSs)
- The path connecting the TSSC and the tape controllers
- The path connecting to the tape controllers and the 8-port tape controller Ethernet router in the base frame

The 251 8-port Ethernet router expands this network to the expansion frame. Figure 2-18 outlines this network for the Library Manager (see the thin lines), as well as the network for the IBM System Storage TS3000 System Console.

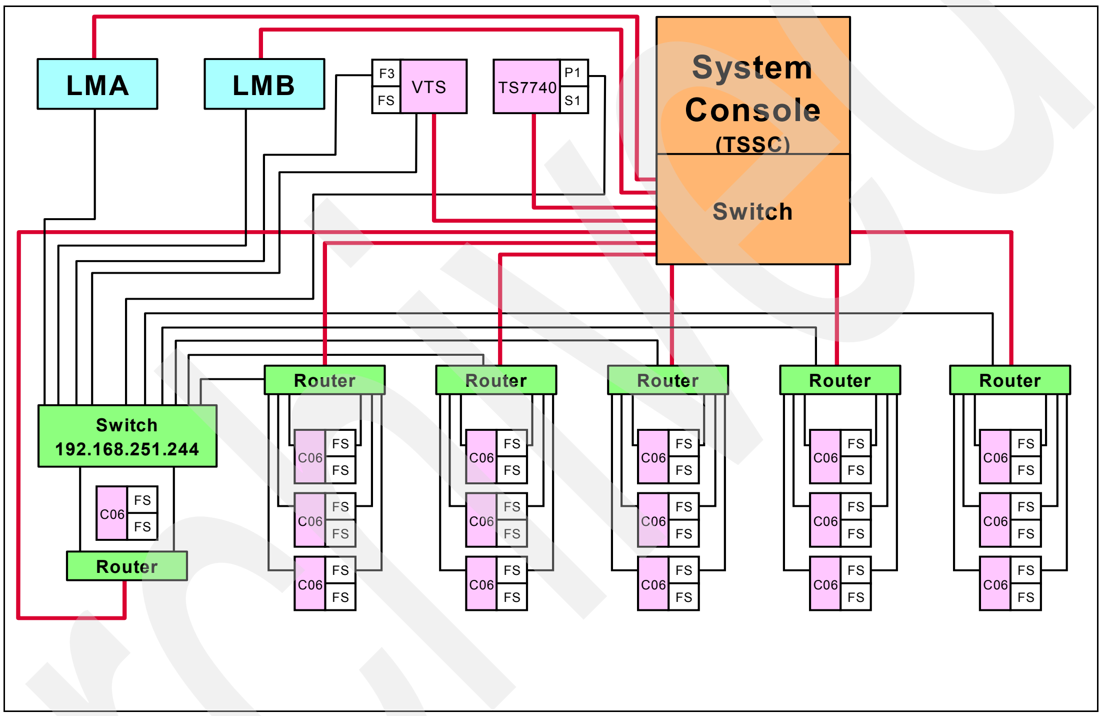


Figure 2-18 The 192.168.251.xxx and 172.31.1.xxx networks

Figure 2-18 shows the two 24-port Ethernet switches that route the communications among the IBM 3953-L05 Library Managers and any attached TS1120 Model C06 Controller, TS7740 node, and IBM 3494 VTS Model B10 or B20. Two 24-port Ethernet switches are required in order to provide a redundant communications network. FC5505, Base User Interface, installs both 24-port Ethernet switches in the base frame. The TS1120 Model C06 Controllers are connected internally in the IBM 3953 subsystem using a LAN; there is no option for serial connections (with RTIC cards) as there is in the IBM 3494.

172.31.1.*xxx* network

This network serves as the TSSC network and is shown in Figure 2-18 (see the bold lines). The TSSC connects to the 16-port System Console Ethernet switch. The following components connect to the 16-port System Console Ethernet switch:

- TS7740 nodes
- VTS systems
- Library Manager A

- Library Manager B (if installed)
- Base frame tape controller (through its 8-port tape controller Ethernet router)
- Expansion frame and tape controllers (through the 251 network 8-port Ethernet router in the expansion frame)
- TS3500 Tape Library directly to the IBM 3953-L05 Library Managers through the 8-port Ethernet router

IP Address assignment

In the parallel 250 and 251 networks, the IP addresses are assigned as follows:

- The 24-port Ethernet switches are assigned IP addresses of 192.168.251.244 and 192.168.250.244.
- Each tape controller is assigned two IP addresses of the form 192.168.25*x*.*yyy*, where *x* is 0 and 1. The *yyy* component is assigned as:
  - Tape controller in base frame (Frame 1): *yyy* = 010
  - Three tape controllers in first expansion frame (Frame 2): *yyy* = 020, 030, and 040
  - Three tape controllers in second expansion frame (Frame 3): *yyy* = 050, 060, and 070
  - Three tape controllers in third expansion frame (Frame 4): *yyy* = 080, 090, and 100
  - Three tape controllers in fourth expansion frame (Frame 5): *yyy* = 110, 120, and 130
  - The first tape controller in the fifth expansion frame (Frame 6): *yyy* = 140. If no TS7740 or VTS systems are installed, two more tape controllers can be installed in this frame (values 150 and 160). If TS7740s or VTSs are installed:
    - For the first TS7740 or VTS installed: *yyy* = 150
    - For the second TS7740 or VTS installed: *yyy* = 160
- The 8-port 3592-J70 Ethernet router in the base frame is assigned IP address 192.168.251.015. Each 8-port Ethernet router in the expansion frames is assigned two IP addresses of 192.168.250.*yyy* and 192.168.251.*yyy* where *yyy* can be:

025	Router in the first expansion frame
055	Router in the second expansion frame
085	Router in the third expansion frame
115	Router in the fourth expansion frame
145	Router in the fifth expansion frame

Dual Ethernet network

The network communications between the IBM 3953 Library Manager Model L05 and the TS7740 node, VTS, or IBM 3592 Tape Controller Model J70s must have a redundant path. It is required in both single and dual IBM 3953 Library Manager configurations.

IPv6 functionality

The TS3500 Tape Library supports Internet protocol (IP) addresses in both IPv4 and IPv6 format. IPv6 is designed to allow the Internet to grow steadily, both in terms of the number of hosts connected and the total amount of data traffic transmitted. For detailed information about IPv6, refer to Appendix B, “IPv6 overview” on page 465.

2.5.5 Reliability and availability

IBM supplies a number of redundant features as part of the TS3500/3953 Tape System:

- Dual Fibre Channel switches
  Each tape controller, TS7740 node, or VTS has two Fibre Channel switches provided in the IBM 3953 frames. These Fibre Channel switches connect the IBM 3592 tape drives to the control units, TS7740 nodes, or VTSs, which offers redundancy and avoids single points of failure in accessing the attached tape drives. Note that the second switch is optional when specifying the Model J70 controller.
- Dual networks and paths
  There are two Ethernet networks for internal communications within the library subsystem. Each frame has two Ethernet switches, or *hubs*, supporting a primary and secondary network (the “250” and “251” networks). This design avoids single points of failure in the communications network between the components.
- Dual power
  A number of dual power features are available in the components that make up the subsystem:
  - The IBM 3953 base frame optionally provides the power switching units with the capability to automatically switch to a backup power supply if the main power supply is lost. This capability protects the internal components, which have only one available power connection. You can optionally specify an additional power distribution unit (PDU) to connect the power supply to two independent branch power circuits.
  - The IBM 3953 expansion frame optionally provides an additional PDU; all the units in the expansion frames can be connected to independent power supplies.
  - A Frame Model L23 and any D23 that contains drives have their own enhanced frame control assembly, which has two power supplies for redundancy and supplies power to the drives and the library.
  - The 2 Gb and 4 Gb Fibre Channel switches, which are supplied to attach the tape drives to the controllers or VTSs, have dual power connections for optional connection to separate power supplies.
- Dual line cord
  The units listed above under “Dual Power” have the option of dual line cords, or power distribution units (PDUs), to allow connection to two independent branch power circuits.
- Dual Library Managers
  You can order a second Library Manager for installation in the base frame. The active unit maintains a heartbeat with the standby, which, if the active unit is lost, allows the standby machine to take over operations. The two Library Managers maintain current copies of the database; the status and currency of the copies are protected on nonvolatile memory cards.
- Dual accessors
  You can specify a High Availability Option for the TS3500 Tape Library, which provides two always-active robots. The Model HA1 supplies a left garage for a failing robot, and an additional D frame with special features provides the right garage and the second robot.
- Drive redundancy
  IBM 3592 tape drives have both available dual power supplies cross-configured between the drives. They also have two external Fibre Channel adapters that you can use to provide redundant paths.

- TS7700 Virtualization Engine
  Two TS7700 Virtualization Engines, which are attached to physically separate IBM TS3500 Tape Libraries, can be connected together into a TS7700 Dual Cluster Grid to offer data redundancy and availability for disaster recovery.
- Peer-to-Peer VTS
  You can combine two VTSs (either IBM 3494 Model B10 or Model B20) installed inside two physically separated IBM 3494 or TS3500 Tape Libraries into one Peer-to-Peer VTS (PtP VTS) to provide a fully automated, fully redundant system without single points of failure.
- TS3000 TotalStorage System Console
  This is a Linux-based Intel unit for use by IBM engineering, offering enhanced support capabilities. Although it is primarily for maintenance use, the TSSC is becoming a key feature in tape installations. You can attach a number of different devices to it through a private dedicated LAN so that it can manage error reporting and enable remote support. The TSSC can remotely monitor each attached device to determine if it is working properly and report any error alerts for the early detection of problems. Use of the TSSC can expedite microcode updates, reduce service times, and enhance local service.
  The same TSSC can be shared among the following units:
  - IBM System Storage TS7700 Virtualization Engine
  - IBM 3494 Model VTC, B10, B20, HA1, L10, L12, L14, and L22
  - Peer-to-Peer VTC in an IBM 3494 Model CX1
  - IBM 3592 Model J70 Tape Controller
  - IBM TS1120 Model C06 Tape Controller
  - IBM TS3500 Tape Library
  - IBM 3953 Library Manager Model L05

2.5.6 TS3500 performance

Here, we introduce the performance of cartridge move time and mount throughput in TS3500 Tape Library.

- Cartridge move time

  Move time is the time required for the cartridge accessor to pick a cartridge from a random slot, move the cartridge to a drive, pivot (if required), and insert the cartridge into the drive. In a single-frame IBM TS3500 Tape Library, the typical time to move a cartridge from a cartridge storage slot to a tape drive, for example, is less than 2.7 seconds; for a six-frame configuration, it only increases to 3.8 seconds; for the maximum 16 frames, the average move time is still only 6.2 seconds, as shown in Table 2-10 on page 54. For maximum performance, as demonstrated in the table, drives must be centrally located and as close together as possible. The table does not apply to libraries that contain dual accessors.

Table 2-10 Library performance without dual accessor

Library configuration	Average move times with all drives in frame 1	Average move times with all drives in central frame
1 frame	2.7 seconds	N/A
2 frames	2.6 seconds	N/A
4 frames	3.3 seconds	2.9 seconds
6 frames	3.8 seconds	3.3 seconds
8 frames	4.4 seconds	3.7 seconds
12 frames	5.3 seconds	4.3 seconds
16 frames	6.2 seconds	4.7 seconds

- Mount throughput

  Mount throughput is a measure of the overall capability of the cartridge accessor and tape drives. It is defined as the number of cartridges that the tape library can mount in one hour. A *mount*, often called the *mount/demount cycle*, involves removing the cartridge from a drive, returning it to its storage slot, collecting another cartridge from a random storage slot, moving it to the drive, and loading the cartridge into the drive.

  Table 2-11 shows the mount throughput performance for the UltraScalable Tape Library with and without dual accessors. The table demonstrates that to maximize performance with dual accessors, each accessor must have drives centrally located in its preferred zone.

Table 2-11 Library mount throughput

Library configuration	Without dual accessor		With dual accessor	
	Mounts per hour with all drives in frame 1	Mounts per hour with all drives in central frame	Mounts per hour with all drives in frame 1	Mounts per hour with all drives in central frame
1 frame	550	N/A	N/A	N/A
2 frames	520	N/A	N/A	N/A
4 frames	410	430	N/A	1000
6 frames	350	380	N/A	900
8 frames	310	350	N/A	800
12 frames	255	300	N/A	700
16 frames	215	260	N/A	600

> **Note:** The dual accessor mount throughput assumes that the library is partitioned into at least two logical libraries so that each of the cartridges located in the two zones are mounted in drives within each zone with no accessor path overlap.

2.5.7 HD Frame performance considerations

In HD frames, the cartridge accessor performs a *shuffle* operation in order to access the cartridges stored in Tier 2 and beyond. A shuffle is the process of moving cartridges in lower tiers into the gripper, or other available slots, in order to access cartridges in higher tiers (Tier 2 or greater). In order to reduce the occurrence of shuffle operations and to take advantage of repeated accesses of certain cartridges, the role of cartridge cache is assigned to all single-deep (Tier 0) slots in an HD library. In order to maintain efficient shuffle operations, the library performs a load balancing of the tiers, which stores cartridges across all HD slots in the library string. In other words, all HD slots are filled to a minimum tier level until that tier is full across the library, which reduces the need to access cartridges in higher tiers.

The mount performance for a TS3500 Tape Library that includes HD frames is dependent on the library configuration and cartridge usage. For most configurations, the impact is not noticeable. For configurations with high accessor utilization (as measured in mounts per hour), the overall reduction in mount performance compared to a TS3500 Tape Library without HD frames can range from no impact to a worst-case 50% reduction in mounts per hour (for a 99% full library in which all expansion frames are HD frames). This reduction in mount performance is determined by the distribution of tiers from which cartridges are mounted and the need to destage least-recently-used (LRU) cartridges from the cartridge cache. The library configuration and cartridge usage influence the reduction in mount performance in the following ways:

- Each non-HD frame in the configuration increases the mounts from Tier 0.
- Unlicensed capacity decreases the mounts from the highest tiers and decreases the time required for shuffle operations (load balancing ensures the highest tiers are the last ones utilized).
- Lower capacity utilization decreases the mounts from the highest tiers and decreases the time required for shuffle operations (load balancing ensures the highest tiers are the last ones utilized).
- A higher ratio of cartridges that are mounted more than once (*cartridge cache hits*) increases the mounts from Tiers 0 and 1.
- Cartridge eject operations prior to mount operations reduce the need to destage LRU cartridges, because eject operations empty some Tier 0 slots.

Eject and insert performance can also be impacted for a TS3500 Tape Library that includes HD frames. The impact to eject performance is determined by factors similar to mount performance (distribution of tiers from which cartridges are ejected). The impact to insert performance is different, because inserts tend to go to HD frames since Tier 0 slots are nominally kept full. This impact to insert performance is determined by the following factors:

- A shorter time delay between eject and insert operations increases the inserts to non-HD frames (this is because eject operations will empty some number of Tier 0 slots).
- A shorter distance between the I/O stations used for inserts and the HD frames decreases the insert move time to those frames.

3

Tape drives and controllers

This chapter describes the tape drives and controllers supported by the IBM System Storage TS3500 Tape Library. It describes the hardware, features, and integration of these components into the TS3500 Tape Library, as well as the media types supported by the 3592 tape drives.

We describe these models:

- IBM System Storage TS1130 Model E06/EU6 Tape Drive
- IBM System Storage TS1120 Model E05 Tape Drive
- IBM TotalStorage Enterprise 3592 Model J1A Tape Drive
- IBM Enterprise Tape Controller 3592 Model J70
- IBM System Storage TS1120 Model C06 Tape Controller

Note: The 3592 Model J70 was withdrawn from marketing effective 29 September 2006. It is still currently supported in the TS3500 Tape Library, so we describe it briefly in this chapter.

3.1 IBM System Storage TS1100 Tape Drive family

The IBM System Storage TS1120 and TS1130 tape drives (machine types 3592-E05 and 3592-E06/EU6) offer a design focused on high capacity, performance, and high reliability for storing mission critical data. With the September 2003 introduction of the first generation of the new family of tape drives, IBM advanced its high-end half-inch cartridge tape technology to a new level. The second generation of the 3592 family enhanced the capacity and performance characteristics, which now become increased again by the IBM System Storage TS1130 Model E06/EU6 Tape Drive, the third generation of the 3592 family, which provides a capacity of 1 TB of uncompressed data.

3.1.1 The 1 TB background

On 5 April 2002, IBM achieved an unprecedented feat; 1 TB of data was recorded, without compression, to a tape contained in a half-inch format tape cartridge. This technological accomplishment set the foundation for the 3592 Tape Drive family. By using the evolutionary progression of technology building blocks that IBM had set in place over the preceding five years, an enterprise tape drive roadmap was laid out that reached and exceeded 1 TB in native cartridge capacity over several tape drive generations.

The 3592 Model J1A became the first tape drive generation of the enterprise tape family. It enabled storage of 300 GB of data to a cartridge even if it is incompressible (900 GB with 3:1 compressible data). An even more innovative achievement was that these same cartridges are designed to be reused by the second generation of 3592 tape drives, the TS1120 Model E05, to store significantly more data; using the JA media, we can store 500 GB and with the high capacity cartridge, 700 GB without compression. Now with the third generation of IBM 3592 Tape Drive, IBM kept its promise documented in the roadmap for 3592 tape drives. The TS1130 Tape Drive is not just a new drive, but it is the IBM commitment to further tape technology development.

Note: The 3592 Model J1A is no longer being marketed, but it is still currently supported in the TS3500 Tape Library, so we describe it in this chapter.

3.1.2 Nomenclature

The TS1130 Tape Drive actually has several naming attributes similar to the 3592-E05:

- Machine type and model

  3592 Model E06 and 3592 Model EU6 are the device models:

  - The Model E06 is the factory build model.
  - The Model EU6 is the field miscellaneous equipment specification (MES) upgrade model for E05 to E06 conversions.

  The 3592 Model E06 and EU6 drives display as a 3592-3E, which indicates that this is the third generation 3592 drive and has the encryption feature enabled.

- Product name

  TS1130 is the product name.

Because of so many common considerations for the TS1120 and the TS1130 tape drives and in order to simplify this material, we use the name *3592-J1A* for the first 3592 generation and *3592 Model E* for the IBM System Storage TS1120 Tape Drive and IBM System Storage TS1130 Tape Drive in the following chapters.

3.2 Common characteristics of the 3592 Tape Drive family

We make you familiar with the common characteristics of the 3592 Tape Drive family in terms of technology enhancements, reliability and availability improvements, features for performance and capacity, and the media, which is reusable by all three generations.

3.2.1 Technology enhancements

The key features of the 3592 Tape Drive family include:

- *Virtual backhitch*, which is the optimum adaptive format and algorithm designed for improved start/stop write synchronize performance (refer to “Virtual backhitch (nonvolatile caching)” on page 66).
- High performance and robust dual microprocessor architecture. One microprocessor operates the host attachment interface (running what is essentially proven 3590 host attach microcode), while the other microprocessor is allowed to focus strictly on writing data and reading data from tape. Each microprocessor is designed to reset the other microprocessor to act as a fail-safe.
- S/390® and System z attachment through ESCON and FICON by means of the existing J70 controller, as well as the TS1120 Tape Controller.
- Statistical Analysis Recording System (SARS) algorithm with extended mount count.
- Fast random access performance when operating on any of the Short Length Cartridge (SLC™) types.
- Support of an enhanced capacity scaling and segmentation format when operating on the full length Read/Write (R/W) cartridge types JA and JB, enabling very fast locate and read times.
- Streaming Lossless Data Compression (SLDC) algorithm (enhancement of the Ziv-Lempel (LZ1) algorithm).
- Cartridge memory of 4K designed for the 3592 to support advanced features.

3.2.2 Recording format

The IBM 3592 Tape Drive uses an advanced interleaved bidirectional serpentine recording technique that writes eight or 16 (depending on the drive) data tracks at a time on a 3592 cartridge. The 3592 cartridge is a half-inch, advanced metal particle, dual layer tape, and the tape layout consists of five servo bands (which are prerecorded on the tape) and four data bands where the data is written. Refer to Figure 3-1 on page 60. The servo bands provide location information to control the positioning of the head as it writes and reads data within the data band. We explain this function in detail in “Servo tracks” on page 62.

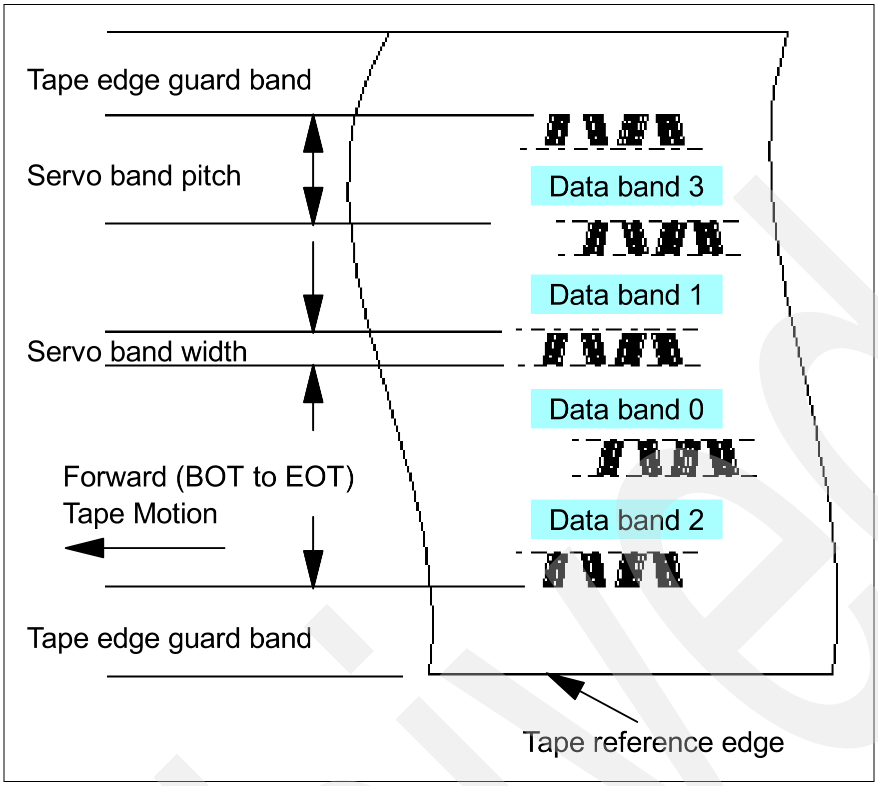


Figure 3-1 The layout of the servo and data bands on the 3592 media

As shown in Figure 3-1, the area between adjacent servo bands is a *data band*. There are four data bands, each with a number of data tracks (128 - 288, the number of data tracks differs for each model), on the 3592 media. The data bands are numbered 2, 0, 1, and 3, with data band 2 nearest the Tape Reference Edge and data band 3 farthest from the Tape Reference Edge.

As Figure 3-2 on page 61 shows (here, for example, a J1A written cartridge), each data band is actually composed of eight data sub-bands, one for each of the eight write heads. Each sub-band is written by a given write-head position in a technique called a *linear serpentine*, which means that the tape moves back and forth longitudinally while the head is indexed up or down laterally at each pass. This design makes it possible to write multiple distinct tracks in a given data sub-band.

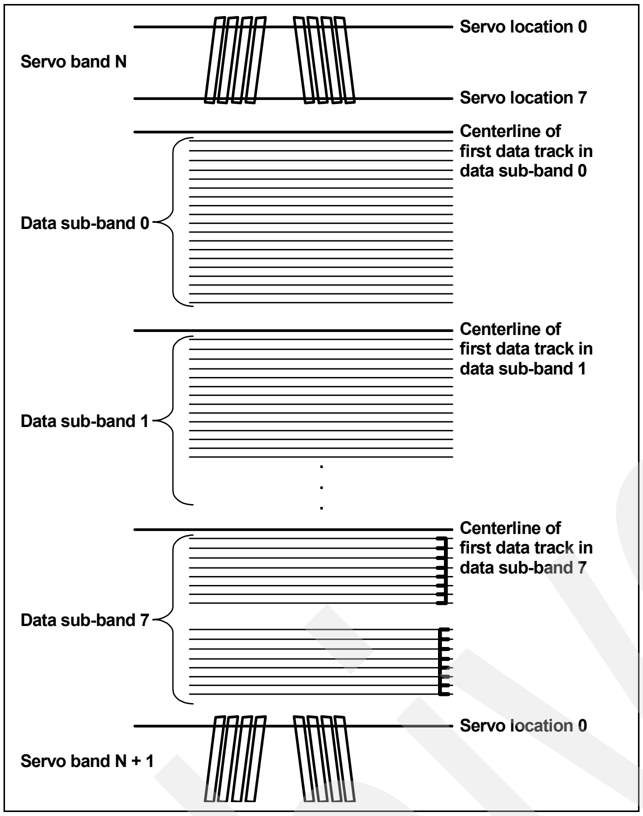


Figure 3-2 Section of tape showing one data band and its surrounding servo bands

Figure 3-3 on page 62 shows an even closer look at a data band. It demonstrates the serpentine method that is used to write data. The numbers on the right indicate the tracks, which are written simultaneously on each data sub-band in a converging spiral in 16 passes for J1A, 14 passes for E05, and 18 passes for E06: down (tape outbound from cartridge) and back (tape inbound to cartridge), each at a different lateral offset. Given the eight or 16 channel heads, eight or 16 tracks of data are written simultaneously in this linear serpentine pattern, each track in separate data sub-bands. After a given data band is full, a coarse-actuator motor moves the head to another quarter of the tape. This process continues until all four data bands are filled.

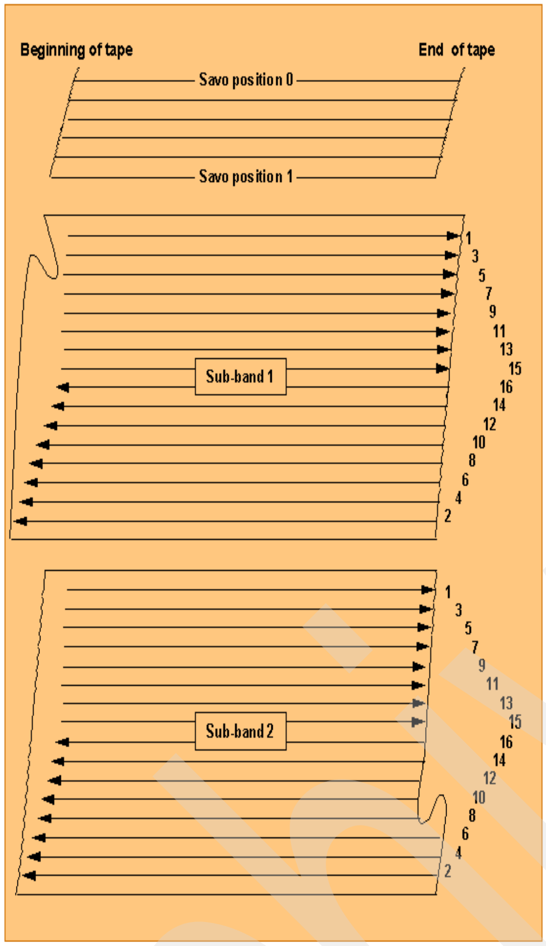


Figure 3-3 Close-up view of two data sub-bands here for J1A with eight tracks and one servo band

Servo tracks

Servo tracks enable accurate positioning of the tape drive head over the data track, ensuring that the head does not stray onto an adjacent track. They are necessary to support high-data densities on the tape where the tracks are very close together. The servo tracks are written at the time of cartridge manufacture, before the cartridge is usable for data storage and retrieval. Each tape write head has two *servo heads*, one servo head for each of the two *servo bands* that it spans. As shown in Figure 3-1 on page 60, five servo bands numbered 0 through 4 make up the servo tracking mechanism on the 3592 tape. They are each located at specific distances from the tape reference edge1. Within the servo bands are *servo stripes*, groups of which make up *servo bursts*. Four servo bursts make up a *servo frame*; the first two bursts (as written in the forward tape-motion direction) contain five servo stripes, and the second two bursts contain four servo stripes.

Track following

Each pair of servo bursts is at an angle to each other, and the servo heads move so that they keep a constant value for the distance between the bursts by measuring the time taken between each burst (*timing-based servo* (*TBS*)). In this way, the servo is able to follow a straight line within the servo band; any small deviation away from the correct path causes a variation (plus or minus) in the gap between the bursts (refer to Figure 3-4 on page 63). Provided that the servo head element follows a straight line along the servo band, then the distance “*x*” shown in the figure remains constant.

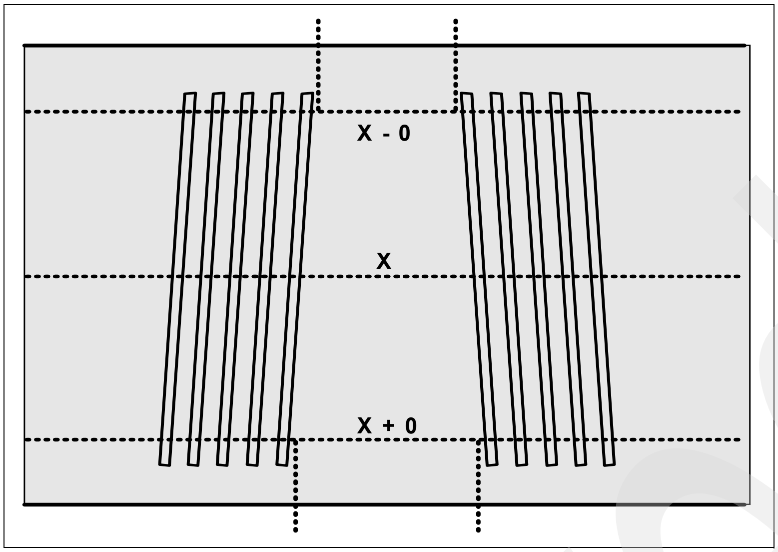


Figure 3-4 Diagram of the timing-based servo track

Two servo bands are used simultaneously to provide two sources of servo information for increased accuracy. For this format, there are control positions within the servo band used to reposition the head in order to write forward and reverse wraps, within each of the four data bands. This timing-based servo technology can be finely tuned and is capable of supporting extremely high-track densities, because more than eight positions can be defined within the same servo band, thus expanding the potential track densities. In addition to the significant advances in the tape coating process using the high-quality metal particle media, we can confidently fulfill the road map design for reformatting this same media at higher densities.

3.2.3 Reliability and availability

The 3592 drive incorporates and expands on the high reliability and function of previous IBM drives developed over many years of experience. It builds on proven technologies to both enhance as well as apply new techniques to ensure high reliability and availability.

Improved availability

Improved availability characteristics include:

- Single field-replaceable unit (FRU)

  When you place a service call, the IBM service support representative (SSR) does not replace any parts or subassemblies inside the canister. The new smaller drive unit means that for any failure within the drive, the IBM SSR quickly exchanges the entire unit rather than perform lengthy diagnostics or component replacement in the field.

- Redundant, hot-pluggable power supplies

  In all configurations, the drives are seated in *cradles* that contain two power supplies. Each pair of power supplies can be used by one or two drives. One of these power supplies is sufficient to run both drives, and the second power supply is provided for redundancy.

- Retention of Fibre Channel Worldwide Name ID during service action

  When a failed drive is exchanged, you do not have to reconfigure the attached hosts to recognize a replacement drive. This function also eliminates any issues with SAN hosts finding incorrect addresses during a system restart.

Advanced technology

Advanced technology characteristics include:

- Robust loader mechanism

  The loader mechanism has been designed to be suitable for the heavy duty cycle usage in mainframe systems. The leader block on the tape cartridge is replaced by a metal pin, which is enhanced over previous drive implementations for increased robustness.

- Elimination of drive pneumatics and mechanical adjustments

  The aerodynamic movement of the tape over the flat lap head pulls the tape very close to the head while the tape is moving and provides maximum efficiency in reading and writing. Because of the shape of the head, particles do not accumulate on the tape, eliminating the possibility of debris contaminating the tape surface. Air-bearing heads effectively cushion the tape moving across the head, but whenever the tape stops, it relaxes toward the head surface. The head has a two stage actuator: one mechanism for moving to the required tape wrap and another finer actuator for adjustments to the track-following servo.

- Straighter and shorter tape path for better tape tracking

  Tape tracking is improved by using grooved rollers to provide surface-controlled guiding. This characteristic not only decreases potential wear or damage on the edges of the tape, but in conjunction with the shorter tape path, lateral movement is decreased.

- Speed matching to reduce backhitching. Refer to 3.2.4, “Features designed for capacity and performance” on page 65 for further details.

  Buffering, speed matching, and virtual backhitch algorithms all serve to eliminate physical backhitching, which not only improves performance, but reduces the wear on the drive mechanics that is caused by continually braking and reversing direction.

- Channel calibration to optimize performance and data integrity

  The drive uses individual R/W data channel calibration, exploiting sophisticated techniques that were originally implemented in disk technology.

Enhanced service functions

These service functions include:

- Enhanced Statistical Analysis Recording System (SARS) recording. The tape drive uses the SARS to assist in isolating failures between media and hardware. The SARS uses the cartridge performance history saved in the cartridge memory (CM) module and the drive performance history kept in the drive flash EEPROM to determine the more likely cause of failure. The SARS can cause the drive to request a cleaner cartridge (based on usage) to mark the media as degraded and to indicate that the hardware is degraded. SARS information is reported through the TapeAlert flags and through media information messages (MIMs) and Service Information Messages (SIMs).

- Diagnostic information

  The drive maintains logs to assist engineering or service personnel. The logs are included in drive dumps and are accessible to service personnel in a number of ways, including through the new hot-pluggable service panel. Dumps are maintained over Power On Reset (POR).

- Additional temperature and voltage sensors to improve error isolation

  The drive contains sensors and circuits to detect errors. A temperature sensor monitors the temperature of the drive electronics. Voltage sensors detect when the power supply is out of tolerance. Other errors, such as tape velocity checks, Read/Write data integrity checks, and servo checks, are performed using circuitry and sensors. The drive microcode is designed to check for logic errors to handle hardware-detected errors and to detect and report microcode-related errors.

- Drive status indicators and reliability, availability, and serviceability (RAS) functions on the library drive interface

  The drive provides indicators for Fibre Channel status, whether the power is good, and faults. However, the drive hot-pluggable service panel is the key service tool to perform test procedures and interpret results. You can now access many functions and information from this panel that were previously only available from the 3494 Library Manager interface.This panel is more convenient and accessible to clients, as well as service personnel.

- Concurrent microcode update and switch new/old copy of drive code
- Backup drive Vital Product Data (VPD card) stored from the drive

  When a drive is replaced, you can quickly download the VPD to the drive using the backup, which reduces the time taken for repair.

- Functional microcode updates through the Library Manager broadcast

  You can update the firmware (microcode) in the 3592 Tape Drive in several ways, and the update no longer requires an Field Microcode Replacement (FMR) tape. You can update the firmware by using the:

  – FMR cartridge that contains the updated code
  – Host attachment (Fibre Channel (FC) bus) using the write buffer command
  – RS-422 port to the drive if supported by the library automation
  – RS-232 debug port at the rear of the canister

- Preventive maintenance

  The 3592 Tape Drive requires no preventive maintenance beyond the use of the cleaning cartridge. The 3592 media cartridges require proper care and appropriate handling and shipping procedures.

3.2.4 Features designed for capacity and performance

As we have mentioned previously, the unique features and specifications of the 3592 make it a true enterprise tape drive in both performance and reliability. We describe these industry leading features in detail in the following sections.

Data buffer

The drive has a large data buffer with read-ahead buffer management, which addresses the lowest band of data rates, effectively collecting more blocks of data together in the buffer before writing the data out at a higher speed to the drive. As a result of this data buffer, the drive stops and starts less often, which in general improves the overall performance and reliability of the drive and tape.

Speed matching

For medium data rates when operating from a host that cannot sustain the maximum 3592 data rate, the drive performs dynamic *speed matching*. The drive adjusts the native data rate of the drive as closely as possible to the net host data rate (after data compressibility has been factored out). The 3592 drive operates at different speeds (between six and seven speeds depending on the drive used) when reading or writing the 3592 format in an attempt to match the effective host data rates. If the net host data rate is between two of the speed matching native data rates, the drive calculates at which of the two data rates to operate. Speed matching reduces the number of required backhitches. In certain environments, the drive's backhitch is completely masked by the drive's data buffer, and thus, the system throughput is not improved or reduced by speed matching.

Cartridge memory (CM)

Contained within the cartridge is the *cartridge memory* (CM), which is a passive, canticles silicon storage device (4096 bytes) that is physically a part of the cartridge. The CM holds information about that specific cartridge, the media in the cartridge, and the data on the media. It is designed to support the high resolution tape directory feature (refer to "High resolution tape directory" on page 66). Communication between the drive and the CM occurs through a non-contact passive radio frequency interface, which eliminates the need for physical connections to the cartridge for power or signals.

High resolution tape directory

The 3592 drive maintains a tape directory structure with a higher granularity of information about the physical position of data blocks and file marks on the media. This feature gives the 3592 drive improved nominal and average access times for locate operations. Locate times are therefore uniform; they are based on the position of the block or file mark on the tape independently of the uniformity of the block size or file mark distribution along the length of the tape. The 3592 locate and space performance therefore is targeted to be completely and singly dependent upon the longitudinal position on tape of the target block or file mark. This might be specified as follows:

- Locate time to any block or file mark on tape = longitudinal position/locate speed.
- A block located at physical end-of-tape (EOT) on a J1A Tape Drive requires less than 82 seconds to retrieve. No block needs to exceed this locate time.
- A block closer to beginning-of-tape (BOT) takes a linearly proportionate shorter time to retrieve.

Virtual backhitch (nonvolatile caching)

The 3592 stages write data through an intermediate DRAM buffer on its way to tape. This buffer is volatile, because it does not retain what is stored in it if power is lost. For streamed writes (or reads), this buffer yields considerably improved performance. When a pre-3592 drive performs a streamed write to tape and the buffer empties, or if a synchronizing command is received that forces the buffer to be written to tape, the streamed writing ceases for want of data. Any non-immediate write-type command (such as how file marks are typically written) is considered a synchronizing command. Non-immediate write-type commands require the drive to store data to tape before returning command complete (with good status) in response to that command, which by definition forces all the data in the volatile buffer to be written to tape.

When streaming writes cease, a pre-3592 Tape Drive halts the tape and repositions it upstream of where the writing ended. This action allows subsequently received data to be written immediately following the previously written data to eliminate the waste of the considerable length of tape from the point at which good status is returned to the host, to the point at which the host has subsequently sent enough data to resume writing. For example, if tape is streaming at 4.74 m/s when the buffered data falls below the threshold, an entire meter of tape can pass unwritten in about 210 milliseconds. Substantial lengths of unwritten tape can significantly reduce capacity. Here, a backhitch has been used by typical tape drives to eliminate this capacity loss following a synchronizing write to tape.

Nonvolatile Caching (NVC) is a 3592 feature that can help greatly improve write performance through backhitch reduction. This feature temporarily reserves portions of physical tape for cache areas. Data received from the host is written to the volatile buffer as usual and also to nonvolatile tape cache areas with the exception that no backhitch is typically necessary when writing temporary copies to cache areas of tape. This temporary capacity loss is easily recouped. The data is written to temporary cache areas and is not released in the volatile buffer, but instead it accumulates. This accumulation typically continues until the buffer is nearly full. At this time, the accumulated data in the buffer is rewritten through a streamed write to the standard area of tape. When the rewrite is complete, the temporary cache areas of tape are released so that they can be overwritten. Writing temporary copies to the cache areas of tape without backhitching until the buffer is nearly full and then streaming a rewrite of the data to the standard area of tape can help significantly improve the average write throughput to tape.

As an example, if a synchronizing event occurs after every 256 KB of data, the best that the 3590 can average is about 0.4 MB/s; basically, 256 KB divided by the backhitch time plus some system overhead. The 3592-J1A, for example, can average about 2.9 MB/s under the same conditions, which is more than a factor of eight better in write throughput because of the backhitches eliminated by NVC writing. Aside from the potentially improved write throughput performance, the second effect of NVC writing is to recover the capacity lost by the standard writing technique. Data received between synchronization events fills containers of data to be written to tape called *device blocks* or *datasets*. The standard writing technique calls for padding out the last partially filled dataset. This padding on average typically amounts to half the size of the last dataset. Given the large dataset sizes of modern tape drives, this loss can be substantial.

For example, some systems write as little as 64 KB of data between synchronizations. The minimum dataset size of the 3592 Tape Drive can hold about 400 KB of data. The 64 KB of data might compress to about 20 KB of data. If so, then the dataset containing this 20 KB of compressed data is going to be written with 380 KB of unused space, which amounts to a 95% capacity loss in that dataset. The streaming rewrite of the data that is accumulated in a buffer causes nearly all the datasets written to a standard area of tape to be written out in full, which can be thought of as *dataset packing*. For example, NVC written data might allow in excess of 900 GB of 3:1 compressible data to be written to JA media on a J1A drive, even if the data written is synchronized every 64 KB.

Writing in NVC mode is automatically invoked by the drive when host writing behaviors are detected that get better performance when in NVC writing mode. Similarly, NVC writing is discontinued when host commands are received that do not benefit from NVC writing, or when commands, such as rewind, are received. When NVC writing is exited, the drive writes any packed datasets that are accumulated in its buffer before beginning execution of the command that caused NVC mode to be exited. Because it is automatically invoked and exited, NVC writing is designed to be transparent to host applications. The only indication that NVC writing occurs is the improved capacity and performance that can result from this new mode of writing.

The two components of nonvolatile caching, backhitch reduction and dataset packing, are designed to provide major performance and capacity improvements over a standard tape drive, such as 3590, or Linear Tape-Open (LTO) writing of synchronized data. Dataset packing improves overall tape capacity. Backhitch reduction decreases the frequency of mechanical repositions. Nonvolatile caching provides an innovative approach to increasing both capacity and write performance in a way that is designed to be transparent to host applications.

3.2.5 Performance or capacity scaling

The 3592 drives support scaling and segmentation modes on the Read/Write (R/W) (JA/JB) cartridges (3592-J1A supports JA only) to allow clients to trade off capacity for improved access times. While 256 settings of capacity are supported on the 3592 drive, there are basically three primary settings used:

- Full capacity default mode
- 20% scaled fast access mode (capacity scaled, front of tape through an x'35' setting)
- Performance scaling for 87% capacity (segmented format, capacity scaling setting x'E0')

Performance scaling, also known as *capacity scaling*, is a function that allows you to contain data in a specified fraction of the tape, yielding faster locate and read times. This function is made possible through the action of modifying internal formatting indicators in the medium (and in the CM chip), so that the normal serpentine track format is altered in such a way as to limit the recorded portion of the tape to a specified fraction of the linear dimension of the medium (illustrated for 3592-J1A in Figure 3-5). The 3592 allows an application to issue a command to scale an individual cartridge (**`Mode Select`** command). It pertains only to the cartridge that is currently loaded; it is not persistent.

The result of performance scaling a tape to a percentage value (for example, 20%) is that the maximum number of recordable gigabytes is reduced to 20% of the normal value, and the average time to locate a random record on a full tape starting from load point is (very roughly) 20% of the time to locate a random record from load point for a full, unscaled tape. To compare, the average time to locate a random record on an unscaled (serpentine) tape that has only been filled to 20% capacity is nearly the same as the average time to locate a random record on an unscaled tape that has been filled to 100%. Scaling cuts the access time proportionately, and it also introduces normal end-of-tape programmatic warnings when approaching the scaled capacity limit in the same sense that those indicators are returned at end-of-tape when unscaled.

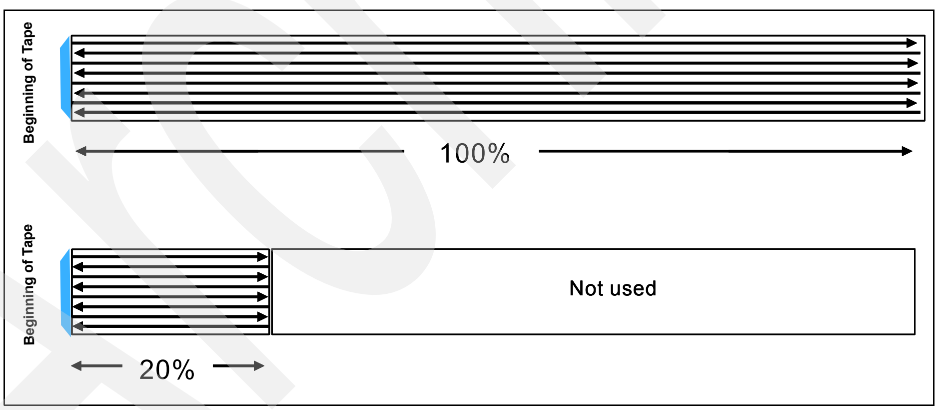


Figure 3-5 Examples for a 100% tape and scaled tape by 20%

The details of how different capacities are set are:

- The 3592 drive does not change current cartridge scaling unless a SCSI **`Mode Select`** command (CDB) specifying Mode Page X'23' (with appropriate non-default parameter settings) is received while the cartridge is positioned at the beginning of tape. The drive can sense and report the scaling state of the current medium through a **`Mode Sense`** command specifying Mode Page X'23'.

- The cartridge can be rescaled from any current value to any supported new value. Tape is logically erased by this rescaling (the end of data mark is written at the beginning of the tape), but not physically erased as with the long erase command. Scaling or rescaling one cartridge does not cause rescaling of the next cartridge; you must issue an explicit command for each cartridge to be scaled or rescaled.
- The drive provides the option of setting scaling values of *N*/256ths of full capacity, where *N* ranges from x'16' (22 decimal equals about 8% capacity) to x'EB' (236 decimal equals about 92%). Refer to Table 3-1 on page 70 for a complete list of capacity scaling options.
- For scaling factors *N* greater than x'4B', the drive scales to the specified amount and creates a fast access segment in the beginning of the scaled region.
- At all scaling factors, the drive supports early warning at the end of the scaled region (appropriate unit attention message to inform software that it needs to flush buffers and close the volume) and reports the physical end-of-tape check condition at the end of the scaled region just as it does at the actual physical end-of-tape if the region is unscaled.

Performance segmentation

Performance segmentation provides fast access and capacity by allowing the tape to be divided into two segments: one segment as a fast access segment to be filled first and the other segment as additional capacity to be filled after the first segment. So, it is high performance in two ways. It has segmentation so it has high performance random access in the first segment as though it was a scaled cartridge, while still providing an additional larger capacity as shown in Figure 3-6.

Implications:

- If host systems provide a means to limit the amount of data that a client places on the media, for example, with a % utilization construct, the user gets much faster average access time to the first data; also, additional locates on the same volume improve significantly.
- With segmentation, there is a small, less than 1% degradation in the data rate due to the increased number of wrap changes. Segmentation also reduces the nominal cartridge capacity by approximately 10%.

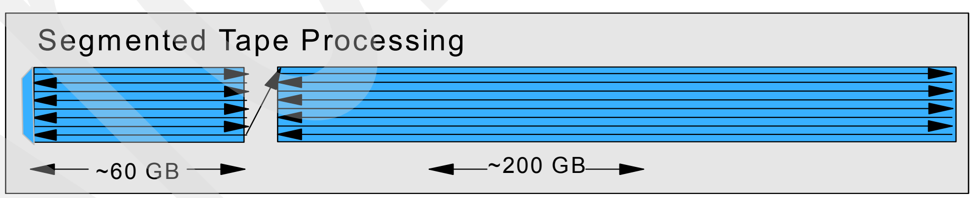


Figure 3-6 Example for a segmented tape on 3592-J1A

Table 3-1 on page 70 summarizes which capacity settings yield segmentation for JA media.

Table 3-1 Capacity scaling settings

Capacity scaling setting	3592-J1A capacity in GB	3592-E05 capacity in GB	3592-E06 capacity in GB	Segmentation
0x00	300	500	640	NO
0x01 – 0x15	27	45	60	NO
0x16 – 0x4A	27 - 87	45 - 145	58 - 185	NO
0x4B – 0xE0	88 - 262	145 - 437	185 - 560	**YES**
0xE1 – 0xEB	263 - 275	437 - 460	560 - 585	**YES**
0xEC – 0xF0	281	470	600	NO
0xF1 – 0xFF	300	500	640	NO

Performance scaling and segmentation support

You implement performance scaling and segmentation functions in z/OS using the Data Class attributes in Interactive Storage Management Facility (ISMF). For information about how to implement these functions, refer to 9.2.8, “Defining SMS constructs through ISMF” on page 260.

3.2.6 Host attachment

In a System z environment, the IBM 3592 tape drives do not attach directly to the host. They are either attached to a TS7700 Virtualization Engine, a VTS Model B10 or B20, or they are attached to an IBM 3590-J70 Tape Controller or TS1120 Model C06 Controller. The 3592 tape drives come with dual-ported switched fabric 2 Gb (Model J1A) and 4 Gb Fibre Channel attachments (3592 Model E) to attach to the TS7700 Virtualization Engine, VTS, or tape controllers. Support for the TS1130 Tape Drive with TS7700 will be available post-GA of the TS1130. VTS does not support the 3592-E06 tape drives. The 3592 Model E drives attempt to connect at 4 Gb (FC-4) but auto-negotiate down to 2 Gb (FC-2) and then 1 Gb (FC-1) if the system or switch to which it is connected cannot support 4 Gb. Similarly, the 3592-J1A Tape Drive attempts to connect at 2 Gb but auto-negotiates down to 1 Gb if the system or switch to which it is connected cannot support 2 Gb.

The 3592 tape drives can operate either as an NL port (FCAL support) or as an N port (supporting direct connection to a Brocade switch for example, also known as *point-to-point*). The 3592 drive auto-negotiates to either an N or an NL port depending on whether it sees a loop or a point-to-point connection when the drive starts up, unless it has been set to force an explicit setting of these configurations. Regardless of whether the 3592 connects as an NL port or an N port, it auto-negotiates to be a public device (attached to a switch) or a private device (attached to another N port, such as directly to a host). If a library drive is replaced, an IBM SSR can select that the replacement unit does automatically inherit the configuration attributes of the failed unit. This selection helps you avoid having to reconfigure the zoning in the switches. Alternatively, you can use the panels to change these fields directly at any time.

The 3592 drives can attach to the 3592 Model J70 Controller or the TS1120 Model C06 Controller for attachment to ESCON or FICON channels on ES/3090™, ES/9000®, S/390, or System z.

For the latest information about applications and the levels that support 3592 tape drives, refer to the Independent Software Vendor (ISV) matrixes at:

http://www.storage.ibm.com/tape/conntrix/pdf/3592_isv_matrix.pdf

You can obtain information about host bus adapter (HBA) support for the 3592 drive at:

http://knowledge.storage.ibm.com/HBA/HBASearchTool

For a detailed description of Fibre Channel attachment planning, refer to *IBM System Storage TS1120 Tape Drive and Controller Introduction and Planning Guide,* GA32-0555.

3.2.7 3592 Cartridges and media

Users are faced with the need to cost-effectively store more digital information than ever before, often to meet growing regulatory and legal requirements. The 3592 tape drives are designed to help meet these needs with the IBM System Storage Tape Cartridge 3592. The 3592-J1A, 3592-E05, and 3592-E06 use the 3592 tape cartridge, which offers various capacity options depending on the drive and recording format that you use or the cartridge model that you order (Data, WORM, or Economy).

These capabilities expand the range of client data workloads that can be addressed with the 3592 tape drives. The economy cartridge can help lower the cartridge cost for users with smaller capacity needs and provide faster access to data. The WORM cartridges provide non-erasable, non-rewritable storage media. Users with regulatory or legal requirements to store electronic records for long periods of time might be able to use the 3592 tape drives to provide cost-effective storage.

The 3592 cartridges have a form factor similar to the 3590 tape cartridge. They are supported in the IBM TotalStorage 3494 Tape Library, IBM System Storage TS3500 Tape Library, and StorageTek™ Automated Cartridge System (ACS) automation environments.

The 3592 cartridge contains 0.5 inch tape media with a new dual-coat, advanced-particle media and has improved areal density capabilities that differ from the tape media in any previously shipped cartridge. The 3592 cartridge is designed to have the strength and durability of an enterprise cartridge. Enhanced assembly strengthens the cartridge at critical locations and helps to make the 3592 cartridge less susceptible to damage, for example, if you drop it.

The tape is pulled from the cartridge by means of a leader pin rather than a leader block as in the 3590, and a sliding door covers the area formerly occupied by the leader block in a 3590 cartridge. A locking mechanism prevents the media from unwinding when the cartridge is not located within a drive. A special mechanical design provision prevents the 3592 cartridge types from being loaded into 3590 or 3490 drives; if inadvertently loaded into a 3590, the cartridge present sensor does not change state and the drive does not attempt to load.

Media types

The 3592-J1A uses four media cartridge types: JA, JJ, JW, and JR. The 3592-E05 and the 3592-E06 use six media cartridge types: JA, JJ, JW, JR, JB, and JX. All six cartridge types contain the same dual-coat, advanced-particle media. Capacity on these media types depends on whether the cartridge is used by Model 3592-J1A, 3592-E05, or 3592-E06. Table 3-2 on page 72 shows the six media types and the capacity options that are available with 3592 tape drives.

Table 3-2 IBM TotalStorage Enterprise 3592 media types

Media type and description	Media type	Length	Native capacity 3592-J1A (E1 format)	Native capacity 3592-E05 emulating J1A (E1 format)	Native capacity 3592-E05 (E2 format)	Native capacity 3592-E06 (E3 format)	Native capacity 3592-E06 (writing in format E2)
MEDIA5 DATA	JA	609 m	300 GB	300 GB	500 GB	640 GB	500 GB
MEDIA6 ECONOMY	JJ	246 m	60 GB	60 GB	100 GB	128 GB	100 GB
MEDIA7 WORM	JW	609 m	300 GB	300 GB	500 GB	640 GB	500 GB
MEDIA8 ECONOMY WORM	JR	246 m	60 GB	60 GB	100 GB	128 GB	100 GB
MEDIA9 EXTENDED DATA	JB	825 m	N/A	N/A	700 GB	1000 GB = 1 TB	700 GB
MEDIA10 EXTENDED WORM	JX	825 m	N/A	N/A	700 GB	1000 GB = 1 TB	700 GB

Figure 3-7 shows four of the media types. The WORM cartridges pictured on the left have a platinum-colored shell, and the R/W cartridges on the right have a black shell. The write protect tab, door, and label for the full length cartridges (both WORM and R/W) are dark blue.The write protect tab, door, and label for the extended length cartridges (both WORM and R/W) are dark green. The write protect tab, door, and label for the economy (short length) cartridges are light blue.

Figure 3-7 IBM TotalStorage Enterprise 3592 WORM and R/W cartridges

Figure 3-7 shows two WORM cartridges on the left and two R/W cartridges on the right.

Labels

The 3592 cartridges use a media label to describe the cartridge type. Figure 3-8 shows a 3592 cartridge with a JA label. In tape libraries, the library vision system identifies the types of cartridges during an inventory operation. The vision system reads a volume serial number (VOLSER), which appears on the label on the edge of the cartridge. The VOLSER contains from one to six characters, which are left-aligned on the label. If fewer than six characters are used, spaces are added. The media type is indicated by the seventh and eighth characters.

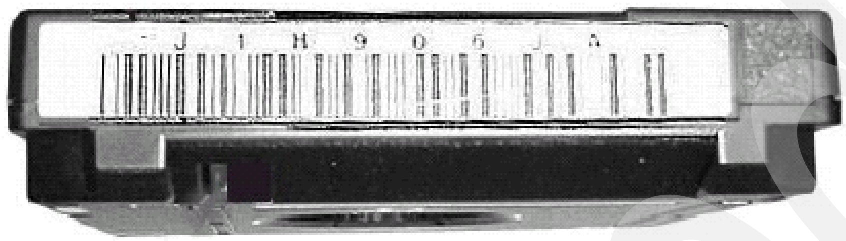


Figure 3-8 View of the 3592 cartridge label

Cleaning cartridges

There is one cleaning cartridge designed specifically for the 3592 drives. As with the data cartridges, the 3592 cleaning cartridges are not interchangeable with any other model cleaning cartridges (that is, LTO), so you must have both types of cleaning cartridges if you have both types of drives in your environment. The cleaning cartridge also contains a cartridge memory (CM) device, which automatically tracks the number of times that it has been used. Cleaning cartridges need to be replaced after 50 uses. The physical characteristics of the 3592 cleaning cartridge can be used to distinguish it from the 3592 data cartridges. The product label on the top of the cartridge is white with the word "`cleaning`" printed on it. Instead of the write-protect switch, there is a non-moveable light gray block. The cartridge door is also light gray. If you order cleaning cartridges with pre-attached labels, the first three characters of the volume serial number (VOLSER) are `CLN`.

3.2.8 3592 WORM functionality

The IBM TotalStorage Enterprise Tape Cartridge 3592 Write Once Read Many (WORM) data cartridges are designed to provide non-alterable, non-rewritable tape media for long-term records retention. WORM characteristics include:

- WORM cartridges are available as 300 GB or 60 GB native capacity for E1 format (3592-J1A), 700 GB, 500 GB, or 100 GB native capacity for E2 format (3592-E05), and 1000 GB, 640 GB, or 128 GB native capacity for E3 format (3592-E06).
- Non-reversible screws are used to secure the media housing.
- WORM and R/W cartridges can be intermixed within the same IBM TotalStorage Enterprise Automated Tape Library 3494, IBM System Storage TS3500 Tape Library, or StorageTek Automated Cartridge System (ACS) solutions.
- When the drive senses that a cartridge is a WORM cartridge, the microcode prohibits changing or altering user data already written on the tape. The microcode tracks the last appendable point on the tape by means of an overwrite-protection pointer stored in the cartridge memory (CM).
- Each WORM cartridge is identified using a Unique Cartridge Identifier (UCID).

Basic WORM

The 3592 tape drives support both the 3592 R/W cartridges, as well as 3592 WORM cartridges. The WORM cartridge is geometrically identical to a R/W cartridge and uses the same rewritable media formulation. The servo format, which is mastered onto the tape at manufacturing, is different for WORM cartridge types, however. The WORM function comes not from any inherent non-reversible media characteristic (such as permanent WORM on optical media or such as compact disc recordable (CD-R) or ablative optical WORM), but rather by the way that the 3592 drive's microcode handles a WORM cartridge. The drive's microcode does not allow overwrite or erasure of previously written user data, such as records or file marks; however, the drive's microcode supports appending new data following existing data.

Unique cartridge identifier

Each IBM TotalStorage Enterprise 3592 Tape WORM cartridge is identifiable through a unique cartridge identifier (UCID). The intent of the UCID is that it is constructed to guarantee that it is unique worldwide. This identifier is derived from a concatenation of the 4 byte unique CM serial number of the CM chip in the 3592 WORM cartridge and the 8 byte unique tape serial number created from information mastered into the timing-based servo (TBS) at the time that the cartridge is manufactured. The parts of UCID that come from this serial number are written to a locked part of the CM. This additional level of security supports legal audit requirements. Furthermore, the UCID allows unique cartridge tracking and can be the differentiator to other WORM tape providers.

Drive operation to prevent overwrite

A WORM drive handles a WORM cartridge differently than a R/W cartridge. In general, it responds to a subset of the Small Computer System Interface (SCSI) commands that work on a R/W cartridge. For example, an `Erase` command is rejected with the appropriate error posted. Additionally, a WORM drive rejects certain command sequences of otherwise valid commands. For example, if a cartridge is not empty, a `Rewind` command followed by a `Write` command is rejected with the appropriate error posted. In general, the drive prevents overwrite. There are, however, exceptions, which the drive has to support to be flexible and "application software transparent." Specifically, the drive has to support certain overwrite cases.

WORM permits overwrite for the following scenarios:

- WORM permits overwrite in order to allow extending files.
- It permits overwrite to allow appending files.
- WORM permits overwrite in order to allow relabeling a new scratch tape. It then overwrites the VOL1 record if there are no subsequent records on the tape.
- WORM relies on known header/trailer constructs.
- Statistical Analysis and Reporting System (SARS) data can be written and updated on WORM tapes, because the SARS data is not in the user area of the tape.

Final destruction of WORM cartridges

You cannot reuse a WORM cartridge after you have written to it; therefore, you need to destroy it when it is no longer of use. If the WORM cartridge has sensitive data, you need to *bulk-erase* it, which erases everything on the tape, including the mastered servo pattern, rendering it useless, before you send it to the landfill or the incinerator.

3.3 The IBM System Storage TS1130 Tape Drive

The IBM System Storage TS1130 Tape Drive (also referred to as the 3592 Model E06 and EU6) is the third tape drive generation of the IBM 3592 tape family. This generation provides higher capacity and performance compared to the predecessor, 3592 Model E05. The TS1130 records in two recording formats, supporting both encryption and non-encryption. Enterprise format 3 (EFMT3) is used to represent the non-encrypted recording format, and enterprise encrypted format 3 (EEFMT3) is used to denote the encrypted recording format. With these recording formats, the non-compressed capacity of the extended length MEDIA9 and MEDIA10 cartridges is increased from 700 GB to 1 TB. The 3592 Model E06 is downward-read compatible (*n*-2) to the 3592 Model J1A format (EFMT1), and the 3592 Model E06 is downward-write compatible (*n*-1) to the 3592 Model E05 formats (EFMT2/EEFMT2). All current media types are supported.

Host interfaces to System z and Open Systems platforms are maintained; the System Storage TS1130 Tape Drive is supported by IBM 3592 Model J70 Tape Controller, the System Storage TS1120 Tape Controller Model C06, and the TS7700 Virtualization Engine using 4 Gb dual port fiber cards. It allows for the integration into the IBM TotalStorage 3494 library, the TS3500 library, the TS3400 library, a stand-alone rack, and the Sun Silo. There is no support for the 3494 Model B10 or B20 Virtual Tape Server.

Figure 3-9 shows the front view of the IBM TS1130 Tape Drive.

Figure 3-9 Front view of the TS1130 Tape Drive

The TS1130 Tape Drive maintains the same features and technology enhancements introduced with the 3592 Model J1A and extended by the TS1120. In addition, the TS1130 offers several enhancements over the predecessor models, which we explain in more detail on the following pages.

Features introduced with the 3592-J1A and 3592-E05 include:

- Digital speed matching
- Channel Calibration
- High resolution tape directory
- Recursive Accumulating Backhitchless Flush or Nonvolatile caching (NVC)
- Backhitchless backspace
- Streaming Lossless Data Compression (SLDC)
- Capacity scaling
- Single field-replaceable unit (FRU)

- Error detection and reporting
- Statistical Analysis and Reporting System (SARS)
- Encryption support
- Dual stage 16-head actuator
- Offboard data string searching
- Enhanced logic to report logical end-of-tape

3.3.1 Multiple subsystem and automation support

As with the previous models, the 3592-E06 supports all the same subsystems and automation environments. The 3592-E06 and 3592 cartridges support multiple automation libraries and can be easily transported between environments. These systems are summarized in Table 3-3.

Table 3-3 Subsystem support summary

Subsystem	3592-E06	3592-E05	3592-J1A
3494-L22	4 drives per frame	4 drives per frame	4 drives per frame
3494-D22	12 drives per frame	12 drives per frame	12 drives per frame
3494-D24	8 drives per frame	8 drives per frame	8 drives per frame
Support within a frame	Must be all of the same model	Mix with 3592-J1A is allowed[a]	Mix with TS1120 is allowed[b]
3584-L23	12 drives per frame	12 drives per frame	12 drives per frame
3584-D23	12 drives per frame	12 drives per frame	12 drives per frame
Support within a frame	Full mix of all models allowed	Full mix of all models allowed	Full mix of all models allowed
J70 Controller	Only homogenous drive types	Only homogenous drive types	Only homogenous drive types (or E05 in J1A Emulation mode)
TS1120-C06 Controller	Only homogenous drive types	only homogenous drive types	Only homogenous drive types (or E05 in J1A Emulation mode)
VTS	Not supported	Supported in J1A mode	Supported
TS7700	Not supported[c]	Supported	Supported
SUN Silo	Full mix of all models allowed (20 drives/C20)	Mix of E05 and J1A models allowed (20 drives/C20)	Mix of E05 and J1A models allowed (20 drives/C20)
ADIC Scalar 10000	Supported	Supported	Supported
TS3400	Supported (2 drives/unit)	Supported (2 drives/unit)	Not supported
Rack-mounted	Supported (12 drives/frame)	Supported (12 drives/frame)	Supported (12 drives/frame)

a. As long as the TS1120 is running in J1A Emulation mode.
b. As long as the TS1120 is running in J1A Emulation mode.
c. It is the intent of IBM to provide this support after general availability of the TS1130.

3.3.2 Media reuse

We provide capacity and performance improvements with the TS1130 Tape Drive on existing media:

- The TS1130 Tape Drive reuses all TS1120 supported media types:

  MEDIA5: IBM 3592 Enterprise Tape Cartridge
  MEDIA6: IBM 3592 Enterprise WORM Tape Cartridge
  MEDIA7: IBM 3592 Economy Tape Cartridge
  MEDIA8: IBM 3592 Economy WORM Tape Cartridge
  MEDIA9: IBM 3592 Extended Tape Cartridge
  MEDIA10: IBM 3592 Extended WORM Tape Cartridge

- The TS1130 improves capacity and performance by writing and reading the E06 logical format utilizing higher track density and higher linear density on the same media types.
- The TS1130 supports downward-reading of 3592-J1A and TS1120 native formats and downward-writing of the TS1120 format: *n*-2 for read and *n*-1 for R/W.
- You must apply the appropriate microcode levels available for 3592-J1A and TS1120, which enable the recognition of the E06 format and allow reuse of the media in the older formats. Thus, a Model J1A or E05 drive is able to reformat media previously written in the E06 format and to write on it in the appropriate format.

> **Note:** This reformatting allows a common scratch pool by media type regardless of last written format or allocation target drive.

3.3.3 Capacity and performance

Capacity and performance have been improved compared to the TS1120 Tape Drive for all media types and for all formats that the TS1130 reads or writes.

Capacity improvement

We get a capacity improvement using the 3592-E06 logical format:

- A 42% capacity uplift for JB/JX (extended length media) from 700 GB to 1 TB
- A 28% capacity uplift for JA/JW (standard length media) from 500 GB to 640 GB
- A 28% capacity uplift for JJ/JR (economy short media) from 100 GB to 128 GB

Performance improvement

The overall performance is increased by multiple improvements, such as increased data rate, larger buffer, better backhitching, improved speed matching, read ahead, faster locate, and improved communication links.

Higher data rates

Performance is improved from the TS1120 up to 60% in TS1130 mode, 50% in TS1120 mode for reads and writes, and 50% in 3592-J1A mode for reads only:

- The E06 format data rates go up to 160 MB/s maximum native and to 360 MB/s maximum compressed.
- The E05 format data rates go up to 150 MB/s maximum native and to 360 MB/s maximum compressed.
- The J1A mode for reads only go up to 70 MB/s maximum native and to 360 MB/s maximum compressed.

The maximum compressed data rate numbers might be similar for all modes, but the compression ratio required to reach the data rate is different.

Capacity and performance characteristics are summarized in Table 3-4.

Table 3-4 Capacity and performance summary

Media	E06 format capacity data rate (minimum - maximum)	E05 format capacity data rate (minimum - maximum)	J1A format capacity data rate (minimum - maximum)
JB/JX	1 TB 40 MB/s - 160 MB/s	700 GB 40 MB/s - 150 MB/s	N/A
JA/JW	640 GB 40 MB/s - 140 MB/s	500 GB 40 MB/s - 140 MB/s	300 GB (read only) 30 MB/s - 70 MB/s
JJ/JR	128 GB 40 MB/s - 140 MB/s	100 GB 40 MB/s - 140 MB/s	60 GB 30 MB/s - 70 MB/s

Larger buffer

The main buffer size is increased to 1 GB. This increase improves the drive agility, the file access, and small file handling, which might still be a requirement on z/OS platforms. Furthermore, the buffer reduces backhitches for all workloads and improves the overall write and read performance.

Speed matching

The speed matching function is improved on the TS1130 drive. Both the number of speeds and the range of data rates supported are improved, while the data rate range depends on the logical format and the media typed used:

- Seven R/W speeds are supported for JB media:
  - For the EFMT3/EEFMT3 format, the range is 31 MB/s to 163 MB/s.
  - For the EFMT2/EEFMT2 format, the range is 29 MB/s to 150 MB/s.
- Seven R/W speeds are supported for JA media:
  - For EFMT3/EEFMT3 and EFMT2/EEFMT2, the range is 27 MB/s to 139 MB/s.
  - For the EFMT1 format, the range is 14 MB/s to 70 MB/s.

Virtual backhitch

The small file write synchronize feature is improved, so we get a 30% - 50% net data rate improvement for write synchronize workloads. Learn more about write synchronization in “Virtual backhitch (nonvolatile caching)” on page 66.

Faster high speed space/locate

The load times and unload times have been slightly improved. The maximum locate/rewind speed is increased to 12.4 m/s. With these enhancements, the average first file access time has improved. Refer to Table 3-5 on page 80.

Increased library interface link speed

For the TS3500 library attachment and for the TS3400 libraries, the LDI RS-422 interface speed has been increased to 922 KBAUD. This increase provides faster code downloads and dump uploads from the library. In the 3494 libraries, the BAUD rate remains at the current operating defaults.

Read ahead

On sequential reads, we automatically read ahead and fill the buffer with data sequentially beyond the target block (*N*). If one of these blocks is a target of the next command (such as *N*+200), it is already in the buffer, and thus, transfer is extremely fast. And we then automatically fill the buffer sequentially with data past (*N*+200). Due to the large data buffer, the 3592-E06 supports read ahead of approximately 1000 MB of compressed data from tape. So for applications that issue many repeating sequential short-hop locates (skipping over files and reading the file headers, for example), we outperform competitive drives, which simply stop and wait for the next command, with this unique functionality.

Performance scaling and segmentation

As with the 3592 Model J1A and the 3592 Model E05, performance scaling and performance segmentation are supported with MEDIA5 and MEDIA9 cartridges on the TS1130. Using the recording formats EFMT3/EEFMT3, a MEDIA5 cartridge can be scaled to 128 GB and a MEDIA9 cartridge can be performance scaled to 200 GB. Then, using performance segmentation, a MEDIA5 cartridge can be segmented into a 128 GB fast access segment and a 426 GB slower access segment, and a MEDIA9 cartridge can be scaled to a 200 GB fast access segment and a 666 GB slower access segment. Cartridges that are performance scaled or performance segmented can be reused (reformatted) to their full capacity, to the performance-scaled capacity or to the performance segmentation format as indicated through the assigned data class.

> **Note:** You might not want to scale JB media because of the higher waste of capacity. There is still no software available to use any other segment except the first segment.

3.3.4 Access performance specifications and drive characteristics

Table 3-5 on page 80 summarizes the improvements in the access performance, that is, the time to first data, block locate time from load point, or random locate times, and the drive characteristics.

Table 3-5 Access performance specifications and drive characteristics

Parameter	3592-E06 EFMT3 or EEFMT3	3592-E05 EFMT2 or EEFMT2	3592-J1A EFMT1
Tape speed: locate/rewind	12.4 m/s	10 m/s	8 m/s
Drive load/ready time	12 s	13 s	19 s
Block locate time from load point average	27 s for JA/JW 11 s for 20% scaled JA/JW 11 s for JJ/JR 36 s for JB/JX 15 s for 20% scaled JB	33 s for JA/JW 11 s for 20% scaled JA/JW 11 s for JJ/JR 45 s for JB/JX 15 s for 20% scaled JB	39 s for JA 11 s for 20% scaled JA
Time to first data average (load/ready + locate)	39 s for JA/JW 24 s for 20% scaled JA/JW 24 s for JJ/JR 48 s for JB/JX 28 s for 20% scaled JB	46 s for JA/JW 24 s for 20% scaled JA/JW 24 s for JJ/JR 58 s for JB/JX 28 s for 20% scaled JB	39 s for JA 11 s for 20% scaled JA
Random block locate time	20s for JA/JW 9 s for 20% scaled JA 27 s for JB/JX 12 s for 20% scaled JB	23s for JA/JW 10 s for 20% scaled JA 31 s for JB/JX 12 s for 20% scaled JB	27 s for JA 9 s for 20% scaled JA
Unload time	23 s for JA/JW/JR/JJ/JB/JX	23 s for JA/JW/JR/JJ/JB/JX	21 s for JA
Rewind maximum	66 s for JA/JW 18 s for 20% scaled JA 18 s for JJ/JR 90 s for JB/JX 24 s for 20% scaled JB	66 s for JA/JW 18 s for 20% scaled JA 18 s for JJ/JR 90 s for JB/JX 24 s for 20% scaled JB	77 s for JA 18 s for 20% scaled JA
Read/write speed maximum	8.551 m/s	6.21 m/s	4.74 m/s
Number of tracks	1152	896	512
Linear density	321 kbpi	282 kbpi	282 kbpi
Servo regions	5	5	5
Data tracks recorded simultaneously	16	16	8
Buffer size	1 GB	512 MB	128 MB

3.3.5 Emulation mode

The 3592 Model E06 does not support any emulation modes. Because the drive cannot write the J1A logical format, it cannot fully emulate all of the format behaviors of a TS1120 or 3592-J1A drive.

3.3.6 TS1130 physicals

The TS1130 drive comes with the identical form factor and is plug-compatible with existing 3592 models. It maintains low power and improves power management. The maximum continuous operating power has increased by 2 watts from the TS1120 because of faster motor speeds:

- 39 watts drive-only compared to 37 watts for the TS1120
- Standby power is less than 20 watts

The TS1130 has a standby cooling management feature, which reduces the fan speed when idle, to further reduce power and reduce airborne debris contaminants. The fan operating mode is controlled by a single input signal called “Full speed mode and variable speed mode”. In full speed mode, the fan/blower runs at full speed. In variable mode, the blower adjusts its speed based on the ambient temperature down to a minimum of about 50% of its full speed. Additional characteristics include:

- 3592-E06 drive code enables variable speed mode under the following conditions:
  - The drive has been unloaded and idle for five minutes
  - The internal temperature is at least 3 degrees below the “Full speed required” temperature limit
- The drive code reverts to full speed mode as soon as:
  - A cartridge is placed in the loader or loaded
  - The internal temperature of the drive rises above the “Full speed required” temperature limit

The internal temperature sensor is sampled at a five minute interval.

3592 packaging

Like previous models, the TS1130 is a canister with a drive packaged inside. Unique model markings on the front and rear of the canister allow the identification of an E06/EU6 from a E05 or J1A drive. The canister enclosure provides mounting, connections, fiducial labels for calibration, and status LEDs for use in automation frames. The canister is mounted in various forms of mounting hardware for use in different automation systems. Inside of the canister is the drive unit. The 3592-E06 drive itself has the same physical form factor as the TS1120 and the 3592-J1A drive. Thus, you can change the drive only instead of the complete canister.

The 3592-E06 canister no longer has an RS-232 serial port, which remains if you miscellaneous equipment specification (MES) an existing 3592-E05 to a E06 model. An Ethernet service port has been added to the drive, which currently is used only for service. It is a single, standard RJ-45 connector at the rear of the canister, supports only the IPv4 protocol, and supports online service and debug functions to a non-client network. Both features are not available on the TS1120 model with the MES.

3.3.7 Upgrade considerations

A drive field-MES conversion feature is available to allow for a 3592-E05 to 3592-EU6 model conversion to a TS1130. If you choose this way to replace your TS1120 drive, only the drive will be changed and the canister will remain. This model EU6 is identical to model E06 with the following exceptions:

- Standby fan speed control feature is not available
- The drive Ethernet service port is not available

The serial number of the original drive will be written by the library into the vital product data (VPD) of the replacement drive. The MES is valid for TS3500, IBM 3494 Tape Library, a C20 frame attached to a silo, and a rack-mounted drive.

3.3.8 Firmware updates

Next, we describe the minimal changes to the firmware update mechanisms for the TS1130.

> **Note:** Do not attempt to update drive firmware in a System z environment in which all of the drives are attached to a controller or TS7700/VTS and a change of the drive code has implications on the code of the controller and library.

The changes are:

- All four mechanisms currently supported for microcode updates on the 3592-E05 also provide support on the E06/EU6:
  - Host interface
  - Debug interface
  - Library interface
  - Field microcode replacement (FMR) cartridge
- The TS1130 continues to support concurrent microcode load with deferred activation.
- The TS1130 has a single microcode image that is unique from previous models.

3.3.9 RAS

The reliability, availability, and serviceability features are improved or maintained with the TS1130 Tape Drive. As with its predecessor models, the TS1130 is a single field-replaceable unit (FRU), hot pluggable without a maintenance window, and allows for nondisruptive code load. Fan speed management and unique device microcode file management are available through a LOAD ID. Support is maintained for a larger service display panel. The end of life usage alert for media became activated on full file pass usage. Nearing Media Life (alert x13) is given at 19 900 mounts or 295 full file passes, and media Life (alert x07) is given at 20 000 mounts or 300 full file passes.

3.3.10 Improved media SARS

The media SARS function is improved for the TS1130:

- MIMs and tape alerts now are generated when media passes usage life, as determined by full file passes, meters of tape proceeded, or write pass count, in addition to the total number of mounts, which was already supported.
- The media SARS summary is maintained in the cartridge memory (CM) in a manner in which it can be rebuilt on tape in the event SARS records on tape cannot be read and must be re-initialized. This CM copy is also readable on a down-level 3592-J1A drive to preserve SARS information between logical format conversions.

3.3.11 Encryption

The TS1130 Tape Drive automatically is encryption-enabled in a System z environment when attached to a tape controller. There is no need to enable the drive explicitly as was the case with the TS1120 Tape Drive. Refer to Chapter 4, “Tape Encryption” on page 103.

3.3.12 Tracking written data

Today, an application can track in KBs, the number of logical bytes written, the number of physical bytes written, the amount of free space remaining on a volume, the capacity of the volume, the number of logical bytes deleted, and so forth. Now with a 1000 GB tape (non-compressed), the 3592 Model E06 might overflow some of the 4-byte fields that contained these values. Of particular concern are the logical data-related fields that (with compression) deal with an amount of data that might be larger than the physical capacity of the tape. Applications that use, store, and display this type of information might need to account for and determine how best to handle an overflow situation.

3.4 The IBM System Storage TS1120 Model E05 Tape Drive

IBM System Storage TS1120 Tape Drive Model E05 is the second generation of the 3592 tape drives. It has the same machine type as the 3592-J1A, with the model type, E05, and is designed for applications that require high capacity and fast access to data across a wide range of environments. The TS1120 Tape Drive provides you with the ability to encrypt your data at the drive. For more information about encryption, refer to Chapter 4, “Tape Encryption” on page 103. The TS1120 Tape Drive features dual 4 Gb Fibre Channel interfaces, a native data rate of up to 100 MB/s, and a native physical capacity of up to 500 GB on the JA cartridge or 700 GB on a JB cartridge. As with the previous 3592-J1A, the 3592-E05 includes an RS-422 library interface port for communication with the TS3500 Tape Library. The 3592-E05 has support for attachment to ESCON and FICON channels on System z servers through the following tape subsystems:

- TS1120 Tape Controller
- 3592-J70 Tape Controller
- TS7700 Virtualization Engine[1]
- B10 and B20 Virtual Tape Servers (VTSs) (in J1A Emulation mode)

Figure 3-10 shows the front view of the IBM TS1120 Tape Drive.

Figure 3-10 TS1120 Model E05

3.4.1 Features for reliability, availability, and performance

The TS1120 Tape Drive maintains the same form factor and reliability specification of the previous model 3592-J1A, as well as the features and technology enhancements introduced with the 3592 Model J1A. In addition, the 3592-E05 offers several enhancements over the J1A model.

[1] You can configure TS1120 Model E05 in native E05 mode or J1A Emulation mode. All drives have to operate in the same mode behind a given tape subsystem. You must configure all drives in native E05 mode to enable the support of the 3592 Extended Data cartridge (JB media). You can intermix encryption-capable and non-encryption-capable drives. However, all drives must be encryption-capable to enable Encryption for the TS7700.

Features introduced with the 3592-J1A and incorporated into the 3592-E05 include:

- Digital speed matching
- Channel Calibration
- High resolution tape directory
- Recursive Accumulating Backhitchless Flush or Nonvolatile caching (NVC)
- Streaming Lossless Data Compression (SLDC)
- Capacity scaling
- Single field-replaceable unit (FRU)
- Error detection and reporting
- Statistical Analysis and Reporting System (SARS)

These features are described in detail in 3.2.4, “Features designed for capacity and performance” on page 65.

To further improve performance and capacity, the TS1120 Tape Drive offers additional enhancements over the 3592 Model J1A. The following section describes these enhancements in detail. Table 3-5 on page 80 shows a comparison of the 3592-J1A, the TS1120, and the TS130 Tape Drive characteristics.

Large internal buffer

The 3592-E05 has a 512 MB internal data buffer compared to the 128 MB maximum on the 3592-J1A. In addition to offering higher performance characteristics, the data buffer offers a Read Ahead feature of approximately 500 MB of compressed data from tape. When the drive processes a command to locate or read a block from tape, in parallel with returning the requested block or locate status to the host, the drive automatically continues to stream down the tape and read ahead until the buffer is full. This feature allows subsequent Locate or Read commands of relatively close proximity blocks to be fulfilled from the data buffer at higher speeds than if access to the tape is required.

Dual stage 16-head actuator

The 16-head actuator is designed to improve precision head alignment to help support higher track density. The 3592-E05 uses the Enterprise Format 2 (EFMT2 or E2) recording technology (896 tracks, 16 channels), which increases the data capacity of all four cartridge types to 500 GB for types JA and JW and 100 GB for types JR and JJ. When using the IBM Tape Cartridge 3592 Extended Data (JB and JX media type), the data capacity is 700 GB. The 3592-E05 can also read and write in Enterprise Format 1 (EFMT1 or E1) when emulating the 3592-J1A.

Offboard Data String Searching

The 3392-E05 can search the data content of host records for string matches. This function is called *Offboard Data String Searching*, because the data search might be performed offboard from the host. This feature allows the tape drive to search for records on a tape that contain a particular ASCII or EBCDIC character string (1 to 16 bytes in length) at a maximum data rate of 100 MB/s. It takes longer if the host performs this function, because the host server needs to read the data, buffer the data to disk, and then parse the actual data stream with host software routines. You can program the compare string search content and options through the **`Mode Select`** or **`Send Diagnostic`** command. For information about these commands and details of the programming fields, refer to *IBM System Storage TS1120 Tape Drive SCSI Reference,* GA32-0562.

Enhanced logic to report logical end-of-tape

The 3592-E05 uses enhanced logic to report the logical end-of-tape (LEOT), which is based on a combination of *capacity-based LEOT (CB-LEOT)* and *position-based LEOT (PB-LEOT)* indicators. Position-based LEOT is reported based on reaching a physical position on the tape. With capacity-based LEOT, the 3592-E05 monitors the total accumulated number of physical datasets written to the volume and reports LEOT when 505 GB of uncompressed data has been recorded. In the event that the 3592-E05 is unable to record the number of datasets before reaching the PB-LEOT physical landmark, LEOT is reported immediately upon reaching this physical position. A minimum capacity buffer of 5 GB is guaranteed between LEOT reporting and physical end-of-tape, beyond which no data can be recorded. The effect of this LEOT function is to reduce the variation in the amount of data recorded before LEOT is issued, and therefore for applications that use LEOT to stop the write process, a more consistent capacity is recorded to the media.

Encryption support

The IBM System Storage TS1120 Tape Drive provides you with an option to use drive-based data encryption, which is now standard on all TS1120 tape drives. A chargeable upgrade feature to enable your drive for encryption is available for existing installed TS1120 tape drives. All 3592 media, including Write Once Read Many (WORM) and extended cartridges, can be encrypted. Based on the Data Class that you have defined, the TS1120 Tape Drive can write in either encrypted or non-encrypted format.

> **Note:** When using Tape Drive Encryption, all the TS1120 tape drives that are attached to a single 3592-J70 or TS1120 Tape Controller must be encryption-enabled.

J1A emulation

The 3592-E05 has an emulation mode that enables it to emulate the previous 3592-J1A Model. When attached to a TS7700 Virtualization Engine, a 3592-J70, or a TS1120 Model C06 Tape Controller in heterogeneous frames containing J1A drives, the 3592-E05 drives automatically operate in J1A Emulation mode in these subsystems, even when they are set to operate as native E05 drives. When attached to a VTS, the E05 tape drives always operate in J1A Emulation mode. In this mode, the 3592-E05 drives read and write only in E1 format at the J1A performance and capacity ratings. When removed from these subsystems, the drives automatically revert to native E05 operation, and no action is necessary to restore normal mode.

In J1A Emulation mode, the TS1120 cannot be enabled for Encryption. It can read and write in a format that is compatible with the 3592 Model J1A Tape Drive:

- The TS1120 Tape Drive can read and append to cartridges written by the 3592 Model J1A Tape Drive.
- The TS1120 Tape Drive can write cartridges in a 3592 Model J1A format that can be read and appended to by the 3592 Model J1A Tape Drive.
- The TS1120 Tape Drive cannot read cartridges written by the 3590 or 3490. Cartridges written by the TS1120 Tape Drive cannot be read by the 3590 or 3490. Even though the cartridges are similar in size, they contain different media and thus are not interchangeable.
- The 3592-J1A cannot read or append to cartridges that were created on a TS1120 Tape Drive in either EFMT2 or EEFMT2 mode.
- The TS1120 Tape Drive can be attached to the same 3592 Model J70 or C06 Controller, TS7700 Virtualization Engine, or 3494 VTS Model B10 or B20 with 3592 Model J1A tape drives. This attachment is only supported when the TS1120 is running in J1A Emulation mode. After TS1120 drives are set to run in E05 native mode, intermix is not supported.

3.4.2 Performance scaling and segmentation

The 3592-E05 provides the same support for performance scaling and segmentation on the JA and JB cartridge as the 3592-J1A does for the JA cartridge; however, the higher density E2 format used by the 3592-E05 results in different data capacity for scaled and segmented cartridges than the 3592-J1A.

For example, with the 3592-E05 and EFMT2 format, a JB cartridge can be segmented into a 140 GB fast access segment and a 466 GB slower access segment and a JA cartridge can be scaled to a 100 GB fast access segment and a 330 GB slower access segment.

Like the 3592-J1A, 256 capacity settings are supported on the 3592-E05 drive. We recommend the following three primary settings for use; they are available as labeled and initialized part-numbered cartridges:

- Full capacity default mode: 500 GB
- 20% scaled fast access mode (capacity scaling setting x'35'): 100 GB
- Performance scaling for 87% capacity (segmented format, capacity scaling setting x'E0')

The tapes can subsequently be scaled back to full capacity as needed.

3.5 IBM TotalStorage Enterprise 3592 Model J1A Tape Drive

The 3592 Model J1A is the first offering in the 3592 Tape Drive family that was designed for enterprise applications. Introduced in 2003, it is designed to provide unprecedented levels of cartridge capacity, performance, and reliability. The 3592 surpasses the capabilities of its predecessors by providing up to five times the capacity and two and a half times the data transfer rates of the IBM 3590 series. It is capable of storing 300 GB of native capacity and supporting a native data rate of up to 40 MB/s. Figure 3-11 shows an IBM TotalStorage Enterprise Tape Drive 3592 Model J1A.

Figure 3-11 IBM TotalStorage Enterprise Tape Drive 3592 Model J1A

For its high capacity capability, the 3592 uses the IBM TotalStorage Enterprise Tape Cartridge 3592 (Model 3599), which provides a native cartridge capacity of up to 300 GB. The 3599 media models include:

- Read/Write (R/W) 300 GB data cartridge
- R/W Economy 60 GB data cartridge
- Write Once Read Many (WORM) 300 GB data cartridge
- WORM Economy 60 GB data cartridge

3.5.1 3592-J1A characteristics

The first generation of the 3592 family of tape drives outperformed the IBM 3590 family with its performance and capacity characteristics:

- 40 MB/s native streaming data rate
- 300 GB native cartridge capacity
- Dual active FC-2 ports to support enterprise environments that use dual paths for failover or load balancing
- Support of four cartridge types: JA, JJ, JW, and JR
- Write Once Read Many (WORM) functionality when operating on one of the two WORM cartridge types: JW or JR
- 128 MB data buffer

3.5.2 Performance scaling

The 3592-J1A drive introduced the support for scaling and segmentation modes on the 300 GB Read/Write (R/W) (JA) cartridge only. There are two primary settings used:

- 300 GB default mode
- 60 GB fast access mode (capacity scaled through a ’0x35’ setting to 20% capacity)

The result of performance scaling to a percentage value (for example, 20%) is that the maximum amount of recordable data is reduced to 60 GB, and the average time to locate a random record on a full tape starting from load point is (very roughly) 20% of the time to locate a random record from load point for a full, unscaled tape.

Using segmentation results in a first segment of 60 GB and a slower access segment of 200 GB of capacity.

3.6 IBM System Storage TS1120 Tape Controller

The IBM System Storage TS1120 Tape Controller (TS1120 Model C06 Controller) is the replacement of the IBM 3592-J70. The TS1120 Model C06 Controller is designed to attach to ESCON and FICON channels on System z servers or through a FICON/FC switch with the appropriate levels of system software. The TS1120 Model C06 Controller (shown in Figure 3-12 on page 88) is 442 mm (17.4 inches) wide, 573 mm (22.6 inches) deep and 172 mm (6.8 inches) in height. It weighs 28.1 kg (62 lb.) and 39 kg (86 lb.) with mounting hardware.

Figure 3-12 TS1120 Model C06 Controller

These configurations support the TS1120 Model C06 Controller:

- TS3500: Attachment is the same as the 3592-J70 using the 3953 Tape Frame Model F05. You can intermix these controllers in the 3953-F05 expansion frames.
- IBM 3494 Tape Library: The TS1120 Model C06 Controller resides in an IBM 3952 Tape Frame Model F05.
- Silo: The TS1120 Model C06 Controller resides in a rack or in a 3952-F05 Frame (it replaces the 3590-C10 frame). This controller is then connected to the 3592 drives residing in a 3592-C20 frame.
- Stand-alone: Resides in a rack or in a 3952-F05 Frame. This controller is then connected to the 3592 drives residing in a rack.

> **Note:** The TS1120 Model C06 Controller supports 3592-J1A, TS1120, and TS1130 tape drives; it does not support 3590 tape drives.
>
> Different TS1120 Model C06 Controllers within a single 3952 Tape Controller Model F05 Frame can be connected to tape drives in different libraries.

3.6.1 TS1120 Model C06 Controller characteristics

The TS1120 Model C06 Controller is designed to offer ESCON and FICON attachment to 3592-J1A and 3592 model E drives. It also provides 3494 Library Manager, StorageTek ACS, and stand-alone support through the 3952 Tape Frame. The Model C06 Controller further exploits the performance and functions of the 3592 tape drives, including increased capacity to 500/700 GB when written with a 3592-E05 Tape Drive in EFMT2/EEFMT2 format or 640 GB/1 TB when written with a 3592-E06 Tape Drive in EFMT3/EEFMT3 format on JA/JB media.

You can intermix 3592-J1A and 3592-E05 tape drives behind a single controller, but the 3592-E05 drives operate in 3592-J1A Emulation mode.

You cannot mix TS1130 drives with TS1120 or J1A drives behind the same controller.

> **Note:** To support Tape Encryption, the TS1120 Tape Drive needs to run in E05 mode, not in J1A Emulation mode. Therefore, if you want to use Tape Encryption, you cannot intermix 3592-J1A and TS1120 tape drives behind the same TS1120 Tape Controller.

Enhancements incorporated into the TS1120 Tape Controller include:

- Up to four 4 Gbps FICON attachments
- Up to eight ESCON attachments
- Support for an intermix of ESCON and FICON attachments
- Up to sixteen attached 3592 Model E (or 3592-J1A) tape drives
- Two 4 Gbps Fibre Channel adapters for attaching 3592 tape drives or switches
- Support for 3592 drive hot swap capabilities
- Support for capacity scaling/segmentation with the 3592 tape drives
- Support for WORM capabilities with the 3592 tape drives
- Support for an outboard search interface for increased performance of certain applications. Currently, Data Facility Storage Management Subsystem (DFSMShsm™) audit is the only application written to take advantage of this support.
- Support for IPv6 by FC5248. FC5248 for the TS1120-C06 provides a network switch for IPv4/IPv6 connection to the client network. It provides connectivity to the TS3400 libraries and the TS1120 Model C06 Controller.

> **Note:** For Encryption support, the minimum level of microcode firmware for the TS1120 Controller is 1.21.*x.x.*
>
> When using Tape Encryption in a library that has a mix of controller models, you need to upgrade the microcode firmware of your controllers if you intend to use tape cartridges from a common tape cartridge scratch pool.
>
> When using Tape Encryption, you can only have TS1120 tape drives that are encryption-enabled attached to a single TS1120 Tape Controller.

3.6.2 Installation in a TS3500 Tape Library

To support the 3592-J1A or 3592 model E drives in the TS3500 Tape Library, you install the TS1120 Model C06 Controller in an external frame, the 3953-F05 Frame. There are two versions of the 3953 Tape Frame: the base frame and the expansion frame. Both frames have the same F05 model number and can contain one to three controllers, depending on whether it is a base frame or expansion frame as shown in Table 3-6.

Table 3-6 TS1120 Tape Controllers in 3953 tape frames

Frame	Attachments
3953 Tape Frame Model F05 (base)	Zero to one TS1120 Tape Controllers
3953 Tape Frame Model F05 (expansion)	One to three TS1120 Tape Controllers

A fully configured 3953 Tape System (3953-F05 Frames and 3953-L05 Library Manager) can have up to sixteen subsystems attached (tape controllers or VTSs/VEs). If there are two VTSs or TS7700s attached (maximum), there can only be 14 TS1120 Model C06 Controllers additionally.

Figure 3-13 on page 90 shows a sample of a TS1120 Model C06 Controller installation and configuration in a 3953-F05 base frame with two 3953-F05 expansion frames.

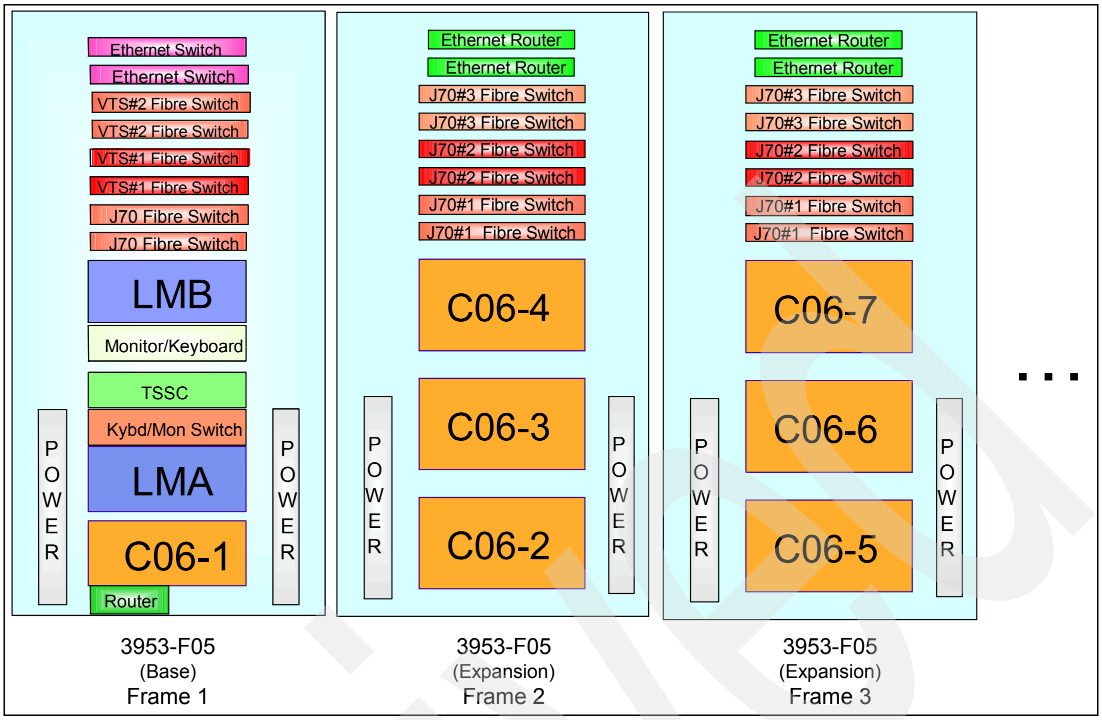


Figure 3-13 Sample configuration of TS112-C06 tape controllers in 3953 frames

In this sample configuration in Figure 3-13, communications among the TS1120 Model C06 Controller and other library components and tape drives are handled by the Ethernet switches or routers and the Fibre Channel switches in the frames:

- Two 24-port Ethernet switches in the top of the base frame direct communications to and from the Library Manager and any attached controllers.
- The 8-port tape controller Ethernet router at the bottom of the base frame attaches to the tape controller in the base frame and connects the controller to the IBM System Storage TS3000 System Console (TSSC) and one of the 24-port Ethernet switches.
- Fibre Channel switches in the base frame direct data between the tape controller in the base frame and its associated tape drives.

> **Note:** You can directly attach one to four 3592 drives without any switch.

- The 8-port Ethernet routers in the top of the expansion frames allow communication between the tape controllers in the expansion frame and the Library Manager in the base frame. The routers also route diagnostic information from the Fibre Channel switches in the expansion frame to their associated tape controllers.
- Fibre Channel switches in the expansion frames route data between the tape controllers in the expansion frame and their associated tape drives. An Ethernet connection transmits diagnostic information from the Fibre Channel switch to its associated tape controller. There must be at least one Fibre Channel switch per tape controller; however, two Fibre Channel switches can be associated with each tape controller for increased reliability.

3.6.3 Attachment features

The IBM TS1120 Tape Controller (like the 3592-J70) has a number of attachment options at the “front end” (that is, to the host) and to the “back end” (that is, to the drives):

- Host attachment:
  - ESCON
  - FICON
  - Mixture of both
- Drive attachment:

  Fibre Channel:
  - Using a 4 Gbps switch with LC connectors
  - Using a 2 Gbps switch with SC connectors

Host attachment

The TS1120 Model C06 Controller has been designed to provide greater throughput and connectivity than previous IBM controllers, offering up to eight ESCON attachments or up to four FICON attachments. An intermix of ESCON and FICON attachments is also available in either short wavelength or long wavelength on the same controller. Table 3-7 shows how you can intermix the attachments.

Table 3-7 Permitted combinations of FICON and ESCON attachments

TS1120 Tape Controller Model C06		**3592-J70 Controller**	
FICON (4 Gbps)	**ESCON**	**FICON (2 Gbps)**	**ESCON**
4	0	4	0
3	2	3	2
2	4	2	4
1	6	1	6
0	8	0	8

Apply the following feature codes to the TS1120 Model C06 Controller to order either ESCON attachments, FICON attachments, or a mixture of the two types. You must have at least one of these features:

- FC3440: Dual ESCON attachment

  Each feature provides dual-ported ESCON host adapters. Up to four of these features can be ordered for a total of up to eight ESCON port attachments. Each port can support up to 64 logical paths and, by using ESCON directors, can be up to 43 km (26.7 miles) from the host system.
- FC3441: 4 Gbps FICON short wavelength attachment

  Each feature provides one FICON adapter with an LC duplex connector for attachment to a FICON host system long wave channel, utilizing a 50-micron multimode fibre cable. The total length of the cable cannot exceed 150 m (452 ft.) and can connect up to 128 logical paths.

- FC3442: 4 Gbps FICON long wavelength attachment

  Each feature provides one FICON adapter with an LC duplex connector for attachment to a FICON host system long wave channel utilizing a 9-micron multimode fibre cable. The total length cannot exceed four km (2.5 miles) and can connect up to 128 logical paths.

- FC3443: 4 Gbps FICON 10 km long wavelength attachment

  Each feature provides one FICON adapter with an LC duplex connector for attachment to a FICON host system long wave channel utilizing a 9-micron single mode fibre cable. The total length cannot exceed ten km (6.2 miles) and can connect up to 128 logical paths.

Drive attachment

The TS1120 Model C06 Controller can attach up to sixteen 3592-J1A or 3592 Model E tape drives. For this attachment, there must be at least one Fibre Channel switch per tape controller in a 3953-F05 Frame to route data between the controller and its associated tape drives. For reliability, two Fibre Channel switches can be associated with the single controller. The tape drives connected to a particular controller do not need to reside in the same frame. They can be spread across multiple frames in the TS3500 Tape Library Frames as shown in Figure 3-14. In Figure 3-14, one TS1120 Model C06 Tape Controller has 16 tape drives attached, 12 of which reside in one frame and four in another frame. Another controller also has 16 drives attached with four tape drives in each of four separate frames.

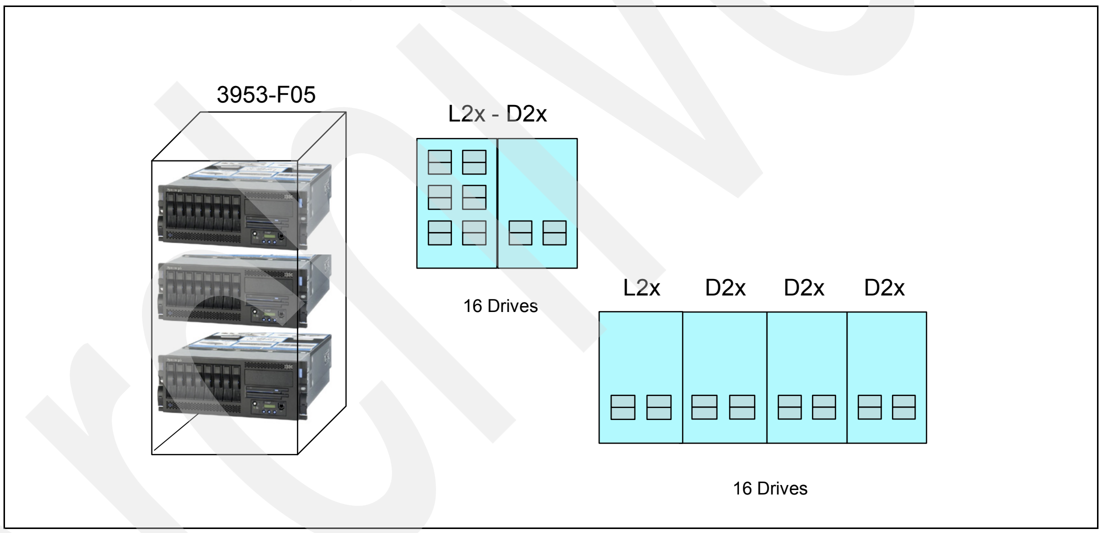


Figure 3-14 Drive placement in the TS3500 Tape Library frames

Feature codes

Order the feature codes for the installation of the TS1220-C06 in the 3953 frame against the controller or against the 3953 Model F05 Frame, depending on the feature required. For more information about feature codes, refer to Appendix G, “Feature codes” on page 511.

3.6.4 Reliability and availability

The IBM System Storage TS1120 Model C06 Tape Controller is designed to provide availability and reliability for IBM System z clients. This controller has many of the reliability and availability characteristics that the 3592 Model J70 offered, such as redundant power supplies with automatic failover, hot swap capabilities, and redundant cooling.

Call Home

The TS1120 Model C06 Controller supports the Call Home function by providing support for the IBM System Storage TS3000 System Console (TSSC) attachment, which was previously known as the IBM TotalStorage Master Console (TSMC).

The Call Home function can report any error alerts for early detection of problems, expedite microcode updates, reduce service times, and enhance local service. FC2720, TS3000 System Console, replaces FC2713, Master Console for Service. Call Home functionality with FC2714, FC2715, and FC2720 connected through Ethernet to the various automated tape library (ATL) frames sends wellness monitoring data through the TSSC. Your IBM SSR can activate the Call Home function during the installation of the controller. The following environments support Call Home:

- TS1120 Model C06 Controller or 3592-J70 in a stand-alone frame or rack
- TS1120 Model C06 Controller or 3592-J70 in a StorageTek Automated Cartridge System environment
- TS1120 Model C06 Controller or 3592-J70 in the 3494 Tape Library
- TS1120 Model C06 Controller or 3592-J70 in the 3952 Tape Frame
- TS1120 Model C06 Controller or 3592-J70 in the 3952-F05 Tape Frame

3.6.5 Compatibility considerations for upgrade and migration

You can use the IBM System Storage TS1120 Tape Controller and 3592 tape drives in various combinations, which provides the flexibility to maximize your configuration when upgrading or adding to your existing tape installations. You must be sure to obey the configuration rules in mixed environments:

- TS1120 Model E05 and J1A tape drives can be attached to the same controller when TS1120-E05 drives emulate 3592-J1A drives[2].
- 3592 Model E tape drives cannot be attached to the same 3592-J70 Controller with 3590 tape drives.
- You cannot intermix 3590 models B, E, or H on the same 3592-J70 Controller.
- The TS1120 Model C06 Controller does not support 3590 tape drives.
- The 4-Gbps or 2-Gbps Fibre Channel switch must be used exclusively by the TS1120 Tape Controller.
- The 4-Gbps or 2-Gbps Fibre Channel switch or 2109 Model F16 or S16 switch must be used exclusively by the 3592-J70 Controller.
- External fabric is supported.
- TS1120 tape drives that are encryption-enabled are not supported under the same 3592-J70 or C06 controller with TS1120 tape drives that are not encryption-enabled.
- TS1120 tape drives that are encryption-enabled are not supported under the same 3592-J70 or C06 controller with 3592-J1A tape drives.
- No intermix of TS1130 drives with any other 3592 drives is allowed.

[2] To take advantage of the performance improvements of the TS1120 Model E05 drive, only native TS1120-E05 drives must be attached to the TS1120 Model C06 Controller.

Compatibility considerations include:

- The TS1120 Model C06 Controller must be installed in a 3952 Tape Frame Model F05 to be able to control 3592 tape drives in a 3494 Tape Library. This frame is external to the 3494 Tape Library and can hold up to three TS1120 Model C06 Controllers.
- Ensure that you have the correct features depending on where your tape drives are located within your 3494 Tape Library.

3.6.6 Performance overview

The following charts in this section show the performance of the TS1120 Model C06 Controller using the 2 Gbps and 4 Gbps Fibre Channel adapters, as well as a comparison between the 3592-J70 Controller and 3592-J1A Tape Drive.

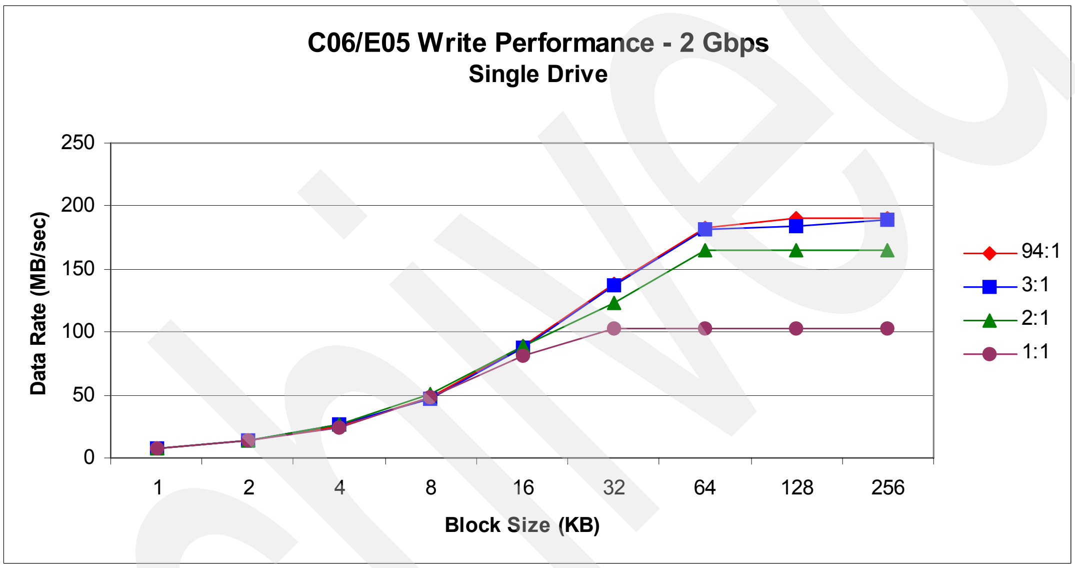


Figure 3-15 TS1120 Model C06 Controller write streaming performance with 2 Gbps

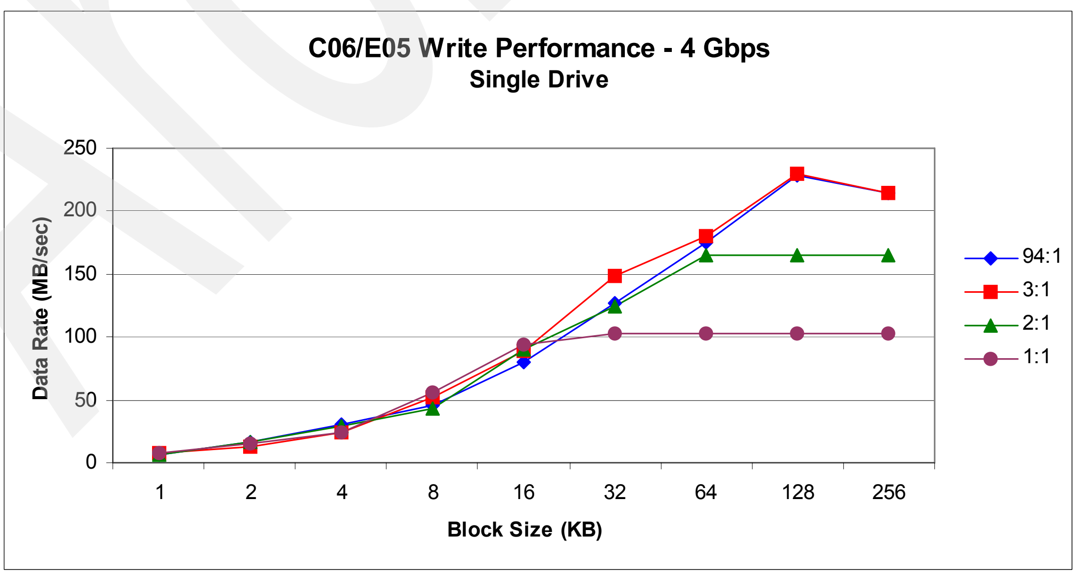


Figure 3-16 TS1120 Model C06 Controller write streaming performance with 4 Gbps

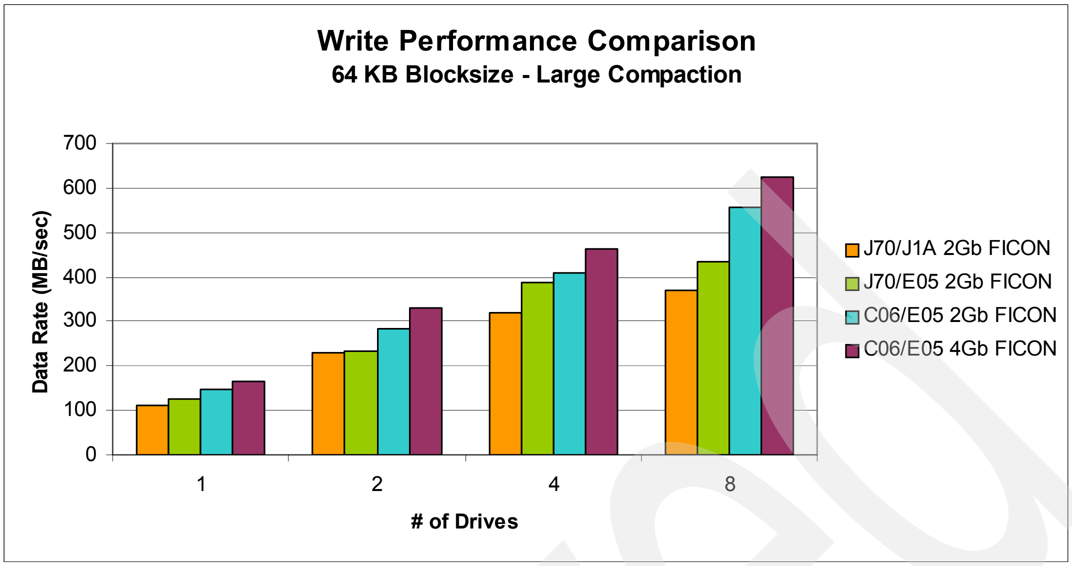


Figure 3-17 Write performance comparison

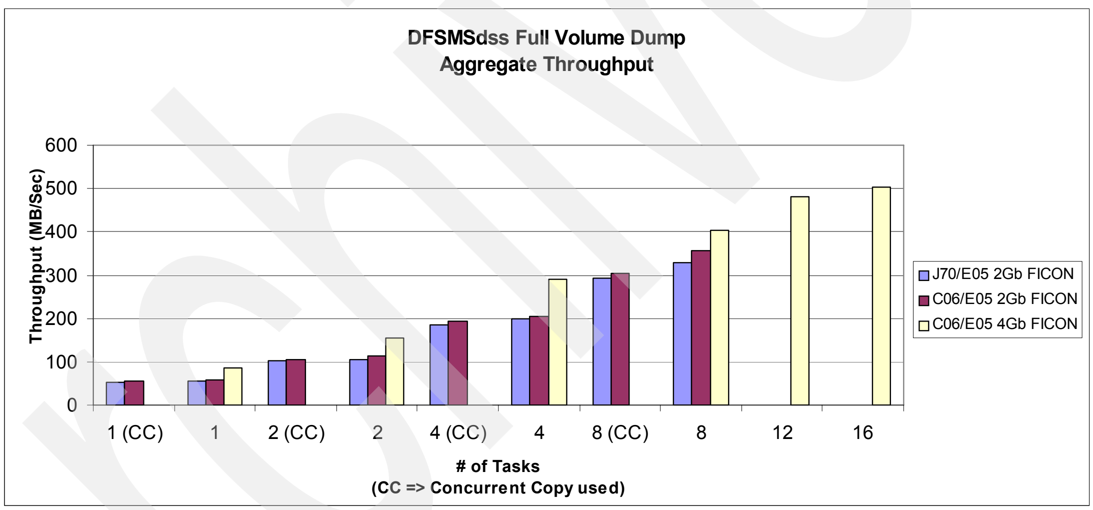


Figure 3-18 Aggregate throughput for DFSMSdss™ full volume dump

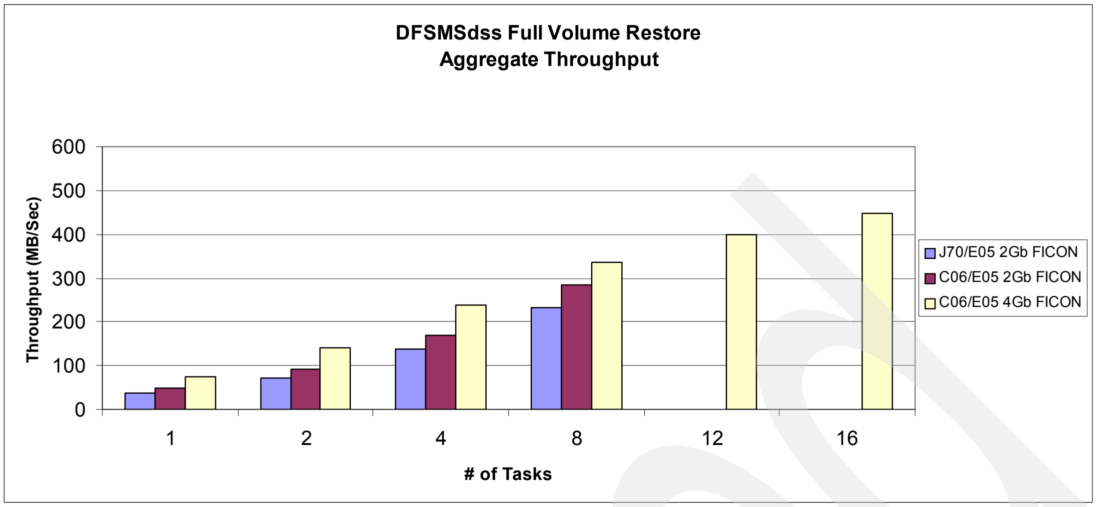


Figure 3-19 Aggregate throughput for DFSMSdss full volume restore

Summary

The TS1120 Model C06 Controller has been designed to provide 1.7 times the throughput of the 3592-J70. It has built on the success of the 3592-J70 while adding extra features and reliability. Although designed to complement the high capacity and high performance TS1120-E05 Tape Drive, it can also use the existing 3592-J1A Tape Drive. The TS1120 Model C06 Controller can be utilized in an existing IBM TotalStorage 3494 Tape Library, protecting the investment made in this infrastructure. It can be used in concert with the 3592-J70 to further utilize already implemented tape infrastructure.

3.7 3592 Model J70 Tape Controller

The Enterprise Tape Controller 3592 Model J70 is designed for environments with ESCON-attached or FICON-attached servers. The 3592-J70 Controller can be installed in the 3494 frames, 3590 Model C10, 3590 Model A14, and stand-alone racks. In the TS3500 Tape Library, the J70 is installed in the 3953-F05 Frame. The J70 (shown in Figure 3-20 on page 97) is 445 mm (17.5 inches) wide, 603 mm (23.8 inches) deep, and 222 mm (8.7 inches) in height. It weighs 29 kg (63 lb.) and 39 kg (86 lb.) including mounting hardware.

Figure 3-20 3592-J70 Controller

In a TS3500 Tape Library configuration, the J70 supports the attachment of 3592-J1A, 3592-E05, and 3592-E06 tape drives.

Enhancements incorporated into the 3592 Model J70 Tape Controller include:

- Support for an intermix of ESCON and FICON attachments
- Attachment of up to sixteen 3592 (J1A, E05, or E06) or twelve 3590 B, E, and H tape drives
- Up to 1.5 times the throughput of the 3590-A60, with FICON attachment using the 3592 Tape Drive
- Support for capacity scaling with the 3592 tape drives
- Support for 3592 drive hot swap capabilities
- Dual-mirrored hard drive for redundancy
- Redundant, hot-swappable power supplies and cooling components with automatic failover

> **Note:** When using Tape Encryption in a library that has a mix of controller models, you need to upgrade the microcode firmware of your controllers if you intend to use tape cartridges from a common tape cartridge scratch pool.
>
> When using Tape Encryption, all TS1120 or TS1130 tape drives attached to a single 3592-J70 Tape Controller must be encryption-enabled.

3.7.1 Model characteristics

In the TS3500 Tape Library, the J70 Controller offers ESCON and FICON attachment of 3592 tape drives. The 3592-J70 Controller is installed in the 3953-F05 base frame. Additional controllers are installed in the 3953-F05 expansion frames, which can each house up to three J70 tape controllers. Figure 3-21 on page 98 shows a sample configuration of three 3953-F05 frames containing the 3592-J70 tape controllers.

Note: The 3592-J1A and 3590 drive models cannot be intermixed behind a single 3592-J70 Controller.

TS1120 tape drives running in Enterprise Tape Format 2 (EFMT2) and TS1120 tape drives running in Enterprise Tape Format 1 (EFMT1), which is also called J1A Emulation mode, cannot be intermixed behind a single 3592-J70 Controller.

TS1120 tape drives running in Enterprise Tape Format 2 (EFMT2) and TS1120 tape drives running in Enterprise Tape Format 2 with encryption-enabled (EEFMT2) cannot be intermixed behind a single 3592-J70 Controller.

TS1130 tape drives cannot be intermixed with other 3592 drive models behind a single 3592-J70 Controller.

To assist in data migration to new, more cost-effective technologies, the 3592-J70 with its associated tape drives can be installed in the same IBM 3494 Library with existing 3490 or 3590 models. It can also be intermixed in the same 3494 Library with the predecessor 3590 Model A60, A50, or A00 controllers, offering a unique and flexible growth opportunity. It can also be installed in the same 3590 Model C10 Frame with a 3590 Model A60 Controller.

Note: IBM 3590 models A14, C10, and C12 were withdrawn from marketing effective 29 September 2006.

The 3592-J70 Controller was withdrawn from marketing effective 1 December 2006.

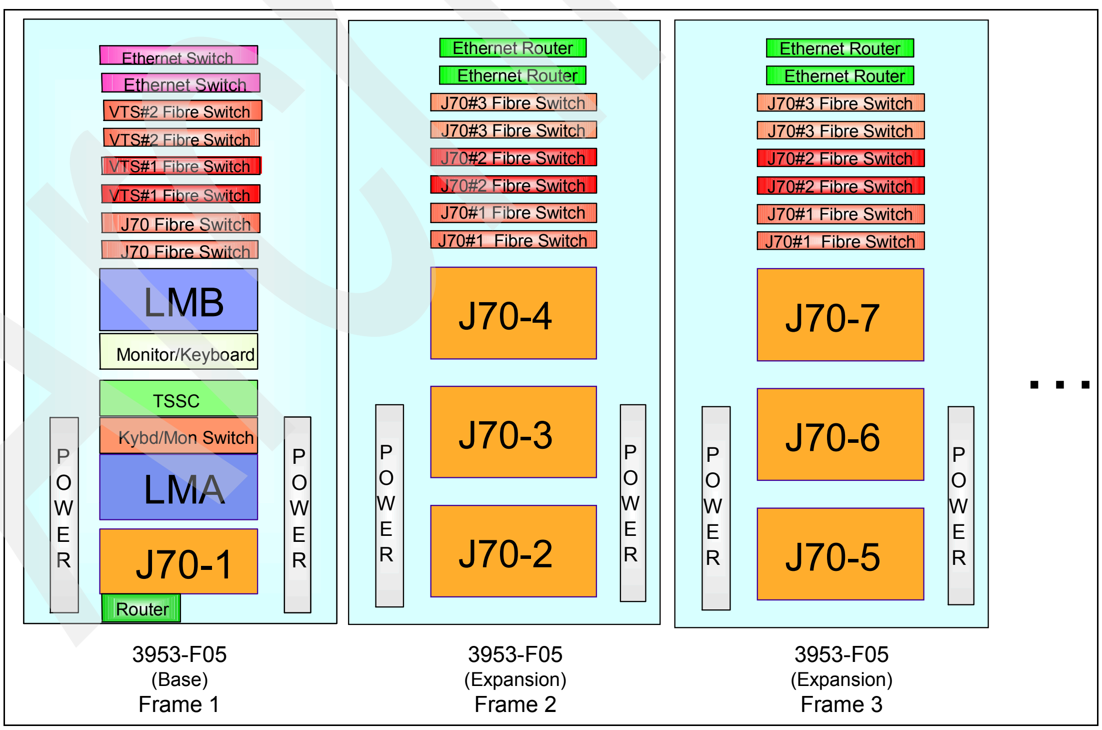


Figure 3-21 3953-F05 frames with 3592-J70 tape controllers

3.7.2 Attachment features

The IBM 3592-J70 Controller (like the Model A60) has a number of attachment options at the "front end" (that is to the host) and to the "back end" (that is to the drives):

- Host attachment:
  - ESCON
  - FICON
  - Mixture of both
- Drive attachment:
  - Fibre Channel:
    - Using a 2 Gbps switch with LC connectors
    - Using a 1 Gbps switch with SC connectors
  - SCSI (for 3590 drives only)

Host attachment

The J70 Controller has been designed to provide greater throughput and connectivity than previous IBM controllers, offering up to eight ESCON attachments, up to four FICON attachments, or an intermix of ESCON and FICON attachments.

The following feature codes apply to the Model J70 to order either ESCON attachments, FICON attachments, or a mixture of the two types of attachments. You must have at least one of these features:

- 3413 dual ESCON attachment

  Each feature provides a dual-ported ESCON host adapter. You can order up to four of these features for a total of up to eight ESCON port attachments. Each port can support up to 64 logical paths.

- 3434 2-Gbps FICON long wavelength attachment feature

  Each feature provides one FICON adapter that can support up to 128 logical paths (maximum of four features).

- 3435 2-Gbps FICON short wavelength attachment feature

  Each feature provides one FICON adapter that can support up to 128 logical paths (maximum of four features).

Table 3-8 shows how you can intermix the attachments. Note that FICON columns show the number of FICON channels, which is equal to the number of FICON features. The ESCON columns show the number of ESCON channels, which is double the number of ESCON features.

Table 3-8 Permitted combinations of FICON and ESCON attachments

3592-J70		3590-A60	
FICON	**ESCON**	**FICON**	**ESCON**
4	0	2	0
3	2	2	2
2	4	2	4
1	6	1	6
0	8	0	8

Feature conversions are available to convert an installed FC3413 to FC3434 or FC3435, as well as to convert an installed FC3434 to FC3435, or FC3435 to FC3434.

Drive attachment

The 3592-J70 can attach up to 16 3592-J1A or 3592 Model E tape drives. For this attachment, there must be at least one Fibre Channel switch per tape controller in a 3953-F05 Frame to route data between the controller and its associated tape drives. For reliability, two Fibre Channel switches can be associated with one controller. The tape drives connected to a particular controller do not need to reside in the same frame. They can be scattered throughout the TS3500 Tape Library frames. The J70 supports an intermix of 3592-J1A and 3592-E05 tape drives; however, this intermix results in the 3592-E05 running in J1A Emulation mode. TS1130 cannot be mixed with other 3592 models.

For further information about feature codes for the 3592-J70 Tape Controller, refer to Appendix G, “Feature codes” on page 511 or *IBM System Storage TS1120 Tape Drive and Controller Introduction and Planning Guide,* GA32-0555.

3.7.3 Reliability and availability

The J70 Controller is built from IBM components, including the System p, AIX operating system, and PCI-X bus architecture. Redundant, hot-swappable power supplies and cooling components with automatic failover help provide high availability for the controller. In addition, the J70 Controller provides support for the IBM TotalStorage System Console (TSSC), which allows administrators to remotely monitor the J70 Controller for early problem detection and to enable service notification, including automatic event-driven service notification to IBM. For more details about the application performance and capacity enhancements, refer to the *IBM System Storage Tape System 3592 Introduction and Planning Guide,* GA32-0464.

Call Home

The IBM 3592 Model J70 Controller supports the *Call Home* function. The Call Home function opens a service alert in the event that a problem occurs with the Model J70 Controller. A service representative can then respond to fix the problem. Standard feature codes (FC2710, FC2711, or FC2712) provide base remote support in the event of a Model J70 Controller service alert. In addition to error alerts, you can enhance Call Home functionality with additional features (FC2713, FC2714, and FC2715). Enhanced Call Home functionality sends “wellness” monitoring data through the TotalStorage System Console. Your IBM SSR can activate enhanced Call Home functionality during the installation of the Model J70 Controller. The following environments support Call Home:

- Model J70 Controller in stand-alone frames
- Model J70 Controller in StorageTek (ACS) environments
- Model J70 Controller in the 3494 Tape Library
- Model J70 Controller in the TS3500 Tape Library

Service menus provide the means to deactivate the remote support, for example, for installations that have extremely restricted security access.

3.7.4 Compatibility considerations for upgrade and migration

You can use the 3592 Model J70 in combination with either 3592 or 3590 tape drives. However, you must be sure to obey the configuration rules in mixed environments:

- You cannot intermix SCSI-attached (3590) and Fibre Channel-attached (3590 or 3592) tape drives behind a single controller. The TS3500 Tape Library does not support 3590 tape drives.

- You cannot attach 3592 Model J1A drives to the same controller with 3590 tape drives, and 3590 models B, E, or H cannot be intermixed on the same controller.
- You can attach 3592-E05 and 3592-J1A tape drives to the same J70 Controller when 3592-E05 drives emulate 3592-J1A drives.
- The 4-Gbps or 2-Gbps Fibre Channel switch or 2109 Model F16 or S16 switch must be used exclusively by the 3592-J70 Controller. The 2109 S16 switch is not supported in the 3953 F05 tape frame.
- External fabric is supported as of 23 October 2004.

4

Tape Encryption

In this chapter, we discuss basic encryption and cryptographic terms and concepts. We introduce you to the IBM Tape Drive Encryption solution, including the IBM Encryption Key Manager. The focus of this chapter is Tape Drive Encryption in a System z environment.

We also outline the hardware and microcode firmware that you will need to upgrade in order to implement Tape Drive Encryption.

For more information about the IBM Tape Drive Encryption solution, refer to the *IBM System Storage TS1120 Tape Encryption Planning, Implementation, and Usage Guide,* SG24-7320.

4.1 Tape Encryption concepts

The IBM System Storage TS1130 and TS1120 tape drives both have the encryption feature installed as a standard and are *encryption-capable*. When attached to a tape controller, the TS1130 Tape Drive is automatically *encryption-enabled* while the TS1120 Tape Drive has to be defined as encryption-enabled before it can write encrypted data. A chargeable upgrade feature is available to enable your existing TS1120 drives that were built before September 2006 for encryption. You can encrypt all 3592 media, including WORM and extended cartridges. You need the new IBM Encryption Key Manager component for the Java™ Platform (Encryption Key Manager) that supports the generation and communication of encryption keys for the tape drives across your enterprise. You can easily exchange encrypted tapes with business partners or data centers that have the necessary key information to decrypt the data key.

The IBM Tape Encryption solution utilizing the IBM System Storage TS1130 and the TS1120 tape drives offers a cost-effective solution for tape data encryption by off-loading encryption tasks from the servers, leveraging existing tape infrastructure incorporated in standard IBM tape libraries, and eliminating the need for unique appliance hardware. While other encryption solutions require hardware appliances or processor power for software encryption, Tape Encryption is done with very little impact on the performance of the 3592 Model E drives.

4.1.1 Introduction to Encryption

3592 Model E-based encryption and the associated Encryption Key Manager (EKM) component are supported in a wide variety of operating system environments, including z/OS, i5/OS®, AIX, Hewlett-Packard UNIX (HP-UX), Sun, Linux, and Windows. The three methods of encryption are:

- *Application-Managed*: The TS1130 and TS1120 tape drives support Application-Managed Encryption (AME) for Open Systems environments. The application controls the Encryption process and generates and provides keys to the 3592 Model E tape drives. Tivoli® Storage Manager has been enhanced to support this capability. Currently, Application-Managed Encryption support is only available on IBM Tivoli Storage Manager.
- *System-Managed*: With System-Managed Encryption (SME), the Encryption policy is passed between the server and the drives. This is the way that System z encrypts data, and it requires the Encryption Key Manager program. Data Facility Storage Management Subsystem (DFSMS) supports the Encryption Key Manager component. System-Managed Encryption is also available for AIX servers. This support requires a new AIX tape device driver, as well as the Encryption Key Manager program. Sun Solaris is also supported through the IBM Tape device driver.
- *Library-Managed*: Encryption by volume and drive policy is supported with the TS1130 and TS1120 tape drives. You set up and control the Encryption process through the library interface. This method of Encryption is supported for the TS3500 Tape Library in Open Systems environments. The Encryption Key Manager component is required for this support. Library-Managed Encryption is available for AIX, i5/OS, Linux, Linux on System z Fibre Channel Protocol (FCP)-connected tape drives, HP-UX, Sun Solaris, and Windows.

The *Encryption Key Manager (EKM)* is a software program designed to complement IBM encryption-enabled tape drives in generating, protecting, storing, and maintaining encryption keys that are used to encrypt information written to and decrypt information read from 3592 tape media. The EKM operates on multiple platforms and is designed to be a shared resource deployed in multiple locations within an enterprise serving IBM encryption-enabled tape drives, regardless of where those drives reside.

The Encryption Key Manager (EKM) component uses standard key repositories on supported platforms. This software must be installed on a supported server and interface with the tape drive to support Tape Encryption in a System-Managed or Library-Managed Encryption implementation.

Encryption Key management

During Encryption, a single data key is used to encrypt the data and, later on, to decrypt the data. Each Encryption method uses a key manager and a keystore to manage and store the keys that are used to encrypt the data key.

When a scratch cartridge is loaded, for System-Managed and Library-Managed Encryption, the drive communicates with the key manager that provides the key to encrypt the data. When data is appended, it must be encrypted with the same key as the existing data on the cartridge.

The data key must stay with the data and cannot be stored unencrypted. The data key is stored in the Cartridge Memory (CM) of the cartridge at the beginning of the tape in an encrypted format and in several places on the tape cartridge.

The data key is encrypted with another set of keys, known as *Key Encrypting Keys (KEKs)*. The KEKs are also provided by the EKM and are referenced by key labels that you define. You can share these labels with authorized external users of the data cartridge. To decrypt the data, you need the matching key to the public key (=KEK) that was used for encrypting the data key in order to decrypt the data. If you want to exchange encrypted cartridges with a partner, you have to use one of the partner's public keys to encrypt the data key.

How Tape Encryption works

Encryption, implemented in the tape drive, encrypts the data before it is written to the cartridge. The tape drive first compresses the data to be written and then encrypts it. To encrypt the data, the tape drive needs an encryption key. This key is provided by the EKM, and it is provided in an encrypted form to make the Tape Encryption solution secure.

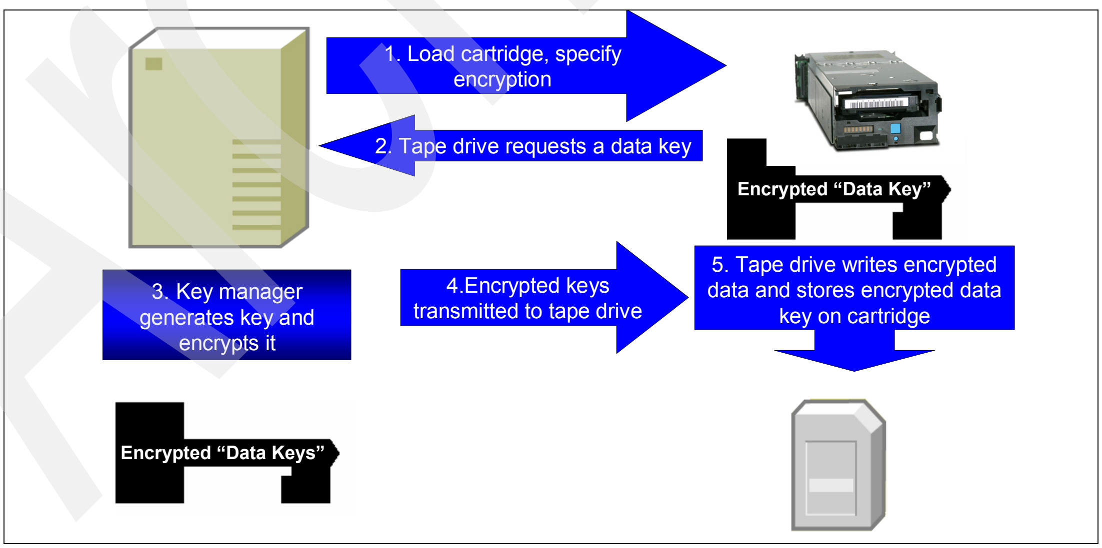


Figure 4-1 Process flow summary for Tape Encryption

The IBM Tape Drive Encryption solution encrypts the data in the drive using the 256-bit Advanced Encryption Standard (AES) algorithm, rather than receiving previously encrypted data. There are several advantages to this approach. By encrypting data in the drive, the drive can offer the most efficient data compression. The drive first compresses the data and then encrypts it, thus providing more efficient data storage and media usage. Encrypting in the drive eliminates the need for any additional machines or appliances in the environment. The TS1130 and TS1120 tape drives can also process non-encrypted workloads, further simplifying your IT environment.

For an encrypted tape cartridge, the cartridge stores both the encrypted user data and the critical key management-related information needed to interact with the EKM when decrypting data on the cartridge. A mix of data written in encrypted and non-encrypted formats is not supported on the same tape cartridge. Whether the data on a cartridge is written in encrypted format or in the clear is determined during OPEN processing, when the first file sequence on the tape is written. If the first file written to a tape is in encrypted format, all subsequent files written to the same tape cartridge must be written in encrypted format. All files written to a single cartridge in encrypted format are encrypted using the same data key. The exception to this rule is the volume label structure for the first file sequence, which is encrypted using a key known to all encryption-enabled 3592 Model E tape drives, which means it is effectively in a non-encrypted format.

Data exchange with business partners or other platforms

It is common practice to share tapes with other organizations for joint development, contracting services, or other purposes. To facilitate this practice, the EKM can store two sets of wrapped Encryption keys on the tape. A wrapped Encryption key contains the data key plus identifying information that allows the EKM to locate the key. This capability allows another organization to read that specific tape without your providing them any shared secret information or compromising the security of your certificates and keys. This ability to read the tape is done by adding the public part of the other organization's public/private certificate and keys to your EKM keystore using a second alias (or *key label*).

When the tape is written, the Encryption key is stored on the tape in several places and protected by two sets of public/private keys: your public/private keys and the other organization's public/private keys. The other organization is then able to use their EKM and their private key to unwrap the data key that allows them to read that specific tape. To reiterate, your EKM must have the certificate and public key of the partner organization added to your key store to allow you to exchange encrypted data with the partner organization. The partner organization must have the associated private key in the keystore used by the partner organization's EKM to decrypt the data key. This capability gives you the flexibility to make a specific tape readable by both your organization and another organization.

4.1.2 Encryption on z/OS

In a System z environment, the Encryption capability is implemented through TS1130 and TS1120 tape drive hardware, microcode additions, and changes to the Library Manager and tape controller, and a new software component called the Encryption Key Manager (EKM).

z/OS DFSMS provides device allocation and media management in the 3494 and TS3500 tape libraries. You need this full support for automated or manual tape library environments for encryption-enabled 3592 Model E tape drives. This full support is required when encryption-enabled tape drives are installed in an IBM tape library environment. Encryption-enabled TS1130 or TS1120 tape drives can coexist in the same library with TS1130 or TS1120 drives that are not encryption-enabled, as well as with 3592-J1A drives and within a 3494 Tape Library with 3590 Model B1*x*, 3590 Model E1*x*, or 3590 Model H1*x*.

The z/OS DFSMS support for tape subsystem Encryption allows you to specify by Data Class that data is to be encrypted when stored by encryption-enabled 3592 Model E tape drives. In addition, the key label-related information that is used to encrypt the data key (of a tape cartridge) can be specified through the DD statement (JCL, dynamic allocation, and TSO

ALLOCATE), Data Class, or Encryption Key Manager component for the Java platform (EKM) defaults. The communication path to the EKM is across TCP/IP with the choice to go either in-band or out-of-band for the key management flow. With out-of-band key management, the communication path to the EKM is handled by the control unit going directly to the EKM. For in-band key management, the communication path to the EKM is handled across ESCON/FICON with an z/OS proxy interface, which handles the key exchange (across TCP/IP) with the EKM.

In-band and out-of-band

With System-Managed Encryption, the Encryption policy is passed between the server and the drives. System-Managed Encryption is the vehicle used for z/OS environments and requires the Encryption Key Manager program.

System-Managed Encryption on z/OS has two configuration options:

- *In-band* is where the tape drive requests to the Encryption Key Manager component travel over the ESCON/FICON channels to the server proxy that is TCP/IP-connected to the EKM. IPv6 support is available with APAR OA22271. In-band is the preferred method for z/OS.
- *Out-of-band* is where the tape controller establishes the communication to the EKM server over TCP/IP connections. The TS7700 Virtualization Engine provides the means to manage the use of Encryption and which keys are used on a storage pool basis. It acts as a proxy between the tape drives and the EKMs, using Ethernet to communicate with the EKMs and Fibre Channel connections with the drives. Encryption support for the TS7700 Virtualization Engine is enabled with Feature Code (FC) 9900.

> **Note:** In-band and Out-of-band Encryption can be used with System Managed Storage (SMS). Out-of-band Encryption currently is only used for the TS7700 and for non-z/OS operating systems, such as z/VSE, where the tape controller acts as a proxy.

For ESCON/FICON System z environments utilizing out-of-band support for Encryption, a router is required to allow the tape controller to communicate with the Encryption Key Manager. FC5593, Router for EKM Attach, provides dual routers to allow redundant connections between the tape controller and the EKM.

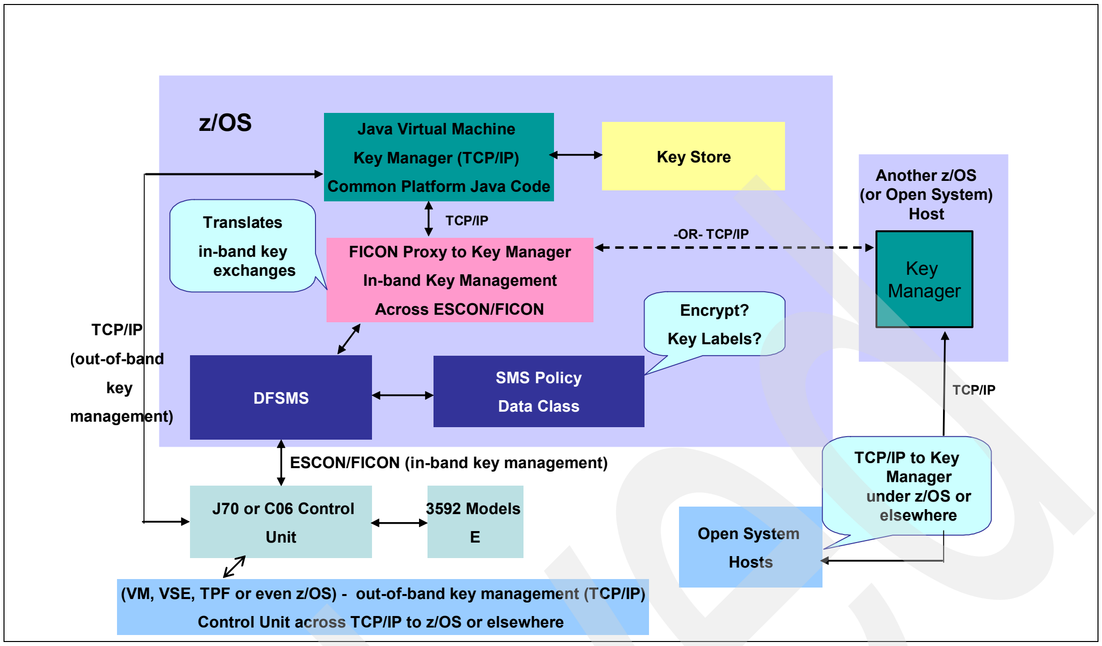


Figure 4-2 z/OS in-band and out-of-band centralized key management

The in-band z/OS proxy allows key management information to be exchanged with a tape drive over existing ESCON/FICON, instead of requiring the deployment of a secondary IP network. The reliability and physical security of the existing I/O attachments are important reasons that many clients choose to use the in-band key management path to the EKM. The z/OS proxy interface communicates with the tape drive (through the control unit) in the current data path and then uses a TCP/IP connection to communicate with the EKM. Because in-band is managed by the I/O supervisor (IOS), it also allows you to display and alter EKM primary and secondary server addresses from the operator console. With out-of-band, the EKM server addresses are only visible on the Library Manager Console, or with the TS7700, EKM server addresses are visible in the TS7700 Management Interface (MI). One other consideration is that with out-of-band, any z/OS image using a drive also must use the EKM for which that drive was set up. With in-band, you can potentially have each z/OS image point to a different EKM, with each pointing to a different keystore. This method allows images sharing drives to be able to use different keystores. You might find this useful if you have a need to support a client or an application where each client requires its own keystore for security or regulatory reasons.

For z/OS Tape Encryption, both methods allow you to configure whether to encrypt the data based on Data Class definitions. You might specify their key labels through the Data Class or through the DD statement (JCL, dynamic allocation, or TSO ALLOCATE). You can also use the EKM-assigned defaults if the key labels are not provided through z/OS. For tapes that will be encrypted or decrypted, you must define and keep track of the key information to be used. DFSMSrmm™ also keeps track of the key labels that were used for a given cartridge.

4.1.3 Encryption with TS7700 on z/OS

When the TS1130 or TS1120 tape drives are used for stacked volumes on an IBM Virtualization Engine, Encryption policies are managed on the TS7700, and Encryption is not based on Data Class as described for a native TS1130 or TS1120. Encryption concepts for the TS7700 are described in 5.3.6, “Tape Encryption” on page 133.

4.2 Encryption Key Manager

The IBM Encryption Key Manager component for the Java Platform (Encryption Key Manager) is a software program designed to provide, protect, store, and maintain Encryption keys that are used to encrypt information written to and decrypt information read from 3592 tape media. The IBM Tape Encryption solution provides an enterprise key management solution with common software for Open Systems and mainframe environments that allows sharing of a common keystore across platforms. Integration with z/OS policy, key management, and security capabilities provides a proven, highly secure infrastructure for encryption key management.

The Encryption Key Manager (EKM) component uses standard key repositories on supported platforms. This software must be installed on a supported server and interface with the tape drive to support Tape Encryption in a System-Managed Encryption or Library-Managed Encryption implementation.

4.2.1 Tivoli Key Lifecycle Manager

As an enhancement and follow-on to the Encryption Key Manager, the Tivoli Key Lifecycle Manager (TKLM) can be used to encrypt your data with the TS1130 and TS1120 tape drives.

Like the Encryption Key Manager, the TKLM serves data keys to the tape drive. The first release of TKLM focuses on ease of use and provides a new graphical interface (GUI) to help with the installation and configuration of the key manager. It also allows for the creation and management of the key encrypting keys (certificates). If you already use the existing Encryption Key Manager, you easily can migrate to the new TKLM.

Host software, including the IOS proxy, has no direct knowledge of which key manager is being used. Specification of either key manager is handled the same way, using the EKM keyword on existing IOS commands. For additional information about the TKLM, refer to the IBM Tivoli Key Lifecycle Manager Information Center.

4.2.2 Overview

References in this document to Encryption Key Manager also apply to the Tivoli Key Lifecycle Manager.

For an encrypted tape cartridge, the cartridge stores not only the encrypted user data, but also critical key management-related information needed to interact with the EKM. The EKM communicates over TCP/IP connections with the tape drive (in-band or out-of-band) to provide the key information required by the tape drive to encrypt or decrypt the data. This TCP/IP connection needs to be secure, and the security can be achieved either by physical security or with IP security protocols, such as Virtual Private Network (VPN). The method for securing this TCP/IP connection relies on existing system capabilities and is outside of the scope of the key management system. The EKM is a common platform application written in JAVA that runs under the Java Virtual Machine (JVM™). The EKM interfaces with an existing keystore, which under z/OS can be one of the hardware-based keystores (JCE4758KS (JCECCAKS) or JCE4758RACFKS (JCECCARACFKS)) that works with the Integrated Cryptographic Service Facility (ICSF), or it can be one of the software-based keystores (JCEKS or JCERACFKS). If the EKM resides outside of the z/OS environment, you can use the JCEKS and IBMi5OSKeyStore software-based keystores or the PKCS11IMPLKS hardware-based keystore.

Encryption process for System-Managed and Library-Managed Encryption

Figure 4-3, illustrates the flow of encrypted data to tape, communication of the keys to the tape drive, and how the keys are stored on the tape media. In this example, we assume that a certificate from a business partner has been imported into this keystore, and it only has a public key associated with it. This public key is the key used to encrypt the data key. The business partner has the corresponding private key needed to decrypt the data key.

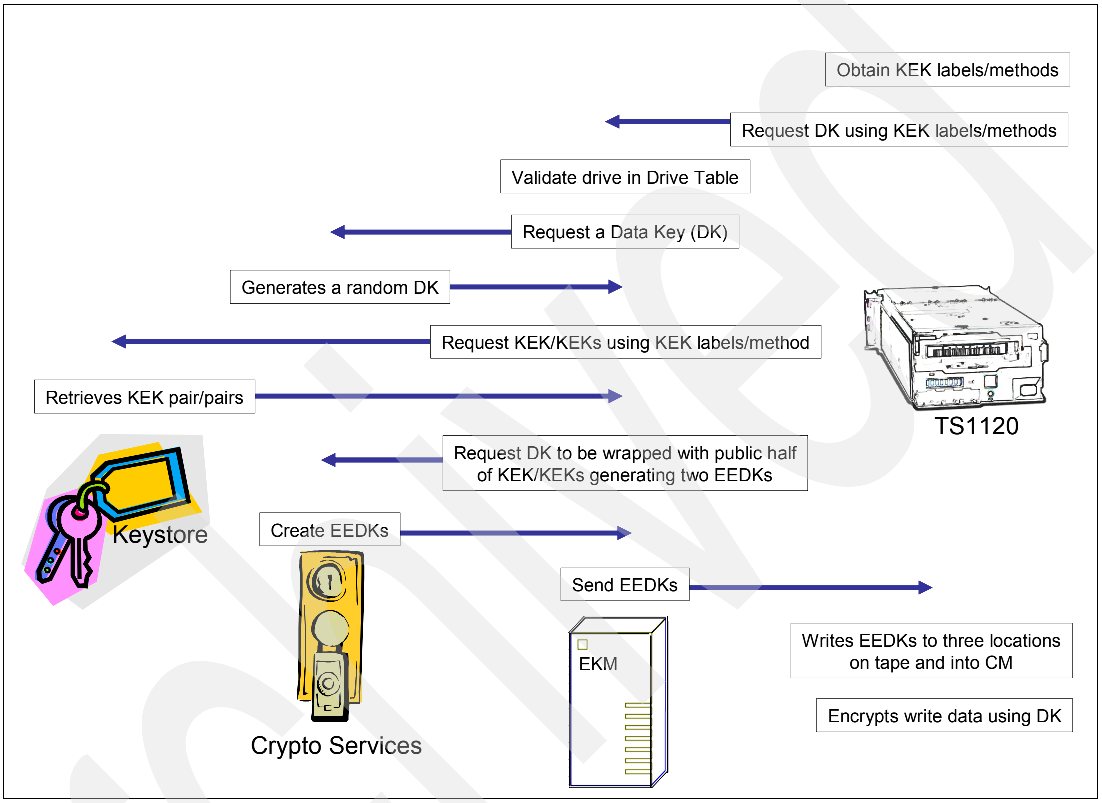


Figure 4-3 Data and encryption key flow

The server sends a write request to the drive. The drive is encryption-enabled, and the host requests that the data is encrypted. As part of the initial write, the drive obtains two Key Encrypting Key (KEK) labels from the host or a proxy, which are aliases for two Rivest-Shamir-Adleman (RSA) KEKs.

When an encryption-enabled tape drive needs a key to perform an encrypted write, a data key is generated by the EKM. The data key (DK) used to encrypt the data on a tape cartridge is encrypted (using the public key of the public/private key pair) with either one or two key encrypting keys (KEKs) stored in the keystores. The KEKs are maintained by the EKM through an existing keystore and are pointed to by the appropriate KEK label, also referred to as the *key label*. The drive requests that the EKM send it a data key (DK) and encrypts the DK using the public KEKs aliased by the two KEK labels.

The EKM can reside on that same z/OS system, on another z/OS system, or even on another platform server. The drive request for the data key and the passing of key management-related information can be done in-band between the drive and the Encryption Key Manager (through the control unit and host across ESCON/FICON), or it can be done out-of-band (through the control unit across TCP/IP). The EKM only has a TCP/IP interface, so in-band communication to the EKM is handled by the z/OS proxy interface. The z/OS proxy interface receives the request from the drive across ESCON/FICON and then interfaces with the established EKM for that system across TCP/IP. The z/OS proxy then communicates back to the drive (through the control unit across ESCON/FICON), providing the key management-related information that the drive needs. With z/OS, the recommended communication path to the EKM is in-band across ESCON/FICON under the same system that initiated the read or write request.

The EKM validates that the drive is in its list of valid drives. After validation, the EKM obtains a random DK from crypto services. The EKM then retrieves the public halves of the KEKs aliased by the two KEK labels. The EKM then requests that crypto services create two encrypted instances of the DK using the public halves of the KEKs, creating two Externally Encrypted Data Keys (EEDKs). The encoding mode (label or Hash) provides instructions that the EKM will use to build the EEDKs that are stored on the tape cartridge.

There are two modes for creating the EEDK:

- CLEAR or LABEL: In this mode, the key label is stored as part of the EEDK structure on the tape cartridge.
- HASH: In this mode, a hash of the public key referenced by the key label is stored as part of the EEDK structure on the tape cartridge.

Storing the Hash value rather than the key label allows for greater flexibility when tape cartridges are exported to another location, especially if that location might be using a different key label (than the originating site) to refer to the same key.

When sharing business partner KEKs, we recommend that you use the HASH mode. The HASH mode lets each party use any KEK label when importing a certificate into their keystore. The alternative is to use the CLEAR or LABEL mode and then have each party agree on a KEK label.

The EEDKs are passed from the EKM to the drive in a secure manner and stored on the tape cartridge. The drive stores the EEDKs at several locations on the tape and in the Cartridge Memory (CM). The EKM also sends the DK to the drive in a secure manner. It is the separately secured DK that the drive uses to encrypt the data.

On subsequent mounts of the cartridge, the drive passes the EEDKs to the EKM so that the EKM can extract the data key that was used. The EKM then passes that data key back to the drive in another encrypted form that the drive can decrypt. Remember that all data on a single cartridge must be encrypted using the same key. This passing of the EEDKs to the EKM is the process to ensure that the same key is used.

The role of DFSMS and policy management is to indicate to the drive during OPEN processing (file sequence 1, DISP=NEW) that the mounted tape volume is to be encrypted (as indicated through the System Managed Storage (SMS) Data Class policy and the specification of EEFMT3 for the recording format on TS1130 Tape Drive and of EEFMT2 for the recording format on TS1120 tape drive). OPEN processing will also pass to the drive critical key management-related information, such as the key encrypting key (KEK) labels and the encoding mechanism (label or public key Hash) specified through Data Class or through the DD statement (JCL, dynamic allocation, or TSO ALLOCATE). The values specified through the DD statement will override any Data Class specification. If the key management-related information is not specified through the DD statement or Data Class, Encryption Key Manager-established defaults will be used that can be specified on both a global and a drive level. Refer to “Defining Data Classes” on page 262 for more information about how to specify the Data Classes that contain information to be encrypted.

Decryption process for System-Managed and Library-Managed Encryption

Figure 4-4 illustrates how the encrypted data key is retrieved from the media, communicated to the EKM, the data key sent from the EKM to the drive, and the data decrypted. In this example, we are decrypting data that was encrypted at another site, as outlined in Figure 4-3 on page 110. The tape has two EEDKs stored in its cartridge memory. We will call these EEDK1 and EEDK2. EEDK1 was stored with the CLEAR (or LABEL) mode selected, and EEDK2 was stored with the HASH mode selected.

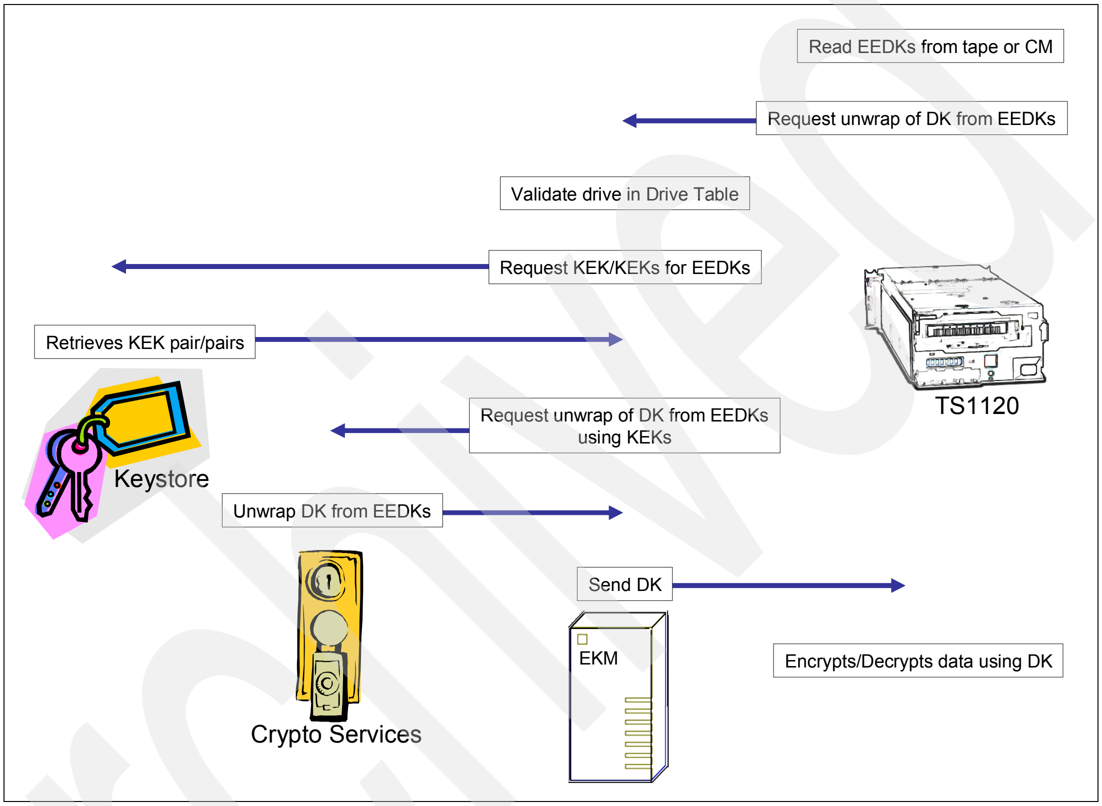


Figure 4-4 Data and decryption key flow

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 tape drive is in its list of valid drives. After validation, the EKM requests that the keystore 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 crypto 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.

For additional information about the Key Manager, refer to the *IBM System Storage Encryption Key Manager Introduction, Planning and User's Guide*, GA76-0418, and the *IBM System Storage Tape Encryption Planning, Implementation, and Usage Guide*, SG24-7320.

Management interfaces

You will need to configure whether to use a direct TCP/IP connection between the storage devices and the Encryption Key Manager (out-of-band) or use the in-band proxy. Under z/OS, the in-band proxy is defined using the IECIOS*xx* PARMLIB member (or the SETIOS EKM command). For z/OS tapes, you can configure whether to encrypt based on Data Class definitions. Furthermore for z/OS, you can specify the key labels through Data Class or through the DD statement (JCL, dynamic allocation, or TSO ALLOCATE). In addition, Encryption Key Manager-assigned defaults can also be used if the key labels are not provided through z/OS. For tape cartridges that will be encrypted or decrypted, you must define and keep track of the key information to be used. For information about key management and the role of the Encryption Key Manager (EKM), refer to the *IBM System Storage Tape Encryption Key Manager Introduction, Planning, and User Guide*, GA76-0418.

Key label specifications

When the first file sequence on a tape is written and Encryption is requested, up to two Key Encrypting Key (KEK) labels can be specified, enabling the data key to be encrypted with two different keys. One of the keys can be used for local (on-site) usage, and the second key can be used for export (off-site) purposes.

You indicate key label specifications by:

- Data Class (using new Interactive Storage Management Facility (ISMF) panel fields)
- DD statement (JCL or dynamic allocation, using new keywords KEYLABL1, KEYENCD1 and KEYLABL2, and KEYENCD2)
- TSO ALLOCATE command (using new keywords KEYLABL1, KEYENCD1 and KEYLABL2, and KEYENCD2)

4.2.3 EKM configuration planning checklist

When planning your EKM configuration, there are a few things that you need to know:

- Know the recipients for your encrypted tape cartridges.

  For each recipient to have access to an encrypted tape, an associated X.509 certificate must exist.
- Know the tape drives that will be used.

  For each tape drive used to read from or write to an encrypted tape cartridge, you need to determine the drive serial number as input into the EKM drive table. However, if you use the EKM *acceptunknown* function, this step is handled automatically for you.
- Are there existing keys and certificates that you can use?

  If there are existing keys and certificates that you can use, you can import or create keys or certificates into the keystore.
- Determine the keystore type that will be employed.

  The keystore will hold the public/private keys and certificates used by the EKM in assisting the tape drives in generating, protecting, and retrieving symmetric encryption keys.

  Depending on the keystore chosen, a keystore can be shared between EKM servers (RACF®, Sysplex, and so forth).

  If EKM servers are running on separate systems, separate keystores will likely be used.

Note: For EKM servers used to handle requests from the same set of tape drives, the information in the associated keystores *must* be kept the same.

Keeping the information in the associated keystores the same allows any of the EKM servers that are contacted to have access to the necessary information to support the requests that it receives from the tape drives for EKM server keystore information.

4.2.4 Advice about working with keys and certificates

You must have your Encryption keys and certificates to get access to your encrypted data. Remember:

- Do not lose your public/private keys and certificates. You will not be able to decrypt your data without them, and your data will be lost.
- Protect your public/private keys and certificates.
- Make sure that you back up your public/private keys and certificates.

Important: Although IBM has services that can help you to recover data from a damaged tape cartridge, if the data on the damaged tape cartridge is encrypted, the data returned to you will be encrypted data. So if you lose your keys, you will have lost your data.

Acting on the advice

Maintenance, backup, and restore of key and certificate information depends on the key ring and keystore implementation used. Here are suggestions that you might want to follow to be sure that you can get access to your keys:

- Create copies of the keystores that the EKM will use.
- Retain a PKCS #12 format file for each key and certificate combination and store it in a secure location (for example, on read-only media and in a locked cabinet).
- Retain a copy of the PKCS #12 format and the keystore at your disaster recovery (DR) sites.

These suggestions allow you to recreate keystores if absolutely necessary. Refer to the *IBM System Storage TS1120 Tape Encryption, Planning, Implementation, and Usage Guide,* SG24-7320, for more information about key management.

4.3 Encryption planning and implementation

In a System z environment, the Encryption capability is implemented through TS1130 and TS1120 tape drive hardware, microcode additions and changes to the Tape Library Manager and tape controller, and a new software component called the Encryption Key Manager (EKM).

4.3.1 Ordering information

The main drive hardware and microcode additions depend on which 3592 model you are going to use:

If TS1130 tape drives will be used for Encryption, check the following features:

- Microcode firmware upgrades to your TS1120 Tape Controller or 3592-J70 Enterprise Tape Controller. When using a common tape cartridge scratch pool, microcode firmware upgrades to your 3590-A60 Enterprise Tape Controller are required.
- Library Manager microcode firmware upgrade.
- The Automatic Tape Library Management Support (ALMS) feature is not required for Encryption in a TS3500, but we recommend it.
- A router for out-of-band key management support and Encryption Key Manager connectivity for tape controllers, tape frames, and the tape subsystem.
- z/OS V1R7 or higher.
- The Encryption Key Manager component.

If TS1120 tape drives will be used for encryption, the following features have to be checked in addition to the TS1130 required features:

- A no-charge encryption-enabled feature code for new TS1120 tape drives.
- An optional chargeable Encryption feature code upgrade, which can contain refurbished parts, for installed TS1120 tape drives.
- z/OS V1R4 or higher.

Note: You will need an IBM SSR to enable the Encryption feature on your TS1120 tape drives.

4.3.2 General hardware requirements

In addition to encryption-enabled 3592 Model E tape drives, you might need to upgrade the microcode firmware of your tape control unit and your Library Manager. If you decide to use out-of-band System-Managed Encryption, you also need a router.

3592 Model E Tape Drive Encryption support

Encryption capability is standard on all TS1130 tape drives and on IBM System Storage TS1120 tape drives manufactured after 8 September 2006. For IBM System Storage TS1120 tape drives manufactured prior to 8 September 2006, a chargeable upgrade, FC5592, is available to enable the drive for Encryption. The Encryption capability includes drive hardware, as well as microcode additions and changes.

You can use the IBM Tape Cartridge 3592 Extended with a native physical capacity of 700/1000 GB Data (JB) or WORM (JX), the IBM TotalStorage Enterprise Tape Cartridge 3592 with a native physical capacity of up to 500/640 GB Data (JA) or WORM (JW), or the IBM TotalStorage Enterprise Economy Tape Cartridge with a native physical capacity of up to 100/128 GB native Data (JJ) or WORM (JR) to hold your encrypted data.

Under z/OS, with system-managed tape support, all devices under a single control unit must be homogeneous, so a mix of TS1130 and TS1120 tape drives is not supported under the same TS1120 Model C06 Controller nor is a mix of encryption-enabled TS1120 and non-encryption-enabled TS1120 tape drives. By attaching the drives to different tape controllers, a mix of TS1130, TS1120, and J1A tape drives can exist in the same tape library.

Additionally, TS1130 and TS1120 tape drives that are encryption-enabled can write on separate media in either encryption or non-encryption format based on your needs.

> **Note:** Tape drives attached to the same tape control unit must all write in the same format. For example, if you attach both TS1120 tape drives and 3592-J1A tape drives to the same controller, the TS1120 Tape Drive operates in 3592-J1A Emulation mode.
>
> With encryption-enabled tape drives, the access time to data on the tape drive increases, because the drive must communicate with the EKM to either obtain a data key or to have a key decrypted.

IBM Tape Controller Encryption support

In a System z environment, you can attach your 3592 Model E encryption-enabled drives to either a TS1120 Tape Controller Model C06 or a 3592-J70 Tape Controller. To utilize encryption support, all the tape drives attached to the same controller must be encryption-enabled.

To configure and activate the Encryption capability of the tape control unit and attached tape drives, you need to order CU Encryption Configuration/Plant or Field (FC9595 or FC5595) for your Tape Controller model J70 or C06. You must also order CU Encryption Configuration/Field (FC5595) whenever an Encryption configuration change is required on the tape controller or attached tape drives. You must install the CU Encryption Configuration features whether or not you implement in-band or out-of-band support.

For in-band Encryption, no other control unit features are required. For out-of-band Encryption, FC5593 is required on the 3592 Tape Controller (Model C06 or J70), or the Tape Frame (3952 Model F05 or 3953 Model F05), the Library Manager Frame (3494 Model L*xx*), or the 3590 Model C10 frame to provide a path through the router to the EKM.

> **Note:** When the CU Encryption Configuration features are installed, it is not necessary to order the Encryption Configuration/Plant or Field (FC9592 or FC5592) on the 3592 Model tape drives attached to the controller. Unless the TS1120 or TS1130 tape drives are installed in a client rack, the minimum level of Library Manager microcode is also shipped when FC9595 is ordered or the first time that FC5595 is ordered for the control unit; this microcode is only supported with encryption-capable TS1120 and TS1130 tape drives.

Support for the 3592 Model E Encryption function when it is installed in any IBM controller attachment requires a minimum level of microcode firmware for all of your controllers where you intend to use tape cartridges from a common tape cartridge scratch pool. The microcode firmware levels that you need are:

1.21.*5.xx*	For any TS1120 Tape Controller (3592-C06)
1.19.9.*xx*	For any 3592-J70 Enterprise Tape Controller
1.16.1.11	For any 3590-A60 Enterprise Tape Controller

> **Note:** A 3590-A60 Enterprise Tape Controller does not support the attachment of TS1130 or TS1120 tape drives. If you mix 3590-A60 tape controllers in a library with other tape controllers that have attached encryption-enabled drives and use a common tape cartridge scratch pool, you need to update the microcode firmware of your 3590-A60 to 1.16.1.11.

3953 Tape Library Manager Encryption support

3592 Model E Encryption support for tape drives attached using a 3953 Library Manager requires a minimum level of microcode firmware in the Library Manager of LM534.*xx*. The level of microcode firmware required will be shipped the first time that you order FC5595 or FC9595.

ALMS and Encryption in the TS3500 library

The Automatic Tape Library Management Support (ALMS) feature is not required for Encryption in a TS3500 in Open Systems environments, but we recommend it. For System z attachment through the IBM 3953 Tape System, ALMS is a prerequisite.

Encryption in a TS3500 Tape Library with ALMS is configured by logical library. Encryption in a TS3500 Tape Library without ALMS is configured by physical library. Specifically, all drives in the non-ALMS library *must* be the new TS1130 drive or TS1120 drive with encryption-enabled using the same IBM System Storage TS1130 or TS1120 tape drive Encryption method even if the drives are in separate logical libraries. This requirement results in the following restrictions for adding drives to non-ALMS libraries:

- Encryption-capable drive added to a non-ALMS library that contains non-encryption-capable drives: You can add a drive that is encryption-capable to a library that previously did not have encryption-capable drives, but you cannot enable encryption.
- Non-encryption-enabled drive added to a non-ALMS library that contains encryption-capable drives, which are not encryption-enabled: You can add a non-encryption-enabled drive to a library that is installed with encryption-capable drives, which are not set for encryption. The drives that are encryption-capable are then restricted from becoming encryption-enabled.
- Non-encryption-capable drive added to encryption-capable and encryption-enabled non-ALMS library: A drive that is not encryption-capable cannot be added to a library that has encryption-enabled drives and will be restricted (not available for use).

Router for out-of-band support

If you use out-of-band support, you need to install one FC5593 on the 3953 Model F05 containing FC5505, Base Frame, to support up to sixteen 3592 tape controllers in a 3953 Tape System.

4.3.3 General software requirements

Tape Encryption is supported by z/OS V1R4 or later. You also need IBM Software Developer Kit (SDK) for Java 2.

z/OS support for Tape Encryption

The encryption-enabled TS1130 tape drives require z/OS V1R7 or later with the enabling APAR OA22119. There are toleration program temporary fixes (PTFs) available for DFSMSrmm running on z/OS V1R6.

The TS1120 tape drives with encryption-enabled are supported for attachment to ESCON and FICON channels on System z servers. z/OS support of System-Managed Encryption with TS1120 tape drives requires:

- z/OS and z/OS.e V1R5 or later
- z/OS V1R4 with z/OS V1R4 z990 Exploitation Support feature
- z/OS.e V1R4 with z/OS.e V1R4 z990 Coexistence Update feature
- An Encryption Key Manager component available to the z/OS system

For z/OS V1R6 and V1R7, refer to enabling APAR OA15685, and for z/OS V1R8, refer to enabling APAR OA17562. An enabling APAR will also be available for z/OS V1R4 and V1R5. For additional information about the support provided, refer to the 3592 preventive service planning bucket (PSP) Bucket.

Note: You can use the encryption-enabled TS1120 tape drives on systems that run z/OS V1R4 or later. However, you must use z/OS V1R5 or later to use media types MEDIA9 and MEDIA10 and z/OS V1R7 or later to use TS1130 tape drives.

For details about supported software versions and release levels for the TS1130 and TS1120 tape drives, as well as hardware support information, refer to the following Web site:

http://www.ibm.com/servers/storage/tape/3592/interop.html

Other mainframe platform support for Tape Encryption

Tape Encryption is currently supported on other mainframe platforms using System-Managed Encryption with the TS1120:

- z/VM V5.1 and V5.2

  This support includes transparent support for VM guests. The z/VM support requires the Encryption Key Manager component running on another operating system other than z/VM using an out-of-band connection. Encryption is turned on using ATTACH or SET RDEVICE. The encryption key labels are defined using SET KEYALIAS or ATTACH.

  z/VM provides guest toleration support for the TS1130 on supported releases of z/VM Version 5. This support allows attachment of the TS1130 to guest operating systems that support it, including guest access to the drive's Encryption capabilities. PTFs for APAR VM64459 will be required for the VM control program. PTFs for APAR VM64458 will be required for the RMS component of DFSMS/VM™ FL221 for environments where RMS is required.

- z/TPF V1.1

  The z/TPF support requires the Encryption Key Manager component running on another operating system other than z/TPF using an out-of-band connection. Encryption is turned on or off based on tape name. The EKM default key labels are used for the key labels.

- z/VSE V3.1

  The z/VSE support requires the Encryption Key Manager component running on another operating system other than z/VSE using an out-of-band connection. Encryption is turned on or off based on the JCL ASSGN statement. The encryption key labels are defined using the JCL KEKL statement or using the EKM defaults.

  Note: z/VSE 4.2 provides native and guest support under VM for TS1130.
  z/VM and z/TPF will provide support after general availability of the TS1130.

Encryption Key Manager (if the EKM is run on z/OS)

If the Encryption Key Manager is run on the z/OS system, one of these IBM SDKs for Java 2 must be installed:

- IBM SDK for z/OS, Java 2 Technology Edition, V1.4, 5655-I56 (at the SDK1.4.2 SR6 or later level)
- IBM 31-bit SDK for z/OS, Java 2 Technology Edition, V5.0, 5655-I98 (at the SDK5 SR3 or later level)

For details about supported software versions and release levels for the TS1120 Tape Drive, as well as hardware support information, refer to the following Web site:

http://www.ibm.com/servers/storage/tape/3592/interop.html

4.3.4 Linux on System z

Library-Managed Encryption is available for System z servers connected to the TS3500 through Fibre Channel Protocol (FCP) that run one of the following Linux on System z distributions:

- SUSE® Linux Enterprise Server 9 (SLES 9)
- Red Hat Enterprise Linux (RHEL 4)

Library-Managed Encryption with Linux on System z requires:

- An Encryption Key Manager component available to the TS3500
- A TS3500 Tape Library

If the Encryption Key Manager is run on a Linux on System z partition, you must install and update one of the following Java 2 SDKs:

- Java 2 Standard Edition SDK 5
- Java 2 Standard Edition SDK 1.4.2

You can obtain updates to the Linux Java SDK at this Web site:

http://www-128.ibm.com/developerworks/java/jdk/linux/download.html

4.3.5 Media support for encryption-enabled 3592 Model E tape drives

Encryption-enabled TS1130 tape drives read and write in both recording formats (encrypted and non-encrypted format) EEFMT3 and format EFMT3.

Encryption-enabled TS1120 tape drives read and write in the recording format EEFMT2, the encrypted format, as well as the non-encrypted format 1, also known as J1A emulation.

The IBM System Storage encryption-enabled TS1130 and TS1120 tape drives use all currently available media types, Media5 - Media10. The usable capacity is the same for the encrypted format as for the non-encrypted format.

> **Note:** For detailed information about planning and installing 3592 Tape Encryption, refer to the *IBM System Storage Tape Encryption, Planning, Implementation, and Usage Guide*, SG24-7320.

4.4 Other considerations

This section provides additional topics to consider when implementing tape encryption.

4.4.1 Disaster recovery considerations

If you plan to use a disaster recovery (DR) site, the EKM provides a number of options to enable that site to read and write encrypted tapes:

- Create a duplicate EKM at the DR site with the same information as your local EKM (configuration file, tape drive table, and keystore). This EKM is then in place and capable of taking over for one of your existing production EKMs to read and write encrypted tapes.
- Create a backup copy of the three EKM data files to be able to recover as needed. If you create a current copy of the three data elements needed by the EKM (configuration file, tape drive table, and keystore), you can start an EKM at any time to act as a duplicate at the DR site. If your DR site uses different tape drives from your primary site, the configuration file and tape drive table must contain the correct information for the DR site.

  > **Note:** Remember that you must not use the EKM to encrypt the three EKM data files (configuration file, tape drive table, and keystore), because you cannot decrypt them without a functioning EKM.

- Use the second Externally Encrypted Data Key (EEDK) on each tape cartridge to encrypt tape cartridges in order that a private key, which is unique to the DR site, is one of the entities that can read the encrypted tape. You can also choose to write an alternate certificate for the DR site. This consists of using the certificate of the DR site to write your existing tapes in exactly the same way that you provide this capability to another organization.

  In other words, in addition to storing your data encryption key on your tapes, wrapped using your organization's public/private key, the data key is also stored on the same tapes wrapped using the DR site's public key (certificate). This design allows a functioning EKM at that site to use its own keystore with its own public/private key to read the tapes. If your DR site uses different tape drives from your primary site, the configuration file and tape drive table must contain the correct information for the recovery site.
- Consider setting the EKM variable *drive.acceptUnknownDrives* in the configuration file to `true`. Refer to the *IBM System Storage TS1120 Tape Encryption Planning, Implementation, and Usage Guide,* SG24-7320, for more information about this variable.

4.4.2 Encryption with other backup applications

Tivoli Storage Manager supports Application-Managed Encryption with all IBM tape libraries, including the TS3500. Tivoli Storage Manager manages the encryption keys itself and does not require the EKM for Application-Managed Encryption.

For more information, refer to *IBM System Storage Tape Encryption Solutions*, SG24-7320.

All backup applications currently supported on the TS3500 Tape Library support Library-Managed Encryption, because the application is not involved in the encryption process. These applications include Symantec NetBackup, EMC NetWorker, CommVault Galaxy, and BakBone NetVault.

4.4.3 Performance considerations

Unlike software encryption or encryption appliances, the TS1120 Encryption solution can encrypt data with minimal performance impact and without requiring additional equipment in your computing environment. You might be concerned that encryption will impact the performance of your applications or backup processing. Extensive testing shows there is little degradation to performance with encryption-enabled drives. The data rate claims of the drive remain unchanged.

With encryption-enabled, when writing from load point, the access time to the first write from the beginning of tape increases due to the time needed to retrieve, read, and write the encryption key. In z/OS, this added time is detected in OPEN processing, the time between the mount message and the IEC705I "`Tape On`" message. The tape drive unload time has a similar increase.

If your EKM is on a z/OS platform, insure that it has a Workload Manager (WLM) job priority similar to other system services, such as VTAM® or TCP/IP. You do not want situations where the EKM has to wait for CP cycles to return keys to access and return keystore information, because this wait can delay processing across your enterprise.

Using Virtual IP Addressing (VIPA) in your z/OS setup can contribute to both better performance and redundancy with running with a z/OS-based EKM. Refer to the *IBM System Storage TS1120 Tape Encryption Planning, Implementation, and Usage Guide*, SG24-7320, for more information about this topic.

With z/OS, you might also see a longer delay when using in-band if your primary key manager is unavailable. In this case, the IOS Proxy Retry Logic first attempts to communicate with the primary key manager. The IOS proxy interface might retry several times before switching over to the secondary key manager. While the retries occur, the job can appear stopped.

Before cancelling a job, ensure that you allow enough time for the retry attempts that might be occurring on the primary and also the secondary key manager. Typically, each attempt can take around three minutes with two retry attempts on the primary key manager before attempting to connect to the secondary key manager.

Similar logic is in place with the secondary key manager. After the proxy interface has switched to the secondary key manager, it always attempts to communicate with the primary key manager on subsequent communications; however in this case, only one (shortened) attempt is made to communicate with the primary key manager before going back to the secondary key manager. If the IOS proxy interface cannot communicate with the primary key manager, even though the job might have been successful, message IOS627E is issued in the job log and in the system log alerting you to a potential problem with the primary key manager.

4.4.4 Re-keying support for the TS1120 and TS1130

When a tape cartridge is encrypted, the Data Key used to encrypt the data is also encrypted, or *wrapped*, using the public key from a private/public Key Encrypting Key pair. This encrypting creates an Externally Encrypted Data Key (EEDK) that is stored on the tape cartridge in non-user data areas of the tape. The private key of that public/private key pair is then used to decrypt the data key.

When the first file sequence on a tape is written and encryption is requested, up to two key labels can be specified enabling the cartridge's data key to be encrypted, or wrapped with two different public keys. This generates an EEDK for each of the key labels specified. One of the key labels can be used for local (on-site) usage, and the second key label can be used for export (off-site) purposes.

Allowing the specification of two key labels works well if the usage of the tape is known ahead of time, but what if the volume needs to be exported at a later date using a different public key or what if the existing keys have been compromised?

A mechanism is provided in the drive and the encryption key manager that enables a cartridge's data key to be reencrypted with new key encrypting keys using new key labels. This re-keying support enables a tape cartridge to be re-keyed without having to copy the data to another volume. This re-keying is accomplished through the drive and the external key manager by:

- Decrypting one of the existing EEDKs stored on tape to get the DK
- Reencrypting it with different KEKs to create new EEDKs
- Overwriting the existing EEDKs with the new EEDKs

This re-keying support enables an already encrypted tape cartridge to have its data key re-encrypted using new KEKs (through the specification of new key labels).

Note: In addition to the needed host support (refer to APAR OA20076), re-keying also requires the TS1120 Model C06 Tape Controller with machine code level 1.21.3.*xx*, or later, or the J70 machine code level 1.19.7.*xx*, or later, also available since 31 August 2007.

5

IBM Tape Virtualization solutions

This chapter provides a detailed description of the components, the underlying concepts, and the architecture of the IBM Virtualization Engine TS7700 and the IBM TotalStorage Virtual Tape Server (VTS).

This chapter covers the following topics:

- Underlying concepts of tape virtualization with the TS7700 and IBM 3494 VTS[1].
- General product design
- Hardware components that make up each solution
- Attachment of the TS7700 and IBM 3494 VTS to an IBM System Storage Tape Library TS3500 through the IBM System Storage 3953 Tape System
- Architecture of the TS7700 and IBM 3494 VTS
- Functional characteristics of the TS7700 and IBM 3494 VTS

Note: The information contained in this book refers to the TS7700 Virtualization Engine R1.4a and lower.

For detailed planning and implementation information about the IBM Virtualization Engine TS7700, refer to:

- *TS7700 R1.4a and lower: IBM Virtualization Engine TS7700: Tape Virtualization for System z Servers*, SG24-7312
- *TS7500 R1.5 and higher: IBM Virtualization Engine TS7740 R1.5 and TS7720: New Virtualization Options for Mainframe Servers*, SG24-7712

For more information about the IBM TotalStorage Virtual Tape Server, refer to:

- *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring,* SG24-2229
- *IBM TotalStorage Peer-to-Peer Virtual Tape Server: Planning and Implementation Guide,* SG24-6115

[1] The IBM 3494 Model B10 and B20 were withdrawn from marketing effective 1 December 2006.

5.1 Tape virtualization basics

Tape virtualization was introduced as a response to the underutilization of tape capacity. Because many applications are not able to fill the high capacity media of today's tape technology, you can end up with a large number of underutilized cartridges, wasting a lot of space on your physical media and requiring an excessive number of cartridge slots in your tape automation system. *Tape virtualization* fully utilizes the capacity of current tape technology by using a disk buffer as intermediate storage before writing client data to high capacity tape cartridges. However, System z virtual tape subsystems emulate the function and operation of IBM 3490 Enhanced Capacity (3490E) tape drives. These emulated tape drives are called *virtual tape drives*, and to an attached host, they appear identical to physical tape drives. Emulation is transparent to the host and to applications.

Another benefit that you get from tape virtualization is the large number of drives available to applications. Each tape virtualization subsystem provides you with up to 256 virtual tape devices, depending on virtualization subsystem models. If you have a situation where applications contend for tape drives and jobs have to wait because no physical tape drive is available, tape virtualization can efficiently address these issues by providing a large number of virtual tape drives.

Figure 5-1 illustrates the main components that are used to create a complete virtualization solution.

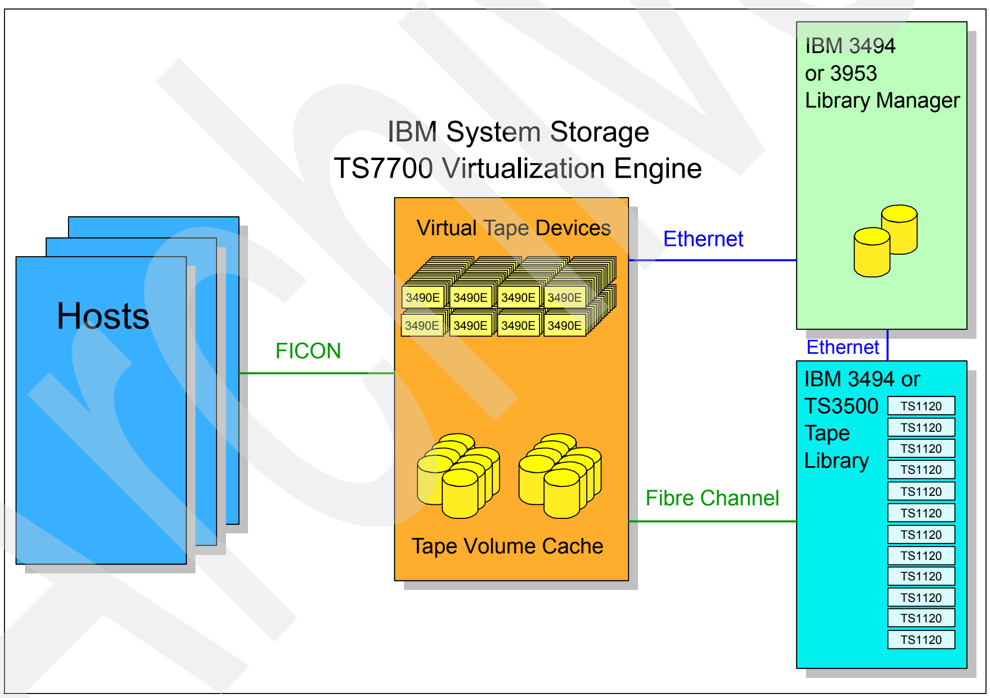


Figure 5-1 Main components of a virtualization solution

Data written to or read through a virtual tape drive resides in a virtual volume on a portion of the virtualization subsystem's disk storage media called the *Tape Volume Cache* (*TVC*). A *virtual volume* shows the same characteristics as a Cartridge System Tape or an Enhanced Capacity Cartridge System Tape.

The TVC's associated storage management software manages the virtual volumes and the movement of data between the TVC and the IBM 3592 or IBM 3590 tape drives associated with the virtualization subsystem.

A migration occurs when a virtual volume is moved from the TVC to a physical tape cartridge to free space in the TVC for new data. The virtual volume is now a logical volume. A recall occurs when a logical volume is moved from a physical tape cartridge back to the Tape Volume Cache. The logical volume again becomes a virtual volume. One or more logical volumes can reside on a physical tape cartridge (also called a *physical volume*). A tape cartridge containing more than one logical volume is called a *stacked volume*. Each virtualization subsystem is assigned a range of VOLSERs for use with its physical volumes. The virtualization subsystem maintains the relationship between logical volumes and the physical volumes on which they reside.

The IBM 3953-L05 Library Manager maintains a database that is based on the VOLSERs of the physical volumes and also stores the logical volumes associated with the physical volumes.

The IBM Tape Virtualization solution for System z servers, the IBM Virtualization Engine TS7700, is the follow-on product of the IBM TotalStorage Virtual Tape Server (VTS). The IBM TotalStorage Virtual Tape Server was available as a Model B10 or a Model B20.

Two or three virtualization systems of the same model, which are attached to physically separate tape libraries, can be connected for data redundancy and high availability. More specifically, up to three TS7700 Virtualization Engines can be connected into a Multi Cluster Grid. Two VTS systems Model B10 or two models B20 can be connected into a Peer-to-Peer VTS (PtP VTS) through Virtual Tape Controllers (VTCs) installed inside one or more IBM 3494-CX1 Virtual Tape frames.

The following list summarizes the key benefits that you can expect from tape virtualization:

- High availability and disaster recovery configurations
- Fast access to data through caching on disk
- Utilization of current tape drive, tape media, and tape automation technology
- Transparent migration to new tape technology
- Capability of filling high capacity media 100%
- Large number of tape drives available for concurrent use
- No additional software required
- Reduced Total Cost of Ownership (TCO)

5.2 Tape virtualization design

In the following sections, we provide short descriptions of the concepts that we use throughout this chapter. You have to consider the differences between 3494 VTS and the TS7700 Virtualization Engine.

5.2.1 Tape Volume Cache

The *Tape Volume Cache* (TVC) is disk space where logical volumes are stored. The TVC is under complete and exclusive control of the virtualization subsystem. TVC capacity can be adjusted so that it can hold more virtual volumes than just those currently associated with virtual tape drives. The Tape Volume Cache storage management software adjusts capacity as necessary. After an application modifies and closes a virtual volume, it is copied by the storage management software to a physical volume as a background process. The virtual volume remains active until its disk space is needed to satisfy another mount request. Leaving the virtual volume in place in the TVC allows for fast access to its data when subsequently requested, much faster than if a physical volume needed to be mounted in a tape drive and read. When the host requests to mount the volume, the physical volume is recalled to the TVC as a virtual volume if the original virtual volume is no longer resident in the TVC.

5.2.2 Physical drives

The physical tape drives used by a tape virtualization subsystem, 3590, 3592-J1A, and TS1120 supported by 3494 VTS and 3592-J1A and TS1120 supported by TS7700 are installed in the IBM TS3500 Tape Library. The physical tape drives are not addressable by any attached host system. They are completely under the control of the tape virtualization subsystem.

> **Note:** Intermixing IBM 3952-J1A and TS1120 tape drives is only supported when the TS1120 operates in 3592-J1A Emulation mode. To support the exploitation of the native capacity of the TS1120 (3592-E05) Tape Drive by the TS7700, all tape drives must be TS1120s operating in native E05 mode.
>
> At the time of writing this book, TS7700 support for TS1130 was not available yet.

5.2.3 Stacked volume

The physical cartridges used by the tape virtualization subsystem to store logical volumes are completely under its control and are not known to the hosts. The physical volumes are called *stacked volumes*. The stacked volumes must have unique machine-readable VOLSERs and external labels just as any other cartridges in a tape library.

Through the Library Manager, you define which physical cartridges are to be used by the tape virtualization subsystem. Logical volumes stored on those cartridges are mapped by the internal storage management software. When you use pooling, your stacked volumes can be assigned to individual pools. Logical volumes can then be assigned to the stacked volume pools.

5.2.4 Virtual drives

From a host perspective, a tape virtualization subsystem looks like multiple logical IBM 3490E tape control units, each with sixteen drives attached through ESCON or FICON channels. Virtual tape drives are defined just like physical IBM 3490 controller addresses through the hardware configuration definition (HCD). Up to 256 virtual drives are supported.

Using regular operating system (OS) commands, you can manage virtual drives just as you manage real tape drives.

5.2.5 Virtual volumes

A *virtual volume* is created in the TVC when the host writes data to the tape virtualization subsystem. All host interaction with tape data in a tape virtualization system is through virtual volumes and virtual tape drives.

Each virtual volume has the same characteristics as a real volume, except for capacity. With a tape virtualization subsystem, a large volume size option is available, which increases the maximum native volume size up to 4000 MB. The end of volume is signaled when the total number of bytes written into the TVC after compression has reached 400 MB for an emulated cartridge system tape (CST), 800 MB for an emulated enhanced capacity cartridge system tape (ECCST) volume, or 1000, 2000, or 4000 MB using the larger volume size options.

With data compression based on the Ziv-Lempel algorithm (IBMLZ1) by the FICON channel card in a tape virtualization subsystem, the maximum actual host data stored on a virtual CST or ECCST volume can vary from 1.2 GB up to 12 GB (assuming a 3:1 compression ratio). The default logical volume sizes of 400 MB or 800 MB, still used at insert time, can be overwritten at every individual scratch mount by the use of a Data Class construct.

5.2.6 Logical volumes

When a virtual volume is copied from the TVC to a physical tape cartridge, it becomes a *logical volume*. When a logical volume is moved from a physical cartridge to the TVC, the process is called *recall*, and the volume becomes a virtual volume again.

Although tape virtualization subsystems emulate a 3490E tape of a specific size, 400, 800, 1000, 2000, or 4000 MB, the space used in the TVC is no more than that needed for the number of bytes of data written to the virtual volume. When the virtual volume is written to the physical tape, it uses only the space occupied by the data. In other words, neither the TVC nor the physical tapes are partitioned in any way into 400 MB, 800 MB, 1000 MB, 2000 MB, or 4000 MB segments. As virtual volumes are copied from the TVC to a physical cartridge, they are stacked on the cartridge end to end, taking up only the space written by the host application. This arrangement maximizes the utilization of a cartridge’s storage capacity.

You can define up to 500 000 logical volumes per VTS B10 or B20, and up to 1 000 000 virtual volumes per TS7700 Virtualization Engine. For an IBM 3953 Tape System with two TS7700s, a maximum of 2 000 000 logical volumes is supported. A Multi Cluster Grid can have the same number of virtual volumes as a stand-alone cluster (1 000 000).

5.2.7 Data compression

IBM virtualization subsystems include the data compression capability. Data is compressed when written into the TVC. Whether tape drive compression is switched on is determined by whether it provides any additional benefit over the compression in the TVC.

5.3 TS7700 Virtualization Engine

In this section, we provide an overview of the TS7700 Virtualization Engine and its configuration options.

5.3.1 Components

The IBM System Storage Virtualization Engine TS7700 is the newest member of the IBM TS7000 Virtualization family. It represents the fourth generation of IBM Tape Virtualization for mainframe systems and replaces the highly successful IBM TotalStorage Virtual Tape Server (VTS).

The TS7700 Virtualization Engine is designed to provide improved performance and capacity to help lower the total cost of ownership for tape processing. It introduces a new modular, scalable, high-performing architecture for mainframe tape virtualization. It integrates the advanced performance, capacity, and data integrity design of the IBM TS1120 tape drives with high-performance disk and a new advanced IBM System p server to form a storage hierarchy managed by robust storage management firmware with extensive self-management capabilities.

The TS7700 Virtualization Engine utilizes outboard policy management to manage physical volume pools and cache management and to control selective dual copy, dual copy across a grid network, and copy mode.

The TS7700 offers a new standards-based management interface and enhanced statistical reporting (VEHSTATS), compared to the VTS. You can obtain information about how to use VEHSTATS and all the TS7700 monitoring and evaluating tools at the following sites:

- Tools can be downloaded internally from the following intranet sites:

  `ftp://submit.boulder.ibm.com/download/tapetools/`
  `http://w3-1.ibm.com/sales/systems/ibmsm.nsf/docnames/tapetools`

- IBM Business partner tools can be located at the following Internet site:

  `http://testcase-yellow.boulder.ibm.com`

- Client tools can be located at the following Internet site:

  `ftp://ftp.software.ibm.com/storage/tapetool/`

The TS7700 Virtualization Engine integrates the following components into the virtual tape solution:

- One *IBM Virtualization Engine TS7740 Server* Model V06 (3957 Model V06)
- One *IBM Virtualization Engine TS7740 Cache Controller* Model CC6 (3956 Model CC6)
- One, two, or three *IBM Virtualization Engine TS7740 Cache Drawers* Model CX6 (3956 Model CX6)

Figure 5-2 shows the TS7700 Virtualization Engine components installed in an IBM 3952 Frame.

Figure 5-2 TS7700 Virtualization Engine

Important characteristics of these components are:

- The TS7700 Server provides host connection of up to four FICON channels and connections to the tape library and tape drives for back-end tape processing.
- A TS7700 with Grid Communication features can be interconnected with one or two other TS7700s to provide peer-to-peer copy capability between two or three TS7700s using IP network connections.
- The TS7740 Cache, comprised of the TS7740 Model CC6 and the TS7740 Model CX6, provides 6 TB of TVC capacity before compression.
- Each TS7700 cluster supports up to a maximum of 256 3490E virtual tape drives and up to 1000 000 logical volumes, each with a maximum capacity of 1.2 GB to 12 GB (assuming 3:1 compression and using the 400 to 4000 MB volume sizes).
- Cache increments can be ordered from 2 TB to 6 TB uncompressed in 1 TB increments (FC5267). Cache increments are enabled by a license key and allow you to better tailor the costs of a solution to meet your client's needs.
- Performance increments of 100 MB/s (FC5268) can be ordered up to 600 MB/s.

5.3.2 Nodes

The VTS performs all functionality with a single System p server. The VTS also serves as the RAID disk controller and is tightly integrated into the system. TS7700 Virtualization Engine is built on a distributed node architecture.

The nodes perform either virtualization (vNode) or hierarchical data storage management (hNode). Based on the node architecture, a vNode or an hNode can run on separate virtualization hardware or can be combined to run on the same virtualization hardware. When a vNode and an hNode are combined and run on the virtualization hardware, this combination of nodes is referred to as a gNode (general node). At the time of writing this book, the TS7700 Virtualization Engine runs one gNode.

vNode

The *vNode (virtualization node)* presents the image of virtual drives to a host system. It receives tape drive and library requests from the host and processes them as though the vNode were a real device. It also translates the tape requests through a virtual drive and uses a file in a file system to represent the virtual tape image.

hNode

The *hNode (hierarchical storage management node)* performs all of the management of a logical volume residing in disk cache or physical tape after it has been created or altered by the host system through a vNode. The hNode is the only node that is aware of physical tape resources and the relationships between the logical volumes and the physical volumes. It is also responsible for any replication of the logical volumes and their attributes across site boundaries.

gNode

The *gNode (general node)* can be considered a vNode and an hNode sharing the same physical server. Consider it the equivalent of the IBM Virtual Tape Server in terms of a single controller having both the virtualization and hierarchical storage management capabilities.

5.3.3 Cluster

The TS7700 Virtualization Engine cluster combines the Virtualization Engine with a disk subsystem TS7740 cache. The architecture allows additional disks or nodes to be added in the future to expand the capabilities of the system. A *cluster* provides FICON host attachment and 256 virtual tape device addresses. The cluster also includes that part of the TS3500 Tape Library that is assigned to the TS7700 Virtualization Engine.

Figure 5-3 illustrates a TS7700 cluster and the components.

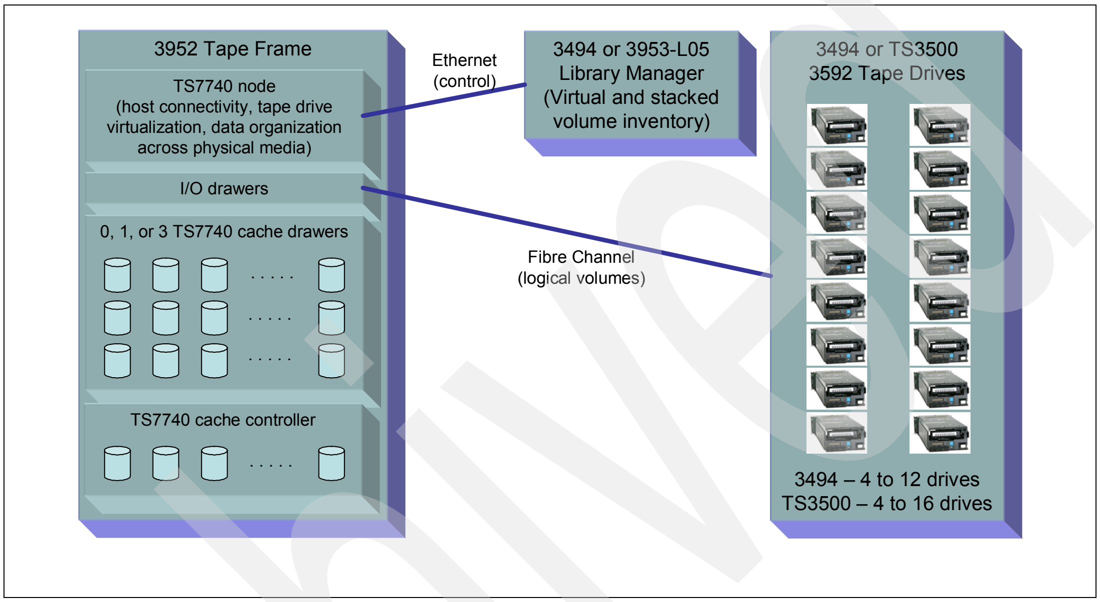


Figure 5-3 TS7700 components

5.3.4 Grid configuration

Two or three TS7700 clusters can be interconnected to provide a disaster recovery/high availability solution that is called a *Multi Cluster Grid*. Each TS7700 cluster has 256 virtual 3490E drives. The Grid enablement feature must be installed on the TS7700 Virtualization Engines, and an Ethernet connection must be established between the clusters. Each cluster has two 1 Gb Ethernet adapters and uses TCP/IP for communication to the other TS7700 clusters.

Note: More than one situation has occurred where a TS7700 was ordered with FC4015 (Grid enablement) and the intention is to initially use the TS7700 in a stand-alone test environment. This TS7700 must be “install complete” (service code 20 CIA 1) before being used in this test configuration. This use of a grid-enabled TS7700 in a stand-alone environment is an unintended use and requires that the TS7700 is “Reset to Factory Settings”, also sometimes referred to as “*manufacturing cleanup*”, before using the TS7700 in a grid configuration.

The “Reset to Factory Settings” function is not currently part of the TS7700 product. This function might be delivered in a future release. The activity to perform a reset (to wipe out the data or to wipe out both the data and the configuration) is not a valid warranty item nor expense. This reset must be done by business design assurance (BDA), PFE, or development and is billable to the IBM Account Team. An ICA must be created to cover the cost of BDA/PFE/development involvement.

With release 1.3 code installed, a valid alternative is to order the TS7700 without FC4015. When the time comes to use the TS7700 in a grid configuration, it must be connected to an IP network and FC4015 must be ordered as a miscellaneous equipment specification (MES), plus a new TS7700 (with FC4015) must be ordered as its grid partner. The MES feature code’s cost is used to offset the additional expense for the IBM service support representative (SSR) to upgrade the unit. Release 1.4 code includes support to merge an existing stand-alone cluster with a Two Cluster Grid to form a three-way grid.

Logical volume attributes and data are replicated across the clusters in a grid configuration to ensure the continuation of production work if a single cluster becomes unavailable. Any data replicated between the clusters is accessible through any of the other clusters in a grid configuration. More specifically, all vNodes in a grid have direct access to all logical volumes in the grid, either from the local cluster’s TVC through Fibre Channel or from a remote cluster’s TVC through a wide area network (WAN) connection. During mount processing, a TVC is selected as the I/O TVC. All I/O operations associated with the virtual tape drive to which the mount was issued are routed from its vNode to the TVC on the selected cluster.

A Multi Cluster Grid configuration presents a single Composite Library image to the host; the entire subsystem appears as a single tape subsystem to the attached hosts. The host does not see the underlying Distributed Libraries similar to the prior generation’s Peer-to-Peer Virtual Tape Server (PtP VTS). Multiple TS7700 Virtualization Engine grid configurations can be attached to host systems and operate independently of each another.

Currently, a *Multi Cluster Grid* comprises two or three clusters. The architecture is designed to allow more than three clusters in a Multi Cluster Grid configuration in the future.

Figure 5-4 on page 132 illustrates a TS7700 Two Cluster Grid with the required network infrastructure.

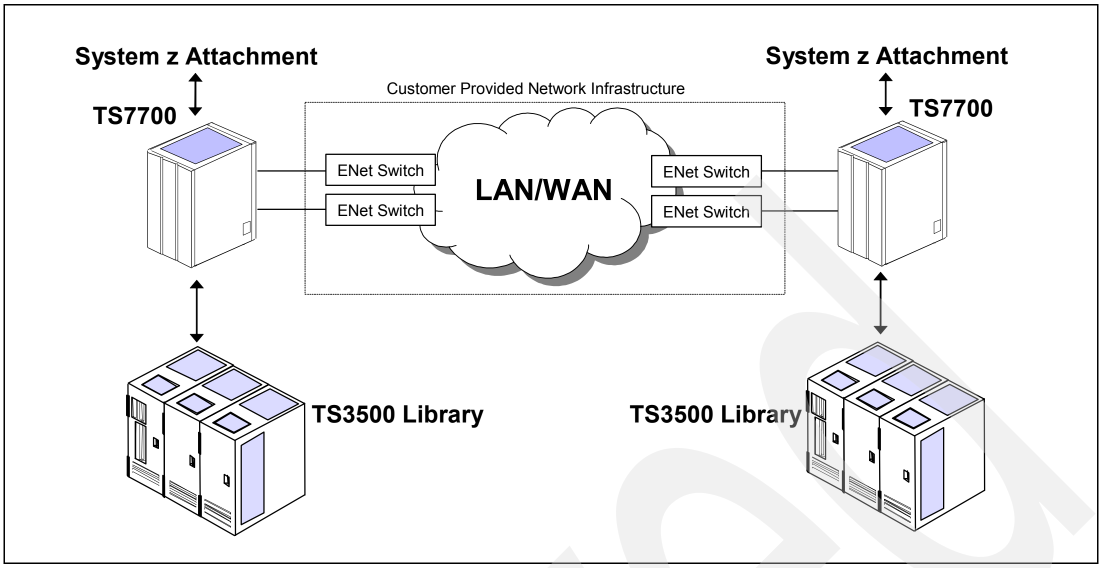


Figure 5-4 TS7700 Two Cluster Grid

Figure 5-4 illustrates a TS7700 Three Cluster Grid with the required network infrastructure. As in a Two Cluster Grid, each cluster contains a TS7700 Tape Library and tape drives. The library can be an IBM 3494 Tape Library or the IBM TS3500 Tape Library.

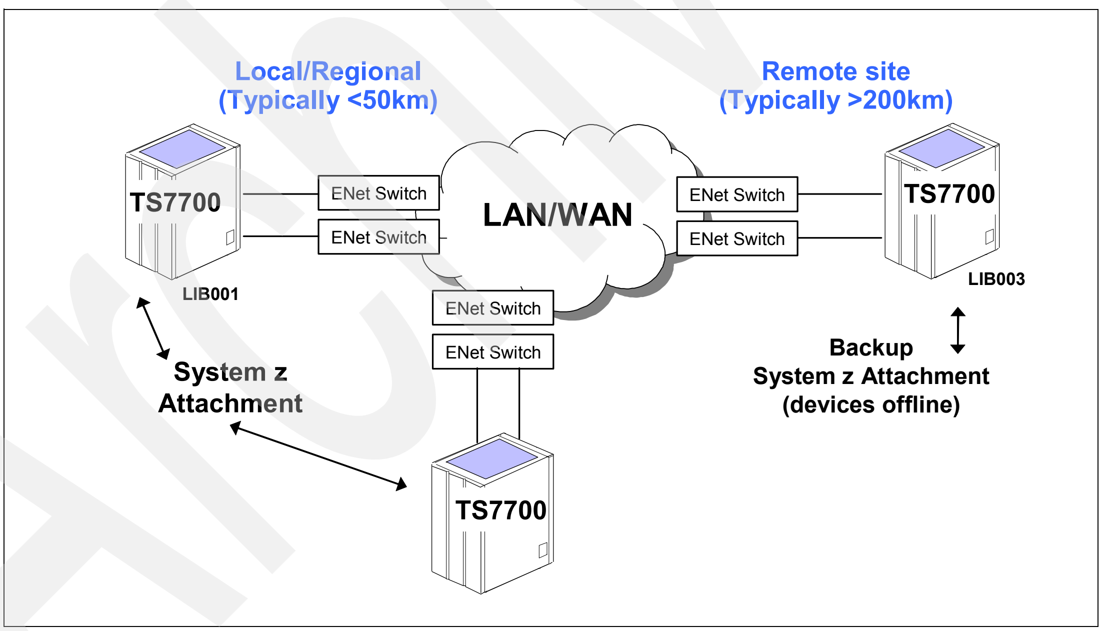


Figure 5-5 TS7700 Three Cluster Grid

When two or three clusters are connected to a grid, logical volumes and their copies, if configured for copies, reside on both clusters. Planning of logical volume management and possible Multi Cluster Grid configuration options is required to make sure that the grid configuration meets your data availability and disaster recovery objectives. This planning is especially important for volume ownership and copy consistency point options.

Removal of a cluster

If you have used the grid capability for a relocation process or any other temporary purpose, you now have the function (with TS7700 Release 1.4A) to remove a cluster from a grid non-disruptively. Furthermore, you might want to get rid of all of the information and data of this cluster. Therefore, you can use the cleanup function. It is a one-time process and contains the following actions:

- Delete the TS7700 database
- Logically delete logical volumes from the tape volume cache (this does not delete the data on the disks or back-end tape cartridges)
- Reset all configuration information set by the IBM SSR during the installation to the default manufacturing state

The cluster can then be used as a stand-alone machine or attached to a different grid. Both the removal function and the cleanup function are available on a feature code basis.

For a full description of Multi Cluster Grid configuration options, refer to *IBM Virtualization Engine TS7700: Tape Virtualization for System z Servers*, SG24-7312.

5.3.5 Copy Export

A very interesting function that is only supported on the TS7700 is the *Copy Export* function. It enables the client to move physical volumes with data critical for continuing business operations outside a library to an off-site vault.

Copy Export is supported for a Single Cluster Grid with Release 1.3 and is supported in a Multi Cluster Grid starting with Release 1.4. However, the expected use is for clients with a Single Cluster Grid who require that data is moved off-site, or for clients with a Multi Cluster Grid where a primary need is validating and testing a client-described disaster scenario.

Copy Export supports moving the logical copy of the original logical copy to another location and keeping the original logical copy within the original TS7700 and available for normal production. A related function is called *Copy Export Recovery*, where you insert the physical volumes and establish the TS7700 again based on the contents of the physical volumes.

Copy Export Recovery requires an empty Single Cluster Grid. But with the introduction of FC5267 and FC5268 as described in 5.3.1, “Components” on page 127, you can tailor a solution based on what you can afford.

5.3.6 Tape Encryption

Encryption is also supported on TS7700. Encryption of backstore tapes helps control the risks of unauthorized data access without an excessive security management burden or subsystem performance issues. IBM Tape Encryption solutions all use an Encryption Key Manager (EKM) as a central point from which all encryption keys are handled. The EKM communicates with the TS7700 Virtualization Engine, and Encryption on the TS7700 is controlled outboard on a physical stacked volume pool basis and is set using the Management Interface (MI). As you set up Encryption for all logical volumes in a specific pool, you can use it in addition to the Copy Export Function as well. For more information concerning Encryption and the TS7700, refer to 4.1.3, “Encryption with TS7700 on z/OS” on page 108.

5.3.7 Library Request host console commands

Library Request host console commands provide a way for an administrator or an operator to determine the status of resources and to obtain information about the resources of the TS7700, as well as to prioritize some of the active work. Library Request host console commands also enable the client to perform problem determination. You can be proactive addressing the delay of a single important job that is waiting for recalls from back-end drives. The commands are only for TS7700 clusters and were introduced with the TS7700 Virtualization Engine code level 8.3.*x.x*. z/OS support is also required.

Table 5-1 shows a list of all of the commands and a short description of each command.

Table 5-1 Overview of Library Request commands

Keyword1	Keyword2	Keyword3	Description	Composite Library	Distributed Library
CACHE	N/A	N/A	Requests information about the current state of the cache and the data managed within it associated with the specific Distributed Library.	N/A	Y
COPYEXP	*VOLSER*	RECLAIM	Requests that the specified physical volume that has been exported previously in a copy export operation is made eligible for priority reclaim.	N/A	Y
COPYEXP	*VOLSER*	DELETE	Requests that the specified physical volume that has been exported previously in a copy export operation is deleted from the TS7700 database. The volume must be empty.	N/A	Y
LVOL	*VOLSER*	N/A	Requests information about a specific logical volume.	Y	N/A
PDRIVE	N/A	N/A	Requests information about the physical drives and their current usage associated with the specified Distributed Library.	N/A	Y
POOLCNT	00-32	N/A	Requests information about the media types and counts, which are associated with a specified Distributed Library, for volume pools beginning with the value in keyword2.	N/A	Y
PVOL	*VOLSER*	N/A	Requests information about a specific physical volume.	N/A	Y

Keyword1	Keyword2	Keyword3	Description	Composite Library	Distributed Library
RECALLQ	*VOLSER*	N/A	Requests the content of the recall queue starting with the specified logical volume. Keyword2 can be blank.	N/A	Y
RECALLQ	*VOLSER*	PROMOTE	Requests that the specified logical volume is promoted to the top of the recall queue.	N/A	Y
STATUS	GRID	N/A	Requests information about the copy, reconcile, and ownership takeover status of the libraries in a grid configuration.	Y	N/A

All the commands are presented and described in *IBM Virtualization Engine TS7700: Tape Virtualization for System z Servers*, SG24-7312.

5.3.8 Secure Data Erase

Expired data on a physical volume remains readable until the volume has been completely overwritten with new data. Some clients are concerned that a court order might expose them to liability, and they are concerned about the cost of trying to find an old version of a data volume. Another concern is the security of old data.

TS7700 Release 1.3 adds physical volume erasure on a physical volume pool basis that is controlled by an additional reclamation policy. It utilizes the Outboard Policy Management Definitions that are standard on the TS7700. With the Secure Data Erase function, all reclaimed physical volumes in that pool are erased by writing a random pattern across the whole tape prior to being reused. In the case of a physical volume that has encrypted data, the erase can involve just “shredding” the encryption keys on the volume to accomplish the erasure. A physical cartridge is not available as a scratch cartridge as long as its data is not erased.

The Secure Data Erase function is performed in one of two ways:

- For an unencrypted physical volume (or a physical volume that is encrypted, but its previous use was unencrypted), the erasure is performed by writing a random data pattern on the physical volume being reclaimed. In the case of the encrypted volume, the encrypted data keys are also erased.
- For an encrypted physical volume whose previous use was also encrypted, the physical volume is erased by erasing the encrypted data keys. By erasing the data keys, the data on the volume cannot be decrypted, rendering it “erased”. This way is a much faster method than the first method, because only the encrypted data keys need to be erased. This process takes only a few minutes compared to a multi-hour process for writing the random pattern across the whole tape.

As part of this Data Erase function, an additional reclaim policy is added. The policy specifies the number of days that a physical volume can contain invalid logical volume data before the physical volume becomes eligible to be reclaimed.

5.3.9 Data integrity by volume ownership

The concept of ownership has been introduced with the TS7700 to ensure data integrity. At any point in time, a logical volume is owned by one cluster. The owning cluster controls access to the volume and the attributes of a volume. This concept of ownership replaces the concept of Master VTS, which has a subsystem-wide scope instead of a volume-wide scope.

If a logical volume is written on one of the TS7700 clusters in the grid configuration and copied to the other TS7700 cluster, both the original volume and the copy can be accessed through the other TS7700 cluster. This is subject to *volume ownership*. At any point in time, a logical volume is "owned" by one cluster. The owning cluster has control over access to the volume and over changes to the attributes associated with the volume (such as volume category or storage constructs).

The cluster that has ownership of a logical volume can change dynamically. The TS7700 node passes the ownership of the logical volume as part of mount processing, as required, to ensure that the cluster with the virtual device associated with the mount has ownership. If the TS7700 clusters in a grid configuration and the communication paths between them are operational, the change of ownership and the processing of logical volume-related commands are transparent in regard to the operation of the TS7700. If a TS7700 cluster has a host request for a logical volume that it does not own, and it cannot communicate with the owning cluster, the operation against that volume fails, unless some additional direction is given. Volume ownership takeover provides the additional direction to transfer ownership.

When the owning cluster has failed or is known to be unavailable (for example, it is being serviced), its ownership of logical volumes is transferred to the other TS7700 cluster as listed:

- **Read Ownership Takeover:** When Read Ownership Takeover (ROT) is enabled for a failed cluster, ownership of a volume is allowed to be taken from a TS7700 cluster that has failed. Only read access to the volume is allowed through the other TS7700 cluster in the grid. When ownership for a volume has been taken in this mode, any operation attempting to modify data on that volume or change its attributes fails. The mode for the failed cluster remains in place until a different mode is selected, or the failed cluster has been restored.
- **Write Ownership Takeover:** When Write Ownership Takeover (WOT) is enabled for a failed cluster, ownership of a volume is allowed to be taken from a cluster that has been marked as failed. Full access is allowed through the other TS7700 cluster in the grid. The mode for the failed cluster remains in place until a different mode is selected, or the failed cluster has been restored.
- **Service Preparation/Service Mode:** When a TS7700 cluster is placed in service preparation mode or is in service mode, ownership of its volumes is allowed to be taken by the other TS7700 cluster. Full access is allowed. The mode for the cluster in service remains in place until it has been taken out of service mode. Note that you cannot set a cluster in Service Preparation mode after it has failed already.

You can set the level of ownership takeover, Read-only or Write Ownership, through the TS7700 Management Interface (MI).

Autonomic Ownership Takeover Manager

Autonomic Ownership Takeover Manager allows a subsystem to automatically take ownership of the volumes that are owned by a failed site. An Autonomic Ownership Takeover requires two TSSCs. The path between the two TSSCs is used to determine if the remote node is down, or if the communication path between the sites is down. If the TSSC is able to reach the TSSC at the remote site, the remote TSSC determines the state and health of the remote node and passes information back to the local site.

Only when it has been confirmed that the other TS7700 is no longer operational does the requesting TS7700 automatically enter one of the ownership takeover modes without requiring an intervention by an operator or by service personnel. The TSSCs at each site can be configured to enable or disable this function and to select which ownership takeover mode to enter if the other TS7700 is determined to be no longer operational.

Copy Consistency Point

In a grid environment, you can specify where and when you want to have a copy of your data. Currently, there are three settings, two Copy Consistency Points and an option of having no copy at all. The settings are:

RUN The copy occurs as part of the rewind-unload operation and before the rewind-unload operation at the host completes. This mode is comparable to the immediate copy mode of the PtP VTS.

Deferred The copy occurs some time after the rewind-unload operation at the host. This mode is comparable to the deferred copy mode of the PtP VTS.

No Copy No copy is made.

For each cluster in a Multi Cluster Grid, you specify a setting for the cluster and a setting for the other clusters. The settings do not need to be the same on all clusters. When a volume is mounted on a virtual tape device, the Copy Consistency Point policy of the cluster to which the virtual device belongs is honored.

Site to site consistency

The TS7700 architecture introduces a new access point function. With the prior generation PtP VTS, the VTCs performed the access point function to logical volumes, as well as the replication function. The hardware for the VTCs has now been eliminated, and their function has been embedded in the Virtualization Engine. The access point function is now part of the vNodes, and the replication function is part of the hNodes. Associated with each cluster of vNodes and hNodes is the Tape Volume Cache (TVC), and like the prior generation VTS, this TVC is where host data resides when accessed.

A significant difference with the TS7700 architecture is that any vNode in the grid can access the data within the TVC of any cluster directly. A copy of the data does not have to be in the TVC in the same cluster as the vNode that the host uses for data access. In a TS7700 grid, you might want to have multiple copies of a virtual volume on different clusters within the grid. You might also want to specify when the copies are performed relative to the job that has written to a virtual volume and specify that differently for each cluster.

The replication policies are defined at the Library Manager associated with the TS7700 cluster and can be different for each Library Manager, which allows for maximum flexibility to configure the TS7700 grid for disaster recovery, high availability, or both. For example, you can select a site to always have the most current version of a logical volume.

Time coordination

All nodes within the entire subsystem *must* coordinate their time with one another. All nodes in the system keep track of time in relation to Coordinated Universal Time (UTC). Statistics are also reported in relation to UTC.

The TS7700 logs its UTC time in the Library Manager logs every ten minutes. This provides a means to synchronize the Library Manager and TS7700 logs.

The preferred method to keep nodes in sync is with a Network Time Protocol (NTP) server. The NTP server can be a part of the grid/wide area network (WAN) infrastructure, it can be a part of a client intranet, or it can be a public server in the Internet.

If an NTP server is not available, the time in cluster 0 of the grid is used and the master time. The other clusters in the grid synchronize their time with cluster 0.

Dynamic link load balancing and control

TS7700 Release 1.4A adds new functions for the grid link performance, the status monitoring of the links, and the copy control.

Dynamic link load balancing

Today, the copy-workload, which has to go to the other clusters within a grid, is balanced equally on the grid links. The *dynamic link load balancing* function compensates for unbalanced network performance by different network equipment or path length. It is designed to control grid performance in adverse conditions. A host warning message is issued if grid links are severely degraded (difference in link performance exceeds 75%). The workload will be adjusted automatically to better utilize the total link capability. The link capabilities are evaluated every five minutes. A host console request provides information about the performance of the grid links from the perspective of a specific TS7700 (refer to Figure 5-6).

```
CBR1280I Library ATL0001A request.
Keywords: Status,Gridlink
----------------------------------------------------------------------
GRIDLINK STATUS V1
 CAPTURE TIMESTAMP: 2008-02-08 12:45:32
 LINK VIEW
  LINK NUM    CFG   NEG    READ  WRITE  TOTAL ERR  LINK STATE
                           MB/S   MB/S   MB/S        01234567
         0   1000  1000    87.2  102.4  189.6   0    -AA
         1   1000  1000    74.9  104.6  179.5   0    -AA
         2      0     0     0.0    0.0    0.0   0
         3      0     0     0.0    0.0    0.0   0
----------------------------------------------------------------------
 LINK PATH LATENCY VIEW
  LIBRARY         LINK 0         LINK 1         LINK 2         LINK 3
          LATENCY in MSEC
  ATL001B              6              7              0              0
  ATL001C             19             20              0              0
----------------------------------------------------------------------
CLUSTER VIEW
  DATA PACKETS SENT:                 103948956
  DATA PACKETS RETRANSMITTED:        4967
  PERCENT RETRANSMITTED:             0.00477
----------------------------------------------------------------------
 LOCAL LINK IP ADDRESS
  LINK 0 IP ADDR:  9.11.200.60
  LINK 1 IP ADDR:  9.11.200.61
  LINK 2 IP ADDR:
  LINK 3 IP ADDR:
```

Figure 5-6 Example for the host console request

You might be confused to see a total link traffic of each link, which is larger than 100 MB/s (remember that a 1 Gbit link is supposed to deliver approximately 100 MB/s). The links are full duplex; there is an outbound path and an inbound path and each path has a 1 Gbps potential rate in each direction simultaneously. However, you will not be able to achieve that rate, because each side must send acknowledgements (ACKs) for the data that it receives, which reduces what it can send.

A white paper is available to describe this host console request in depth. Refer to:

http://www-03.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP101091

Host console copy control

A host console request is available to suspend and resume logical volume copies on a cluster basis. For example, you might suspend the copy for a specific logical volume in a three site grid (local-local-remote) on the remote cluster only.

5.3.10 Composite Library

The *Composite Library* is the logical image of a Multi Cluster Grid, which is presented to the host. As opposed to the IBM Virtual Tape Server, a Single Cluster TS7700 Virtualization Engine also has a Composite Library LIBRARY-ID defined. From an architectural perspective, a stand-alone TS7700 is considered a grid consisting of just one cluster. We refer to this cluster as a *Single Cluster Grid*.

Both with a Single Cluster Grid configuration and a Multi Cluster Grid configuration, a Composite Library is presented to the host. In the case of a stand-alone TS7700, the host sees a logical tape library with sixteen 3490E tape control units, each with 16 IBM 3490E tape drives, which are attached through two or four FICON channel attachments. In the case of a Two Cluster Grid, the host sees one logical tape library with 32 3490E tape control units, each with 16 IBM 3490E tape drives, which are attached through four, six, or eight FICON channel attachments.

5.3.11 Distributed Library

A *Distributed Library* is a Library Manager partition in a TS3500/3953 library associated with a TS7700 Virtualization Engine. The Distributed Library is attached to its own TS3500/3953. Within the 3953 Library Manager, the TS7700 occupies a Library Manager partition in the same manner as a VTS occupies a Library Manager partition.

A Distributed Library comprises the hardware components of one cluster and consists of:

- Virtualization Engine
- Disk cache controller
- Disk expansion drawers
- Attachment to a physical library
- Frame
- Number of physical drives

In a grid configuration, which includes multiple TS7700 Virtualization Engines, each of which has the Grid Enablement Feature installed, two or three Distributed Libraries are required. The host has sufficient knowledge about the Distributed Libraries to allow appropriate console message handling of messages from the Library Manager of a Distributed Library. On the host, the Distributed Library is only defined to System Managed Storage (SMS). It is defined using the existing Interactive Storage Management Facility (ISMF) panels and has no tape devices defined. The tape devices are defined for the Composite Library, not for the Distributed Library.

5.3.12 Media JB/JX support

The JB/JX media is supported by the TS3500 and 3494 libraries, the TS1120 Controller, the 3592 J70 Controller, and the 3592 C20 Silo Compatible Tape Frame. The JB Extended Data media is supported in the TS7700 Virtualization Engine. JA cartridges used by the TS1120 will be supported at 500 GB, and JB cartridges will be supported at 700 GB. TS7700 FC0521 (which supplies the latest firmware release) must be installed to get this capability. The IBM SSR must select an option on the service menu to allow the TS1120 drives to operate in native E05 mode. Only TS1120 drives operating in native E05 mode will support JB media. When the TS7700 Virtualization Engine is online and the drives are running in native Model E05 mode, 3592 Model J1A drives cannot be added to the configuration. This includes Model J1A drives that were powered off when the transition was made to online and were subsequently powered on. The Model J1A drives must be removed from the configuration.

A physical volume written by a drive in Model J1A mode (either on a real Model J1A drive or a Model E05 drive that is set to J1A Emulation mode) is readable by the drive running in native Model E05 mode.

Different media types can be mixed within a pool and within a library, but a separate pool for JB cartridges is not required. Pooling can be used to control JB media use, if desired.

There is no support for the extended media by the 3494 VTS.

5.3.13 Management Interface

The storage management interface for the TS7700 Virtualization Engine complies with industry standards that make it easier to manage devices from different manufacturers. It complies with the Storage Management Initiative - Specification (SMI-S) standard. The Storage Networking Industry Association (SNIA) promotes SMI-S as a means to standardize interfaces between management software and storage devices obtained from different manufacturers.

The Management Interface (MI) is a Web-based interface that has been introduced with the TS7700 Virtualization Engine. It is used to monitor and configure the system, to manage access, and to manage logical volumes. Most of the tasks that you previously performed using the Library Manager Console have been consolidated into this interface.

5.3.14 Architectural capabilities

When you compare a PtP VTS with a TS7700 Two Cluster Grid, the differences are quite obvious. With the TS7700, you do not need any Virtual Tape Controllers, and the peers in a grid are connected through Ethernet rather than through ESCON or FICON as they were previously with the VTS. When you look at a stand-alone VTS and a Single Cluster Grid, the differences are not as apparent at first glance. They look similar from a functional perspective; however, the architectural design of a TS7700 is completely different from that of a VTS. In the following section, we discuss the architectural design of the TS7700 and its capabilities.

> **Note:** In this section, we discuss the potential capabilities that a modular design offers for the future. The current version of the TS7700 Virtualization Engine is limited to one gNode per cluster and to three clusters in a Multi Cluster Grid configuration.

Modular design of the TS7700 Virtualization Engine

The modular design of the TS7700 separates the functionality of the system into smaller components with well-defined, open interfaces, which:

- Provide a platform where the smaller components can be tailored from a small solution into an extremely large solution, so that it can eventually give you the capability to grow the solution with your needs
- Allow for vNode and hNode to run on separate hardware
- Allow for horizontal scalability, because the TS7700 uses standardized interfaces to talk with outside components (TCP/IP)
- Provide the ability in the future to be able to plug in different components of the same functionality to provide a solution for specific environments

With the modular design of the TS7700, it might be possible in the future to add gNodes or to add vNodes and hNodes separately to an existing cluster configuration. You might want to add vNodes to increase the number of virtual device addresses or to add vNodes with special functionality to perform additional tasks. More hNodes will give you better performance and increase availability. Instead of replacing one monolithic system with another, bigger system, adding vNodes and hNodes will allow you to grow according to your needs by horizontally scaling the components of the system.

The standards-based interfaces between the elements are Fibre Channel Protocol (FCP) for data movement and TCP/IP for command and control (including the Management Interface). The current functions of the VTCs in a PtP VTS have been integrated into the hNode in what we call the *Grid layer*. The Grid layer interconnects all of the nodes whether they are in the same cluster or in another cluster.

A comparison of the modular design of a TS7700 and the monolithic design of a VTS is shown in Figure 5-7.

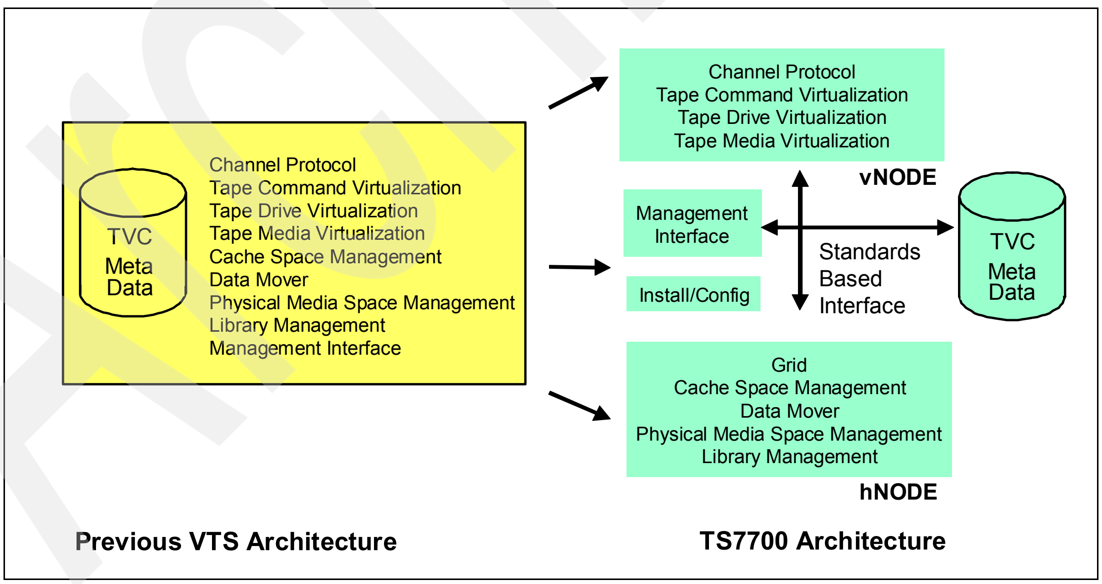


Figure 5-7 Monolithic design of a VTS compared to the modular design of TS7700

Serviceability can also profit from having more than one node in a cluster. A nondisruptive code update will require two gNodes (or a pair of vNodes and a pair of hNodes). Redundant Nodes might eliminate or minimize the risk of planned and unplanned outages.

Because the cache is a modular component of the system, you will be able to upgrade the cache with minimal impact to the entire system.

When we have discussed a Multi Cluster Grid so far, we have always referred to a Two or Three Cluster Grid, because this is the only grid configuration that we support today. From an architectural perspective, there is no need to limit the number to three clusters in a grid.

5.4 IBM 3494 Virtual Tape Server

The IBM TotalStorage Virtual Tape Server (VTS) 3494 Model B10 or B20 is the predecessor to the TS7700 Virtualization Engine. Both VTS models have been withdrawn from marketing. We include their description for completeness, because they are still supported in the TS3500 Tape Library.

5.4.1 Components

This generation of VTS products provided an entry model, the Model B10 VTS, and an enhanced model, the Model B20 VTS. These models incorporate data compression and Performance Accelerator features as a standard, as well as an improved controller. The VTS is attachable to an IBM TS3500 Tape Library with the IBM 3953 Library Manager and with IBM 3592 tapes.

The two VTS models come in two frames: Model B10 VTS or Model B20 VTS. They contain the VTS controller and its associated storage management software and the RAID disk arrays that make up the TVC. The Model B10 VTS or Model B20 VTS frame is a stand-alone unit that can be located up to 62 m (200 ft.) from a 3592 drive frame.

The Model B10 VTS supports up to 432 GB of TVC (1.3 TB assuming 3:1 compression), four to six 3590 drives, or four to twelve 3592 drives, up to 64 virtual devices, and up to four ESCON channels, eight SCSI ports, or four FICON channels. The Model B20 VTS supports up to 1.7 TB of TVC (5.2 TB assuming 3:1 compression), four to twelve 3592 tape drives, and up to 16 ESCON channels or eight SCSI ports or eight FICON channels, as well as up to 256 virtual devices.

Figure 5-8 illustrates the components of the Model B10 and Model B20 VTS.

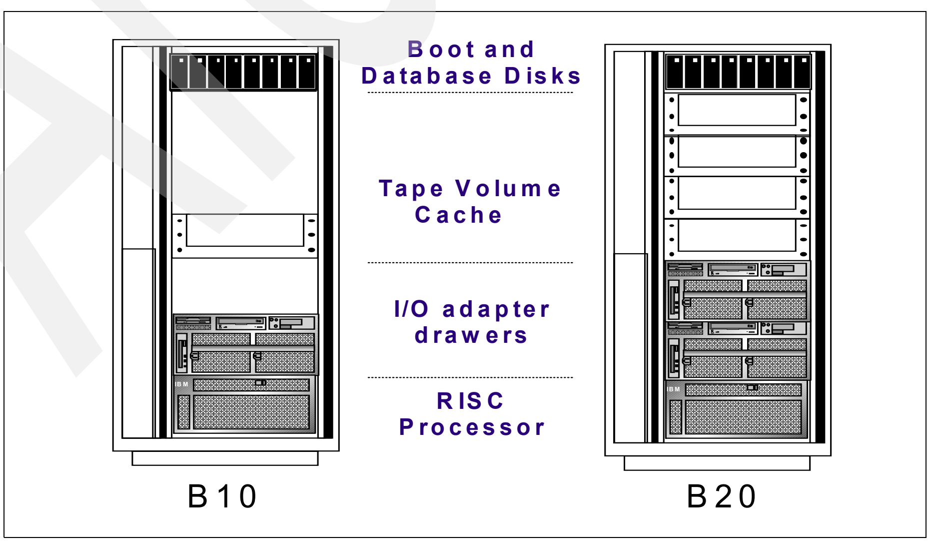


Figure 5-8 3494 Model B10 VTS or Model B20 VTS stand-alone frame

5.4.2 Peer-to-Peer VTS

A Peer-to-Peer VTS consists of either:

- Two IBM 3494 Model B10 VTSs
- Two IBM 3494 Model B20 VTSs

The Peer-to-Peer VTS (PtP VTS) is designed to offer data redundancy and availability by creating and maintaining two identical tapes in the two physically separated VTS libraries that make up the PtP VTS. The PtP VTS automatically creates a copy of any newly created or updated tape volume in both Virtual Tape Servers. This process is performed transparently to the client application and with no host processor resources required. Either volume copy can then be used to satisfy a specific client mount.

In addition to the VTSs, a PtP configuration also contains four or eight Virtual Tape Controllers (VTCs) housed in one to four IBM 3494 CX1 frames. A single VTC presents itself to the host as one or two 3490E tape control units, each with sixteen 3490E tape drives. All communication between the System z host systems and the PtP VTS is through the VTC channel attachments. Table 5-2 lists the supported PtP VTS configurations.

Table 5-2 Supported PtP configurations

VTS model	Number of VTCs	Number of virtual drives	Number of drive addresses per VTC
Model B10 VTS	4	64	16
Model B20 VTS: no FC5265, incremental virtual drives	8	128	16
Model B20 VTS with four FC5265s, incremental virtual drives	8	256	32
Model B20 VTS with two FC5265s, incremental virtual drives	4	128	32
Notes: 1. If installing VTCs in two Model CX1 frames, each frame must contain two VTCs. No other equipment can be installed in the frame. 2. If a Model CX1 Frame contains two ESCON VTCs and two FICON VTCs, the ESCON VTCs must be in the uppermost positions in the frame.			

Peer-to-Peer VTS configuration

Upon initial Peer-to-Peer VTS installation and configuration, the IBM service support representative (SSR) needs you to provide certain information.

Composite Library name

The *Composite Library* is the logical image of the Peer-to-Peer VTS presented to the host. With a PtP VTS configuration, the host sees up to sixteen 3490E tape control units, each with sixteen IBM 3490E tape drives, attached through two ESCON or FICON channel attachments. The number of control unit images that can be seen by the host is dependent on the number of VTCs configured for the solution. The Composite Library presents the same image to the host as does a single (base) VTS and is defined similarly to a base VTS. The Composite Library is identified by a sequence number, which is also known as the LIBRARY-ID.

The IBM SSR needs you to provide a name for the Composite Library to enter in the VTS during the initial configuration. The IBM SSR determines the sequence number to enter in the VTS.

Distributed Library name

A *Distributed Library* is a physical tape library that includes the Peer-to-Peer VTS with copy features installed. There are two Distributed Libraries in a Peer-to-Peer VTS configuration, usually designated as Distributed Library 0 and Distributed Library 1. Host interaction with a Distributed Library is limited to console handling of messages from the Library Manager in the Distributed Library. The Distributed Libraries also use sequence numbers for identification. The IBM SSR needs you to provide names for both Distributed Libraries to enter in the VTS during initial configuration. The IBM SSR determines the sequence numbers for the Distributed Libraries.

User interface Distributed Library selection

You must designate one of the two Distributed Libraries as the user interface Distributed Library. Logical volumes are inserted into the VTS through the user interface Distributed Library, and all VTCs synchronize their time and date with that of the Library Manager in the user interface Distributed Library. The IBM SSR needs you to determine which Distributed Library is the user interface Distributed Library.

Copy mode selection

The IBM SSR needs you to select either Immediate Copy mode or Deferred Copy mode. If you select Deferred Copy mode, you must also specify the Deferred Copy Priority Threshold.

VTC switch addresses

The IBM SSR needs you to provide the switch address for each interface connected through a dynamic director for each VTC.

Preferred I/O VTS selection

The IBM SSR needs you to select which VTS to use for I/O operations. The choices are VTS 0, VTS 1, or no preference.

Force scratch mounts to use preferred I/O VTS

Certain conditions can cause a VTC to select the non-preferred I/O VTS for scratch mount processing, which can result in requiring longer times to process the workload. The IBM SSR needs you to choose whether you want to force the VTC to always select the preferred I/O VTS for scratch mount processing (if it is available), regardless of system conditions. However, choosing this option might cause problems with any tape management system that cannot have known volumes re-initialized outside of its control.

Master VTS selection

You must specify one of the VTSs in a PtP configuration as the master VTS. This designation is required in order to serialize access to logical volumes within the PtP configuration. The master VTS is the focus for synchronizing the mounting of volumes to virtual drives and for selection of a VOLSER from a scratch category in response to a scratch mount request. Most display commands from the host are also directed to the master VTS (except commands processed by the user interface Distributed Library). Certain other commands from the host must be directed to the master VTS, such as commands causing a volume to be queued for a mount and commands that change the device category assignment.

The master VTS does not have to be the preferred I/O VTS. When FC4001 - FC4004, Advanced Policy Management, are installed, the copy mode is determined by the master VTS setting, not the preferred I/O VTS setting.

The IBM SSR needs you to select which VTS is the master VTS. The choices are VTS 0, VTS 1, or no preference.

VTC distance from Distributed Libraries

Depending on your configuration, choices for this item are:

- ESCON < 5 km (3.1 miles) and FICON < 30 km (18.6 miles)
- ESCON < 10 km (6.2 miles) and FICON < 80 km (49.7 miles)
- Emulation Mode Channel Extender < 1000 km (620 miles), DWDM < 10 km (6.2 miles), and FICON < 100 km (62 miles)
- Emulation Mode Channel Extender > 1000 km (620 miles) and DWDM < 15 km (9.3 miles)
- ESCON DWDM > 15 km (9.3 miles) and FICON Shuttle Mode Extender > 100 km (62 miles)

For the most recent list of supported FICON directors, visit:

http://www-1.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/FQ105505

Peer-to-Peer VTS functionality

A Peer-to-Peer (PtP) VTS incorporates the functional capabilities of a base IBM 3494 Model B10 or B20 VTS, except for the Export and Import function of either FC4000, Advanced Function, or FC4001 - FC4004, Advanced Policy Management. The two VTSs (each with FC4010, Peer-to-Peer Copy Base) in a PtP VTS act as independently distributed server nodes. They contain added functionality to support the coupling operations of a PtP VTS. They also support channel commands to support large block transfers of compressed logical volumes to and from the attached VTCs. These commands reduce the time that is required to copy logical volumes, especially across long distances. Other functionality allows the VTCs to maintain dual copies synchronized between the two VTSs and provides expedited deletion of redundant logical volume copies from the TVC.

> **Note:** The installation of FC4010, Peer-to-Peer Copy Base, limits the use of the VTS to a PtP configuration.

The IBM 3494 Model B10 or B20 VTSs in a PtP VTS need to be fitted with the same disk storage capacity. If FC4000, Advanced Function, or FC4001 - FC4004, Advanced Policy Management, are installed on a VTS with FC4010, Peer-to-Peer Copy Base, the IBM SSR must disable the Export and Import functions.

VTC

The VTC connects two VTSs, each with FC4010, Peer-to-Peer Copy Base. It also provides two ESCON or FICON host attachments for the PtP VTS. Each VTC is an independently operating distributed node within the PtP VTS. Its operation is independent of other VTCs in the PtP VTS. There are either four or eight VTCs in a PtP VTS; refer to Table 5-2 on page 143.

Table 5-3 on page 146 summarizes key VTC information regarding the two connection methods.

Table 5-3 VTC connection methods

VTC connection type	Maximum host distance	Ordering feature codes
ESCON	43 m (27 miles)	1. FC1001, ESCON Virtual Tape Controller (Plant Install) 2. FC1101, ESCON Virtual Tape Controller (Field Install)
FICON	100 km (62 miles)	1. FC1011 - FC1022 (Plant Install) 2. FC1111 - FC1122 (Field Install)

The VTCs in a PtP VTS perform the following functions:

- Synchronization of the dual copy of logical volumes
- Block transfer of compressed logical volumes for logical volume copy creation
- Balance of VTS workload
- Direction of specific volume mounts to the VTSs with cached copies of the requested virtual volumes

If one VTS is offline for service, the other VTS performs all required operations. When a VTS is returned to service, each VTC resumes dual copy operations to synchronize the VTSs.

The VTC can create logical volume copies in one of two modes. All VTCs within a PtP VTS must use the same mode. The accessibility of a copied volume depends on the mode selected: Deferred Copy or Immediate Copy.

Deferred Copy

In Deferred Copy mode, a VTC schedules creation of the copy when it receives a Rewind Unload command and the unload operation is complete. The completion time of the copy operation depends on VTS activity.

Immediate Copy

In Immediate Copy mode, with both VTSs active, a VTC starts creating a copy as soon as it receives a Rewind Unload command. It signals completion of the Rewind Unload command when the copy operation is complete. If one VTS is offline, the Rewind Unload command completes without the creation of a copy. When the VTS returns online, the copy creation operation has priority.

If FC4001 - FC4004, Advanced Policy Management, are installed, copy mode selection can be made by volume.

5.5 Attachment to the TS3500 Tape Library

Support for attachment of a virtualization subsystem to a TS3500 Tape Library is provided by the 3953 Tape System. This support allows the virtualization subsystem to connect to the Library Manager Model L05, which resides in the 3953-F05 Frame in the same way that a VTS connects to the Library Manager in a 3494 Tape Library. The difference is that the Library Manager is now in a separate external frame to the tape library. Communication between the virtualization subsystem and the 3953 Library Manager is through an Ethernet connection. The FICON/ESCON connectivity from the virtualization subsystem to the host systems has not changed when attached to a TS3500 Tape Library.

Figure 5-9 shows a basic example of a virtualization subsystem connection to the TS3500 with the 3953 Tape System.

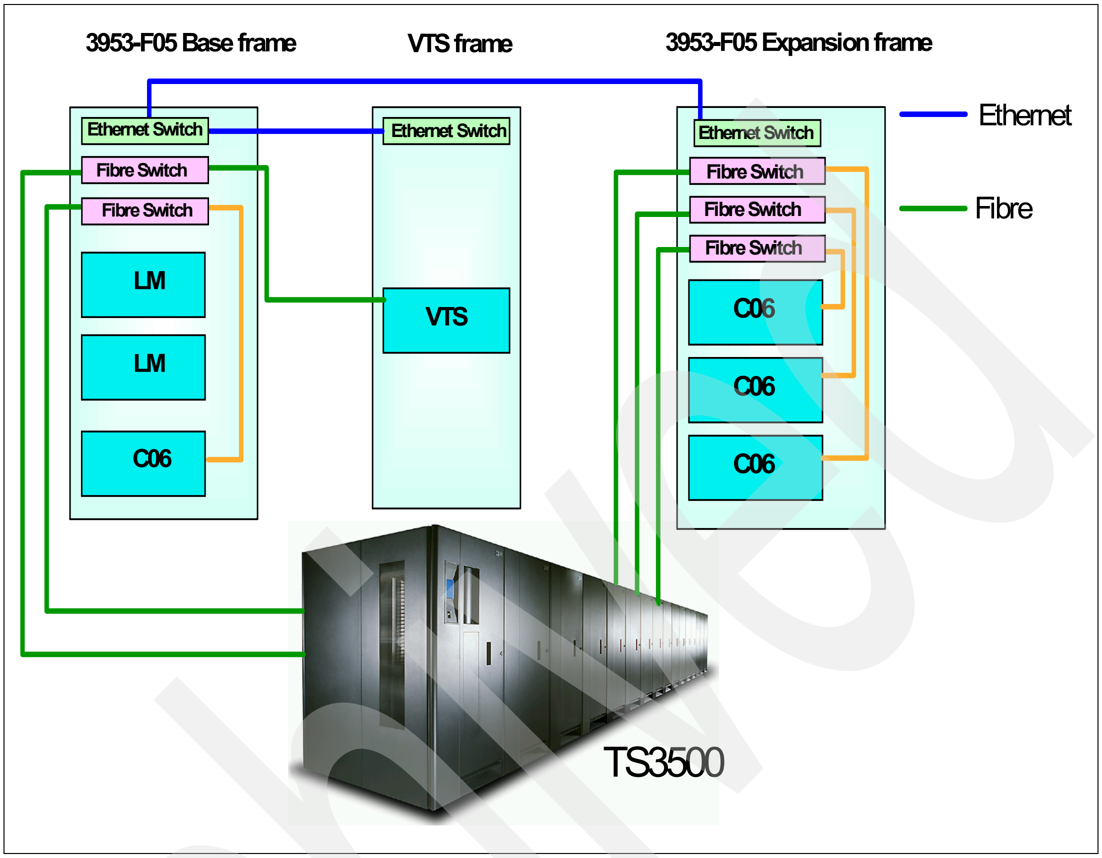


Figure 5-9 VTS attachment to the TS3500 Tape Library

The 3953-F05 Frame also houses the Fibre Channel switches, which facilitate communication between the VTS and its associated physical tape drives in the TS3500 Tape Library. The Multi-Path Architecture of the TS3500 provides the capability for sharing library robotics by partitioning the library into logical libraries, each with its own separate and distinct drives, storage slots, and control paths. Each of these TS3500 logical libraries is managed by a 3953 Library Manager. The VTS and 3592 Model C06-attached or 3592-J70-attached physical tape drives managed by the same 3953 Library Manager must reside in the same logical library, but the tape drives do not need to be in the same physical frame. They can be spread across any of the L23 and D23 frames in the TS3500 Tape Library. FC9217 must be added to the 3494 Model B10 or B20 to indicate attachment to 3592 tape drives in a TS3500 Tape Library. FC9020 is also required on the 3953-F05 Frame, which specifies the attachment of a 3953-F05 Frame to each VTS and provides two 31-meter cables for attachment.

For a full description of the features of the virtualization subsystem attachment to the 3953 Tape system, including the prerequisite and corequisite features, refer to *IBM System Storage 3953 Tape System,* GA32-0557.

6

Basic concepts of sharing and partitioning

This chapter describes the techniques of partitioning and sharing in various System z server environments. We also discuss the levels of partitioning that are possible in a System z environment and introduce these terms:

- TS3500 logical library partition
- Library Manager partition
- System z library partition

This chapter also provides basic information, shows how the Library Manager distinguishes between the various attached systems in a partition, and discusses the usage of Library Manager volume categories and the processes that influence them.

This chapter also provides necessary information to share a tape library between different System z-attached hosts.

6.1 Introduction to partitioning and sharing

Sharing a tape environment is different from sharing in a disk environment. You can simultaneously access a disk volume from different users at a single point in time. Different users might access the same dataset, and the disk volume can be online to multiple systems.

In a tape environment, a tape drive can be allocated to only one system and one user at any point in time. Thus, only one user has access to a tape dataset at a single point in time. However, multiple users can access a tape volume or tape drive one after another. While data on disk allows parallel access of multiple users, tape data can only be processed sequentially.

With the introduction of the first IBM Automated Tape Library, the requirement emerged to use a physical library for more than one attached host in a data center. Many data centers run their business on multiple servers. These servers needed the ease of use of an Automated Tape Library and needed the High Availability feature to meet their Service Level Agreements (SLAs).

Many tape environments were too small (in the total amount of data, as well as from a workload aspect) to justify a dedicated tape library. To solve this problem, *partitioning* was introduced. This functionality allows hosts of different platforms to use common components in the physical library, for example, the accessor or Library Manager, and have dedicated tape drives and cartridges at the same time.

The tape library also allowed *sharing* of its resources. In addition to sharing some hardware components of the tape library, a group of z/OS systems that share the same Tape Control Dataset (called *TCDBplex*) can share a common set of tape drives and cartridges. This construct is often called *SMSplex*.

Cartridges (and the data on the cartridges) can only be used by different hosts if they belong to the same TCDBplex, which includes sharing the same Tape Control Database, as well as the Tape Management System. If a cartridge is defined in more than one TCDBplex and Tape Management system, data loss occurs.

We explain both concepts of using the same tape library from multiple hosts in detail later in this chapter. We also describe how to enable partitioning and sharing and what you must consider when using partitioning and sharing.

6.2 Partitioning a TS3500 for System z hosts

The introduction of the TS3500 Tape Library and the attached 3953 Tape System has changed the methodology of partitioning.

6.2.1 Levels of partitioning

First of all, you must partition your TS3500 Tape Library into different logical libraries. This level of partitioning is necessary to “divide” the TS3500 Tape Library into several independent partitions, which can be used by an Open Systems or System z host. However, this action is also required if you have only System z attached. Each attached 3953 Tape System is defined as a single TS3500 logical library. This level of partitioning is controlled by the TS3500 Tape Library. However, corresponding definitions must be made in the TS3500 Tape Library and in the 3953 Tape System for System z attachment.

Then, a second level of partitioning is provided by partitioning the 3953 Tape System into up to three Library Manager partitions, which represent one *Native* and two virtualization subsystem partitions (*VTS 1* and *VTS 2).* This level is controlled by the Library Manager.

A third level of partitioning is provided by using one Library Manager partition by different hosts using the Library Manager volume categories as separation criteria. Each partition can be viewed as a host logical library with each host logical library (TCDBplex) represented by one TCDB. This level is controlled by the Library Manager, but driven from definitions in the operating systems.

On a z/OS host with System Managed Storage (SMS), an entire or partitioned Library Manager partition is defined as a host logical library.

The terms *TS3500 logical library*, *host logical library*, and *Library Manager partition* are used in all the levels of partitioning and are used in all components, for example, the TS3500, the ETL Specialist, the Library Manager, and SMS. There is no unique naming convention. So, logical library might describe a logical library in the TS3500 Tape Library, as well as a partition in the 3953 Tape System.

Throughout this book, we use the following terminology and definitions:

- The *TS3500 logical library* is defined in the TS3500 with the TS3500 Tape Library Specialist.
- The *Library Manager partition* is defined in the 3953 Tape System through hardware teach.
- The *host logical library* is defined in the operating system, for z/OS, for example, hardware configuration definition (HCD), SMS, and Interactive Storage Management Facility (ISMF).

Figure 6-1 on page 152 shows the levels of partitioning in a System z host environment attached to a TS3500 Tape Library.

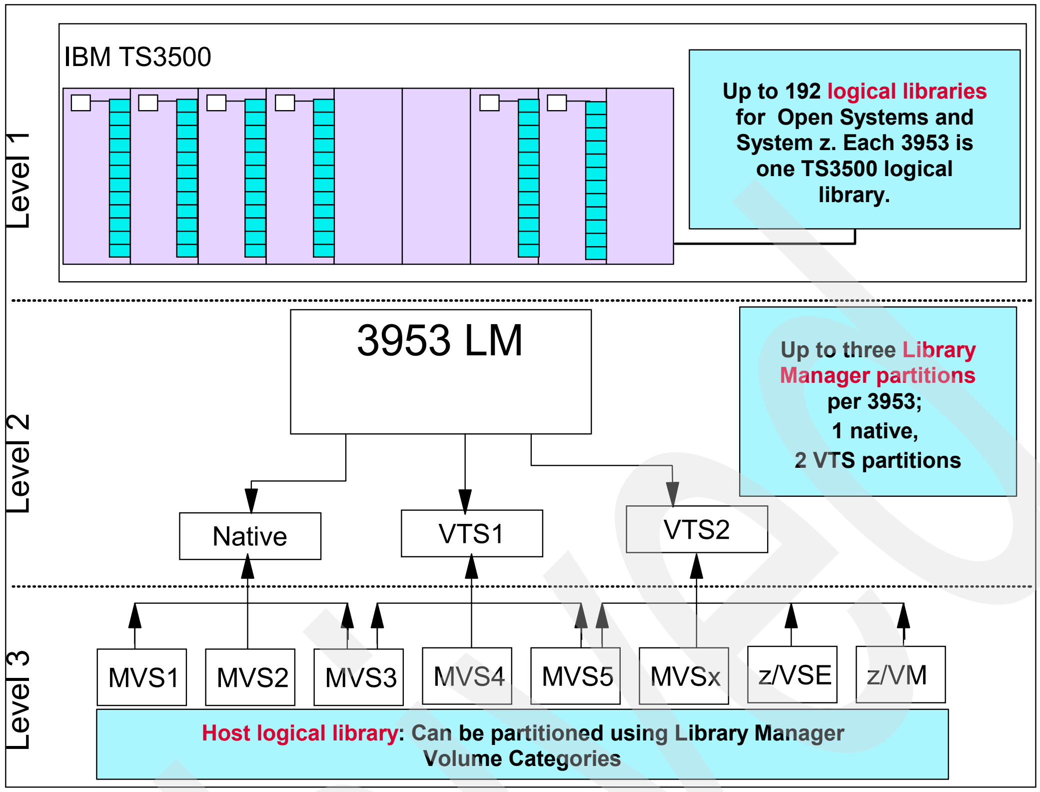


Figure 6-1 Levels of partitioning

Important: All levels of partitioning (TS3500, 3953 Library Manager, and System z partitioning) must be defined to support fully functional System z partitioning.

6.2.2 TS3500 logical library

You define TS3500 logical libraries in the IBM TS3500 Tape Library. You manage these within the IBM TS3500 hardware by using the TS3500 Tape Library Specialist. A TS3500 logical library can support Open Systems attachments or System z attachments, but not both. To define a System z logical partition, you must have *Advanced Library Management Systems* (ALMS) enabled. Refer to 8.1, “IBM TS3500 library setup” on page 202.

You must define at least one 3953 Tape System for the System z attachment. You define each 3953 Tape System as one (and only one) TS3500 logical library. You can attach up to four 3953 Tape Systems to a single TS3500 Tape Library.

For each 3953 Tape System in the TS3500, you must specify the following items:

- Logical library name for the partition.
- Tape drives that are dedicated to that partition.
- Media type, which can be used by the partition.
- Cartridge VOLSERs, which are dedicated to the TS3500 logical library (Cartridge Assignment Policy).
- Control paths to transport the control information, for example, mount and demount. The control paths are enabled to tape drives.

The storage cells, I/O cells, and the cartridge accessor are considered shared across all defined logical libraries on a first come, first served basis.

You must dedicate the tape drives and cartridge VOLSER ranges to a TS3500 logical library in a System z environment. Even though the TS3500 provides dynamic drive assignment, this function is not supported in a System z environment. Usage of dynamic drive assignment will produce unpredictable results.

The TS3500 logical library has no information about the definition of the second level of partitioning. So, it has no knowledge:

- If a TS7700 Virtualization Engine or Virtual Tape Server (VTS) is attached to the 3953 Tape System
- How many TS7700 Virtualization Engines or VTSs (*VTS 1* or *VTS 2)* are attached
- If a native (*Native)* partition exists
- Which drives of the TS3500 logical library will be used by which Library Manager partition

Important: The TS3500 logical libraries are not referenced by the attached System z hosts. There is no definition in the System z hosts that points to the logical library defined in the TS3500. Neither hardware definitions through the Hardware Configuration Definition (HCD) dialog nor System Managed Storage (SMS) definitions refer to the TS3500 logical library.

Figure 6-2 shows an example of the TS3500 logical libraries.

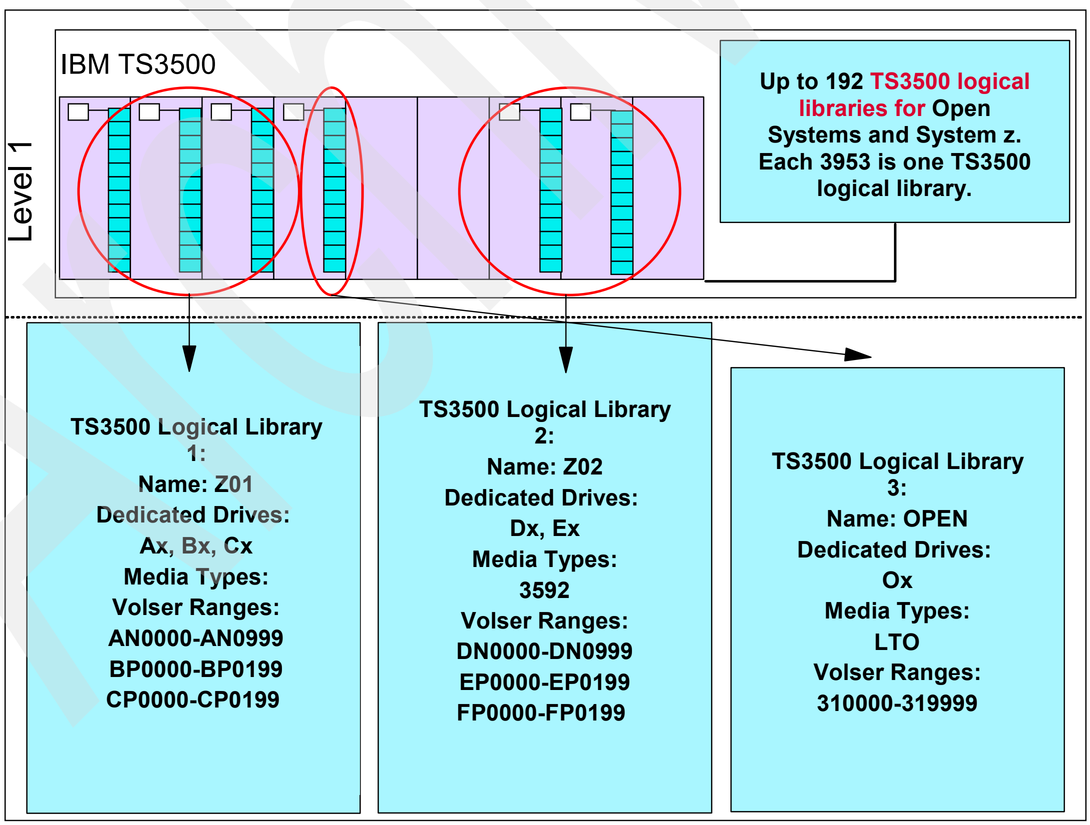


Figure 6-2 Example of TS3500 logical libraries

6.2.3 Library Manager partitions

Depending on your hardware installation, you can have up to three logical partitions per 3953 Library Manager:

- One native partition
- Two TS7700 Virtualization Engine or VTS partitions

There is no need to specify these partitions in the Library Manager, because they are identified during the hardware installation and teach process. This process defines all LIBRARY-IDs related to native and VTS partitions.

This process also creates the necessary definitions, such as which TS7700 Virtualization Engine or VTS is VTS 1 and which one is VTS 2. Therefore, you only have to specify one item related to partitioning: Cartridge VOLSERs that are used by each logical partition inside the 3953 Library Manager.

> **Note:** The 3953 Library Manager Specialist refers to the first TS7700 Virtualization Engine or VTS as VTS 1 and the second TS7700 Virtualization Engine or VTS as VTS 2.

If you assign cartridges to a TS3500 logical library and if there is no matching definition in the 3953 Tape System, the cartridges are offered to the attached System z systems as native cartridges. If none of the systems accepts a cartridge, it remains in the insert category.

> **Important:** These logical partitions are referenced inside the attached System z hosts. They are defined in the HCD and Data Facility Storage Management Subsystem (DFSMS) using their LIBRARY-IDs.

Examples

In Figure 6-3 on page 155 and Figure 6-4 on page 156, we show you two examples for partitioning a TS3500 Tape Library.

In Figure 6-3 on page 155, there is only one 3953 Tape System for System z attachment installed. The 3953 Tape System is defined as a TS3500 logical library named Z01; refer to Figure 6-3 on page 155. The Media Type (3592) and the dedicated tape drives, as well as the cartridge policies, are defined. None of these definitions is known or referenced in the attached System z hosts.

There are three Library Manager partitions (*Native, VTS 1,* and *VTS 2)* defined in the 3953 Tape System. Each Library Manager partition has a unique LIBRARY-ID. This LIBRARY-ID, defined to the 3953 Tape System during the hardware installation and teach process and known in the 3953 is reflected in the System z hosts and must match the information in the HCD and, for z/OS, in DFSMS.

All other tape drives belong to Open Systems logical libraries, which are not shown in this picture.

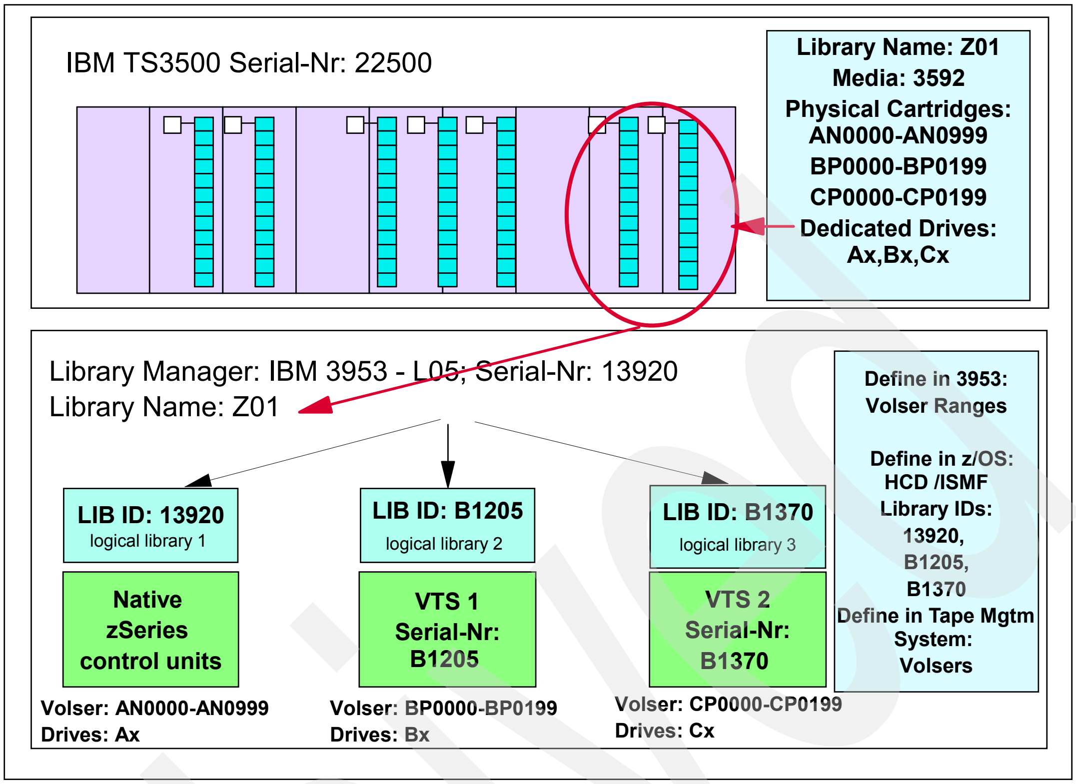


Figure 6-3 Partitioning with one 3953 Tape System installed

There are two 3953 Tape Systems installed in Figure 6-4 on page 156, and accordingly, there are two TS3500 logical libraries defined (named Z01 and Z02). Each TS3500 logical library has three Library Manager partitions defined (*Native, VTS 1,* and *VTS 2)*.

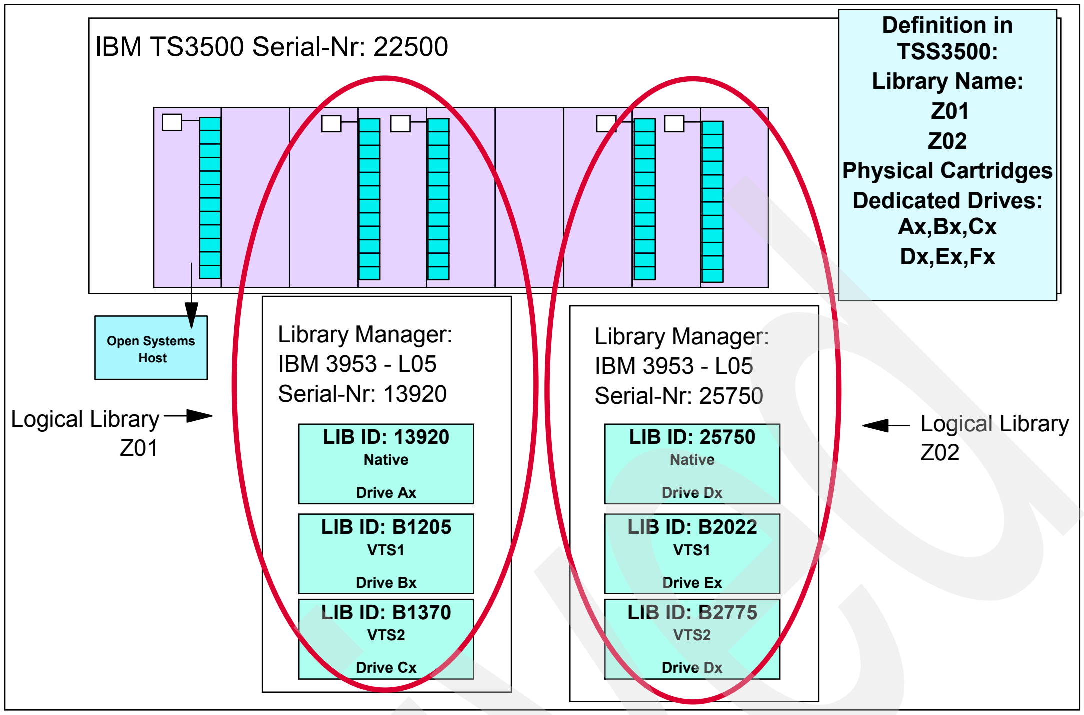


Figure 6-4 Example with two 3953 Tape Systems installed

6.2.4 System z tape library partitioning

We now describe the definitions necessary for a System z library environment. We only briefly describe the implementation here; for further information, refer to Chapter 5, "IBM Tape Virtualization solutions" on page 123. The 3494 Tape Library already uses this level of partitioning, which has not changed with the introduction of the TS3500 Tape Library and 3953 Tape System.

As described earlier, partitioning means that cartridge and tape drives are dedicated to an attached System z environment. However, tape drives can also be used across z/OS systems and TCDBplexes, if certain prerequisites are fulfilled.

Tape volume category usage

All systems attached to a Library Manager partition communicate with the Library Manager and refer to the Library Manager database. In the Library Manager database, volumes are grouped into *volume categories* for use by the Library Manager and the attached host systems.

The main purpose of these categories is to maintain the owner of this cartridge, which in our example is the attached System z system, as well as status and media type, inside the Library Manager database.

This concept allows you to use a single Library Manager partition for multiple hosts and still separate native or logical volumes. This approach is not true for back-end volumes in a TS7700 Virtualization Engine or VTS; back-end cartridges for a TS7700 Virtualization Engine or VTS do not have volume categories.

Tape volume categories also allow you to use different media types in a library, and requests, such as scratch mounts, are honored with the requested media. For example, if an attached system requests a volume for a scratch mount, the attached System z host identifies itself with a unique, assigned volume category, and the Library Manager selects a scratch volume from only this category. Satisfying a scratch mount is not the only purpose in which you use the volume category for partitioning. There are several other processes using and changing volume categories. Some processes are driven by the attached System z host, and other processes are driven by the Library Manager. Therefore, there are also certain volume categories reserved for Library Manager purposes.

For a complete list of all tape volume categories, refer to Appendix C, “Library Manager volume categories” on page 471.

Currently, the Library Manager does not verify whether host is authorized to request a specific volume mount or a mount from a category. The host software is responsible for ensuring that only volumes belonging to the host are mounted.

The Library Manager does not control whether a certain host system is allowed to use a specific category. If, for example, a mount request is issued for a specific volume, the Library Manager does not check whether the requested volume has a category assigned that is used by the requesting host.

Existing volume category ranges

The Library Manager uses volume categories of X’0000’ to X’FFFF’ to group volumes inside an IBM Automated Tape Library. There are four general volume category ranges:

- Volume categorize ranges, which are reserved for the specific platforms to support the partitioning of volumes
- Default categories, which are used if no other information can be retrieved
- Library Manager Exclusive Volume Categories to control the movement and purpose of volumes inside a library
- Reserved categories for future use

Volume categories for partitioning purposes

There is a range of scratch volume categories for partitioning purposes reserved for each platform. The specification of the volume scratch category that is used in a particular System z host is platform-dependent. These scratch categories must be unique for each attached System z host to provide the separation of tapes to different owners.

The following category changes are driven by System z processes:

- *Scratch* will be assigned by return to scratch from the Tape Management System.
- *Private* will be assigned by using the cartridge on a scratch mount.
- *Error* will be assigned if an error occurs during processing.

For z/OS hosts, you can also specify unique Private and Error categories. A z/VM or z/VSE environment uses the common Private category (X’FFFF’).

You *must* define scratch categories in order to use them, and they *must* be unique. Refer to Figure 6-5 on page 158.

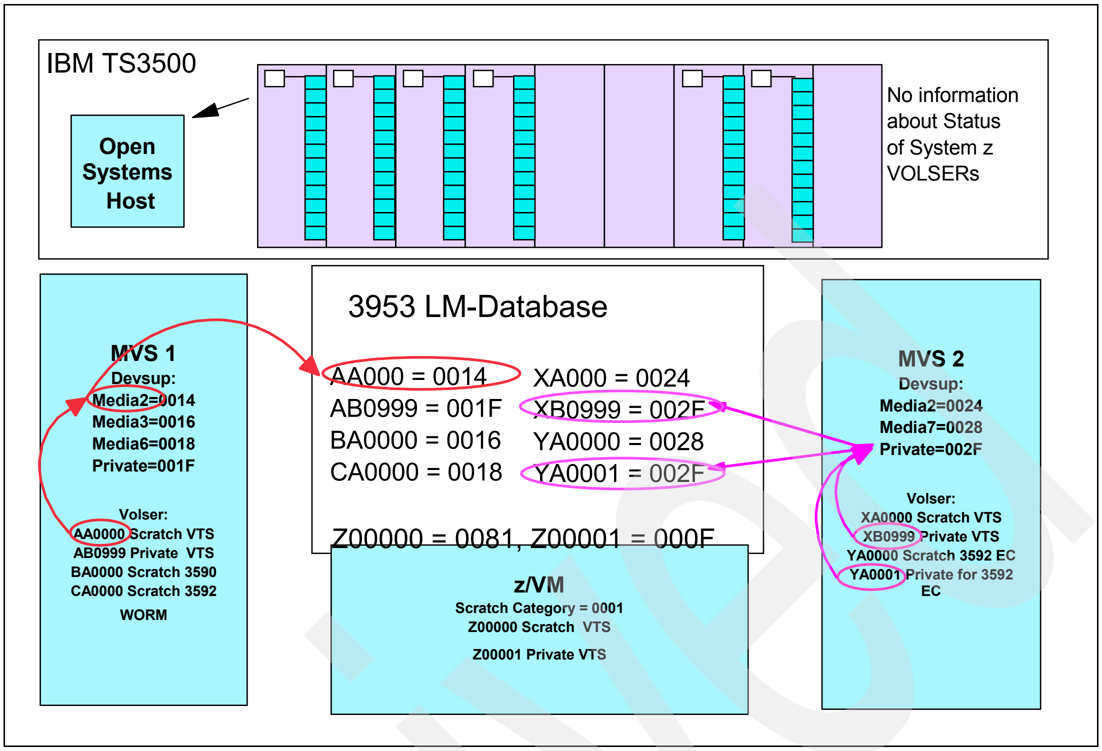


Figure 6-5 Example for the usage of volume categories

Defining volume categories in z/OS

For z/OS systems, the reserved range is from X'0010' to X'007F'. From this range, you specify in each attached z/OS at least a scratch category for each media type used in your environment. However, for z/OS hosts, which share the same tape configuration database (TCDB) and tape management (which is typical for a sysplex), you must define the *same* categories. Otherwise, scratch mounts might not be possible (also refer to Figure 6-6 on page 162). Define the scratch category for each media type in the DEVSUP*xx* member of SYS1.PARMLIB. You can also define a system-specific Private and Error category.

Note that you must define a scratch category for each media type that you use (also refer to Figure 6-7 on page 163):

- MEDIA1 for IBM CST (200 or 400 MB)
- MEDIA2 for IBM ECCST (800 MB) = VTS
- MEDIA3 for IBM 3590 (10 GB)
- MEDIA4 for IBM 3590 Extended Length (20 GB)
- MEDIA5 for IBM 3952 Data (300, 500, or 640 GB)
- MEDIA6 for IBM 3592 WORM (300, 500, or 640 GB)
- MEDIA7 for IBM 3592 Economy (60, 100, or 128 GB)
- MEDIA8 for IBM 3592 Economy WORM (60, 100, or 128 GB)
- MEDIA9 for IBM 3592 Tape Cartridge Extended Data (700 or 1000 GB)
- MEDIA10 for IBM 3592 Tape Cartridge Extended WORM (700 or 1000 GB)

The DEVSUP*xx* parameter is only read at the IPL time of the z/OS image. There is no way to reload these parameters.

Defining volume categories in z/VM

For z/VM, you can define sixteen scratch volume categories, SCRTCH0 to SCRTCHF. They result in the Library Manager volume categories: X’0080’ to X’008F’ (for example, SCRTCH0 = X’0080’). Private volumes that contain data are assigned to a specific user Library Manager volume category, X’FFFF’. You define the default scratch pool in DFSMS/VM in DGTVCNTL DATA. If you do not specify a scratch category, X’0080’ is used. For further information, refer to 10.2, “z/VM native support” on page 303.

Defining volume categories in z/VSE

For z/VSE, you can define 32 scratch volume categories, SCRTCH00 to SCRTCH31. They result in the Library Manager volume category: X’00A0’ to X’00BF’ (for example, SCRTCH00 = X’00A0’). Private volumes that contain data are assigned to a specific user Library Manager volume category, X’FFFF’. The default scratch pool is defined in the Library Control Device Driver (LCDD) with an LCDD control statement or in the Tape Library Specialist in the define library procedure. If you do not specify a scratch category, scratch category X’00A0’ is used. For further information, refer to 10.4, “z/VSE native environments with Tape Library Support” on page 314.

Processes that assign or change volume categories

Every time that a cartridge is inserted, or the cartridge status changes (from scratch to private or from private to scratch), there is a volume category assigned for this cartridge. This assignment is true for physical cartridges that are used as native cartridges, as well as for logical cartridges in a TS7700 Virtualization Engine, VTS, or Peer to Peer (PtP) VTS.

We now describe the most important processes, which influence the volume category of a cartridge. We do not list all of the processes; we only list an overview of how the processes and volume categories interact.

Insert process

After the cartridge assignment processing completes in the TS3500 Tape Library, the cartridge is in the insert processing of the Library Manager and is offered to all attached hosts. Depending on several definitions (tape management and SMS), one host is identified as the owner, and the volume category is set accordingly in the Library Manager database.

For more details about the insert processing, refer to 11.3.1, “Cartridge insert processing” on page 333.

Tape management housekeeping process

Also, during the housekeeping run of your tape management system, expired cartridges are scratch again (from a tape management perspective) and will be reassigned to the scratch category defined for the attached System z host. This reassignment is done using an automatic update process through Object Access Method (OAM). You can also refer to *z/OS DFSMS Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries*, SC35-0427.

Scratch mount

A scratch mount request of an attached System z host contains the assigned scratch category. The Library Manager selects a volume that is assigned in this specific volume category and reassigns the volume to the private category. Consider defining a private category in the DEVSUP*xx* member of SYS1.PARMLIB for each z/OS host or TCDBplex. If you do not assign a private category in the DEVSUP*xx* member, the default private category is used (X’000F’).

Inventory

If during an inventory update, the Library Manager and TS3500 Tape Library discover that a volume is defined in the database but is not actually placed in the library, the volume category is updated to reflect that the cartridge is actually missing, X'FFFA'.

Using default scratch categories

In general, each media type has a default category. If nothing is defined in a System z-attached host, this default is the scratch category for this host. This default can result in data loss, if more than one host uses the default category. Therefore, we highly recommend that you do not use the default categories but define unique scratch categories in each attached System z environment or attached TCDBplex.

Library Manager exclusive volume categories

The Library Manager uses several volume categories to control the purpose and movement of volumes inside a Tape Library. A host system usually cannot mount and process volumes in these categories. The following Library Manager volume categories are reserved for hardware functions:

X'FF00'	Insert category: A volume has been inserted into the library and has not yet been assigned to a category by the host.
X'FF10'	Convenience eject category: The Library Manager has accepted an EJECT request to the convenience I/O station.
X'FF11'	Bulk eject category: The Library Manager has accepted an EJECT request to the high-capacity I/O station.
X'FFF9'	Service volume category: Because of the unique volume serial numbers for service volumes, the Library Manager has identified a volume as a service volume.
X'FFFA'	Manually ejected category: A cartridge is assigned to this category if the cartridge was not found but was in the inventory in the Library Manager database.
X'FFFB'	Purged volume category: Used only with the IBM 3494. If, after an inventory update, the IBM 3494 finds that cartridges have been removed from the library since the last update, it places those volumes in a category called "Manually ejected" (X'FFFA'). The host can upload that category and use this purge volume category to delete the database entries in the Library Manager.
X'FFFC'	Unexpected volume category: Reserved for future use.
X'FFFD'	Cleaner cartridge category for IBM 3590 tape drives: Cartridges are assigned to this category when they are identified as cleaner cartridges by the Library Manager, if they also have the character "J" in the seventh position on the external label.
X'FFFE'	Cleaner cartridge for IBM 3490/3490E tape drives: Cartridges are assigned to this category when they are identified as cleaner cartridges by the Library Manager.

All other categories between X'FF00' and X'FFFE' are reserved categories for use by the Library Manager.

6.2.5 Considerations to share tape drives in a partitioned environment

These conditions must be true for establishing shared drives in a partitioned environment:

- You must define tape drive controllers (for native drive sharing), a TS7700 Virtualization Engine, and VTS-VTCs (for PtP VTS sharing) in HCD to all attached System z hosts.
- The hardware must be attached physically using ESCON or FICON to all attached System z hosts.

> **Note:** A TS7700 Virtualization Engine only supports FICON connections to a System z host.

- You must define a drive as shareable and OFFLINE in the HCD to allow its usage in a shared environment.

You need to provide a service that takes tape drives online and offline on demand without human intervention. There are tools that provide this service from third-party vendors.

Without the implementation of automatic drive switching, a request for a tape results in a write to operator (WTO) to the operator to ask for a device. The operator must then reply. Depending on the implementation in your environment, this situation can lead to time-outs during jobs or can cause other problems, such as the loss of SMF data if the SMF datasets cannot be copied to tape.

However, it is important to note that for the System z environment, these tools are operating in a system-dependent manner. These tools do not support automatically switching devices between different operating systems. Therefore, we do not recommend that you share drives inside an IBM Automated Tape Library between different operating systems.

6.2.6 Examples of partitioned environments

In this section, we provide examples of partitioning to show how you can use partitioning in several environments. Also, these examples clarify the interaction between the levels of partitioning.

In the following examples, VTS 1 and VTS 2 refer to the Library Manager point of view and can represent either a TS7700 Virtualization Engine or a VTS. To make the examples easier to understand, we only use references to VTS.

> **Note:** Think of a single TS7740 cluster as a Single Cluster Grid. Therefore, if you use a TS7700 Virtualization Engine instead of a VTS, the HCD definitions refer to the Composite Library LIBRARY-ID. You must define both the Composite Library LIBRARY-ID and the Distributed Library LIBRARY-ID in ISMF as you do with a PtP VTS configuration.

Example A

An TS3500 library is partitioned between an Open Systems attachment and a System z attachment. The System z attachment contains only a native library, and there is one sysplex connected to it with two z/OS members.

In Figure 6-6 on page 162, we show which definitions must be made on each level.

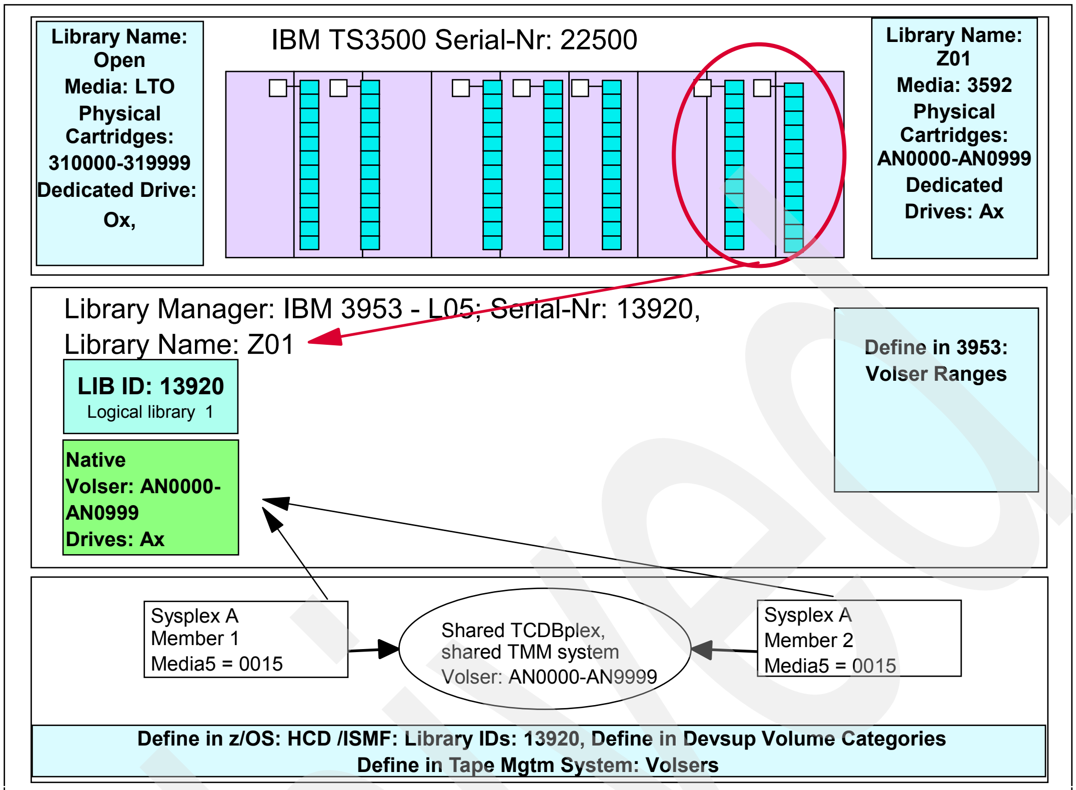


Figure 6-6 Partitioning example A

As you can see in Figure 6-6, the native library is shared among all z/OS hosts. Therefore, you must define the LIBRARY-ID 13920 in each HCD and ISMF for all of the z/OS hosts.

The two members of Sysplex A share the tape configuration database (TCDB) and the Tape Management System. To allow them to share the same VOLSER ranges, they must have also the same MEDIA5= statement in the Devsup parameter. Media 5 refers to 3592 Data Cartridges with 300 GB (3592-J1A), 500 GB (3592-E05), or 640 GB (3592-E06) uncompressed.

Note that all physical VOLSER ranges must be defined in the Cartridge Assignment Policy (CAP) of the TS3500 Tape Library. However, the native VOLSER range AN0000-AN9999 that we used is not defined in the 3953 Tape System. Remember that every VOLSER range, which is defined in the TS3500 logical library to a 3953 Tape System but is not assigned in the 3953 Tape System to a TS7700 Virtualization Engine or a VTS partition as a physical VOLSER, will be treated as native cartridges. Therefore, during the insert processing, they will be accepted from a host, and a media category will be assigned. If no host accepts them, they will remain in the Library Manager in the insert category.

None of the Open Systems definitions is defined in the 3953 Tape System or in the System z hosts.

Example B

A TS3500 Tape Library with one 3953 Tape System has three Library Manager partitions (one native and two VTS). Four z/OS systems are attached. Two of them are a sysplex, and the others are single partitions. The native partition is shared among all the attached z/OS hosts, and the virtualization subsystem partitions are dedicated. Partition VTS 1 is dedicated to one z/OS host, and partition VTS 2 is dedicated to the sysplex.

Figure 6-7 shows which definitions must be made on the different levels.

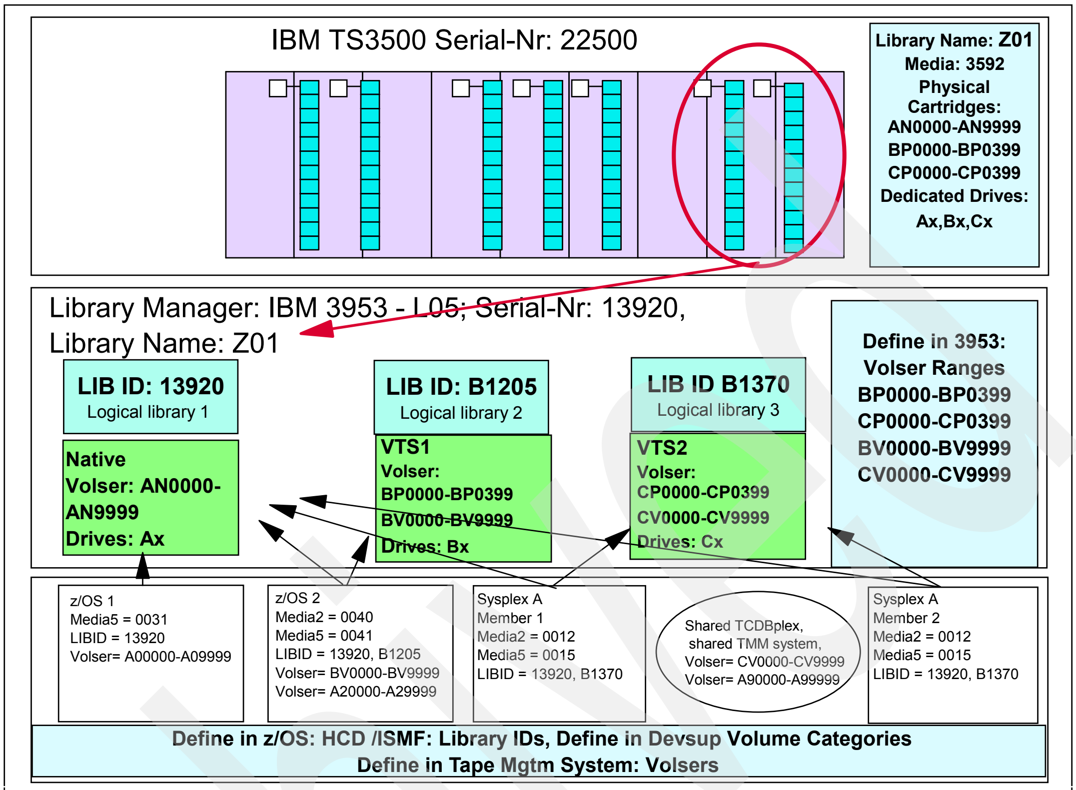


Figure 6-7 Partitioning example B

As you see in Figure 6-7, the native library is shared among all z/OS hosts. Therefore, you must define the LIBRARY-ID `13920` in each HCD and ISMF for all of the z/OS hosts. The VTS LIBRARY-IDs, `B1205` and `B1370`, are only coded in the systems to which they are attached.

For System z/OS 1, there is no MEDIA2 defined in the DEVSUP, because z/OS 1 has no VTS access. The two members of Sysplex A share the tape configuration database (TCDB) and the Tape Management System. They must also have the same MEDIA*x*= statement in the DEVSUP parameter in order to share.

Note that all physical VOLSER ranges must be defined in the CAP of the TS3500 Tape Library. But the virtual VOLSERs for TS7700 Virtualization Engine or VTS are only defined in the 3953 Tape System (here defined as BV0000-BV9999 and CV0000-CV9999).

The native VOLSER range AN0000-AN9999 that we used is not defined in the 3953 Tape System. Remember that every VOLSER range, which is defined in the TS3500 logical library to a 3953 Tape System but is not assigned in the 3953 Tape System to a virtualization subsystem partition as a physical VOLSER, will be treated as native cartridges. Therefore, during the insert processing, they will be accepted from a host, and a media category will be assigned. If no host accepts them, they will remain in the Library Manager in the insert category.

The range of the physical stacked volumes is BP0000-BP0399 on VTS1 and CP0000-CP0399 on VTS2. The physical stacked volumes are not defined to any of the hosts.

Example C

Figure 6-8 shows a TS3500 Tape Library with two attached 3953 Tape Systems. Every 3953 Tape System has only one Library Manager partition, a VTS. Two z/OS images are attached to all VTS partitions.

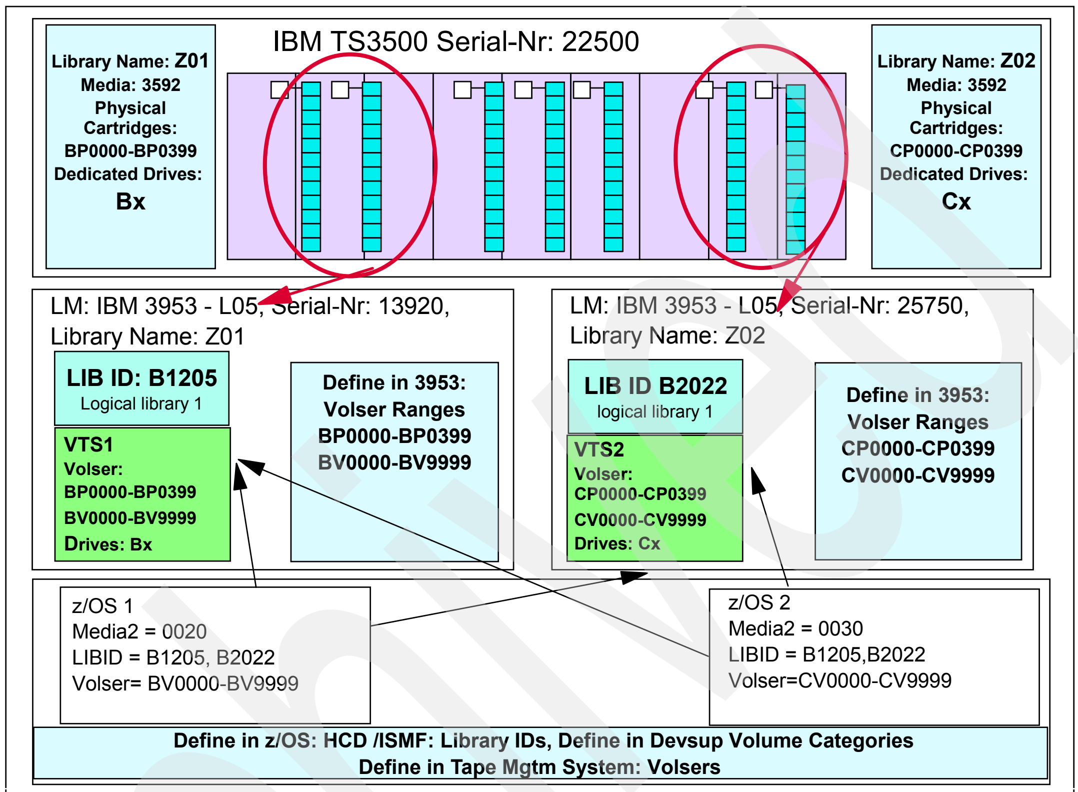


Figure 6-8 Partitioning example C

As you can see in Figure 6-8, there are two 3953 Tape Systems with different VTSs available. The two attached z/OS hosts use both VTSs. Therefore, you must define the LIBRARY-IDs B1205 and B2022 in each HCD and ISMF for all of the z/OS hosts.

Only MEDIA2 is defined in the DEVSUP*xx* in SYS1.PARMLIB for both z/OS hosts. Because there is no native partition, no other MEDIA*x* is needed. However, you can only specify one MEDIA2 statement in the DEVSUP*xx*; therefore, the z/OS uses the same volume category for both VTSs. So, in this example, z/OS1 will use scratch category 0020 for both VTSs.

Note that all physical VOLSER ranges must be defined in the CAP of the TS3500 Tape Library. But the virtual VOLSERs for VTS are only defined in the specific 3953 TS3500 (in this example, as BV0000-BV9999 and CV0000-CV9999).

The range of the physical stacked volumes is BP0000-BP0399 on VTS1 and CP0000-CP0399 on VTS2. The physical stacked volumes are not defined to any of the hosts.

Note: This example is unlikely, because you can attach two VTSs to a single 3953 Tape System. We included this example to show that you must define more than one 3953 Tape System.

6.3 Partitioning and DFSMS/rmm

DFSMS/rmm is also part of partitioning. If you use logical partitioning on a TS7700 or a VTS between two hosts without sharing volumes, you must consider how to separate the VOLSERs. We have already described how to separate logical units and scratch volumes between two hosts in “Example C” on page 164. But, you must also consider how to enter scratch tapes to the correct host, how to reject the use of host1 volumes from host2, and how to reject the use of host2 volumes from host1. Let us continue the example based on host1 named z/OS1 that uses VOLSERs BV0000-BV9999 and host2 named z/OS2 that uses VOLSERs CV0000-CV9999.

Changes needed to the Removable Media Manager (RMM) setup on z/OS1 are:

- Use RMM parameter VLPOOL PREFIX(BV*) TYPE(S) to allow the use of these volumes for default scratch mount processing.
- Use RMM parameter REJECT ANYUSE(CV*), which means do not use VOLSERs named CV* and related to z/OS2 on z/OS1.

Changes needed to the RMM setup on z/OS2 are:

- Use RMM parameter VLPOOL PREFIX(CV*) TYPE(S) to allow the use of these volumes for default scratch mount processing.
- Use RMM parameter REJECT ANYUSE(BV*), which means do not use VOLSERs named BV* and related to z/OS1 on z/OS2.

After establishing these settings, you can enter virtual volumes from the Library Manager or from the Management Interface (MI), and they will be received on the correct host through object access method (OAM). When jobs request a virtual scratch mount, the system will assign the correct pool of volumes as well.

For more information about DFSMS/rmm, refer to *z/OS DFSMSrmm Implementation and Customization Guide*, SC26-7405.

6.4 Partitioning a TS3500 between System z and Open Systems

The partitioning of a TS3500 between System z and Open Systems is still possible. You can provide the necessary definitions with the TS3500 Tape Library Specialist. The same definitions (for example, logical library name, tape drives, and Cartridge Assignment Policies) are valid for Open Systems and System z servers. However, for an Open Systems attachment, you do not need an IBM 3953 Tape System.

There is no way to attach an Open Systems host to a 3953 Tape System, which has the Library Manager database that is necessary for a TS7700 Virtualization Engine or a VTS attachment. Therefore, you cannot use a TS7700 Virtualization Engine or a VTS in a TS3500 environment for Open Systems. Refer to *IBM Virtualization Engine TS7510: Tape Virtualization for Open Systems Servers,* SG24-7189, for more information about Virtualization in Open Systems servers.

Note that you must use eight-character VOLSER reporting if Open Systems-attached and System z-attached logical libraries exist in a TS3500 Tape Library. Refer to “Cartridge and VOLSER naming conventions” on page 179.

6.5 Partitioning summary

The IBM TS3500 Tape Library first divides logically into System z and Open Systems TS3500 logical libraries. These TS3500 logical libraries are not referenced by the System z-attached hosts at all. The TS3500 logical library has no knowledge of the installed TS7700 Virtualization Engine or VTS environment or about which of the dedicated tape drives belongs to a native, TS7700 Virtualization Engine, or VTS environment.

The IBM 3953 Library Manager logically divides its TS3500 logical library again into Library Manager partitions, which represent native and virtual drive partitions.

The System z hosts are only aware of the Library Manager partitions. Open Systems hosts are not able to attach to a TS7700 Virtualization Engine or VTS.

Host logical libraries and existing Library Manager partitions can be used by multiple System z hosts with different tape control databases and tape management systems.

In practice in many client implementations, the entire physical TS3500 library is dedicated to System z with one 3953 Tape System defined under the control of one Library Manager.

6.6 Sharing

As opposed to partitioning, the implementation of sharing has not changed with the introduction of the TS3500 Tape Library and 3953 Tape System.

6.6.1 Sharing in a z/OS environment

Sharing allows the use of a common set of cartridges and tape drives inside a TCDBplex (several z/OS systems share the same tape control database, as well as the same tape management systems).

Considerations for cartridge sharing

All members in the TCDBplex must have the same DEVSUP*xx* in SYS1.PARMLIB definitions for the volume categories. All members in the TCDBplex must also share the tape management system's catalog to allow the usage of the cartridges to all members of the TCDBplex. You must provide the same information, for example, control statements for the tape management system, in all sharing systems.

Considerations for tape drive sharing

Drive sharing is the same for the resident library, TS7700 Virtualization Engine, or VTS logical drives, and stand-alone drives. The following statements must be true in order to implement drive sharing in an environment:

- Tape drive controllers (for native drive sharing), the TS7700 Virtualization Engine, or VTS-VTCs (for PtP VTS sharing) must be defined in the HCD to all members of the TCDBplex.
- The hardware must be attached physically through ESCON or FICON to all members of the TCDBplex.
- The drive must be defined as shareable and OFFLINE in the HCD to allow the usage in a shared environment.

You must provide a service for tape drives to be taken online and offline on demand without human intervention. In a sysplex, this sharing can occur using ATS STAR, which uses the Global Resource Serialization and XCF services for sharing automatically switchable devices.

For systems that do not belong to one sysplex, you must use the IBM Automated Tape Allocation Manager (ATAM) to allow tape drives to be taken online and offline on demand without human intervention beyond sysplex borders. For more information about ATAM, refer to *IBM Tivoli Automated Tape Allocation Manager for z/OS*, SC32-9122.

Without the implementation of automatic drive switching, the request for a tape results in a write to operator (WTO) to ask for a device. The operator must then answer. Depending on the implementation in your environment, this method can lead to time-outs in jobs or cause other problems, for example, loss of SMF data if the SMF datasets cannot be copied to tape.

Figure 6-9 is the same picture as in Example A for partitioning. The two z/OS hosts share the same TCDB, as well as the tape management system. The same category is defined in the DEVSUP*xx*.

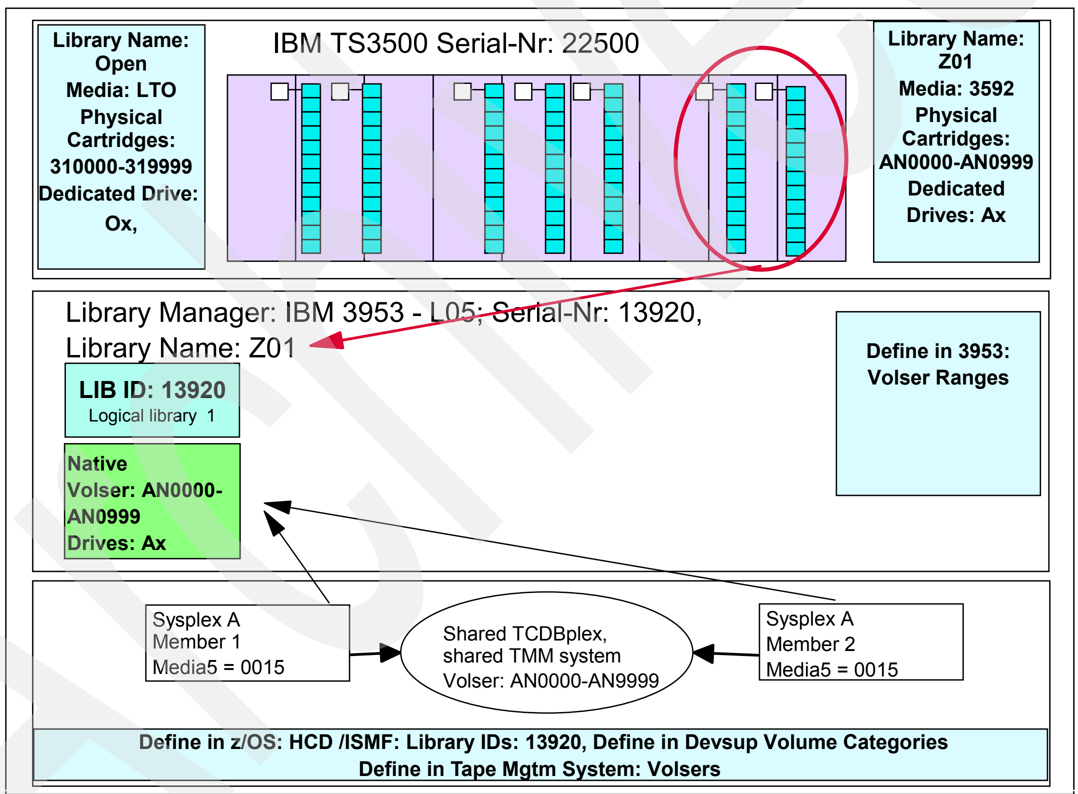


Figure 6-9 Sharing the tape environment in a z/OS environment

6.6.2 Sharing in z/VM environments

You share volumes in a DFSMS/VM environment by means of an installation exit and a control file listing the volumes that are accessible by a single system and by all systems.

Considerations for drive sharing

On z/VM systems, the tape drives are dedicated to a processor when the drive is attached to a user by using the ATTACH command rather than when the drive is brought online by using the VARY command. This implementation allows multiple processors to share access to tape drives that are cabled to each processor by attaching and detaching the drives as required.

6.6.3 Sharing in z/VSE environments

You can only share volumes in a z/VSE environment if the tape management system's volume catalog is shared among the attached hosts, which can only be provided if a shared DASD environment is used and the tape management system allows the usage of multiple hosts. IBM does not provide a tape management system product for z/VSE. For further information, refer to 10.4, "z/VSE native environments with Tape Library Support" on page 314.

Considerations for drive sharing with z/VSE under z/VM

When z/VSE runs as a guest system under z/VM, you can share tape drives and volumes by means of the DFSMS/VM RMS. A z/VSE guest can share drives with other VSE/ESA™ guests on the same VM host or on other VM hosts. You do not need shared DASD. In fact, VSE/ESA guests can also share drives with VM native users. If the natural state of the drives is free, any guest on any physically attached host can ATTACH, and therefore, assignment is established.

If you use the new Tape Library Support for a z/VSE system running under z/VM, drive sharing is no longer possible, because Tape Library Support is not able to provide the detach and attach functions for the drive.

Considerations for drive sharing in a native z/VSE environment

The Tape Library Support in z/VSE does not allow drive sharing between multiple z/VSE systems running in native mode.

For more information about the advantages of Tape Library Support, refer to 10.4, "z/VSE native environments with Tape Library Support" on page 314.

6.6.4 Sharing between z/OS and other System z hosts

Sharing requires that all systems also share the same set of control datasets, including the same tape control database. However, because all System z operating systems use different control mechanisms for managing tape libraries, there is no common point of control, and therefore, there is no sharing between z/OS and other System z hosts.

7

Preinstallation planning

This chapter discusses configuration requirements and recommendations when attaching System z hosts to the IBM TS3500 Tape Library. We provide preinstallation planning support and give you an overview about the tasks and items to consider before you install a System z-attached TS3500 Tape Library.

This chapter includes a comparison between IBM 3494 and TS3500 Tape Library and 3953 Tape System configurations.

The major topics are:

- Installation planning for the TS3500 Tape Library and TS1130 Tape Drive
- Host implementation considerations
- Software support
- IPv6
- Existing hardware integration
- Preinstallation checklist
- IBM 3494 and TS3500 Tape Library comparison

7.1 Installation planning

The planning phase during an installation is one of the most important steps. In this phase, all parties of the team identify, verify, and discuss all necessary actions, which helps to insure that:

- The installed hardware will meet clients' expectations.
- There are no delays during the installation.
- No additional costs during the installation occur.
- Time schedules for installation, as well as for the production readiness, are kept.
- No unplanned outages to already existing production occur.

You need to include the following tasks in this planning phase:

- Select a planning team with assigned responsibilities to ensure that all preinstallation planning and migration tasks are completed.
- Plan dates for additional regular meetings up to the planned installation, and plan implementation dates.
- Create an implementation plan with realistic milestones.

7.1.1 Plan your hardware configuration

First of all, you must plan your hardware configuration of the library with your IBM service support representative (SSR). The following list of questions is a good starting point to configure a library for System z attachment:

- Is the library shared between Open Systems and System z servers?

  If yes, you must remember that the requirements for storage slots and drives for Open Systems have to be considered as well. Note that the frames for Linear Tape-Open (LTO) tape drives and the 3592 model are different and that there is no intermix of both drive models (LTO and 3592) allowed inside a frame.

  Check if the Open Systems rely on eight-character VOLSERs. Also, refer to "Cartridge and VOLSER naming conventions" on page 179.

  Note that a Virtual Tape Server (VTS) attached to a TS3500 Tape Library cannot be shared between Open Systems and System z servers. Refer to 6.4, "Partitioning a TS3500 between System z and Open Systems" on page 165.

- Is the library planned for high availability?

  If yes, plan for the High Availability frames with a dual accessor in the TS3500 and for the redundant Library Manager in each 3953-F05 Frame.

- How many stand-alone TS7700 Virtualization Engine, Virtual Tape Server (VTS), or Peer-to-Peer (PtP) VTS systems will you install?

  This number influences the number of installed 3953 Tape System base and expansion frames. Remember that one 3953 Tape System can host up to two VTS partitions. You can use a VTS partition to install a TS7700 Virtualization Engine or VTS systems. If you plan to install more than two TS7700 Virtualization Engines or VTS systems, you must install an additional 3953 base frame and the corresponding Library Managers. As always, you must install TS7700 Multi Cluster Grid or the PtP VTS in separate physical libraries, and both sides of a TS7700 Grid or Peer-to-Peer VTS cannot reside in the same physical library.

There might be a requirement to upgrade the Library Manager microcode level to support the TS7700 Virtualization Engine. For more detailed planning and implementation information about the IBM System Storage TS7700 Virtualization Engine, refer to *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312.

For more information about the VTS configuration, refer to *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring,* SG24-2229. For more information about the PtP VTS configuration, refer to *IBM TotalStorage Peer-to-Peer Virtual Tape Server: Planning and Implementation Guide,* SG24-6115.

- How many tape controllers will you install?

  This number influences the number of installed 3953 Tape System expansion frames.

- How many tape drives will you install for the System z host (native, as well as VTS drives)?

  This answer influences the number of installed TS3500 Tape Library frames.

Note that the number of installed tape controllers (and the amount of ESCON or FICON connectivity), as well as the number of installed tape drives, is dependent on your performance and throughput issues. There is no general guideline that applies here. For a brief overview about how to measure the usage and throughput of your already installed environment using several IBM tape tools, refer to Appendix A, “Monitoring and reporting” on page 435.

If you plan a 1:1 migration, there might not be a need for a complete sizing analysis. For all other situations, we recommend a complete sizing analysis for the evaluation of the future hardware configuration, especially if a TS7700 Virtualization Engine or a VTS is involved. Make sure that you discuss all client requirements in advance, for example, performance and high availability, and that you can answer these questions:

- Do you want to use the TS3000 Master Console?
- How do you plan to use the Remote Call Home support?
- Are you planning to use Encryption with 3592 Model E encryption-enabled tape drives?

  You might also require an upgrade to the Library Manager microcode level to support Encryption even if you are in a System z environment. Only System-Managed Encryption is supported through Data Facility Storage Management Subsystem (DFSMS) Data Class constructs.

- Remember that you must install and enable the Advanced Library Management System (ALMS).

  There are four ALMS feature codes to use to purchase the ALMS, depending on the installed L*xx* frame’s capacity:

  – Entry ALMS, FC1692, for an entry-capacity L*xx* frame
  – Intermediate ALMS, FC1693, which has a prerequisite of FC1692, for an intermediate-capacity Lxx frame
  – Full ALMS, FC1694, which has a prerequisite of FC1693, for a full-capacity L*xx* frame
  – Or, purchase ALMS, FC1690, for any capacity of L*xx* frames

  For detailed information about L*xx* frame capacity, refer to 2.2.4, “Frame capacity” on page 20.

One of the previously listed ALMS feature codes is required if you want to exploit either:

- Dual active accessor libraries (FC9040)
- System z attachment (FC9217)
- High Density frame (HD)

Minimum configuration

The minimum tape library configuration for System z attachment consists of:

- **TS3500 Tape Library**:
  - TS3500 base frame (Model L23). However, if you install at least two frames (one Model L23 and one Model D23), you can achieve enhanced availability by distributing drives to two frames.
  - One tape drive
- **3953 Tape System**:
  - One IBM 3953 Tape System base frame (Model F05)
  - One Library Manager unit
  - One tape driver controller

Maximum configuration

The maximum tape library configuration for a System z host attachment is:

- **TS3500 Tape Library**:
  - Sixteen drive and cartridge frames (one Model L23 and 15 Model D23s) are supported, or, using the HD-frames (one Model L23 and 15 Model S24s) will be supported as has been previewed[1].

    Note: At the time of writing this book, up to 6887 slots are supported per TS3500 library. IBM plans to provide support for greater than 6887 cartridges in a future release. For the currently supported number of frames when S24 or S54 frames are installed, refer to Table 2-2 on page 18.

  - Two High Availability frames
  - 192 drives total
- **3953 Tape System**:
  - Four 3953 tape systems with one base frame and five expansion frames each (Model F05)
  - Dual Library Manager feature in each of the 3953 tape systems
  - Four native library partitions and eight VTS partitions

    Note: A VTS partition can be a TS7700 Virtualization Engine or a VTS subsystem.

  - For each native library partition, up to 14 tape drive controllers (if both VTS partitions are defined) or up to 16 tape drive controllers (if no VTS partition is defined)

    Note: Up to 192 tape drives can be installed in one TS3500 Tape Library, although a maximum of 256 tape drives is theoretically supported with 16 tape drives attaching to each of the 16 supported tape controllers.

[1] Previews provide insight into IBM plans and direction. Specific availability dates, ordering information, and terms and conditions will be provided when the product functionality is announced.

Figure 7-1 shows the maximum configuration for System z attachment in one TS3500 Tape Library.

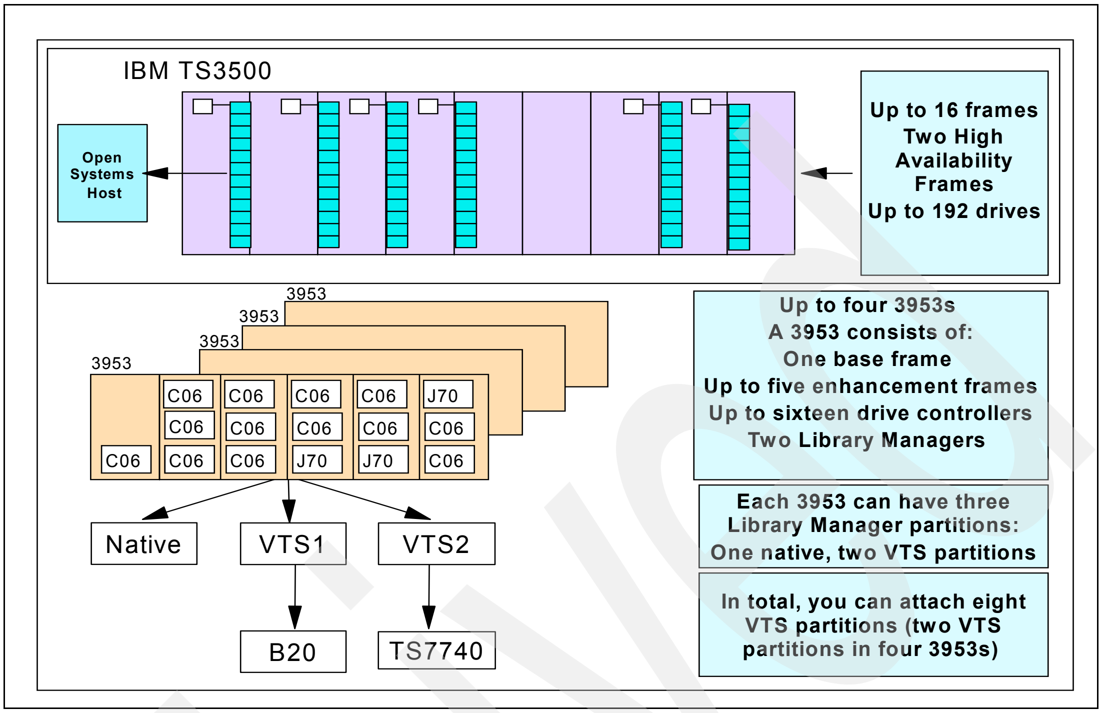


Figure 7-1 Maximum configuration for an IBM TS3500 and IBM 3953 environment

Environmental specifications

The IBM TS3500 Tape Library is a stand-alone tape subsystem consisting of one or more frames and capable of modular expansion to provide large capacities. The frames join end-to-end with the base frame on the left (viewed from the front) and the expansion frames extending to the right.

Physical dimensions

Table 7-1 indicates the physical dimensions of the IBM TS3500 Tape Library frames, and Table 7-2 on page 174 gives their weights according to the number of installed drives, robotics, and tape cartridges.

Table 7-1 Physical dimensions

	Width	Depth	Height
L32, D32	72.5 cm (28.5 in.)	152 cm (59.8 in.)	180 cm (70.9 in.)
L23, D23, L53, D53, and HA1	72.5 cm (28.5 in.)	121.2 cm (47.72 in.)	180 cm (70.9 in.)

Table 7-2 IBM TS3500 Tape Library weight

	Weight of base frame with 1 drive and 0 cartridges	**Weight of base frame with 12 drives and maximum cartridges**
L32	425 kg (937 lb.)	570 kg (1256 lb.)
D32	355 kg (784 lb.)	558 kg (1229 lb.)
L53	366 kg (806 lb.)	526 kg (1160 lb.)
D53	274 kg (604 lb.)	483 kg (1065 lb.)
L23	364 kg (802 lb.)	534 kg (1178 lb.)
D23	270 kg (596 lb.)	494 kg (1089 lb.)
HA1	261 kg (575 lb.)	N/A

Each frame has a set of casters and four leveling jackscrews. The nominal height from the bottom of the jackscrews to the top of the frame is 1840 mm (72.4 in.) and can be varied by ±40 mm (±1.6 in.). The shipping height of the IBM TS3500 Tape Library (on its casters and with jackscrews raised) is 1800 mm (70.9 in.).

Table 7-3 gives the physical specifications (such as height, width, depth, and weight) of models S*xx* of the TS3500 Tape Library.

Table 7-3 Physical characteristics of the TS3500 Tape Library Model S24 and S54

Characteristic	**S24 frame**	**S54 frame**
Height of frame (on casters)	1800 mm (70.9 in.)	1800 mm (70.9 in.)
Width of frame with cover	782 mm (30.8 in.)	782 mm (30.8 in.)
Width of frame without covers[a]	725 mm (28.5 in.)	725 mm (28.5 in.)
Depth of frame (including front and rear doors)	1212 mm (47.72 in.)	1212 mm (47.72 in.)
Weight of base frame with 0 cartridges	285.8 kg (630 lb.)	290.3 kg (640 lb.)
Weight of frame with maximum cartridges	526.2 kg (1160 lb.)[b]	562.5 kg (1240 lb.)[c]

a. Frame width only. Additional interframe spacing of 30 mm (1.2 in.) is required.
b. Maximum 1000 3592 Tape Cartridges. The weight with cartridges assumes a cartridge weight of .242 kg (.534 lb.) for a standard 3592 Tape Cartridge. The actual weight of the library varies, depending on the configuration and cartridge capacity.
c. Maximum 1320 Ultrium Tape Cartridges. The weight with cartridges assumes a cartridge weight of .206 kg (.454 lb.) for a standard LTO Ultrium Tape Cartridge. The actual weight of the library varies, depending on the configuration and cartridge capacity.

When planning for the installation, consider the space implications in your computer room for the possibility of adding more frames in the future.

Floor requirements

Install the library on a raised or solid floor. The floor must have a smooth surface and, if raised, must not have ventilation panels beneath the leveling jackscrews. If carpeted, ensure that the carpet is approved for computer-room applications. To accommodate unevenness in the floor, you can raise or lower the leveling jackscrews to the following specifications:

- Maximum allowable variance must not exceed 7 mm (0.27 in.) for each 76 mm (3 in.).
- Maximum out-of-level condition must not exceed 40 mm (1.6 in.) over the entire length and width of the library.

The floor on which the library is installed must be able to support:

- Up to 4.8 kilograms per square cm (68.6 lbs. per square inch) of point loads exerted by the leveling jackscrews
- Up to 211 kilograms per square meter (43.4 lbs. per square foot) of overall floor loading

The number of point loads exerted depends on the number of frames that make up the library. There are four point loads for each frame (located at the corners of each frame).

Operating environment

The IBM TS3500 Tape Library is designed to operate in the following environment:

- Temperature: 16 - 32 C (61 - 89 F)
- Relative humidity: 20% - 80%
- Wet Bulb: 23 C (73.4 F) maximum

Power and cooling specifications

Power and cooling for the IBM TS3500 Tape Library components are provided by the housing frame. Each base and expansion frame that contains drives has its own *frame control assembly (FCA)*, which receives power from a client-supplied outlet and, in turn, provides AC power to all tape drives within the frame. The FCA for the L32, L53, and L23 contains two DC power supplies; actually, only one DC power supply is needed to operate the entire library. Before support was provided for 16 frames, all additional FCAs in the D frame included one additional DC power supply for redundancy. With support for 16 frames, the additional FCAs in the D32 no longer have a default-installed DC power supply.

Additional DC power supplies can nevertheless be ordered or made available for extra frames. The FCA is not required in expansion frames that contain no tape drives.

Each frame receives single-phase (200 - 240 V AC) power on its own power cord from a client-supplied outlet. Certain countries or regions require two-phase power to achieve the 200-240 V AC required by the frame.

A Dual AC Power feature (FC1901), supporting either 110 V AC or 220 V AC, is available for the IBM TS3500 Tape Library, providing two independent line cords that can be connected to two independent client branch circuits. A power switch connects to one of two client power feeds and passes all AC power to the frame from that feed. The switch monitors the AC line voltage from the feed that it is using and automatically switches to the alternate AC power feed if the incoming voltage drops below a preset level.

Table 7-4 on page 176 lists the power requirements for the L53 and D53 frames.

Table 7-4 Power requirements for the IBM TS3500 Tape Library

Power requirements	Types of line cord	
	220 V AC line cord	**110 V AC line cord**
AC line voltage	200 - 240 V AC (nominal)	100 - 127 V AC (nominal)
AC line frequency	50 - 60 Hz	50 - 60 Hz
Nominal power	1.4 kW	1.2 kW
Line current	8.0 A	12.0 A
kVA	1.6 kVA	1.2 kVA
Heat output	4.8 kBTU/hr.	4.1 kBTU/hr.
Inrush current	200 A (peak for 1/2 cycle)	100 A (peak for 1/2 cycle)

Note: The values shown are for frames with 12 tape drives installed.

7.1.2 Plan the tape drive and cartridge locations within the library

When configuring tape drives and cartridges on an IBM TS3500 Tape Library for use with IBM 3953 Library Manager, you must consider the following mount performance and availability guidelines:

- When tape drives for a 3592 Model J70, TS1120 Model C06 Controller, TS7700 Virtualization Engine, or a VTS are split between two frames, use two frames in close proximity, preferably adjacent frames. This design enhances the clarity of the configuration and the operability, especially if you install multiple TS7700 Virtualization Engines or VTS systems (remember, you can install up to eight VTS partitions in a TS3500 Tape Library).
- If possible, install drives in groups of four to get the maximum free storage slots.
- For a library with dual accessors, use two frames in the same accessor zone for drives attached to the same tape controller, TS7700 Virtualization Engine, or VTS.
- Place tape cartridges in the vicinity of the tape drives onto which they will be mounted. For a library with dual accessors, place the tape cartridges in the same accessor zone as the tape drives. This design reduces accessor travel.
- In a single accessor library, distribute the drives near the center of the library.
- In a library with dual accessors, distribute the drives near the center of each accessor's zone. This distribution reduces the overall travel distance for the accessors.

In a dual accessor environment, both accessors need to make the same number of cartridge movements. The drive placement must take the workload into consideration, because the workload might change during the life cycle of the installed hardware. Consider if the workload of one component (for example, a VTS or native) is extremely higher than the workload of the other components. When you need to consider workload because of varying drive utilization, we strongly recommend that you perform a tape study and proper sizing before you perform the installation, especially if a VTS is installed in the TS3500 Tape Library. Also, to achieve accurate workload-related drive placement, the workload must be predictable and not change in the near future:

- If you plan frequent insert and eject operations, put those cartridges and associated tape drives near the I/O station. This design is especially important in a dual accessor library.

- If you have HD frames in an HA library, for frequent inserts and ejects, place the HD frames in the same zone as the I/O station to reduce accessor travel and contention.

Maximum distances between components

Remember that there are maximum distances allowed between:

- Tape drive controllers in the 3953 Tape System to the tape drives in the TS3500 Tape Library: 33 m (100 ft.)
- The 3953 Tape System and the VTS controller: 33 m (100 ft.)
- The VTS and the attached drives in the TS3500: 14.5 m (45 ft.)
- TS7700 Virtualization Engine and the attached drives in the TS3500: 25 m (77 ft.)

> **Note:** The installation might require extended distances on a request for price quotation (RPQ) base.

When designing and creating the specification for a new library, ensure that the configuration is laid out to meet these recommendations. In certain cases, adhering to these recommendations in practice will rely on the installation of the IBM service support representatives (SSRs). In other cases, for example, a miscellaneous equipment specification (MES) upgrade, you can clearly specify the drive placement within certain frames in the configuration files.

7.1.3 Plan your logical library configuration and sharing

As we explained in Chapter 6, “Basic concepts of sharing and partitioning” on page 149, the logical partitioning of the IBM TS3500 Tape Library and the attachment of a 3953 Tape System are necessary for the System z attachment.

Understand these questions and issues thoroughly before you start with the implementation:

- How many TS3500 logical libraries are planned?

  Remember that every TS3500 logical library for System z has its own 3953 Tape System with at least the base frame:

  - Each TS3500 logical library needs a unique logical library name.
  - You must assign drives dedicated to that TS3500 logical library (sharing drives between TS3500 logical libraries in a System z environment leads to unpredictable results).
  - You must assign the number of cartridge slots.
  - You must assign control paths for the drives. Plan to define:
    - Four control paths for each TS7700 Virtualization Engine or VTS.
    - Four control paths for each controller with four or more tape drives attached.
    - One to three control paths for each controller that has fewer than four installed tape drives. Then, you must define each tape drive for a control path.
  - Cartridge Assignment Policies must be in place. Plan which VOLSER ranges belong to which TS3500 logical library.
- How many Library Manager partitions are planned?

  Remember that each 3953 Tape System can have three partitions (one native and one or two VTS partitions), and you can have a maximum of four 3953 base frames installed.

Each 3953 Tape System can have at least one Library Manager (or two for availability purposes):

– No names for Library Manager partitions exist in the 3953 Tape System. They are referred as *Native*, *VTS 1*, and *VTS 2.* However, you must specify the LIBRARY-IDs for the existing Library Manager partitions.
– If you have more than one 3953 Tape System, plan in advance which 3953 Tape System will host which TS7700 Virtualization Engine or VTS.
– Define the LIBRARY-IDs for all native and VTS partitions at this stage.

> **Tip:** Remember that we recommended in a 3494 that you use the 3494 base frame serial number as the LIBRARY-ID for the native partition. Now, you can have up to four native partitions; therefore, we recommend that you use the 3953 Library Manager serial number as the LIBRARY-ID for the native partition.

- Plan which System z hosts will share the same host logical libraries. For logical partitioning on the host level, review the Library Manager volume category definitions (such as DEVSUP*xx* in SYS1.PARMLIB) carefully and update them if necessary (refer also to 9.2.1, “Updating SYS1.PARMLIB” on page 235).
- Plan your number of scratch pools for the various environments.
- If you plan to use a TS7700 Virtualization Engine, plan for the Outboard Policy Management and the physical pools. Refer to *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312.
- If you plan to use a VTS, plan for the Advanced Policy Management and the physical pools. Refer to *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring,* SG24-2229, and *IBM TotalStorage Peer-to-Peer Virtual Tape Server: Planning and Implementation Guide,* SG24-6115.

7.1.4 Plan your naming conventions

Carefully consider your naming conventions. In a small environment, there might not be a strong need for specific naming conventions. However, in an environment with more physical and logical libraries that are spread across multiple locations, clearly understood naming conventions are a *must*.

Naming conventions are not only useful for operators. They are also useful for SSRs, Help desks, and storage administrators and are even valuable to identify assets for asset management or to simplify handling Problem records or Change records where applicable.

All names must be easy to remember and unique in your data center.

Library naming convention

In the TS3500 Tape Library, each logical library needs a name, which you can specify. The TS3500 logical library name can be up to fifteen characters long, and there are no duplicate names allowed inside a TS3500 Tape Library. Refer to Figure 8-2 on page 203, which is the Create Logical Library panel.

Library Manager partitions in the 3953 Tape System have no names; they are referred to as *Native*, *VTS 1,* and *VTS 2.*

However, in the attached System z System Managed Storage (SMS) environment, you must define a logical library name for each host logical library (refer to 9.2.7, “Defining the library through ISMF” on page 256). We strongly recommend that you use unique library names for all of your native and VTS partitions in your data center environment. Using unique library names gives you more flexibility during migrations and reduces the risk of errors.

> **Restriction:** The first character of a library name must not be the “V” character, and the library name cannot be one of the DFSMSrmm-defined locations (LOCAL, REMOTE, or DISTANT).

LIBRARY-ID naming convention

For each Library Manager partition (Native, VTS 1, and VTS 2), you define a unique five digit hexadecimal *Sequence Number* during the 3953 Library Manager installation. This sequence number is arbitrary, and the client can select it. If the client does not select a number, we recommend that you use the last five digits of a hardware serial number. Consider using these standards:

- For the Library Manager partition that represents the native environment, use the last five digits of the serial number of the 3953-L05 Frame.
- For each Single Cluster TS7700 Grid, use the last five digits of the serial number of the TS7740 node (3957-V06) as the Distributed Library LIBRARY-ID. For the Composite Library LIBRARY-ID, use the last five digits of the 3952 Tape Frame.
- For each Multi Cluster TS7700 Grid, use the last five digits of the serial number of each TS7740 node (3957-V06) as the node’s Distributed Library LIBRARY-ID. For the Composite Library LIBRARY-ID, we have no specific recommendation for this five-digit hexadecimal sequence number. Consider using a number that makes it easily recognizable as associated with the Composite Library of a Multi Cluster TS7700 Grid. Refer to *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312, for more information about creating a sequence number for the Composite Library.
- For each stand-alone or VTS Distributed Library, use the last five digits of the serial number of the VTS.
- For the PtP VTS, the Composite Library LIBRARY-ID defined by your IBM SSR is arbitrary. We have no specific recommendation for this five-digit hexadecimal sequence number. Consider using a number that makes it easily recognizable as associated with a Composite Library. Refer to the *IBM TotalStorage Peer-to-Peer Virtual Tape Server: Planning and Implementation Guide,* SG24-6115, for more information about creating the sequence number for the Composite Library. The IBM SSR defines the Composite Library during the installation in the VTS. Also, the Composite Library LIBRARY-ID is defined in the hardware configuration definition (HCD) and SMS. It is not defined in the 3953 Tape System.

> **Important:** These sequence numbers must match the LIBRARY-IDs used in the HCD library definitions and the LIBRARY-IDs used in the Interactive Storage Management Facility (ISMF) Tape Library Define panels.

Cartridge and VOLSER naming conventions

The System z-attached IBM TS3500 logical library does not support cartridges without a barcode label. You must ensure that all eight characters of the barcode, including the media type digits, are reported to the System z hosts. This is the default setting.

This enablement is valid across all logical libraries of a TS3500 Tape Library; it cannot be enabled in one logical library and disabled in another logical library.

> **Important:** All logical libraries must use eight-character VOLSER reporting when System z is attached to the TS3500 library.

If you add a TS3500 logical library for System z to an already-installed TS3500 Tape Library, make sure that the Open Systems logical libraries are already using eight-character VOLSER reporting. If not, you have to plan the migration to an eight-character VOLSER before you implement the System z-attached logical library.

Most Open Systems applications can tolerate either eight or six character VOLSER reporting; however, they will not tolerate a sudden change to the reporting. An Open Systems application might discover that all the six-digit volumes in its database are suddenly missing and have been replaced by a new set of eight-digit undefined volumes.

Here is a summary of the issues regarding VOLSER labels:

- All cartridges need a barcode label.
- Eight-character VOLSER reporting must be enabled (this is the default).
- Identical VOLSER ranges are only allowed for different media types.
- Plan in this stage which VOLSER range will belong to which TS3500 logical library and to which Library Manager partition.
- The definitions of VOLSER ranges in the TS3500 Tape Library must match the definitions of VOLSER ranges in the 3953 Tape System.

Usage of esoterics to address a library

The TS3500 Tape Library with the 3953 Tape System is an SMS-managed library and is controlled using System Managed Storage (SMS) constructs (Data Class, Management Class, Storage Class, and Storage Group) to exploit the full functionality. But for some third-party vendor products, the use of an esoteric to address a native or a VTS partition is necessary. In this case, to exploit the full functionality of the TS3500 Tape Library or VTS, you must change your automatic class selection (ACS) routines to assign a Data Class for this esoteric. Plan your esoterics and define them in the HCD.

7.1.5 Plan your administration and monitoring

Remember that you need IP addresses for various administration and monitoring Web interfaces, such as TS3500 Tape Library Specialist and the installed Library Managers in the 3953 Tape System, as well as the TS3000 System Console (TSSC). The IP addresses must be accessible from the outside network. Make sure that the firewall rules are in place.

You must provide the following information before you start the installation. Items marked with an asterisk character (*) are optional:

- TCP/IP host name for the Library Manager
- TCP/IP address using IPv4 or IPv6, refer to 13.3.14, “IPv4 and IPv6 configuration” on page 404
- Subnet mask (or network mask)
- Router address (or gateway address)*
- Domain name*
- Name server address*

The 3953-F05 uses a Library Manager to control library operations. The Library Manager can optionally provide network connectivity on an external customer-specified network. The Library Manager connectivity can be used for establishing connections to Open Systems hosts through a local area network (LAN) or serial host connection. Library Managers provide the Automated Tape Library Specialist, also called the Web Specialist. The Web Specialist is a Web-based monitoring and management interface to the Library Managers. The 3953-L05 comes standard with an Ethernet connection for the Specialist. In environments where the tape configuration is separated from the LAN-attached hosts and Web clients by a firewall, these ports are the only ports that must be opened on the firewall, all other ports can be closed. Refer to Table 7-5 for reference.

Table 7-5 Customer network interface firewall

Function	Port	Direction (from library)	Protocol
Library operations	3494	Bidirectional	TCP/IP
ETL Specialist	80	Inbound	TCP/IP
Simple Network Management Protocol (SNMP) traps	161/162	Bidirectional	UDP/IP
Encryption Key Manager	1443	Outbound	Secure Sockets Layer (SSL)
Encryption Key Manager	3801	Outbound	TCP/IP

For more information about customer network interface, refer to:

- *IBM System Storage TS3500 Tape Library Operator Guide,* GA32-0560-00
- *IBM System Storage TS3500 Tape Library Introduction and Planning Guide,* GA32-0559-01
- *IBM System Storage TS1120 Tape Drive and Controller Operator Guide,* GA32-0556-00
- *IBM System Storage TS1120 Tape Drive and Controller Introduction and Planning Guide,* GA32-0555-02
- *IBM System Storage 3953 L05 Library Manager Operator Guide,* GA32-0558-00
- *IBM System Storage 3953 Tape System Introduction and Planning Guide,* GA32-0557-00
- *IBM TotalStorage 3494 Tape Library Introduction and Planning Guide,* GA32-0448-10
- *IBM Encryption Key Manager component for the Java platform Introduction, Planning, and User's Guide,* GA76-0418
- *IBM Virtualization Engine TS7700 Series Introduction and Planning Guide,* GA32-0567-00

The installation worksheets in Appendix E, "Installation worksheets" on page 497 give you detailed information that is needed for the tools.

The internal LAN inside the library (for internal communication) does not need IP addresses accessible from the outside network, and you do not have to consider firewall rules.

User administration

For the Web interfaces, you need to define user IDs and passwords for various roles, such as operations, tape administration, storage administration, and technicians. To ease your installation, look for an existing concept, such as the Resource Access Control Facility (RACF) user IDs. Even if you cannot access RACF to maintain the access rights, you can use the same user IDs to simplify the usage for the client.

If this does not apply to your environment, make up your own user ID assignment system and use that in your environment. Do not use different user IDs for the same person on different libraries.

There is no connection between libraries to exchange updates to user IDs and passwords. Therefore, you must maintain the user IDs and passwords in every library.

Education

If you have never installed an IBM library before, plan education for your storage administrators, the operating personnel for the TS3500 Tape Library Specialist, the 3953 Enterprise Tape Library (ETL) Specialist, the usage of the TSSC, and for managing the library.

If you are familiar with the IBM 3494, the Library Manager in the 3953 Tape System is similar. However, there is an additional set of activities required to prepare the TS3500 logical libraries before you set up the Library Manager. Therefore, we recommend additional training for the usage of the TS3500 Tape Library Specialist.

Daily operational procedures

The 3953 Tape System allows you to back up your Library Manager or VTS database to an external media. Plan to regularly back up this data. All constructs, such as Data Class, Storage Class, Storage Group, and Management Class, and all user ID information, are included in the backup.

Procedures for insert and ejects must be in place. You also need to define procedures to reinitialize volumes (where applicable).

If there is a Multi Cluster TS7700 Grid installed and a site is removed from the grid unexpectedly, other sites might not be able to automatically acquire ownership of the volumes that it owned, for example, if Automatic Ownership Takeover Manager requirements are not met, or if it has not been confirmed that the remote TS7700 Virtualization Engine is no longer operational. When this condition occurs, you must have a procedure in place for an Administrator user to grant the remaining clusters the authority to acquire ownership away from the unavailable site.

7.1.6 Plan the hardware installation

After the actual hardware configuration is planned, plan the hardware installation. We recommend that you run an initial installation planning meeting with the IBM SSRs and an Installation Planning Specialist. Include the people responsible for the data center environment, such as floorspace and power considerations. IBM SSRs might use the *IBM System Assurance Product Review Guide* for this meeting. This document is only available to IBM internally through the intranet at this Web site:

http://w3-03.ibm.com/support/assure/assur30i.nsf/Web/SA

There are two special considerations:

- Distances for installation. Refer to “Maximum distances between components” on page 177.
- Maximum weight on a raised floor.

For more information about the floor requirements and detailed plans for the machines, refer to the *IBM System Storage 3953 Tape System Introduction and Planning Guide*, GA32-0557, and the *IBM System Storage TS3500 Tape Library Introduction and Planning Guide,* GA32-0559.

7.1.7 Preinstallation planning for the TS1130

The TS1130 installation in a new TS3500 library or integration in an existing 3592 Tape Drive environment needs preinstallation planning mainly because of the new formats that the TS1130 introduces and coexistence and compatibility considerations.

The TS1130 Tape Drive characteristic format

The 3592 Model E06 is downward-read compatible (*n*-2) to the 3592 Model J1A format (EFMT1) and is downward-write compatible (*n*-1) to the 3592 Model E05 formats (EFMT2/EEFMT2). As with the 3592 Model E05 drive, by default, when writing from the beginning-of-tape (BOT), the 3592 Model E06 drive records in the non-encryption recording format (EFMT3); however, you can change this default at the drive.

To account for recording in the non-encryption recording format, under z/OS and OPEN processing, the non-encryption format EFMT3 is assumed and explicitly set, unless explicitly requested through Data Class to record in the lower recording formats (EFMT2/EEFMT2) or the encryption format (EEFMT3). This design guarantees that whatever recording format is set for the drive default, DFSMS appropriately handles the specified format through the Data Class, thus ignoring any drive default setting. For a better understanding of the various formats, refer to Table 7-6.

Table 7-6 Drive formats

Formats	**3592-E06**	**3592-E05**
Native recording formats	EFMT3/EEFMT3	EFMT2/EEFMT2
Read compatible formats	EFMT1/EFMT2/EEFMT2 (*n*-2 on read)	EFMT1
Write compatible formats	EFMT2/EEFMT2 (*n*-1 on write)	EFMT1
Media types and capacity		
MEDIA5/6	640 GB (EFMT3/EEFMT3) 500 GB (RFMT2/EEFMT2)	500 GB (EFMT2/EEFMT2) 300 GB (EFMT1)
MEDIA7/8	128 GB (EFMT3/EEFMT3) 100 GB (EFMT2/EEFMT2)	100 GB (EFMT2/EEFMT2) 60 GB (EFMT1)
MEDIA9/10	1000 GB (EFMT3/EEFMT3) 700 GB (EFMT2/EEFMT2)	700 GB (EFMT2/EEFMT2)

System-managed tape library support

With the system-managed tape library support, the 3592 Model E06 can coexist with the 3592 Model J1A and the 3592 Model E05 in the same tape library Model TS3500, which enables the devices to be able to coexist and to be properly managed and allocated. The EFMT3/EEFMT3 recording formats that are used by the IBM 3592 Model E06 can be specified by the storage administrator when defining their Data Classes. Thus, through the automatic class selection (ACS) routines, a specific job or application can be easily directed to the tape drive and the recording formats, which is particularly important if a library contains heterogeneous devices and is used to direct allocation to a specific type of device. In addition, when writing from BOT, specification of the lower recording technology (EFMT2/EEFMT2) enables the 3592 Model E05 (3592-2 and 3592-2E, as appropriate) and the 3592 Model E06 to be eligible for the write request. Also, for a volume that is recorded in the tape configuration database (TCDB) with a recording format of EFMT2/EEFMT2, both the 3592-E05 (3592-2 and 3592-2E, as appropriate) and the 3592-E06 are considered for the request.

However, because the 3592 Model E06 is downward-read, but not write compatible with the EFMT1 format, the 3592 Model E06 is only considered eligible for an EFMT1 request if explicit specification of the existing read-compatible special attribute indicator (in the tape configuration database) or usage of the LABEL=(,,,IN) on the DD statement of JCL is used. This approach is similar to the mechanism that was used with the 3590 Model E and 3590 Model H.

Media preferencing

As with EFMT2/EEFMT2, a Data Class specification of EFMT3/EEFMT3 (with no media type specified) enables MEDIA9, MEDIA5 or MEDIA7 scratch cartridges to be used, in capacity order from greatest to least. This media preferencing is the same media preferencing that is used if a 3592 Model E06 drive is allocated and no media type was specified.

System-managed tape implementation tasks for TS1130

Consider the following steps when planning to use the TS1130 tape drives:

1. Define the new devices using HCD.
2. Modify your ACS routines to select tape storage groups and libraries with 3592 Model E06 devices.
3. Add, as appropriate, Data Classes to use EFMT3 or EEFMT3 on the 3592-3E drives (EFMT3 is the default if not specified)
4. As appropriate, set the read-compatible special attribute indicator (TDSSPEC) in the tape configuration database (TCDB) for EFMT1 tape volumes to indicate that the volumes can be read by a 3592-3E device.
5. Specify, as appropriate, the key label-related information for your EEFMT3 Data Classes and review the other support that is needed for tape encryption.
6. Contact your tape management system vendor to obtain their support and any modified installation exits.

Coexistence considerations

The coexistence of various 3592 tape drive models differs between a library and a stand-alone environment.

Library environment

In an IBM tape library environment (automated or manual) with various 3592 models, the system-managed tape library support can be used to manage device allocation to an appropriate device. In addition, in the system-managed tape library environment, as with past support, all 3592 Model E06 drives under the same control unit must have the same recording format capabilities and report under the same error-recording data set (ERDS) physical identifier (EPI). There is no mix of 3592 models allowed (although the control units support a mix).

Stand-alone environment

In the stand-alone (non-system-managed) environment, the requirement is placed on the installation to manage and separate, as appropriate, the various drive technologies and capabilities using user-defined esoterics. Although a mix of 3592 Model E05 and 3592 Model E06 devices is allowed by the control unit, we recommend that you have homogeneous devices under the same control unit for easier separation and management.

In the stand-alone environment, you typically manage device allocation through user-defined esoterics and a media preference through the tape management system pooling support. This device allocation management is particularly important with today's drives all emulating the same device type and the need to keep devices with differing recording technologies separate. With this support, you continue to manage the drive allocation as you do today, with the Data Class recording technology specification continuing to being used to indicate if a lower recording technology needs to be used. This drive allocation management enables you to take advantage of the dual recording (write) capability of the tape drive, for interchange purposes and is the same mechanism that is used in the system-managed tape library environment. This mechanism continues to expand on the support that was delivered with the 3592 Model E05 and is also the mechanism that is used to select performance scaling and performance segmentation.

Usability considerations

As with the 3592 Model E05, because the 3592 Model E06 is also downward-read and downward-write compatible with older recording technologies, Data Class continues to be used as the control mechanism for the lower recording formats. In addition to the appropriate microcode updates, VOLNSNS=YES in the DEVSUP*xx* PARMLIB member needs to be specified.

Planning for the OAM Object Tape support

When using TS1130 tape drives with OAM Object Tape support, you must consider the usage of the ERDS physical identifier within and outside of an OAMplex environment, because the 3592 Model E06 can read or write volumes using recording formats EFMT2/EEFMT2 or EFMT3/EEFMT3, or it can read volumes that are written in recording format EFMT1.

For this support, OAM continues to associate the volume with the device on which it was written by recording the ERDS physical identifier (EPI) in the DB2® TAPEVOL table, and it handles the EPI value for the new device consistently with the manner in which the 3592 Model E05 is currently handled. The ERDS Physical ID (EPI) value for the 3592-3E drive is a hex '14' and is stored in the DB2 TAPEVOL table of the OAM Optical Configuration Database (OCDB) for a volume written in EFMT2, EEFMT2, EFMT3, and EEFMT3 by a TS1130 drive and displayed, as appropriate, in the volume display.

In a stand-alone environment, you must segregate 3592 Model J1A, 3592 Model E05 (not encryption-enabled), 3592 Model E05 (encryption-enabled), and 3592 Model E06 drives in their own unique esoteric to prevent allocating a 3592-J1A or TS1120 drive for a volume written with EFMT3/EEFMT3 recording technology, because EFMT3/EEFMT3 is only compatible with TS1130 drives.

In an IBM tape library environment, you can use the SETOAM DATACLASS parameter at the storage group (or global level) to specify a desired recording technology and ensure allocating an appropriate drive.

Consider the following steps when planning to use TS1130 drives and if these devices are in an IBM tape library:

1. Follow the steps listed in "System-managed tape implementation tasks for TS1130" on page 184.
2. Add Data Classes for EFMT3 and EEFMT3 recording technologies (EFMT3 is the default if nothing is specified).
3. Review ACS routines for STORE and CTRANS environments for any changes that might be necessary to ensure proper class assignment.

Encryption considerations

The existing tape subsystem encryption support in z/OS allows specification through Data Class that the data is to be encrypted (for system-managed and non-system-managed tape). In addition, the key label-related information that is used to encrypt the data key of a tape cartridge can be specified through the DD statement (JCL, dynamic allocation, and TSO ALLOCATE), Data Class, or Encryption Key Manager (EKM) defaults.

Encryption Key Manager (EKM)

The communication path to the EKM is across TCP/IP with the choice to use either in-band or out-of-band communication for the key management flow between the drive and the EKM. The TS7700 Virtualization Engine, for example, allows for out-of-band encryption only. The TS7700 Virtualization Engine provides the means to manage the use of encryption and which keys are used on a storage pool basis. It also acts as a proxy between the tape drives and the EKMs, using Ethernet to communicate with the EKMs and Fibre Channel connections with the drives. Encryption support is enabled with Feature Code (FC) 9900 for the TS7700. Refer to the white paper *IBM Virtualization Engine TS7700 Series Encryption Overview V1.1*, which is available from IBM Techdocs at:

http://www-03.ibm.com/support/techdocs/atsmastr.nsf/Web/Techdocs

The EKM is a common platform application written in Java that runs under the Java Virtual Machine (JVM). With out-of-band key management, the communication path to the EKM is handled by the control unit going directly to the EKM. Then for in-band key management, the communication path to the EKM is handled across ESCON/FICON with the I/O Supervisor (IOS) proxy interface handling the key exchange (across TCP/IP) with the EKM. With either in-band or out-band communication to the EKM, both a primary and a secondary EKM are supported.

TS1130 encryption support

This same encryption supports the 3592 Model E06 and the encryption format EEFMT3. As with the 3592 Model E05, for an encrypted tape cartridge written on the 3592 Model E06, the cartridge stores not only the encrypted user data, but it also stores critical key management-related information that is needed to interact with the EKM when decrypting data on the cartridge. This information is stored on the tape cartridge in the Externally Encrypted Data Key (EEDK) structure.

Whether the data on a cartridge is encrypted is determined during OPEN processing, when the first file sequence on the tape is written. If the first file written to a tape is encrypted, all subsequent files written to that same tape cartridge become encrypted using the same data key and the same recording format.

TS1120 tape drives are encryption-capable, but the drive encryption feature needs to be enabled before the drive can write encrypted data. An encryption-enabled TS1120 drive displays as 3592-2E as compared to an encryption-capable but not enabled drive that displays as 3592-2. For the TS1130, rather than support two versions of the drive (one that is encryption-enabled and one that is not), the tape control unit ensures that the encryption feature in the 3592 Model E06 drive is always enabled. The 3592 Model E06 drives then display as a 3592-3E. The “3E” indicates that this is the third generation 3592 drive and has the encryption feature enabled.

When writing from beginning of tape (file sequence 1, DISP=OLD or DISP=SHR for volume reuse), because this processing does not go through the Data Class ACS routine, OPEN processing needs to determine if encryption had previously been used and ensure that encryption is requested for this next usage of the tape. So if the previous usage of the tape was encrypted in EEFMT2 or EEFMT3 recording format, OPEN explicitly sets the encryption format (EEFMT3) and obtains and passes the volume’s existing key management-related information to the drive (key label and encoding mechanism). In this case, a new data key is generated and used; however, the volume's existing key management-related information is used to encrypt the data key. Support for the TS1130 is similar to the 3592 Model E05 encryption support in handling the encryption format EEFMT2 and consistent with today's 3592 Model E05 drives where on reuse, if encryption was not used, the highest non-encryption recording format is specified.

When appending to a file (DISP=MOD) or when writing additional file sequences to a tape, as with past tape devices, the same recording format is used for all data on the tape. A mix of recording formats is not supported on the same tape. And if the data being written continues to another volume, all volumes of a multi-volume data are also written using the same recording format, which is enforced during EOV processing.

DUMP support

DFSMSdss supports dumping to tape devices that are encrypting the data being written to them. O/C/EOV takes care of starting the encryption session with the tape controller based on the DATACLAS of the DFSMSdss Dump Data Set for encryption-enabled TS1120 and TS1130 drives.

Because DFSMSdss Cross Memory does not currently understand when a tape drive to which it is writing is encrypting data, the override support in native DFSMSdss does not take effect. As a reminder, currently DFSMSdss overrides Software encryption when at least one output device is encrypting the data. Software encryption is requested through DFSMSdss keywords, such as RSA or KEYPASSWORD.

DFSMSdss DUMP and COPYDUMP output (OUTDD or OUTDYNAM) supports multiple output data sets. If software encryption is requested and one of the output devices is encrypting the data written to it, then the software encryption will be overridden, and all output devices that are not encrypting the data will not be written to. If several of the devices are not written to because they will not be encrypting the data, an ADR519E message is issued indicating that some outputs are not processed. An ADR324E message is issued for each of the output data sets that will not be written to. Processing will continue.

DFSMSdss will consider output devices that record in EEFMT3 or EEFMT2 to be devices that encrypt their data. Therefore, when overriding software encryption, only devices that are not writing in EEFMT2 or EEFMT3 will be excluded from the output. If software encryption is not requested, DFSMSdss supports writing to multiple outputs where some are encrypting the data in the hardware and some are not. DFSMSdss notifies an application through its Application Programming Interface (Exit 06 and Exit 26) that the particular output is encrypting the data written to it when the device is recording in EEFTM2 or EEFMT3 format.

> **Note:** For a detailed discussion of the tape encryption support, refer to the *IBM System Storage Tape Encryption Planning, Implementation, and Usage Guide,* SG24-7320, and to *z/OS DFSMS Software Support for IBM System Storage TS1130 and TS1120 Tape Drives (3592),* SC26-7514.

7.2 Host implementation considerations

The implementation of the library consists of three steps:

1. Hardware configuration definition (HCD) to I/O: You use the HCD to define the tape control unit and the tape drives that belong to an IBM 3953 Tape Library to the input/output definition file (IODF).

   These definitions are hardware-related, and you must create them independently of the host operating system for:

   – z/OS
   – VSE/ESA and z/VSE
   – z/VM

   We discuss the HCD definitions that are required for the definition of tape controllers and their attached tape drives in detail in 8.3, “Hardware I/O configuration definition” on page 213.

2. Definitions in the hardware: You create several definitions, especially for partitioning and VOLSER assignment, in the library (TS3500) or the Library Manager (3953). You must make these definitions before you actually define the library to the System z using Interactive Storage Management Facility (ISMF).

3. Software definitions: Here you define the new tape library to the individual operating system. You use the same definition process for TS7700 Virtualization Engine or VTS virtual drives that you use for IBM TS3500 Tape Library resident drives attached to a drive controller (called a *native library*). If you use z/OS DFSMS and SMS tape, you update SMS constructs and automatic class selection (ACS) routines, Object Access Method (OAM) definitions, and your tape management system during this phase.

Perform these tasks during the installation:

1. Update the tape management system:

   – Update the tape management exits as appropriate.
   – Define the physical and logical VOLSER ranges.

2. Update the storage management system software:

   – SYS1.PARMLIB members.
   – OAM parameters.
   – Define the Tape Configuration Data Base (TCDB).
   – Define the library to SMS.
   – Define or update SMS constructs.
   – Define or update Automatic Class Selection (ACS) routines.
   – Install applicable Object Access Method (OAM) exits (CBRUXCUA, CBRUXENT, CBRUXEJC, and CBRUXVNL). Typically, your tape management system provides the exits.

   For a detailed description of the DFSMS implementation, refer to 9.2.7, “Defining the library through ISMF” on page 256.

   This publication provides special considerations for the implementation of a TS770 Virtualization Engine: *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312.

   These publications provide special considerations for the implementation of a VTS, *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring*, SG24-2229, and for the implementation of a Peer-to-Peer VTS, *IBM TotalStorage Peer-to-Peer Virtual Tape Server: Planning and Implementation Guide*, SG24-6115.

7.3 Software support

Because the host systems are, in general, unaware of the type of system-managed tape library that they use, no additional software support is *required* to attach a TS3500 Tape Library configuration to a System z host. However, you must check whether your software levels support the tape drives, controllers, TS7700 Virtualization Engine, or VTSs that you install inside the IBM TS3500 Tape Library and 3953 Tape System.

7.3.1 Software requirements for z/OS

z/OS V1R4 and later provide the recommended support for the TS3500 attachment. Small Product Enhancements (SPE) or Program Temporary Fixes (PTFs) might be required to support functions, such as WORM.

The recent hardware enhancements, such as the TS1130 Model E06 Tape Drive, require z/OS V1R7 and the enabling APAR OA22119.

Note: The only operating systems that plan to support the TS1130 this year are z/OS and z/VSE.

We strongly recommend that you review the following Preventive Software Planning (PSP) Buckets:

- Upgrade 3584DEVICE, Subset 3584/ZOS
- Upgrade 3592DEVICE, Subset 3592MVS/ESA

You can access these PSP Buckets using this Web site:

https://techsupport.services.ibm.com/server/390.psp390

The PSP Buckets include all of the necessary APARs and PTFs to exploit the full functionality of the new environment. This Web site shows a list of all of the latest fixes.

Note: Although z/OS V1R4, V1R5, V1R6, and V1R7 support the TS7700, these versions are no longer supported as of September 2008. An extended service contract is recommended if you plan to use these z/OS levels.

7.3.2 Coexistence considerations

For the 3592 Model E06, an enabling PTF for each release level does pre-REQ and if-REQ all of the necessary support ensuring that you have all of the appropriate support on your system prior to using the tape drive. Also, the new tape drive is not allowed online unless all of the supporting code is installed.

Updated microcode is needed on the 3592 Model J1A and the 3592 Model E05 to support media reuse from the EFMT3/EEFMT3 format. Support for the 3592 Model E06 is available through enabling APAR OA22119 on z/OS V1R7, which has been available since 5 September 2008.

7.3.3 Software requirements for z/VM

DFSMS/VM FL221 provides the recommended support for z/VM 3.1.0, 4.4.0, and 5.1.0. CP APAR VM63325 and DFSMS/VM APAR VM63353 provide support for the TS1120 tape drives. CP APAR VM63461 and DFSMS/VM APAR VM63460 provide support for the IBM 3592 enhanced media support, including WORM media and the economy length cartridge, for the VTS:

IBM intends to provide support for the TS1130 tape drives after general availability: z/VM Version 3 Release 1 or later. Native z/VM support with FICON requires APAR VM62710.

> **Note:** z/VM V3R1 and V4R4 support the TS7700, but these levels are out of service. An extended service contract is recommended for support.

7.3.4 Software requirements for VSE/ESA and z/VSE

We strongly recommend that you review the following Preventive Software Planning (PSP) Buckets: Upgrade 3584DEVICE, Subset 3584/ZVSE.

You can find these PSP Buckets using this Web site:

`https://techsupport.services.ibm.com/server/390.psp390`

Inside the PSP Bucket, you can find all necessary APARs and PTFs to exploit the full functionality of the new environment. The PSP Bucket includes a list of the latest fixes.

The following restrictions have to be considered:

- Native z/VSE 3.1 and later releases support the attachment of TS3500 Tape Library, a stand-alone VTS, and TS1120 tape drives.
- Native z/VSE 4.2 and later releases support the attachment of TS1130 tape drives.
- There is no support for PtP VTS. z/VSE provides support for PtP VTS only as a guest under VM.
- Guest support under VM/ESA® or z/VM with VGS for the VTS is provided with z/VSE V3.1, DFSMS/VM Function Level 221 with PTFs, and EREP Version 3.5 with PTFs.

For further information, refer to Chapter 10, “Software implementation: Other System z platforms” on page 301.

7.3.5 Linux on System z

Linux on System z has limited capabilities with respect to tape drives. Linux on System z does not have the ability to manage a library. It is not practical to access tape drives attached through a control unit (CU). Only fibre-attached drives are an option; there is no library management software for FICON-attached drives on zLinux. You will need library and tape management software in any case to mount, umount, label, check, and so forth the tape cartridges; the zLinux device driver is required, but it is not enough. It provides access to the drives and to the control paths (changer devices), but the driver alone cannot manage the library. You need the Tivoli Storage Manager Library Manager function (small/medium installation) or iRMM (large installation) to manage the library and tapes. So for the zLinux side, there is only one solution: The drives are fibre-attached, and the solution requires the zLinux device driver *and* a Tivoli Storage Manager-type function.

Because the TS7700 appears to a host as 16 control units, Linux on System z does not support the TS7700 Virtualization Engine.

7.4 Integrating existing hardware

There are several specific considerations if you plan to integrate existing hardware, or if you plan to migrate from existing hardware to a new library complex. For migration purposes, refer to 12.1, “Migration scenarios” on page 358.

Depending on the existing hardware, such as the TS3500 Tape Library, tape controllers, tape drives, a TS7700 Virtualization Engine, a VTS, or a PtP VTS, different actions might be necessary:

- Microcode update to support an intermix of existing and new installed hardware
- Update to existing environment (new feature code might be necessary)
- Remove and reinstall tape drives in new frames
- Move hardware to a different floorspace to stay within the maximum distances between components

You must plan in advance for downtime according to the actions that you need to take.

7.4.1 Attachment of existing IBM 3592 drives or VTSs

Support for the IBM 3953 Tape Frame requires a functional microcode update to an installed IBM 3592 Tape Controller Model J70 and IBM 3494 VTS models B10 and B20. Any IBM 3592 Tape Controller Model J70, IBM System Storage TS1120 Tape Controller Model C06, or VTS/TS7700 that needs to attach to IBM 3592 Tape Drive models in the IBM TS3500 Tape Library requires a microcode firmware upgrade.

This microcode firmware level ships on each new IBM 3592 Tape Drive model, IBM 3592 Tape Controller Model J70, VTS, and TS7700. To get the new firmware update installed for previously installed 3592 drive models, IBM 3592 Tape Controller Model J70s, or VTS systems, order these features:

- For installation of System z-attached 3592 tape drives in an IBM TS3500 Tape Library, order FC0500, Library Manager Functional Enhancement Field, for each IBM 3592 Tape Drive model.
- For installation of an IBM 3592 Controller Model J70 in an IBM 3953-F05 Frame, order FC0520, Functional Enhancement Field, for each IBM 3592-J70. This feature also updates the drive microcode firmware on any attached IBM 3592 Tape Drive model.
- For attachment of an existing IBM 3494 VTS to IBM 3592 tape drives in an IBM TS3500 Tape Library, order FC0521, VTS Functional Enhancement Field, for each VTS.

> **Important:** Moving a productive VTS that is installed in an IBM 3494 Tape Library to an IBM TS3500 Tape Library is supported with FC0522 or FC0523, which is ordered against the B10 or B20. This feature code requires the VTS to be at VTS R7.4+5. Attaching the TS1120 Tape Drive Model E05 to a VTS also requires this VTS licensed internal code (LIC) level.

For each System z tape controller or VTS/TS7700, set up the control path drives according to these rules:

- A minimum of four drives where there are four or more attached drives.
- All of the drives where there are one through three attached drives.
- You cannot set up more than eight drives.

7.4.2 VTS considerations

A stand-alone VTS, when installed in an IBM 3494, can attach to Open Systems host systems through Small Computer System Interface (SCSI) channel attachments. An IBM TS3500 Tape Library using the IBM 3953 Library Manager does not support SCSI attachment. Therefore, you cannot migrate a VTS with an Open Systems workload to a TS3500 library. Consider not migrating to the TS3500 Tape Library, or moving the workload of the Open Systems server to a TS7510 Virtualization Engine before the migration. For more information about the TS7510, refer to *IBM Virtualization Engine TS7510: Tape Virtualization for Open Systems Servers,* SG24-7189.

Moving a VTS with only a System z workload from a 3494 to a TS3500 Tape Library is supported with RPQ 8B3378. This RPQ provides IBM SSR instructions, and for new VTS installations, parts are provided with FC9217. The Library Manager must be at LIC level 532 or later, and the VTS needs to have VTS Release 7.4+5 microcode installed for this move. Order FC0521 to upgrade your VTS LIC level. You can upgrade your VTS to R7.4+5 (LIC 2.32.745.*xx*) from VTS R7.4 and from the following releases and LIC levels:

R7.1	2.29.710 or higher
R7.2	2.30.720.40 or higher
R7.3	2.31.730.54 or higher
R7.4	2.32.740.47 or higher

The VTS must have only IBM 3592 tape drives installed. If you plan to move a VTS with IBM 3590 tape drives or a combination of IBM 3590 tape drives and IBM 3592 tape drives installed, you must migrate your logical volumes to IBM 3592 cartridges first and detach the IBM 3590 tape drives from the VTS prior to the move. Refer to *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring,* SG24-2229, for additional information about how to migrate from IBM 3590 tape drives to IBM 3592 tape drives in a VTS.

Note that you move only the VTS and not the switches, which were used in the IBM 3494-D22 Frame. You must order new switches to install in the IBM 3953-F05 Frame. Refer to Appendix G, "Feature codes" on page 511 for details.

7.4.3 TS7700 Virtualization Engine considerations

To support the TS7700 Virtualization Engine in a TS3500 Tape Library with the IBM 3953 Library Manager, minimum microcode levels are required on all components. Refer to Table 7-7 for the correct levels.

Table 7-7 Minimum microcode levels

Component	Microcode level
TS7700 Virtualization Engine	8.0.0.203
IBM 3953-L05 Library Manager	534.01 and EC H27461
TS3500 Tape Library	6130
IBM 3952 Model J1A Tape Drive	85A
TS1120 Model E05 Tape Drive	942

Note: At the time of writing this book, no support of the TS1130 was available yet.

7.5 Preinstallation planning checklist

Include the following items in your preinstallation planning:

1. Ensure that you have completed the appropriate equipment specification and sizing necessary to satisfy application requirements.
2. Establish the milestone end dates for the project (which might be when the equipment is in production):
   - Order and delivery date for the equipment
   - Installation date
   - Test or pilot phase
   - Production date
3. Determine and order required cartridges (including cleaning cartridges), supplies, and consumable equipment necessary to support the library and proposed applications.
4. Order or download any manuals or additional manuals required prior to installation.
5. Prepare a system topology diagram, including:
   - Channel and device addresses
   - Storage Area Network (SAN) and switch configurations
6. Review any planned microcode updates that are required to migrate hardware:
   - System z-attached tape drive hardware to migrate to a new library
   - Open Systems-attached tape drive hardware to migrate to a new library
   - System z attachment to an already installed IBM TS3500 that contains Open Systems-attached tape drives
7. Check operating software levels; refer to Preventive Software Planning (PSP) Bucket.
8. Contact independent software vendors to check support for hardware.
9. Check which support levels are required for tape management software.
10. Prepare the physical environment for the library:
    a. Plan floor space using templates in the planning manuals for IBM TS3500 Tape Library and IBM 3953 Tape System.
    b. Check service clearance areas.
    c. Check access to the site: both physical access for the equipment and also site security.
    d. Plan for power requirements using the planning manuals.
    e. Ensure that there is a suitable telephone line for remote support.
    f. Review any potential security issues with local area network (LAN) or dial-up access to the machines.
    g. Plan cabling:
       - Plan FICON or ESCON infrastructure, the route, and for any additional cables.
       - Make sure that you have LAN infrastructure cables.
       - Review required Fibre Channel cables and lengths.
    h. Check the floor weight support limits and floor covering requirements.
11. Plan the IBM TS3500 Tape Library layout:
    - Logical library names
    - Drive placement and drive assignment to logical libraries
    - Cartridge Assignment Policies for VOLSER ranges

12. Plan the Library Manager partition:
   – Which LIBRARY-IDs are used.
   – Which Library Manager partition and which TS7700 Virtualization Engine or VTS to use (especially if you have more than one 3953 Tape System).
   – Determine your Library Manager VOLSER ranges.
13. Plan your host logical libraries to identify which System z hosts will use which scratch, error, and private volume categories.
14. Clarify who is responsible for the installation and implementation tasks, and establish if you require additional services, either from IBM or third-party vendors:
   – Implementation services, for example, IBM TS3500 logical library setup using ALMS
   – Web Specialist familiarization, including ALMS
   – Product training
   – Operator training
15. Plan DFSMS, PARMLIB, and HCD updates.
16. Plan the activation of your HCD updates and if necessary, IPLs for your operating systems.
17. Plan your security concept, for example, user IDs and levels of access.
18. Complete the Installation Worksheets in Appendix E, “Installation worksheets” on page 497. IBM SSRs, who perform the installation, require this information to configure the subsystem connections, for example, IP address information.
19. Establish a test plan for any required functional, regression, or performance testing.
20. Review systems management procedures.

7.6 TS3500 Tape Library and IBM 3494 comparison

In this section, we summarize the differences between the TS3500 Tape Library and the IBM 3494.

7.6.1 Additional components in the TS3500 Tape Library System z attachment

In the IBM 3494, the Library Manager directly handles all functions controlling the library for all attached hosts. In a System z environment, the necessary commands were transferred through the ESCON/FICON connectivity.

The TS3500 Tape Library, however, does not support this functionality (SCSI library only). Therefore, a separate component for the System z attachment is necessary, the IBM 3953-F05 frame. This frame also hosts the tape controllers (IBM 3592 Model J70 or IBM TS1120 Model C06). The tape drives are installed inside the TS3500 Tape Library. There is no longer any need to install drives attached behind a controller in the same frame or in adjacent frames. You can place these drives anywhere in the library (refer to 7.1.2, “Plan the tape drive and cartridge locations within the library” on page 176).

You partition the Open Systems and System z on the TS3500 Tape Library level. For System z attachment, one 3953 Tape System can represent one native partition and two VTS partitions. If you want to install more than two TS7700 Virtualization Engines or VTS systems, you need an additional 3953 for every two virtualization systems.

Note: Both VTS partitions cannot use the same Multi Cluster Grid (TS7700) or the same PtP VTS (3494-B10 or 3494-B20).

Use ALMS to partition the TS3500, which includes the TS3500 logical library name, as well as the attached drives, maximum slots, and the Cartridge Assignment Policies.

You must define the cartridge VOLSER ranges in ALMS, as well as in the Library Manager.

Use the 3953 Library Manager to create the definitions of the VTS partition.

7.6.2 Tasks performed by the TS3500 Tape Library

Several functions that, in the IBM 3494, are controlled by the integrated Library Manager, do not need Library Manager intervention in a TS3500 Tape Library.

Next, we list the activities that the IBM TS3500 Tape Library handles within its hardware on behalf of the Library Manager: accessor control, teach, library enclosure doors, inventory, and I/O station handling.

Accessor control

The Library Manager sends SCSI move medium commands to the library. It does not directly control the accessor. The Library Manager does not know how many accessors or grippers there are in the IBM TS3500 Tape Library. The IBM TS3500 Tape Library handles robotic movement and any physical motion retries. The IBM 3953 Library Manager does not display individual accessor mounts per hour, because the accessor performing each mount is not visible to the IBM 3953 Library Manager.

Teach

The Library Manager is not responsible for physically configuring the library and the accessor where the library components are. Physical motions to locate elements in the library are handled within the IBM TS3500 hardware. The actual physical coordinates of each cell are kept by the IBM TS3500 Tape Library. Often the true coordinates match the elements reported to the Library Manager, but they might not, because the ALMS code in the IBM TS3500 Tape Library maps virtual element addresses to physical element addresses.

Library enclosure doors

The IBM TS3500 detects the opening and closing of the doors. The IBM TS3500 transitions between *Ready* and *Not ready* (Auto and Pause). You do not change the library mode from the Library Manager panels, as you do in the IBM 3494. The IBM 3953 Library Manager reports *Pause* when the IBM TS3500 Tape Library reports *Not ready* or when the Library Manager cannot communicate with the IBM TS3500 Tape Library. When the library doors are closed, the IBM TS3500 automatically handles scanning the cells.

Inventory

During the library inventory activities, the Library Manager is in a status of Pause, which means that the library has not reported a ready status at that point. When the IBM TS3500 becomes ready, the Library Manager enters the *Auto-Pending* state. Then, the Library Manager issues a series of Read Element Status (RES) commands to the IBM TS3500 Tape Library. The RES responses contain element addresses (where) and the contents of the element (what). The elements in the library include:

- Medium transport (the accessor)
- Storage cells

- Import/Export (the I/O station)
- Data transfer (the drives)

The IBM 3953 Library Manager uses these responses to build the inventory database. When the inventory upload is complete, then the Library Manager reports the status of *Auto*.

> **Important:** If you need to rebuild your host's Tape Configuration Database (TCDB) through a Re-inventory of the library, the process has changed. With the IBM 3494, the logical and physical VOLSERs can be deleted at the beginning of a *Re-inventory Complete* operation. However, with the IBM 3953-L05 attached to the IBM TS3500, the re-inventory complete function has been removed, because the TS3500 performs its own inventory and the 3953 Library Manager electronically uploads the inventory.
>
> To compensate for the removal of this delete capability, a new menu item is available under the *Utilities* drop-down menu called *Delete physical/logical volumes*. This menu is accessible by the IBM SSR and provides the same delete capability as the 3494. After the delete, the IBM TS3500 Tape Library automatically performs an inventory of the physical volumes. The VOLSERs are placed in the appropriate Insert category. If the logical VOLSERs were deleted, they must be reinserted from the Library Manager panel for a VTS or from the Management Interface for a TS7700. The host then needs to upload the VOLSERs and set them to the appropriate category.

I/O station handling

The IBM TS3500 Tape Library performs the scanning of the I/O station. It checks the validity of the cartridge VOLSER and barcode labels. It uses the Cartridge Assignment Policies (previously set through ALMS) to assign the cartridge to the System z-attached logical libraries. If there is no valid policy, the operator is notified.

The IBM TS3500 Tape Library rejects any invalid barcodes prior to reporting to the Library Manager. Thus, the "unreadable" category in the Library Manager is no longer required. Unlabeled cartridges and cartridges with unreadable external VOLSER labels are not supported by the 3953 Tape System. Even though the TS3500 Tape Library supports unlabeled or unreadable external labels for Open Systems hosts, this concept does not apply to System z attachment.

7.6.3 Mapping 3494 operation modes to TS3500 operation modes

Table 7-8 compares the operation modes of the 3494 library and TS3500 Tape Library.

Table 7-8 3494 library and TS3500 Tape Library operation modes

3494 library	TS3500 Tape Library
Pause	Not Setup
Pause	Not Ready becoming Ready
Auto-Pending	Ready
Auto	Ready

Remember that the status of the TS3500 Tape Library does not reflect the status of the Library Manager. To determine the status of the Library Manager, you can use the 3953 Enterprise Tape Library (ETL) Web interface, which is also called the ETL Specialist.

7.6.4 Other differences and their effects on the Library Manager

There are other differences between the 3494 library and the TS3500 Tape Library with the 3953 Tape System installation. In the following list, we provide these differences with brief explanations. Note that several of the panels of the Library Manager have changed, because the information is no longer available in the Library Manager, such as accessor usage.

However, the IBM 3494 Library Manager and the IBM 3953 Library Manager still use the same licensed internal code, and therefore they look similar:

- IBM TS3500 does not support High Capacity I/O, which assigns a block of library cartridge slots to be used for bulk input or ejection of cartridges. There are no High Capacity I/O displays in the IBM 3953 Library Manager.
- Dual accessors in the IBM TS3500 Tape Library are always in dual active mode. Dual accessor activity and any accessor failures are managed by the library intelligence without involvement from the Library Manager. Therefore, individual accessor mounts per hour are not displayed, because they are not visible to the Library Manager.
- Performing a mount/demount does not involve the Library Manager and is not visible to the Library Manager. Therefore, the IBM 3953 Library Manager does not display Home Cell mode: floating or fixed. These functions are handled within the IBM TS3500 Tape Library. The IBM TS3500 Tape Library always operates in fixed Home Cell mode unless an HD frame is installed.
- In the IBM 3494 Tape Library, you can assign a default media type during the Teach process, which is used when the media type is not determined from the barcode or VOLSER ranges. The default media type is meaningless for an IBM 3953 Library Manager, because the IBM TS3500 library handles all aspects of label reading.
- The IBM 3953 Library Manager does not support ARTIC cards, which attach the tape controllers and the VTSs to the Library Manager inside the IBM 3494. There are no displays related to ARTIC cards.
- Because the IBM TS3500 Tape Library handles the availability of the Convenience I/O station, the Library Manager does not display its availability or whether the door is open or closed. However, the IBM 3953 Library Manager displays whether the Convenience I/O station is in Import or Insert mode.
- There are no references to frame numbers in the Library Manager panels, because the Library Manager has no knowledge of a physical location within the IBM TS3500 Tape Library and does not manage the physical location within the library. Instead, the Library Manager panels display a subsystem number that is based on the IP address of the subsystem.
- Any references to a cell (Frame, Column, or Row) have been changed to reflect the element address. Because of the Advanced Library Management System (ALMS), which is required on the IBM TS3500 when you attach the IBM 3953 Library Manager, the element address that is displayed does not relate to a fixed position in the physical library. You need to use the IBM TS3500 Tape Library Operator Panel or Web interface to locate the physical location by the Rack, Column, and Row of a cartridge.
- In the 3494, the Library Manager is in total control of the vision system. The Library Manager is able to support unreadable external VOLSER labels. However, now the IBM TS3500 Tape Library is in control of the vision system. The TS3500 Tape Library only reports readable external VOLSER labels to the 3953 Tape System. Therefore, the concept of unreadable external labels does not apply to the IBM 3953 Tape System.

- You no longer need a cleaning schedule, because the IBM 3592 drive indicates when a cleaning operation is required, and the IBM TS3500 handles all aspects of the drive cleaning. Also, the drive indicates when a cleaning cartridge has reached the end of its life. Today, the cleaning cartridge is not automatically ejected by the IBM TS3500 Tape Library. Note that the cleaning cartridge maintains how many cleanings it has performed, so that cleaning cartridges cannot be reinserted after they are ejected. The cartridge's cartridge memory (CM) chip tracks the number of times that the cartridge is used; however, it is the operator's responsibility to monitor the use of all cleaning cartridges and to remove and replace expired cartridges as necessary. In order to determine cleaning cartridge usage, to enable or disable automatic cleaning, to learn how to use SNMP traps to receive notification about expired cartridges, and for steps to remove a cleaning cartridge, refer to the appropriate sections in the *IBM System Storage TS3500 Tape Library Operator Guide*, GA32-0560.
- The IBM 3494 Tape Library supports IBM 3490E, 3590, and 3592 Enterprise tape drives attached to System z and Open Systems hosts. Although IBM Ultrium 1, 2, 3, and 4 tape drives can be installed inside the IBM TS3500 Tape Library, the IBM 3953-L05 only manages System z-attached IBM 3592 drives through their tape controller or the VTS.

7.6.5 Summary

In many aspects, the 3953 Tape System is similar to the IBM 3494. They both have Library Managers; the 3953 Tape System and the IBM 3494 can each can have up to 18 frames (including the High Availability Feature) and be up to a length of approximately 13.5 m (44 ft). They both can be shared between Open Systems, System z, TS7700 Virtualization Engines, and VTS attachments.

But there are also several major differences regarding the hardware components, such as the separation of control to the TS3500 Tape Library and 3953 Library Manager and the partition aspects. An additional 3953 Tape System separate frame for the System z attachment is introduced, which can represent one native and two VTS partitions as a maximum. Four separated 3953 Tape Systems can be attached to a single TS3500 Tape Library. The separate 3953-F05 frames host the Library Manager and the tape drive controllers. Table 7-9 summarizes the differences.

Table 7-9 Comparison summary

	3494	**TS3500 and 3953**
Hardware	Resides only in the 3494 (except VTS, TS7700, and 3592-C06 Controller equipment).	Two separate installations; TS7700 and VTS not included.
Usage of 3592-C06 controllers	Cannot be installed inside a 3494 Frame, needs an additional 3592 Frame.	Is installed in the 3953 Frame.
Active dual accessors	Is a chargeable feature.	Always active dual accessors.
Dual Library Manager	Feature in the High Availability Frame.	Feature in 3953 Tape System.
Managing control placement	Only one point of control (Library Manager).	TS3500 Tape Library and 3953 Tape System control different tasks of tape processing.
Library working mode	Either fixed or floating home cell mode.	Only fixed home cell mode.

	3494	TS3500 and 3953
Tape controller placement	Inside the 3494 frames or the 3952-F05 Frame for the 3592-C06 Controller.	Inside the 3953 Tape System frames.
Tape drive placement	Drives attached to one controller must reside in the same frame or in adjacent frames.	Drives attached to one controller can be installed anywhere in the library.
Number of VTSs that you can attach	Two.	Eight.
BULK I/O station	Can be configured.	N/A
Unlabeled cartridges	Supported directly by 3494.	Handled by TS3500 panels.
Cartridge location information	Is available in the Library Manager.	Is only available in the TS3500 Specialist, not in the Library Manager.
Partitioning	Partitioning done with parameters inside the 3494.	Basic partitioning is done inside the TS3500 Tape Library (each 3953 Tape System represents one logical library in the TS3500 Tape Library). Further partitioning is done in the 3953 Tape System.
Insert processing	No special considerations.	Cartridge Assignment Policy in TS3500 must be assigned in advance; otherwise, the cartridge remains unassigned.
Insert Notification	N/A	Not supported on a high density library.
Operating	All activities are performed on the 3494.	Activities are needed on the TS3500 and 3953.
Monitoring	SMF94 contains information about the whole library.	SMF94 contains only information about the Library Manager logical partition. Workloads from the TS3500 from other platforms or other 3953 Library Managers are not included.

8

Hardware setup and Hardware Configuration Definition

In this chapter, we describe how to implement the IBM TS3500 Tape Library in a System z environment. IBM service support representatives (SSRs) perform the hardware installation of the library, its associated tape control units, the IBM 3953 Library Manager, and the frames. This hardware installation does not require client involvement other than the appropriate planning (refer to Chapter 7, “Preinstallation planning” on page 169 for details). We discuss in detail the remaining implementation tasks performed at the Library Manager and on the System z host system.

We discuss these topics in this chapter:

- IBM TS3500 library setup
- IBM 3953 Library Manager setup
- Hardware I/O configuration definition

8.1 IBM TS3500 library setup

After the IBM SSRs have physically installed the library hardware, you can use the IBM TS3500 Specialist, which is described in 13.1.2, “IBM TS3500 Tape Library Specialist” on page 381, to set up the logical library. The logical library is managed by the IBM 3953 Library Manager, which is attached to the System z host systems. The installation information, which you provide in the worksheets in Appendix G, “Feature codes” on page 511, also helps you to complete the following definitions.

Note that the steps described in the following section relate to the installation of a new IBM TS3500 Tape Library with all of the required features, such as the Advanced Library Management System (ALMS), already installed. If you attach an existing IBM TS3500, which is already attached to Open Systems hosts, to System z hosts as well, refer to 12.5.2, “Upgrading an installed IBM TS3500 for System z servers” on page 376 for additional actions that might be required.

8.1.1 Defining a logical library using ALMS

The IBM TS3500 Specialist is required to define a logical library and perform the following tasks. Therefore, make sure that the IBM TS3500 Specialist is set up properly and working.

Ensure that ALMS is enabled

You can check the status of ALMS with the TS3500 Specialist as shown in Figure 8-1.

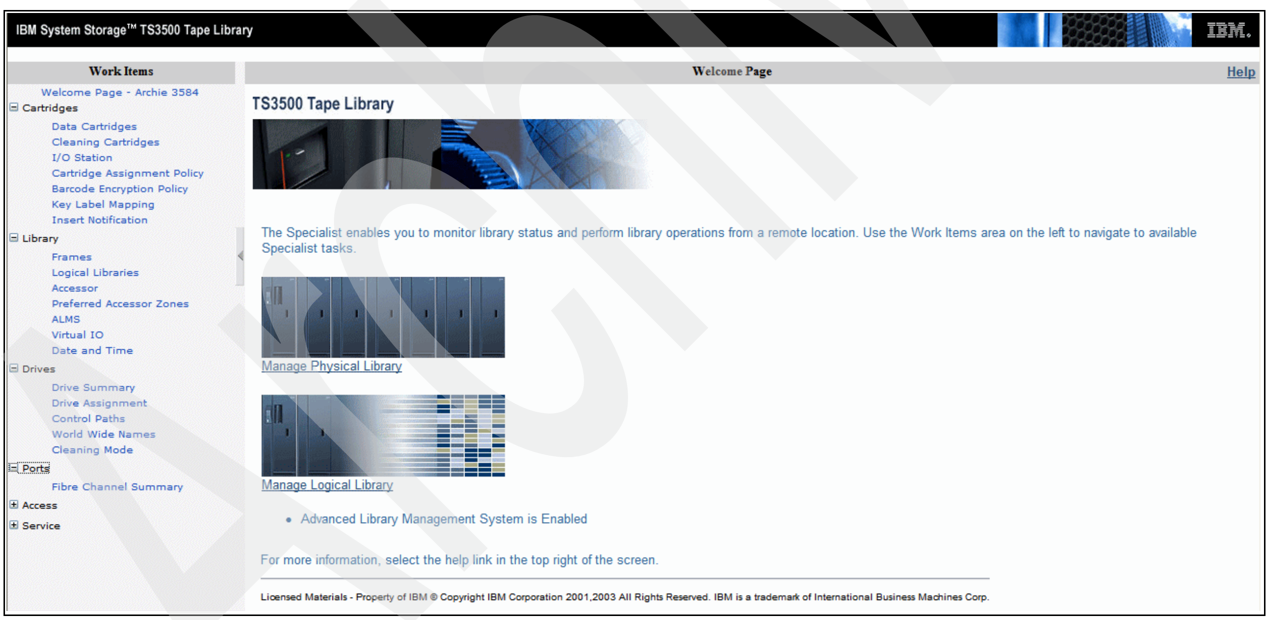


Figure 8-1 IBM TS3500 Specialist

As you can see at the bottom of the panel shown in Figure 8-1, ALMS is enabled for this IBM TS3500 Tape Library.

In addition, when ALMS is enabled, the work items under the Library submenu show Disable ALMS. When ALMS is disabled, the work items display Enable ALMS. If ALMS is not enabled, select this work item. From the next panel, enable ALMS.

When enabling ALMS in an already partitioned IBM TS3500, the cartridges in the library will be correctly assigned to their respective logical libraries. When enabling ALMS in a single logical library IBM TS3500, cartridges already residing inside the library also remain in this single TS3500 logical library and no longer become unassigned.

Define a logical library with ALMS

> **Note:** You can create or remove a logical library from the TS3500 Tape Library by using the Tape Library Specialist Web interface, but not by using the Operator Panel at the IBM 3953 Library Manager.

From the main section of the TS3500 Specialist Welcome Page, select **Manage Logical Libraries**. Alternatively, you can use the work items on the left side of the panel to navigate to the required panel by selecting **Library** → **Logical Library** as shown in Figure 8-2. From the drop-down list box, select **Create,** and click **Go**.

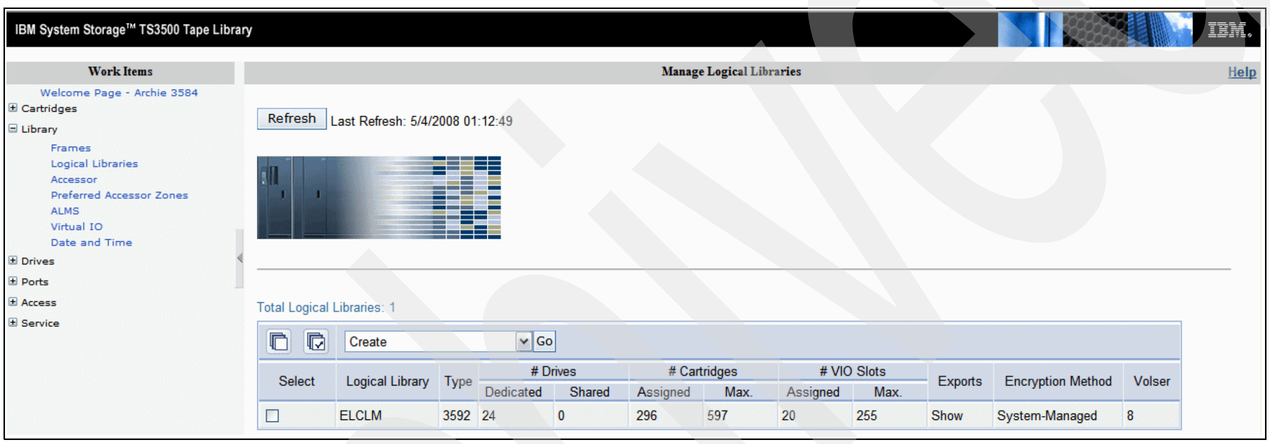


Figure 8-2 Create logical library

This action causes an additional panel, Create Logical Library, to display; Figure 8-3 shows this panel.

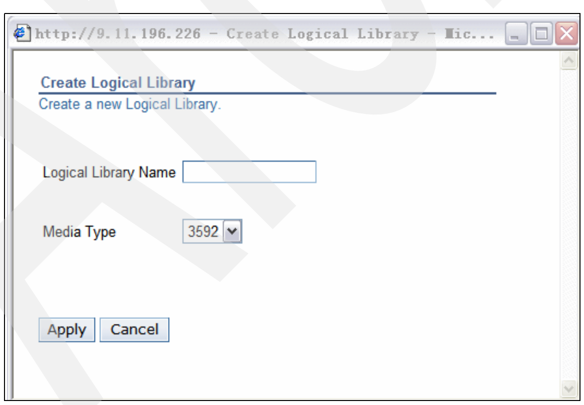


Figure 8-3 Create Logical Library panel

After you have defined your new logical library name and the Media Type 3592, click **Apply**, which creates the logical library and lists it on the Manage Logical Libraries panel.

Define cartridge slots

Define the maximum number of cartridge slots for the logical library. If multiple logical libraries are defined, you can define the maximum number of cartridge slots for each logical library, which allows a logical library to grow without reconfiguring the logical library each time that you want to add empty slots. To define the cartridge slots, click **Cartridges** on the Manage Logical Libraries panel, after you define the logical library. Figure 8-2 on page 203 shows a maximum number of 597 cartridges specified for logical library `ELCLM`.

Add drives to the logical library

From the Manage Logical Libraries panel shown in Figure 8-2 on page 203, select **Drive Assignment** from the drop-down list and then click **Go**. Alternatively, you can use the work items on the left side of the panel to navigate to the requested Web page by selecting Drives, and then selecting Drive Assignment.

Both of these links take you to a filtering panel from where you can select to display the drives by drive or by logical library and, upon your selection, to a panel that allows you to add or remove a drive from a library configuration. It also enables you to add, remove, and share drives in a logical library and change a control path.

Figure 8-4 on page 205 shows the drive assignment panel for all logical libraries in the physical library. Unassigned drives appear in the Unassigned column with the box checked. To assign them, you check the appropriate drive box under the logical library name, select **Apply** from the drop-down list, and then click **Go**.

The menu Help at the top right corner of the panel shown in Figure 8-4 on page 205 provides you with extended Help information, which contains detailed explanations of all of the fields and functions of the panel. The other TS3500 Specialist panels provide similar help support.

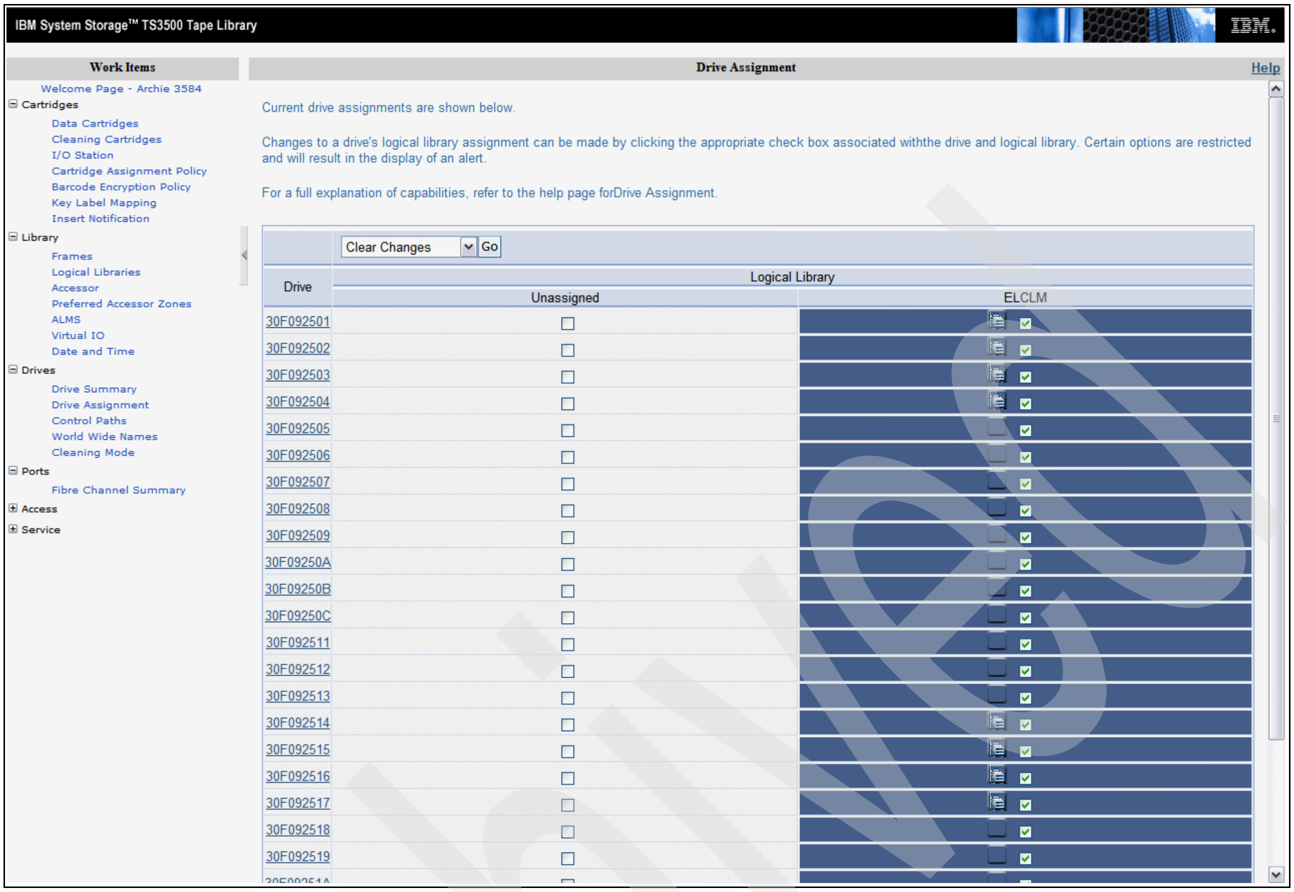


Figure 8-4 Drive Assignment panel

You can reassign physical tape drives from one logical library to another logical library. You can easily reassign physical tape drives for the Open Systems environment where the tape drives attach directly to the host systems without a tape controller, TS7700 Virtualization Engine, or Virtual Tape Server (VTS).

In a System z environment, a tape drive always attaches to one tape controller, TS7700 Virtualization Engine, or VTS only. If you reassign a tape drive from a TS3500 logical library managed by an IBM 3953 Library Manager to a TS3500 logical library used by Open Systems temporarily, you must also physically detach the tape drive from the TS7700 Virtualization Engine, VTS, or tape controller first and then attach the tape drive to the Open Systems host. Only allow IBM SSRs to perform these tasks to protect your tape operation from unplanned outages. The reconfiguration might require host software updates and TS7700 Virtualization Engine or VTS reconfiguration in order to not seriously interfere with your System z production work.

> **Important:** You *must* not attempt to temporarily assign tape drives owned by an IBM 3953 Library Manager partition to another logical library.
>
> In a System z environment, use the Drive Assignment panel only to:
>
> - *Initially* assign the tape drives to the IBM 3953 Library Manager partition.
> - Assign additional tape drives after they have been attached to the TS7700 Virtualization Engine, VTS, or a tape controller.
> - Remove physical tape drives from the configuration *before* they are physically detached from the TS7700, VTS, or tape controller.

Add control paths

Each 3592-C06 or 3592-J70 controller must have at least one control path drive defined, but we recommend that each controller has the optimum number of four control path drives. Each TS7700 Virtualization Engine or VTS needs to have four control path drives. Distribute the control path drives over more than one IBM TS3500 frame to avoid single points of failure.

In a logical library, you can designate any empty, dedicated drive to become a control path drive. A drive that is loaded with a cartridge cannot become a control path until you remove the cartridge. Similarly, any drive that is a control path cannot be disabled until you remove the cartridge that it contains.

Specify the definition of the control path drive on the Drive Assignment panel that is shown in Figure 8-4 on page 205. Control path drives are identified by the symbol on the left side of the drive box. You can change the control path drive definition by selecting or deselecting this symbol.

Note that you do not have to and cannot define cleaning policies for the IBM 3592 tape drives installed inside the IBM TS3500. If you try to define cleaning policies by selecting the work item **Cleaning Mode**, the panel that is shown in Figure 8-5 displays.

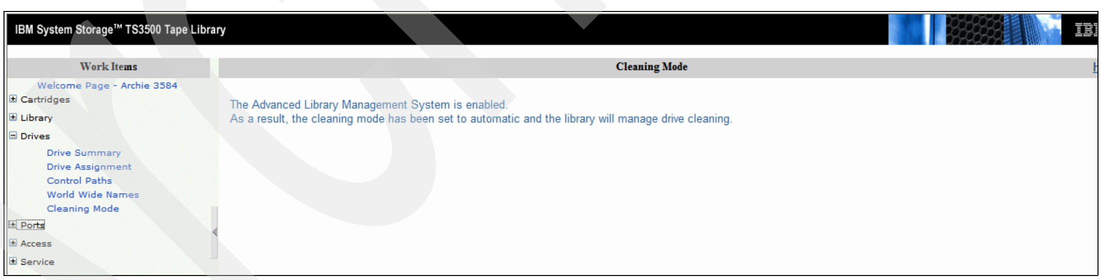


Figure 8-5 Cleaning Mode panel

After you enable ALMS, a tape drive is cleaned automatically when it requests cleaning.

8.1.2 Defining Cartridge Assignment Policies

The Cartridge Assignment Policy (CAP) of the TS3500 Tape Library allows you to assign ranges of cartridge volume serial numbers to specific logical libraries. If you have previously established a Cartridge Assignment Policy and you place a cartridge with a VOLSER that matches that range into the I/O station, the library automatically assigns that cartridge to the appropriate logical library. Refer to 13.5, “Inserting System z data volumes” on page 416 for more information about the process to insert cartridges.

Select **Cartridge Assignment Policy** from the **Cartridges** work items to add, change, and remove policies. The maximum quantity of Cartridge Assignment Policies for the entire IBM TS3500 library is 300. Figure 8-6 shows a single VOLSER range that is defined for logical library `ELCLM`.

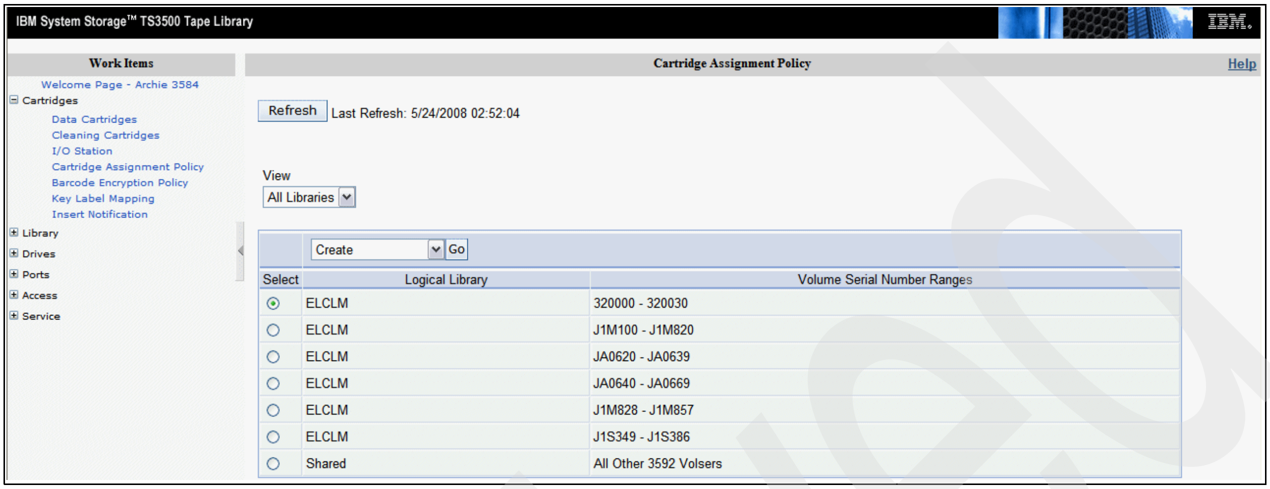


Figure 8-6 Cartridge Assignment Policy panel

The IBM TS3500 library allows duplicate VOLSER ranges for different media types only. For example, Logical Library 1 and Logical Library 2 contain Linear Tape-Open (LTO) media, and Logical Library 3 contains IBM 3592 media. Logical Library 1 has a Cartridge Assignment Policy of ABC100-ABC200. The library will reject an attempt to add a Cartridge Assignment Policy of ABC000-ABC300 to Logical Library 2, because the media type is the same (both LTO). However, the library will allow you to add a Cartridge Assignment Policy of ABC000-ABC300 to Logical Library 3, because the media type (3592) is different.

In a System Managed Storage (SMS) z/OS environment, all VOLSER numbers across all storage hierarchies are required to be unique. We strongly recommend that you follow the same rules across host platforms as well whether you are sharing an IBM TS3500 between System z and Open Systems hosts or not.

> **Note:** The Cartridge Assignment Policy does not reassign an already assigned tape cartridge. To reassign a cartridge, use the procedure for assigning cartridges to a logical library; refer to 13.5.3, “Inserting physical volumes in the IBM TS3500” on page 417.

8.1.3 Insert Notification

Manual cartridge assignment using Insert Notification is not supported on a high density library. For any partitioned library, we recommend that Cartridge Assignment Policy is configured to provide automated assignment of all inserted cartridges.

8.1.4 Eight-character VOLSER support

As displayed in Figure 8-2 on page 203, the column in the table shows the number of VOLSER characters set for each logical library. A logical library can be set to report a six or eight character VOLSER. When set to a six character VOLSER, the library only reports the first six characters of the VOLSER to the host. When set to an eight character VOLSER, the library reports all eight characters to the host, which includes the six character VOLSER and the two character media type.

In a System z environment, the IBM 3953 Library Manager requires that all eight characters of the VOLSER, including the two character cartridge identifier, are reported to allow proper media management.

You can change the setting by selecting the check box for the desired logical library, selecting **Modify Volser Reporting** from the drop-down list, and then clicking **Go** in the panel shown in Figure 8-7.

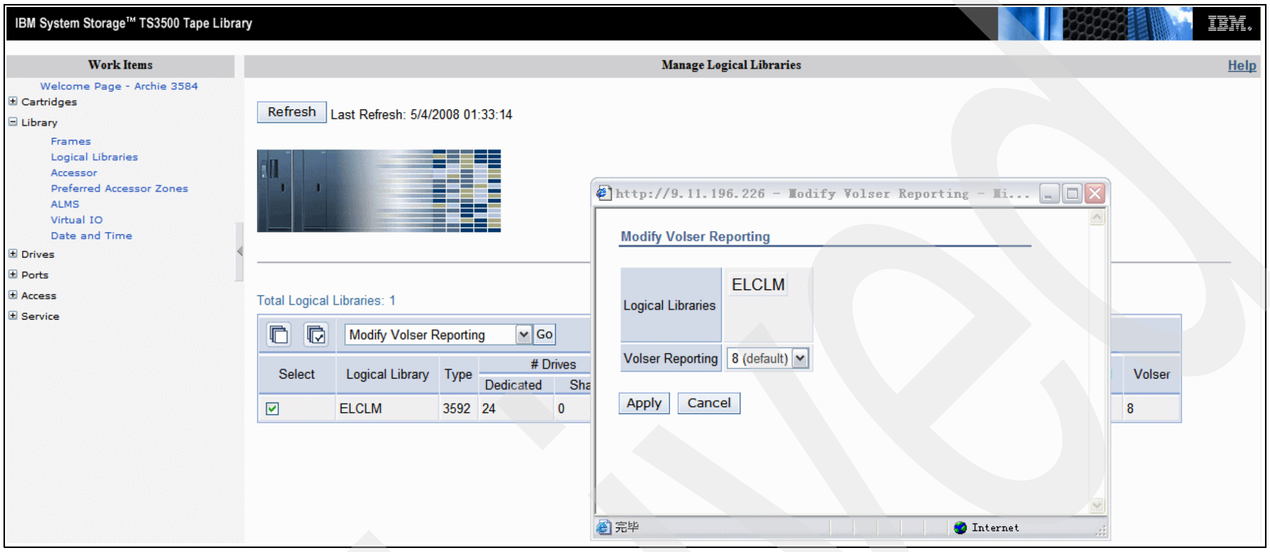


Figure 8-7 Modify Volser Reporting panel

8.2 IBM 3953 Library Manager setup

The tasks that you perform on the 3953 Library Manager are basically the same as the tasks that you perform on the 3494 Library Manager, because the tasks are related to the management of this specific TS3500 logical library. The tasks are dependent on whether only tape controllers with native drives are attached or whether one or two TS7700 Virtualization Engines or VTS systems are attached as well. You can perform most of the tasks either through the 3953 Library Manager Console or through the Enterprise Tape Library (ETL) Specialist, which is the Web-based browser interface to the Library Manager. For both VTS partitions and the native tape drives, you have to define VOLSER ranges on the 3953 Library Manager, as well as on the IBM TS3500 Specialist.

8.2.1 Defining VOLSER ranges for physical cartridges

After a cartridge is assigned to a TS3500 logical library managed by an IBM 3953 Library Manager, the IBM 3953 Library Manager uses the VOLSER ranges defined in its VOLSER Range Table to direct the cartridge to the proper partition (Native, VTS 1, or VTS 2) and to assign the proper Library Manager category. We recommend that you define the proper policies in the VOLSER Range Table before inserting the cartridges into the IBM TS3500 Tape Library.

Important:

- You must assign Cartridge Assignment Policies (CAPs) at the library hardware level before using the library with System z hosts.
- TS7700 Virtualization Engines, VTSs, and native physical volumes must fall within ranges that are assigned with the CAP to System z host logical libraries in the IBM TS3500.
- The policies for the System z cartridge ranges must match any host tape management policies.

You can use the ETL Specialist to define the VOLSER ranges for the native and VTS partitions. From the ETL Specialist Welcome Page, select **Administer Library Manager → Modify volser ranges**. Figure 8-8 displays the panel where you can define new VOLSER ranges or update existing VOLSER ranges.

The small gray question mark (?) at the top right corner of the panel that is shown in Figure 8-8 provides you with extended Help information, which contains detailed explanations of all of the fields and functions of the panel.

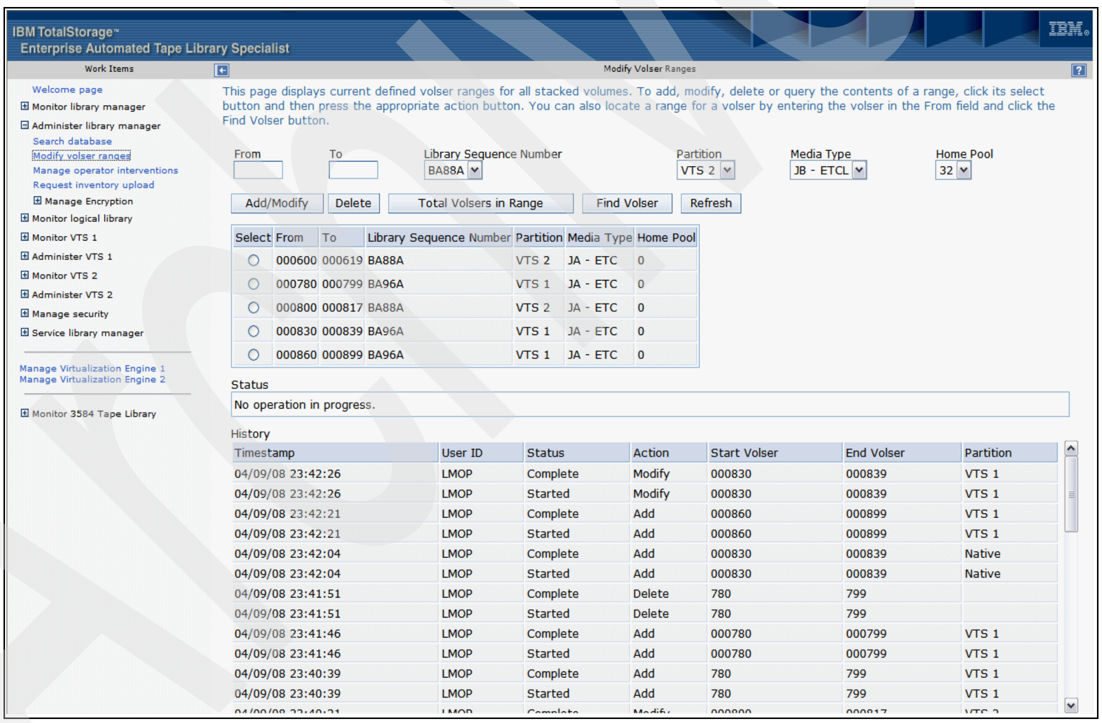


Figure 8-8 Modify Volser Ranges panel

The VOLSER entry fields must contain six characters. The characters can be letters, numerals, or spaces. You must enter the *From* and *To* VOLSERs in the same format; to be precise, both *corresponding characters* in each VOLSER must be the same: either both alphabetical or both numerical. For example, AAA998 and AAB004 are of the same form, but AA9998 and AAB004 are not. The VOLSERs that fall within a range are determined as follows: The VOLSER range increases so that alphabetical characters increase alphabetically and numerical characters increase numerically. For example, VOLSER range ABC000-ABD999 results in a range of 2000 VOLSERs (ABC000-ABC999 and ABD000-ABD999).

In Figure 8-6 on page 207, we showed you how to define the Cartridge Assignment Policies for one logical library. You must define the same VOLSER ranges again as shown in Figure 8-8 on page 209. In Figure 8-8 on page 209, you determine to which partition within the TS3500 logical library managed by the IBM 3953 Library Manager the cartridges are assigned.

Note: The VOLSER ranges that you define on the IBM TS3500 Tape Library and on the IBM 3953 Library Manager apply to physical cartridges only. You must *not* define VOLSER ranges for logical volumes if the TS7700 Virtualization Engine or a VTS is installed. You must define *logical volumes* and their VOLSER ranges differently. Refer to 13.5.4, “Inserting logical volumes into a TS7700 Virtualization Engine” on page 422 and 13.5.5, “Inserting logical volumes into a VTS” on page 424.

8.2.2 Native partition considerations

No additional definitions are required at the hardware level other than setting up the proper VOLSER ranges at the TS3500 library. At the 3953 Library Manager, the definition of VOLSER ranges for the native partition is optional. The Library Manager logic assigns the VOLSER to the native partition when the VOLSER matches a range in the range table or when the VOLSER does not match any range. VOLSERs destined for a VTS partition must have a range defined. In other words, if a VOLSER does not match a VOLSER range, the Library Manager assigns it to the native partition.

Although you can now enter cartridges into the TS3500 library, we recommend that you first complete the required definitions at the host as described in subsequent sections of this chapter before you insert any cartridges into the TS3500 library.

Starting at 8.3, “Hardware I/O configuration definition” on page 213, we describe details of the host implementation steps where you can find the sample HCD definitions for a tape controller and its attached tape drives.

For more information about how to insert cartridges into the IBM TS3500, refer to 13.5, “Inserting System z data volumes” on page 416.

8.2.3 TS7700 Virtualization Engine considerations

The TS7700 Virtualization Engine functions that you plan to use determine the definitions required at the hardware level for the implementation of a TS7700 Virtualization Engine. In addition to defining initial VOLSER ranges as described in 8.2.1, “Defining VOLSER ranges for physical cartridges” on page 208, the TS7700 definitions from the Library Manager also include these tasks:

- Define stacked volume ranges.
- Define logical volume ranges using the TS7700 Management Interface (MI).
- Define Fast Ready categories.
- Define TS7700 Virtualization Engine management policies.
- Define inhibit reclaim schedule.
- Set reclaim policies.
- Define free storage threshold.
- Define SNMP traps.
- Create operator intervention definitions.

Note: Management policies and Outboard Policy Management (OPM) definitions relate to a TS7700 cluster. If you install a Multi Cluster TS7700 Grid, you must create the same management policies and OPM definitions on all TS7700 clusters.

In this section, we provide an overview of the functions that you must perform. You can find these functions on the ETL Specialist as Work Items under Administer VTSx on the left side of the panel that is shown in Figure 8-9.

You can obtain additional information about the 3953 Library Manager setup tasks in *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312.

Management policies

From the IBM 3953 Library Manager Console or by using the ETL Specialist, you can define:

- **Inhibit Reclaim Schedule**: The time when no space reclamation occurs in the VTS.
- **Reclaim Threshold**: The amount of data on a cartridge below which the cartridge becomes eligible for space reclamation.
- **Free Storage Threshold**: The amount of free cartridge capacity below which a warning message is sent to the host console.

Outboard Policy Management (OPM)

If the TS7700 Virtualization Engine has the Outboard Policy Management feature installed, define the management constructs before you start using the TS7700 Virtualization Engine.

Depending on the OPM functions that you plan to use, define:

- Storage Groups
- Management Classes
- Storage Classes
- Data Classes
- Pool Properties

As an example, Figure 8-9 shows the Enterprise Tape Library (ETL) Specialist panel for managing Data Classes.

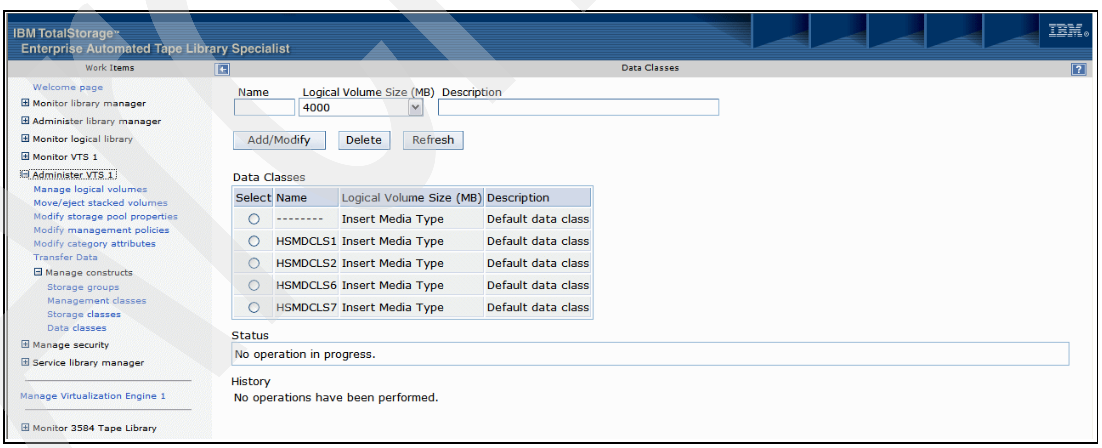


Figure 8-9 Manage Data Classes panel

Manage logical volumes

To insert logical volumes into a TS7700 Virtualization Engine, you need to use the TS7700 Management Interface. To access the TS7700 Management Interface from the ETL Specialist, you select the work item, **Manage Virtualization Engine 1**, on the left of the panel that is shown in Figure 8-9.

This action displays the TS7700 Virtualization Engine Grid Summary panel. To insert logical volumes into the TS7700 Virtualization Engine, you select the work item **Insert Logical Volumes** from the **Operations** pull-down menu as shown in Figure 8-10.

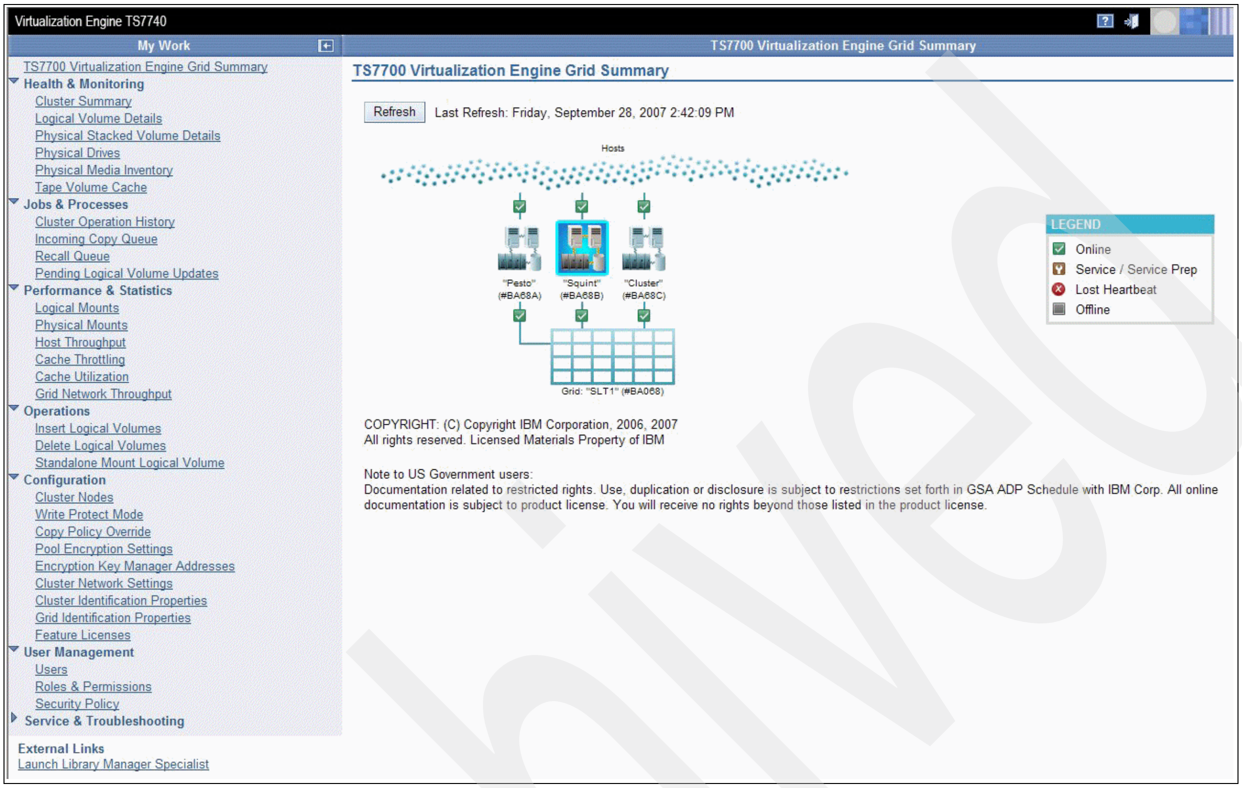


Figure 8-10 Virtualization Engine Grid Summary panel from the TS7700 Management Interface

Unlike the logical volume insertion for a Peer-to-Peer (PtP) VTS where you must use the ETL Specialist of the User Interface Library, you can insert a logical volume from any TS7700 cluster. Composite Library Operations are serialized across the TS7700 clusters of the grid to ensure that multiple sites do not perform conflicting operations.

For a detailed explanation about how to insert a logical volume, refer to 13.5.4, “Inserting logical volumes into a TS7700 Virtualization Engine” on page 422.

8.2.4 VTS and Peer-to-Peer VTS considerations

Most of the considerations described in 8.2.3, “TS7700 Virtualization Engine considerations” on page 210 still apply for a VTS configuration except for managing logical volumes and the tool that you use.

To insert logical volumes into a VTS, you need to use the ETL Specialist. Under Administer VTSx on the left of the panel shown in Figure 8-9 on page 211, you select **Manage Logical Volumes.**

This ETL Specialist function allows you to insert logical volumes into a VTS or PtP VTS. We recommend that you complete the software definitions first before you insert logical volumes into the VTS.

Unlike other definitions for a Peer-to-Peer VTS, you cannot insert logical volumes on both physical VTS systems. Use the Library Manager of the User Interface Library to insert the logical volumes of a Peer-to-Peer VTS.

For a detailed explanation about how to insert logical volumes, refer to 13.5.5, “Inserting logical volumes into a VTS” on page 424.

Refer to the *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring*, SG24-2229, and the *IBM TotalStorage Peer-to-Peer Virtual Tape Server: Planning and Implementation Guide*, SG24-6115, for in-depth discussions of implementation considerations.

8.3 Hardware I/O configuration definition

Hardware Configuration Definition (HCD) is the required I/O configuration definition tool that defines which channel subsystems, controllers, and devices exist and can be accessed by the operating systems. All I/O configuration settings are stored in an I/O configuration repository called the *I/O Definition File* (IODF). Before you can use a tape drive on a z/OS host, you must define it to the hosts through HCD.

The HCD definitions for an IBM System Storage TS1120 Model C06 or IBM 3592-J70 Tape Controller, TS7700 Virtualization Engine, or a VTS are no different than the definitions when these devices are installed in an IBM 3494 Tape Library. For completeness, we have included the HCD panels to define a Model J70 Tape Controller and its drives through HCD, as well as a discussion of the support for LIBRARY-ID and LIBPORT-ID in HCD.

You can find the appropriate HCD examples for TS7700 Virtualization Engine, VTS, and Peer-to-Peer VTS in the following IBM Redbooks publications:

- *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312
- *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring*, SG24-2229
- *IBM TotalStorage Peer-to-Peer Virtual Tape Server: Planning and Implementation Guide,* SG24-6115

8.3.1 Control unit definition

To define a control unit, follow these steps:

1. From the Hardware Configuration primary display (Figure 8-11 on page 214), enter the name of the IODF file that you want to update and select option **1**. **Define, modify, or view configuration data**. Press Enter.

   If this is not an IODF work file, the system prompts you to create an IODF work file. The name of the IODF file is in the format *hlq.*`IODF`*cc.yyyyyyyy.*

   Note the following explanations:

   – *hlq* is a high-level qualifier of up to eight characters.
   – *cc* is for any two hexadecimal characters.
   – *yyyyyyyy* is up to eight optional characters.

```
                                   z/OS V1.8 HCD
Command ===> ________________________________________________________________

                           Hardware Configuration

Select one of the following.

1   1.  Define, modify, or view configuration data
    2.  Activate or process configuration data
    3.  Print or compare configuration data
    4.  Create or view graphical configuration report
    5.  Migrate configuration data
    6.  Maintain I/O definition files
    7.  Query supported hardware and installed UIMs
    8.  Getting started with this dialog
    9.  What's new in this release

For options 1 to 5, specify the name of the IODF to be used.

I/O definition file . . . 'MASTER2.IODFC4.WORK'                  +
```

Figure 8-11 Hardware Configuration definition primary panel

2. To define the control unit, select option **4. Control units** on the Define, Modify, or View Configuration Data panel (refer to Figure 8-12). Press Enter.

```
-------- Define, Modify, or View Configuration Data -------------
    Select type of objects to define, modify, or view data.

     _4 1. Operating system configurations
             consoles
             system-defined generics
             EDTs
               esoterics
               user-modified generics
        2. Switches
             ports
             switch configurations
               port matrix
        3. Processors
             partitions
             channel paths
        4. Control units
        5. I/O devices
```

Figure 8-12 HCD: Define, Modify, or View Configuration Data panel

3. Now, the Control Unit List panel appears. Refer to Figure 8-13 on page 215.

```
 Goto  Filter  Backup  Query  Help
 --------------------------------------------------------------------------
                            Control Unit List                    Row 1 of 1495
 Command ===> ___________________________________________ Scroll ===> CSR

 Select one or more control units, then press Enter.  To add, use F11.

 / CU   Type +        #CSS #MC Serial-# + Description
 _ 0000 OSA           4        __________ OSA GIGABIT,SUBAREA 214
 _ 0010 OSA           2        __________ OSA GIGABIT,SUBAREA 204
 _ 0020 OSC           1        __________ FASTETHERNET ICC
 _ 0030 OSC           3        __________ FASTETHERNET ICC
 _ 0110 3274          1        __________ ________________________________
 _ 0140 3490          1        __________ BUCKSKIN BARR52
 _ 0141 3490          1        __________ BUCKSKIN BARR52
 _ 0142 3490          1        __________ BUCKSKIN BARR52
 _ 0143 3490          1        __________ BUCKSKIN BARR52
 _ 0144 3490          1        __________ BUCKSKIN BARR52
 _ 0145 3490          1        __________ BUCKSKIN BARR52
 _ 0146 3490          1        __________ BUCKSKIN BARR52
 _ 0147 3490          1        __________ BUCKSKIN BARR52
 _ 0148 3490          1        __________ BUCKSKIN BARR52
 _ 0149 3490          1        __________ BUCKSKIN BARR52
```

Figure 8-13   HCD: Control Unit List panel

4. On the Control Unit List panel, press F11 to get to the Add Control Unit panel that Figure 8-14 shows.

```
------------------------- Add Control Unit ---------------------

Specify or revise the following values.

Control unit number . . . . 0700 +

Control unit type . . . . . 3590         +

Serial number . . . . . . . __________
Description . . . . . . . . ________________________________

e Connected to switches  . . . 50  __ __ __ __ __ __ __  +
e Ports  . . . . . . . . . . . 08  __ __ __ __ __ __ __  +

If connected to a switch:

Define more than eight ports . . 2   1. Yes
                                     2. No
Propose CHPID/link addresses and
unit addresses . . . . . . . . . 2   1. Yes
                                     2. No
```

Figure 8-14   HCD: Add Control Unit panel

5. When the Add Control Unit panel appears (Figure 8-14 on page 215), enter the responses that match your environment. You might want to update this panel with the machine's serial number and a description. If you are uncertain about any of the required responses, press F1 for Help. Fields that have a plus sign to their right display a set of prompts when you press F4.

   We enter control unit number `0700` in our example as shown in Figure 8-14 on page 215. The IBM 3592 Model J70 Tape Controller runs in 3590 emulation mode; therefore, we define 3592 tape control units as Control Unit Type `3590`.

   We have a FICON switch in our sample configuration, so must enter the switches and ports.

6. After you press Enter, the Select Processor / Control Unit panel appears. Select the processor (`A2097.1` in our example) to which you will attach the control unit by typing an `s` to the left of A2097.1 as shown in Figure 8-15.

> **Note:** If you plan to attach the control unit to multiple processors, type a `g` to the left of each processor that you want to attach to the control unit.

```
                                Select Processor / CU
                                                         Row 1 of 12 More:       >
Command ===> _______________________________________________ Scroll ===> CSR

Select processors to change CU/processor parameters, then press Enter.

Control unit number . . : 0330     Control unit type . . . : 3590

             ---------------Channel Path ID . Link Address + ---------------
/ Proc.CSSID 1------ 2------ 3------ 4------ 5------ 6------ 7------ 8------
_ A2097.1    33.08   _______ _______ _______ _______ _______ _______ _______
_ A2094.0    _______ _______ _______ _______ _______ _______ _______ _______
_ A2094.1    _______ _______ _______ _______ _______ _______ _______ _______
_ A2094.2    _______ _______ _______ _______ _______ _______ _______ _______
_ A2094.3    _______ _______ _______ _______ _______ _______ _______ _______
_ A2097.0    _______ _______ _______ _______ _______ _______ _______ _______
_ A2097.2    _______ _______ _______ _______ _______ _______ _______ _______
_ A2097.3    _______ _______ _______ _______ _______ _______ _______ _______
_ DF97A.0    _______ _______ _______ _______ _______ _______ _______ _______
_ DF97A.1    _______ _______ _______ _______ _______ _______ _______ _______
_ DF97A.2    _______ _______ _______ _______ _______ _______ _______ _______
_ DF97A.3    _______ _______ _______ _______ _______ _______ _______ _______
******************************* Bottom of data ********************************
```

Figure 8-15 HCD: Select Processor / Control Unit panel

7. Press Enter to continue and add the channel path ID (CHPID), the base unit address, and the number of units for each processor to which you will attach the control unit as shown in Figure 8-16 on page 217. If you have more than one Channel Subsystem specified in your Central Electronics Complex (CEC), also enter the Channel Subsystem ID.

```
------------------------- Add Control Unit -------------------------


Specify or revise the following values.

Control unit number  . : 0700        Type . . . . . . : 3590
Processor ID . . . . . : A2097       A2097
Channel Subsystem ID . : 1           CSS1 ON A2097

Channel path IDs . . . . 33    __   __   __   __   __   __   __    +
Link address . . . . . . 08    ____ ____ ____ ____ ____ ____ ____  +

Unit address . . . . . . 00    __   __   __   __   __   __   __    +
Number of units  . . . . 016   ___  ___  ___  ___  ___  ___  ___

Logical address  . . . . __  + (same as CUADD)

Protocol . . . . . . . . __  + (D, S or S4)
I/O concurrency level  . _   + (1, 2 or 3)
```

Figure 8-16   HCD: Add Control Unit panel

8. Press Enter to complete the definition of the control unit. Press F3 to save your responses and exit from the Control Unit Definition menu.

> **Note:** There is no difference in the HCD definitions for the control units and the devices between the attachment to a FICON or ESCON channel, as long as you do not implement any FICON cascading. You specify channel type (ESCON or FICON) in the channel definitions, which we do not include here.

Next, you must define the attached devices for this controller.

8.3.2 Device definition

To define the attached devices for this controller:

1. From the HCD entry panel that is shown in Figure 8-12 on page 214, select option **5**, type an `s` to the left of the control unit that you defined on the Control Unit List panel, which displays the I/O Device List panel. From here, press F11 to get the Add Device panel.
2. On the Add Device panel (refer to Figure 8-17 on page 218), add the device number, the number of devices, the device type, and the connected control unit. Press Enter.

```
------------------------------ Add Device ---------------------------

Specify or revise the following values.

Device number  . . . . . . . . 0700   (0000 - FFFF)
Number of devices  . . . . . . 16___
Device type  . . . . . . . . . 3590_________    +

Serial number  . . . . . . . . __________
Description  . . . . . . . . . ________________________________

Connected to CUs . . 0700  ____  ____  ____  ____  ____  ____  ____ +
```

Figure 8-17 HCD: Add Device panel

3. The Device / Processor Definition panel appears (Figure 8-18). Type an s to the left of the processor that will use the devices. Press Enter.

> **Restriction:** You cannot use Device number 0000. As documented in APAR OW56336, a restriction exists regarding the use of device address 0000 for all SMS-managed tape libraries, because software uses 0000 to indicate a null entry in library-related tables and control blocks.

```
------------------- Device / Processor Definition --------------------
Row 1 of 1
Command ===> ________________________________________ Scroll ===> PAGE

Select processors to change device/processor definitions, then press
Enter.

Device number  . . : 0700       Number of devices  . : 16
Device type  . . . : 3590

                                              Preferred  Device Candidate List
/ Proc.CSSID  SS+  UA+  Time-Out  STADET  CHPID +    Explicit       Null
_ A2097.0     _    40   No        Yes     __         Yes            No
_ A2097.1     _    40   No        Yes     __         Yes            No
_ A2097.2     _    40   No        Yes     __         Yes            No
_ A2097.3     _    40   No        Yes     __         Yes            No
***************************** Bottom of data *****************************
```

Figure 8-18 HCD: Device / Processor Definition panel

4. The Define Device / Processor panel appears (Figure 8-19 on page 219). This panel describes the processor's view of the device. Press Enter twice to get the Define Device to Operating System Configuration panel.

```
------------------------ Define Device / Processor -------------------

Specify or revise the following values.

Device number  . . . : 0700          Number of devices . . . . : 16
   Device type  . . . . : 3590
   Processor ID . . . . : A2097          A2097
   Channel Subsystem ID : 0              CSS0 ON A2097

   Subchannel set ID  . . . . . . . . _   +
   Unit address . . . . . . . . . . 00  + (Only necessary when different from
                                        the last 2 digits of device number)
   Time-Out . . . . . . . . . . . . No   (Yes or No)
   STADET . . . . . . . . . . . . . Yes  (Yes or No)

   Preferred CHPID  . . . . . . . . __  +
   Explicit device candidate list . No (Yes or No)
```

Figure 8-19 HCD Define Device / Processor panel

5. The Define Device to Operating System Configuration panel appears next; refer to Figure 8-20. Type an s to the left of the operating system or systems that will use the TS3500 library. Press Enter.

```
----------- Define Device to Operating System Configuration ----------
                                                              Row 1 of 5
 Command ===> ____________________________________ Scroll ===> PAGE

 Select OSs to connect or disconnect devices, then press Enter.

 Device number  . : 0700          Number of devices  : 16
 Device type  . . : 3590

/ Config. ID   Type     SS Description                    Defined
   _ DASDPLX2     MVS        SYSD ON A2097
   _ DRCLAB       MVS        DRC4/8 ON A2097
   _ MVSJ         MVS        MVSCJ ON A2097
   _ MVSO         MVS        MVSCO ON A2097
   _ SMSTAPE      MVS        MVSCN,MVSCP ON A2097
   _ SMSTAPE2     MVS        MVSC7 ON A2097
   _ SVTPLEX1     MVS        SYSJ,SYSK,SYSL ON A2097
   _ SVTPLEX2     MVS        SYSA/B/F/M/N/O ON A2097
```

Figure 8-20 HCD: Define Device to Operating System Configuration panel

6. The Define Device Parameters / Features panel appears. Refer to Figure 8-21 on page 220. On this panel, you link the operating system to the tape library that you are installing.

.

```
******************** Define Device Parameters / Features *******************
                                                           Row 1 of 10
 Command ===> ___________________________________________ Scroll ===> CSR

 Specify or revise the values below.

 Configuration ID . : SMSTAPE      MVSCN,MVSCP ON A2097
 Device number  . . : 0700         Number of devices  : 16
 Device type  . . . : 3590

 Parameter/
 Feature    Value +          R Description
 OFFLINE    Yes                Device considered online or offline at IPL
 DYNAMIC    Yes                Device supports dynamic configuration
 LOCANY     Yes                UCB can reside in 31 bit storage
 LIBRARY    Yes                Device supports auto tape library
 AUTOSWITCH Yes                Device is automatically switchable
 LIBRARY-ID 00032              5 digit library serial number
 LIBPORT-ID 01                 2 digit library string ID (port number)
 MTL        No                 Device supports manual tape library
 SHARABLE   No                 Device is Sharable between systems
 COMPACT    No                 Compaction
 ***************************** Bottom of data ******************************
```

Figure 8-21 HCD: Define Device Parameters / Features panel

In the panel that is shown in Figure 8-21, you define the only connection between the tape library and the devices. Note that you do not need to define the IBM TS3500/3953 configuration through the HCD, you only define the control units and the devices. However, you must define the devices with the parameter LIBRARY Yes.

We recommend that you always specify `Yes` to the parameters DYNAMIC and LOCANY.

Always specify COMPACT `Yes`; otherwise, you turn off drive hardware compression. In general, we recommend that you use drive compression. If you do not want to use drive compression for specific applications, we recommend that you use the Data Class specification to temporarily turn off drive hardware compression.

You can accept all of the default parameter values, except for the following parameters:

- **OFFLINE** depends on your environment. Offline specifies whether z/OS considers the device online or offline at IPL. If Yes, the device is considered offline at IPL. If No (the default), the device is considered online at IPL. We recommend that you specify `Yes` and use the COMMND*xx* member of PARMLIB to vary drives online. This method is also necessary if you want to use Automatic Tape Switching (ATS STAR or IEFAUTOS).
- **DYNAMIC** specifies whether you allow dynamic activation through an activate command. Always specify `Yes`.
- **LOCANY** specifies whether the unit control block (UCB) can reside in 31-bit storage. Always specify `Yes`.
- **LIBRARY** specifies whether to indicate that the device belongs to an automated tape library. Specify `Yes`.
- **AUTOSWITCH** defines the devices as automatically switchable. Specify `Yes` to indicate that the device will be treated as automatically switchable. For tape drives to be automatically switchable, they must be shared by systems in a Parallel Sysplex®.

– **LIBRARY-ID** and **LIBPORT-ID** are described in detail in “HCD support for LIBRARY-IDs and LIBPORT-IDs” on page 221.

– **SHARABLE** specifies whether you want to share the defined device between multiple processors. Specify `Yes`. For tape drives, the OFFLINE parameter must be set to Yes for using sharable tape devices.

– **COMPACT** specifies whether to indicate that compaction is available for tape devices. Compaction is standard on 3490, 3490E, and all 3590 and 3592 tape drives. Specify `Yes`.

Press Enter.

7. The Assign/Unassign Device to Esoteric panel displays. Defining esoterics is site-dependent and optional. You do not have to define tape library resident devices to an esoteric in system-managed tape. Use esoteric device names when the number of installed physical drives is fewer than the number of devices defined in HCD in order to prevent allocations going to offline devices in the tape library. You must handle the esoteric device names in your System Managed Storage (SMS) automatic class selection (ACS) routines and assign them to an appropriate tape Storage Group. Now you have defined your tape library and drives, and a production IODF is built and then activated.

8.3.3 HCD support for LIBRARY-IDs and LIBPORT-IDs

The *LIBRARY-ID* is the unique identification number of a tape library. It specifies the hardware ID associated with the tape library that you define. LIBRARY-ID is defined by the IBM SSR at the time of the library installation. In terms of the z/OS operating system, *LIBPORT-ID* reflects the order in which the tape control units connect to the Library Manager and provides the tape drive pool ID, which is transparent and only used by allocation. LIBRARY-ID and LIBPORT-ID are optional z/OS HCD parameters. They allow the HCD to provide to the logical library configuration information that is normally obtained by the operating system at IPL time.

When adding the IBM 3592 tape drives in the IBM TS3500 Tape Library through the HCD, you can optionally supply the information for LIBRARY-ID and LIBPORT-ID. If you do not provide the information, the operating system attempts to obtain the information from the tape subsystem at IPL or I/O activation time. If the operating system cannot get the information from the subsystem (which is the case if the subsystem is not powered on during IPL), the devices cannot be used. Therefore, we recommend that you provide the default information for LIBRARY-ID and LIBPORT-ID.

Note: If you do not use LIBRARY-ID and LIBPORT-ID, devices that are unavailable during IPL cannot be varied online without reactivating the IODF.

Each IBM 3953 logical library consists of a maximum of three partitions:

- The first partition (Native) is all of the native IBM 3592 tape drives attached to the 3592-C06 or 3592-J70 tape controllers assigned to the logical library.
- The second partition (VTS 1) is the first TS7700 Virtualization Engine or VTS assigned to the logical library.
- The third partition (VTS 2) is the second TS7700 Virtualization Engine or VTS assigned to the logical library.

Note: Each IBM 3953-L05 Library Manager or pair of Library Managers (LMA and LMB) attached to the IBM TS3500 comprises one (and only one) IBM TS3500 logical library.

The IBM SSR assigns a unique five character *Library Sequence Number* to each logical library (Native, VTS 1, and VTS 2) during the 3953 Library Manager Configuration process.

For a native 3953/TS3500 library, this number can be the last five digits of the serial number of the Model F05 base frame. For a stand-alone VTS or for the Composite Library LIBRARY-ID of a Peer-to-Peer VTS, it is the last five digits of the serial number of the VTS. This Sequence Number must match the LIBRARY-ID number used in the HCD definition for the partition, as well as the LIBRARY-ID coded in the library definition in Interactive Storage Management Facility (ISMF).

Note: We strongly recommend that you assign the last five digits from the serial number of the IBM 3953-F05 base frame as the LIBRARY-ID of a native library.

A TS7700 Virtualization Engine requires that you define both a Composite Library LIBRARY-ID and Distributed Library LIBRARY-ID even with stand-alone TS7700 Virtualization Engines (Single Cluster TS7700 Grid). For a Single Cluster TS7700 Grid, use the last five digits of the serial number of the TS7740 node (3957-V06) as the Distributed Library LIBRARY-ID. For the Composite Library LIBRARY-ID, use the last five digits of the serial number of the 3952 Tape Frame.

For each Multi Cluster TS7700 Grid, use the last five digits of the serial number of the TS7740 node (3957-V06) as their Distributed Library LIBRARY-ID. For the Composite Library LIBRARY-ID, we have no specific recommendation for what to use for this five character hexadecimal sequence number. Consider using a name or number that makes it easily recognizable as associated with the Composite Library of a Multi Cluster TS7700 Grid. Refer to *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312, for more information about naming the Composite Library.

The LIBPORT-ID is assigned by the IBM 3953 Library Manager to each native IBM 3592 tape subsystem associated with its logical library. It is also called the *Subsystem ID* and identifies the subsystem's sequential position in the library configuration.

Subsystem IDs are assigned starting with the 3592-C06 or 3592-J70 controllers in the IBM 3953-F05 base frame and increments by one for each controller located sequentially in IBM 3953-F05 expansion frames. The first controller tape subsystem is assigned a Subsystem ID of 01, and each subsequent Subsystem ID increments by 1 in hexadecimal notation. Subsystem IDs are *not* assigned to empty locations in the expansion frames.

Note: We recommend that you install the tape controllers inside the IBM 3953-F05 frames by filling all slots sequentially; otherwise, you have to redefine LIBPORT-IDs if you later fill gaps between already installed controllers.

In IBM 3953, you can have these configurations:

- Only a Native partition:
  - Up to sixteen IBM 3592 tape controllers Model C06 or J70: Subsystem IDs 01 to 16.
- Only a VTS partition:
  - No IBM 3592 tape controllers.
  - The TS7700 Virtualization Engine or VTS has Subsystem ID 15.
- Only two VTS partitions:
  - No IBM 3592 tape controllers.
  - The first TS7700 Virtualization Engine or VTS has Subsystem ID 15.
  - The second TS7700 Virtualization Engine or VTS has Subsystem ID 16.

- A Native partition and one VTS partition:
  - Up to fifteen IBM 3592-J70 controllers: Subsystem IDs 01 to 14 and Subsystem ID 16.
  - The TS7700 Virtualization Engine or VTS has Subsystem ID 15.
- A Native partition and two VTS partitions:
  - Up to fourteen IBM 3592-J70 controllers: Subsystem IDs 01 to 14.
  - The first TS7700 Virtualization Engine or VTS has Subsystem ID 15.
  - The second TS7700 Virtualization Engine or VTS has Subsystem ID 16.

Figure 8-22 shows you the LIBRARY-ID and the placement of one TS7700 Virtualization Engine (VTS-1) and one VTS subsystem (VTS-2) in an IBM 3953-L05 Library Manager.

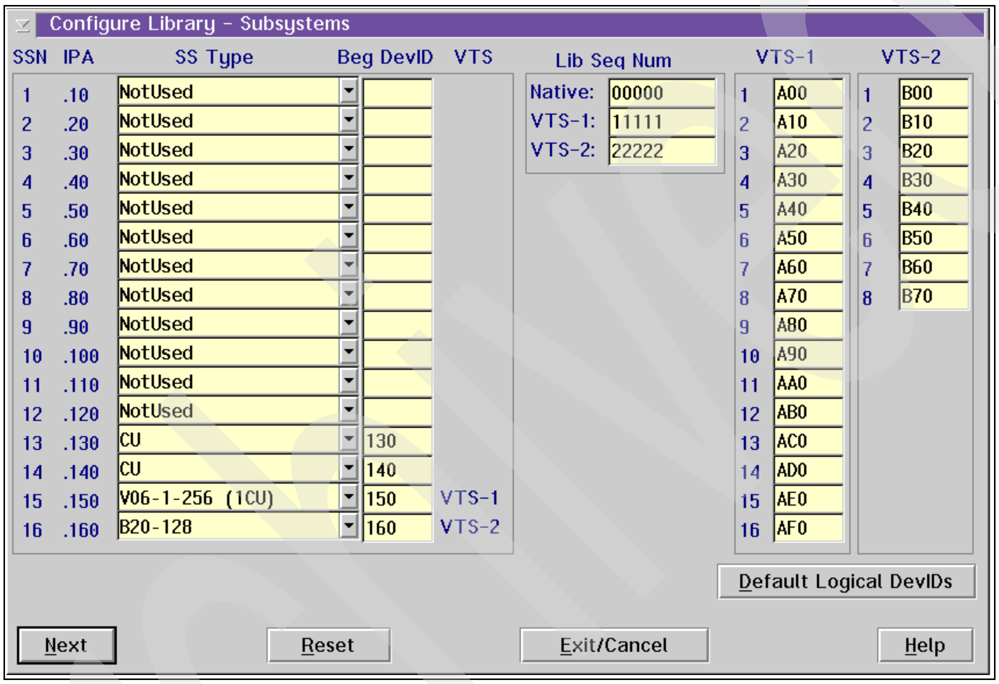


Figure 8-22 Library Manager configuration

A native partition is not required. However, if there are no tape controllers installed, and therefore, no native partition exists, we still recommend that you have the IBM SSR enter a Library Sequence Number as shown in Figure 8-22.

8.3.4 Defining a TS7700 Virtualization Engine

> **Note:** The information contained in this book refers to the TS7700 Virtualization Engine R1.4a and lower.

The definition of a TS7700 Virtualization Engine is almost the same as that for a native library, because from a host perspective, the TS7700 Virtualization Engine looks like sixteen IBM 3490E tape control units with 16 devices each attached through FICON. The most important points to observe are:

- HCD definitions are required.
- You must define 16 control units with 16 devices each per cluster in the grid configuration. Use CUADD = 0 through CUADD = 7 and LIBPORT-IDs of 01 through 08 for the first eight control units as shown in Table 8-1 on page 224.

Table 8-1 CUADD and LIBPORT-ID for the first set of 128 virtual devices

CU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
CUADD	0	1	2	3	4	5	6	7
LIBPORT-ID	01	02	03	04	05	06	07	08

For the ninth to sixteenth control units, use CUADD = 8 through CUADD = F and LIBPORT-IDs of 09 through 10. Refer to Table 8-2.

Table 8-2 CUADD and LIBPORT-ID for the second set of virtual devices

CU	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
CUADD	8	9	A	B	C	D	E	F
LIBPORT-ID	09	0A	0B	0C	0D	0E	0F	10

- Use the Composite Library LIBRARY-ID for the device definitions even with a Single Cluster TS7700 Grid.
- Keep the link address blank when you do not use a FICON director.
- Specify LIBRARY=YES when you use system-managed tape.

Figure 8-23 shows the Add Control Unit HCD panel with the definition of one TS7700 Virtualization Engine control unit. Note that the control unit type differs from a native library, because only the emulated tape drives are defined in the HCD, not the physical tape drives installed inside the IBM TS3500 Tape Library.

```
-------------------------- Add Control Unit -------------------------
Specify or revise the following values.

   Control unit number  . : 0441        Type . . . . . . : 3490
   Processor ID . . . . . : A2097       A2097
   Channel Subsystem ID . : 1           CSS1 ON A2097

   Channel path IDs . . . . 3D    E8    __   __   __   __   __   __    +
   Link address . . . . . . 20    23    ____ ____ ____ ____ ____ ____  +

   Unit address . . . . . . 00    __    __   __   __   __   __   __    +
   Number of units  . . . . 016   ___   ___  ___  ___  ___  ___  ___

   Logical address  . . . . 1 + (same as CUADD)

   Protocol . . . . . . . . __  + (D,S or S4)
   I/O concurrency level  . _   + (1, 2 or 3)
```

Figure 8-23 HCD: Add Control Unit for TS7700 Virtualization Engine

The definition in Figure 8-23 is for the second control unit using the Unit Address or CUADD = 01. *Control Unit Address* is used to allow access to all logical control units of a TS7700 Virtualization Engine through all channel paths.

Figure 8-24 on page 225 shows you the virtual representation from a host's point of view of a TS7700 Virtualization Engine configuration without a FICON director. Only every second CTLUNIT is shown to give you an overview. Make sure that you define all sixteen.

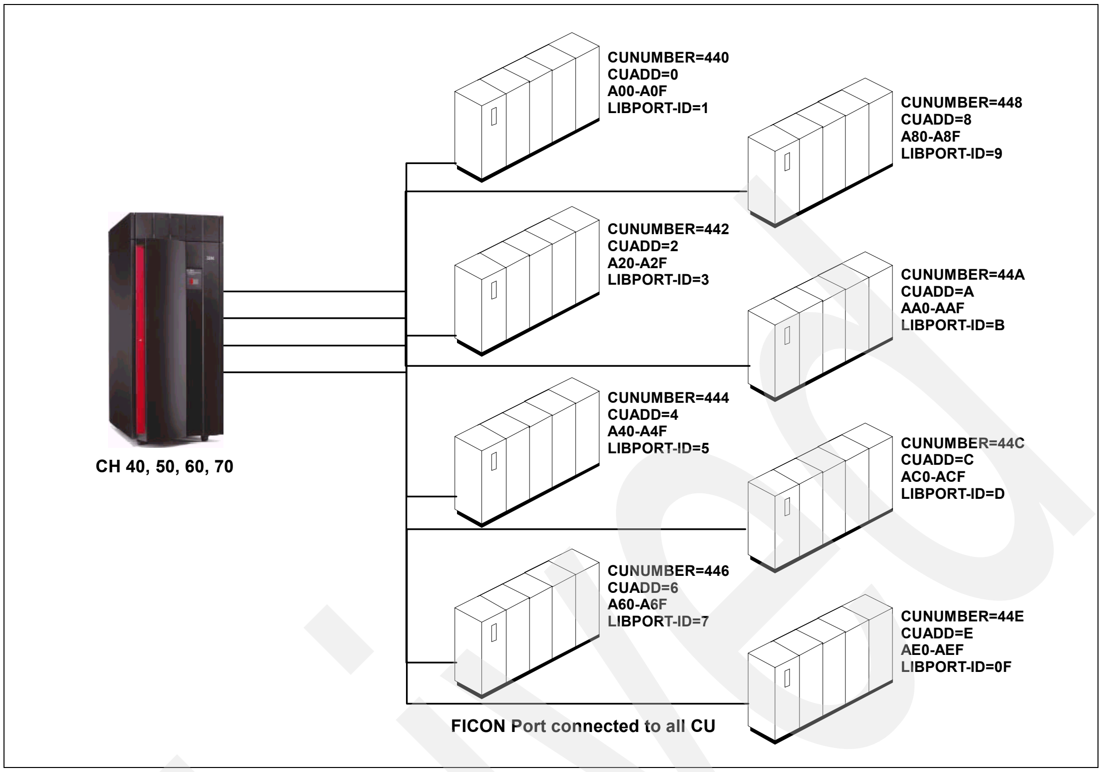


Figure 8-24 TS7700 definition without a FICON director

The channel connections shown in Figure 8-24 indicate that the host connects to all control units through all channel paths.

For additional information about the HCD or logical path considerations, refer to the IBM Redbooks publication, *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312.

8.3.5 Defining a Multi Cluster TS7700 Grid

Each TS7700 has 256 virtual devices with sixteen logical control units (LCU 0-F). The host generates the physical paths to each site separately, so the host sees one Composite Library image and three Distributed Libraries if you define a Three Cluster Grid.

Logical control units and physical paths are defined on a vNode/gNode boundary, similar to the Virtual Tape Controllers (VTCs) in the previous generation of the PtP VTS. All of them are part of the same Composite Library image presented to the host. Table 8-3 on page 226 shows the possible subsystem IDs (LIBPORT-IDs) for each cluster in a Three Cluster Grid configuration.

Table 8-3 LIBPORT-ID for each cluster in a Three Cluster Grid configuration

Cluster	Logical control units (LCUs)	LIBPORT-IDs (hex)
0	0 - 7	01 - 08
	8 - F	09 - 10
1	0 - 7	41 - 48
	8 - F	49 - 50
2	0 - 7	81 - 88
	8 - F	89 - 90

This definition is essentially the same as for a Single Cluster Grid configuration. The only major and important difference is that you need to specify the range 41 - 50 for the LIBPORT-IDs of cluster 1 and range 81 - 90 for cluster 2. Refer to *IBM Virtualization Engine TS7700 Series Introduction and Planning Guide*, SG32-0567, for more information about defining a Multi Cluster TS7700 Grid.

8.3.6 Defining a Virtual Tape Server

The definition of a Virtual Tape Server (VTS) is almost the same as the definition for a TS7700 Virtualization Engine, because from a host perspective, the VTS subsystem looks like four, eight, or sixteen IBM 3490E tape control units.

Each control unit emulates sixteen 3490E virtual tape drives attached through FICON or ESCON channels.

Through the HCD dialog:

- Define the number of IBM 3490E tape control units that you have.
- For each sixteen VTS 3490E virtual tape drives, you can specify LIBRARY=YES and the LIBRARY-ID. You must enter the LIBPORT-ID to address the logical drives correctly.

> **Note:** We strongly recommend that you use the last five digits of the serial number of the IBM 3494 VTS as its LIBRARY-ID.

To access control units in the VTS properly, you must define the correct number of control units using logical unit address (CUADD) = 0 to 15 as shown in Table 8-4 on page 227. Define each control unit with sixteen drives.

The LIBPORT-ID identifies the subsystem's sequential position in the library configuration. Because the VTS represents a single logical library from a host's perspective, 01 is always the first LIBPORT-ID to use.

Refer to Table 8-4 on page 227 for the LIBPORT-ID values that are used for different VTS configurations.

Table 8-4 The relationship between the number of virtual drives, LIBPORT-ID, and CUADD

VTS model/number of virtual drives	LIBPORT-ID	CUADD
B10/64	01 to 04	0 to 3
B20/128	01 to 08	0 to 7
B20/256	01 to 16	0 to F

For additional information about HCD or logical path considerations, refer to *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring,* SG24-2229.

8.3.7 Implementing a Peer-to-Peer Virtual Tape Server

From a host perspective, a Peer-to-Peer (PtP) VTS looks like four, eight, or sixteen IBM 3490E tape control units, each with sixteen IBM 3490E tape drives attached through ESCON or FICON channels.

However, in a PtP VTS configuration, each Virtual Tape Controller (VTC) represents either one or two control units, attached to the host through two ESCON or FICON channels. Therefore, the definitions are slightly different than for a stand-alone VTS, where all control units are defined with all channel paths available to the VTS. Figure 8-25 shows a sample VTS configuration of a Model B10 PtP VTS with four VTCs.

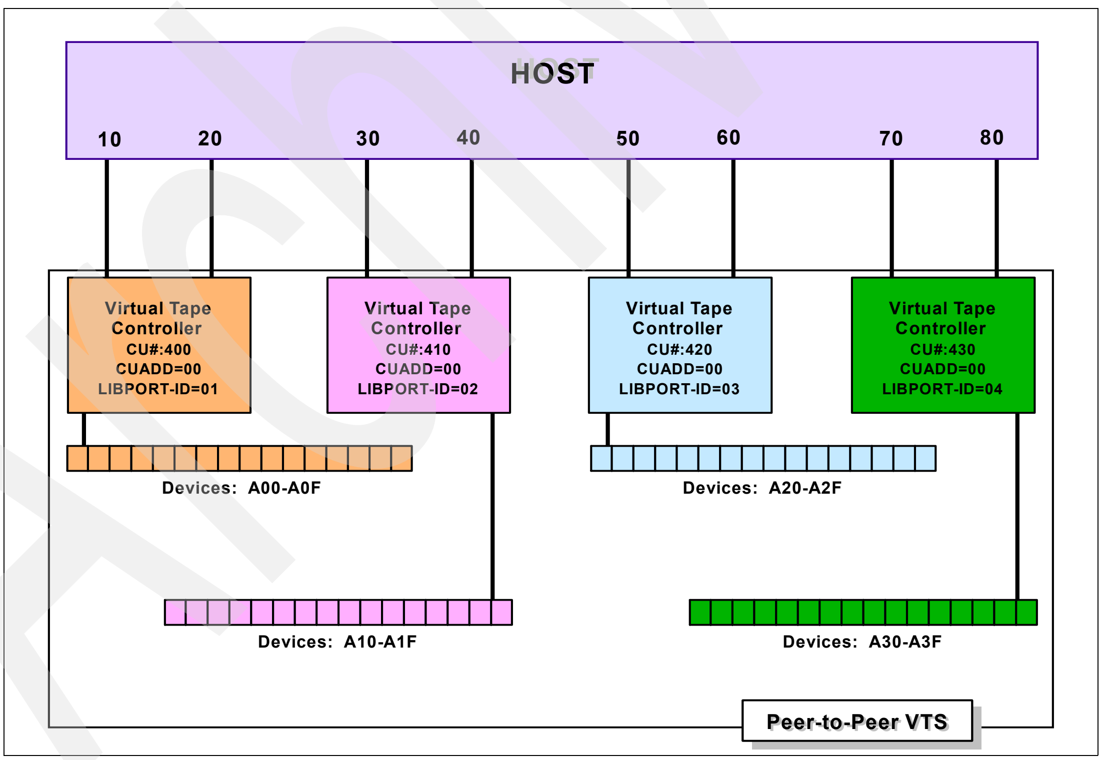


Figure 8-25 PtP VTS definition

In a configuration, as shown in Figure 8-25, where one VTS represents one control unit only, you do not need to increment the CUADD number when you define the four control units. However, in a Model B20 PtP VTS with 256 devices or with four VTCs only where a single VTC represents two control units, you must define the first control unit of each VTC using CUADD = 00 and the second control unit with CUADD = 01.

You define the virtual drives the same way as shown for the stand-alone VTS. You must define VTS virtual tape devices with the LIBRARY=Yes option. When specifying the LIBRARY-ID, remember that you must use the Composite Library LIBRARY-ID of the PtP VTS in the HCD definition. The five character LIBRARY-IDs of the Distributed Libraries are only used in the SMS library definitions, not in the HCD definitions.

The first sixteen IBM 3490E logical drives must be assigned the lowest LIBPORT-ID (LIBPORT-ID = 01), and the second sixteen IBM 3490E logical drives must be assigned LIBPORT-ID = 02. You have to define each of the sixteen logical drives, incrementing the LIBPORT-ID by 1 as shown in Figure 8-25 on page 227.

In a configuration where one VTC represents two tape control units, the numbering for the LIBPORT-ID is different. Figure 8-26 shows the definitions for a PtP VTS Model B20 with eight VTCs and 256 virtual devices. The numbering for the LIBPORT-IDs starts at the first VTC, which is defined with LIBPORT-ID = 1 and CUADD = 0. The next control unit that you define is the first control unit on the next VTC. Only after one control unit is defined for each VTS, the second control unit for each VTC is defined using CUADD = 1 and incrementing the LIBPORT-ID by one.

Subsystem IDs - 8 VTC x 32 Device Configuration

	VTC0	VTC1	VTC2	VTC3	VTC4	VTC5	VTC6	VTC7
Devices x0 - x0F	1	2	3	4	5	6	7	8
Devices x10 - x1F	9	A	B	C	D	E	F	10

```
CNTLUNIT
CUNUMBER=500,PATH=(0A,0B),UNIT=3490,UNITADD=((00,16)),LINK=(29,39),CUADD=0,LIBRARY-ID=11111,LIBPORT-ID=01
IODEVICE
ADDRESS=(200,16),UNIT=3490, CUNUMBER=(500),UNITADD=00
OTHER 14xCU with LIBPORT-ID 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B, 0C, 0D, 0E, 0F
CNTLUNIT
CUNUMBER=1400,PATH=(CA,CB),UNIT=3490,UNITADD=((00,16)),LINK=(C6,D6),CUADD=1,LIBRARY-ID=11111,LIBPORT-ID=10
IODEVICE
ADDRESS=(1100,16),UNIT=3490, CUNUMBER=(1400),UNITADD=00
```

Figure 8-26 LIBPORT-IDs for PtP VTS configurations

In a PtP VTS configuration with four VTCs and 128 devices, only VTC0 through VTC3 are defined. Note that, nonetheless, you must use the same LIBPORT-IDs, which is indicated in Figure 8-26 by different colors of both groups of VTCs.

For more information and examples of HCD for a PtP VTS, refer to the *IBM TotalStorage Peer-to-Peer Virtual Tape Server: Planning and Implementation Guide,* SG24-6115.

9

Software implementation in z/OS

This chapter describes the basic components of system-managed tape and the implementation and customization of IBM System Storage Tape subsystems in z/OS.

The TS3500 Tape Library with the added 3953 Library Manager enables the Open Systems Small Computer System Interface (SCSI) medium changer library to be connected and used by System z-attached hosts. The 3953 Library Manager provides capabilities similar in functionality to the Library Manager associated with the 3494. The 3953 Library Manager also uses the existing system-managed tape library support so the definitions and System Managed Storage (SMS) constructs required for implementation of the TS3500 in the system-managed environment are the same as those for the existing 3494 Tape Library.

If you already use system-managed IBM tape libraries under z/OS, the major updates that are required are for your System Managed Storage (SMS) constructs and automatic class selection (ACS) routines.

This chapter discusses:

- System-managed tape components
- Software implementation and customization

For the JES3 specific definitions, refer to Appendix D, “JES3 examples and information” on page 481.

9.1 z/OS software environments

In this section, we describe the software environment for system-managed tape. System-managed tape allows you to manage tape volumes and TS3500 IBM tape libraries through a set of policies that determines the kind of service to give to the datasets on the volume.

The automatic class selection (ACS) routines process every new tape allocation in the SMS address space. The production ACS routines are stored in the active control dataset (ACDS). These routines allocate to each volume a set of classes that reflects your installation's policies for the data on that volume. The ACS routines also direct the volume to a Storage Group.

The Storage Class routine determines whether a request is SMS-managed. If no Storage Class is assigned, the request is not SMS-managed, and allocation for non-specific mounts is made outside of the TS3500 Tape Library.

For SMS-managed requests, the Storage Group routine assigns the request to a Storage Group. The assigned Storage Group determines which host logical library in which TS3500 logical library to use. A tape Storage Group is associated with one to eight host logical libraries and the tape volumes stored inside the Library Manager partitions. All volumes of a multivolume dataset must be contained within a single Library Manager partition and a single Storage Group as well.

Figure 9-1 shows the process flow of the automatic class selection routines.

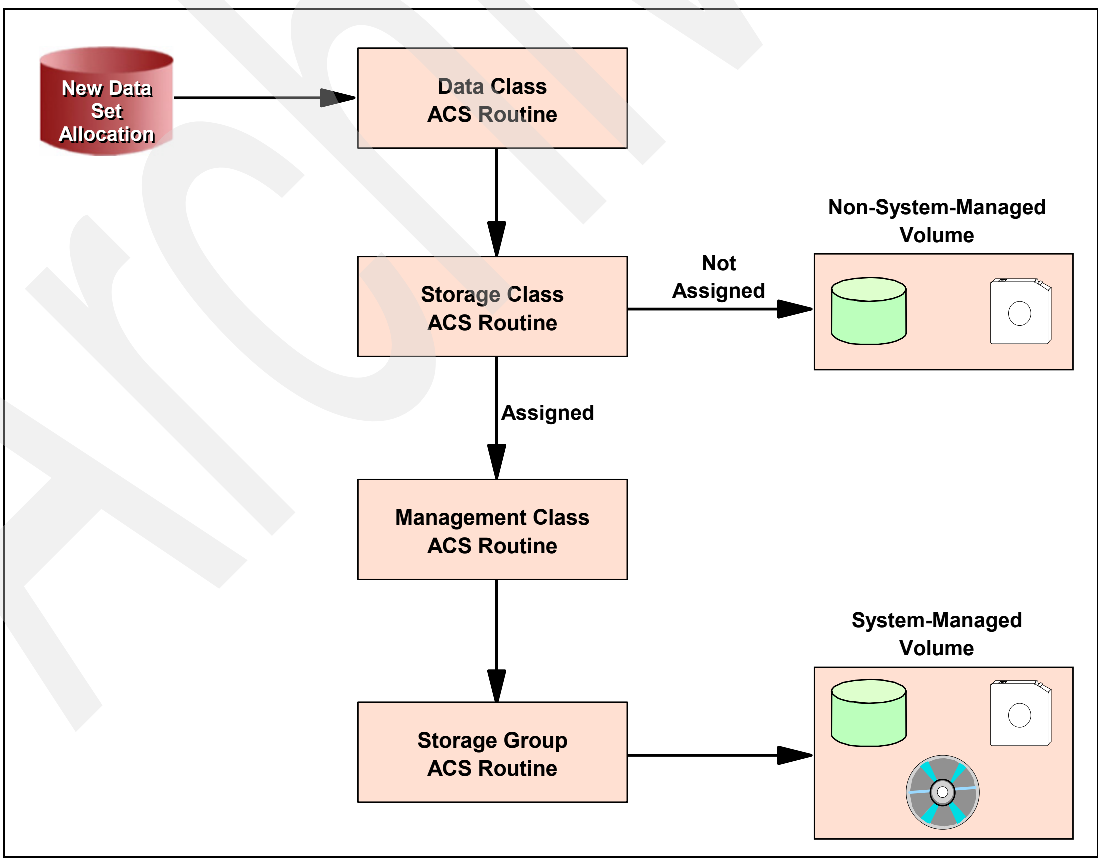


Figure 9-1 ACS process flow

The ACS routines are invoked for every new allocation. Tape allocations are passed to the object access method (OAM), which uses its Library Control System (LCS) component to communicate with the Library Manager.

Figure 9-2 shows an overview of the system-managed tape environment.

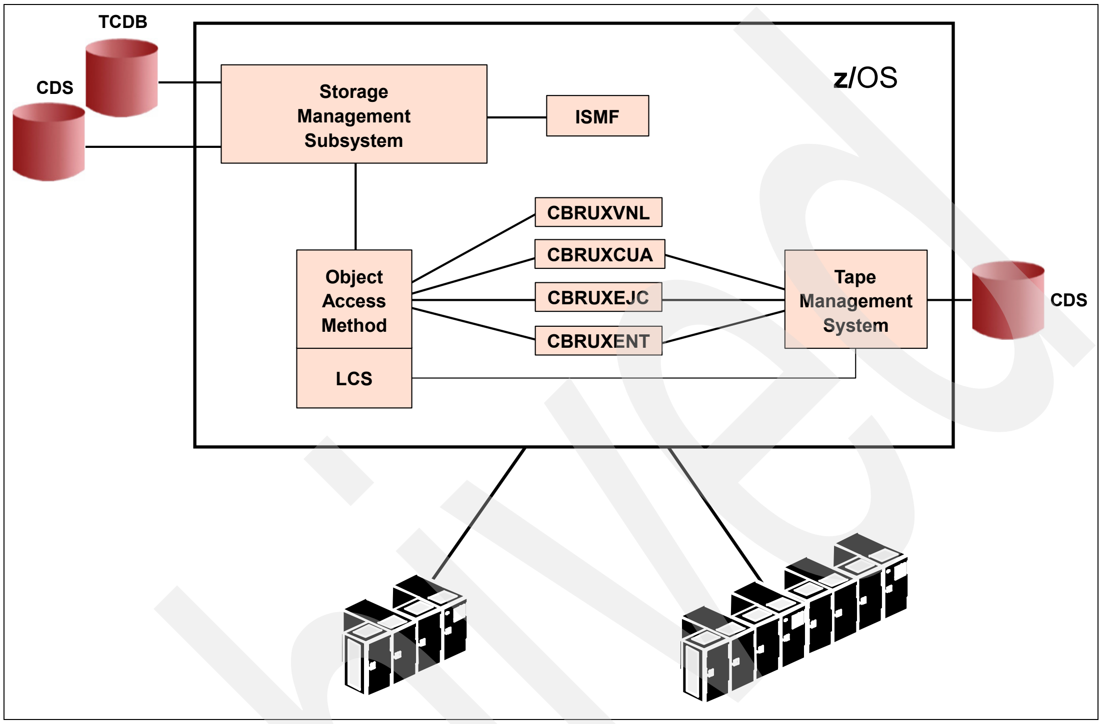


Figure 9-2 System-managed tape environment overview

The basics of system-managed tape are:

- OAM and LCS
- SMS address space
- Tape configuration database (TCDB)
- Interactive Storage Management Facility (ISMF)
- Tape management system
- Additional z/OS commands

> **Note:** This chapter addresses the most common situation where you have system-managed tape in an automated tape library (ATL) environment, such as the IBM TS3500 Tape Library.
>
> Nevertheless, you can also have system-managed tape in a manual tape library (MTL) environment. In this situation, you can define one or more manual tape libraries with each library consisting of a set of stand-alone drives and volumes. This support is discussed in the *z/OS DFSMS Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries*, SC35-0427.

OAM and LCS

To use system-managed tape, the OAM address space must be active. Its LCS component is the interface between z/OS and the Library Manager in the 3953.

The OAM has three components: Object Storage and Retrieval (OSR), OAM Storage Management Component (OSMC), and LCS. We discuss only the use of LCS, because the other components of OAM are not necessary in a system-managed tape environment. For more information about this component, refer to the *z/OS DFSMS Object Access Method Planning, Installation, and Storage Administration Guide for Object Support,* SC35-0426.

LCS is the internal interface from z/OS to the Library Manager. All information about physical movement (mount and demount requests) goes through LCS to the selected library. z/OS commands, the ISMF interface, and several tape management systems also use this interface. Library functions, such as Cartridge Entry and Inventory, communicate through this interface with the tape configuration database (TCDB) and with the tape management systems.

Several programming interfaces and installation exits belong to the OAM/LCS part:

- The programming interface that is provided by the LCS External Services macro (CBRXLCS) to support functions, including:
  - Query the name and type of the tape library in which a volume resides
  - Change volume attributes
  - Change current operating modes of a Peer-to-Peer (PtP) Virtual Tape Server (VTS) library

  Note: For a complete list of the functions that can be performed when invoking the LCS External Services programming interface by means of the CBRXLCS macro, you can refer to Chapter 6 of the *z/OS DFSMS Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries*, SC35-0427.

- Installation exits CBRUXENT, CBRUXEJC, CBRUXCUA, and CBRUXVNL to manage entry, exit, change use attribute, and volume-not-in-library handling. Use of these exits is optional and depends on how your tape management system supports the TS3500 Tape Library.

For more information about OAM, refer to the *z/OS DFSMS Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries*, SC35-0427.

Tape configuration database

For system-managed tape, information about volumes is stored in the tape configuration database (TCDB), which is an integrated catalog facility (ICF) of type VOLCAT. The TCDB consists of one or more volume catalogs.

The device type field in the volume record contains the tape device selection information (TDSI) as mapped by macro CBRTDSI. This information is a set of four, one-byte fields, which together describe the volume characteristics determining the device types on which the volume can successfully be mounted. The following definitions are available:

- Recording Technology:
  - Unknown
  - 18-track, 36-track, 128-track, 256-track, and 384-track
  - EFMT1, EFMT2, EEFMT2, EFMT3, and EEFMT3
- Media types:
  - Media type - unknown
  - MEDIA1 (Standard Capacity Cartridge System Tape)
  - MEDIA2 (Enhanced Capacity Cartridge System Tape)
  - MEDIA3 (High Performance Cartridge Tape)
  - MEDIA4 (Extended High Performance Cartridge Tape)

- MEDIA5 (Enterprise Tape Cartridge)
   - MEDIA6 (Enterprise WORM Tape Cartridge)
   - MEDIA7 (Enterprise Economy Tape Cartridge)
   - MEDIA8 (Enterprise Economy WORM Tape Cartridge)
   - MEDIA9 (Enterprise Extended Tape Cartridge)
   - MEDIA10 (Enterprise Extended WORM Tape Cartridge)
- Compaction:
   - Unknown
   - None
   - Compacted
- Special attributes:
   - None
   - Read only

A *volume catalog* contains entries for tape volumes and tape libraries but does not contain entries for individual datasets. At least one general volume catalog and any number of specific volume catalogs must be defined. Storing the information for any particular range of volume serial numbers in a specific volume catalog aids performance in accessing the TCDB and might ease the use of TCDBs across systems and applications.

> **Note:** Even though Access Method Services (IDCAMS) commands can change the content in a TCDB, we recommend highly that you use ISMF to perform functions against a tape library. Changes caused by an IDCAMS command in the TCDB are not transferred to the Library Manager in the 3953 Tape System. Therefore, discrepancies can occur. Use the IDCAMS CREATE, ALTER, and DELETE commands only to recover from volume catalog errors.

If you run SMSplex (where multiple z/OS images use the same SMS), the TCDB must be shared in this SMSplex. Therefore, you can allow access to a volume by more than one system in the SMSplex.

Interactive Storage Management Facility

The Interactive Storage Management Facility (ISMF) provides a series of applications for administrators to define and manage SMS configurations. ISMF allows you to work with the tape libraries and library-resident volumes and alter the TCDB entries. The typical tasks that you can perform with ISMF are:

- Define and redefine tape libraries.
- Display tape library attributes.
- Alter tape library definitions.
- Copy tape library definitions.
- Delete tape library definitions.
- List tape libraries and volumes.
- Display tape volumes.
- Audit tape volumes and libraries.
- Alter tape volumes and libraries.
- Eject tape volumes.

Tape management system

Depending on the management system that you use, certain functions for a highly improved system-managed tape are available. This chapter refers only to DFSMSrmm, which is the IBM tape management system and an optional feature of z/OS. DFSMSrmm records all tape dataset and volume information and provides utilities to perform expiration processing and vaulting. It retains information about volumes regardless of whether they are in a library, part of system-managed tape, on-site, or off-site.

DFSMSrmm interacts through OAM directly with the OAM/LCS interface. Ejects, change location, and other commands referring to a physical location movement immediately create an action in the library. The easiest way to be consistent between the DFSMSrmm control dataset (CDS) and the TCDB is to use Removable Media Manager (RMM) panels or the RMM TSO subcommands for movement processing instead of ISMF.

Entering a physical cartridge into the library can cause actions in DFSMSrmm (depending on the customization of RMM). Also, the output from housekeeping runs is transferred directly through OAM/LCS to the Library Manager inventory (scratch update).

Independent software vendor (ISV) tape management systems also provide the OAM installation-wide exits that support IBM tape libraries. If you use ISV tape management systems, we recommend that you contact the vendor to check which release provides the OAM installation-wide exits that support IBM tape libraries. Also, ask for the necessary customization to exploit as much benefit as possible from the OAM/Installation Exits (for example, automatic scratch update after housekeeping).

Specific commands for tape libraries

The specific commands that you use for tape libraries are:

- LIBRARY: To reenable exits, eject volumes, query and set cartridge loaders, and display the status of tape drives. Also, the import and export of logical volumes in an VTS are driven by LIBRARY commands.
- DISPLAY SMS: To display library information or data about a volume.
- VARY SMS,LIBRARY: To vary libraries online and off-line.
- Modify OAM: To audit volumes.

For more information about these commands, refer to 13.8.1, "DFSMS operator commands" on page 430.

9.2 Software implementation and customization

This section explains the necessary steps to implement system-managed tape in your environment. Implementing and activating SMS are not part of this section; however, to learn more about those tasks, refer to *z/OS DFSMS: Implementing System Managed Storage*, SC26-7407.

Follow these steps to implement system-managed tape:

1. Update SYS1.PARMLIB.
2. Define the security profiles.
3. Allocate the TCDB.
4. Prepare and start OAM.
5. Customize OAM.
6. Update and customize your tape management system.
7. Define the library through ISMF.

8. Define the DFSMS constructs through ISMF.
9. Perform a pre-ACS installation exit (optional).
10. Write ACS routines.
11. Activate the SMS configuration and restart OAM.
12. Set up JES3 support (only where applicable).
13. Perform DFSMShsm customization (only where applicable).
14. Verify your installation.

9.2.1 Updating SYS1.PARMLIB

You need to update and verify the following PARMLIB members:

- **SCHED*xx***: Add the OAM initialization module CBROAM to the system program properties table (PPT).
- **IGDSMS*xx***: Add the OAMPROC and OAMTASK optional parameters if you want the OAM address space to start automatically as part of the SMS initialization. If you use a vendor's tape management system, it might require that the OAM address space is started after the tape management system initialization. In this case, do not start the OAM automatically. Check with the vendor of the tape management system product.
- **IEFSSN*xx***: Add or update the OAM1 entry with the name of the initialization module (CBRINIT) that is executed at IPL.
- **CONSOL*xx***: Update the CONSOL*xx* member referenced by IEASYS*xx* if you want to receive library messages at a specific console. You must also define this console name during ISMF library definition to SMS.
- **DEVSUP*xx***: Provide device support options for relabeling processing in an intermixed environment. If you share your library with other attached hosts, you can specify volume category codes in this member to provide a unique range of tapes for each attached system. That is, you can specify MEDIA1 to MEDIA4 plus the new volume categories (where *xxxx* is a 4-digit hexadecimal category code) added to the IBM TS3500 Tape Library partitioning for 3592 support:
  – MEDIA5=*xxxx*
  – MEDIA6=*xxxx*
  – MEDIA7=*xxxx*
  – MEDIA8=*xxxx*
  – MEDIA9=*xxxx*
  – MEDIA10=*xxxx*
- **COMMND*xx***: Add the VARY *XXXX*,ONLINE command if you want to bring some tape drives online after the IPL, and HCD has the devices defined with OFFLINE=YES.
- **GRSCNF*xx* (optional)**: If you are going to share the tape library among two or more systems in an SMS complex, you can create a global resource serialization ring to include all sharing systems, which allows OAM to serialize the cartridge entry process.
- **LOAD*xx* (optional)**: Update columns 64 through 71 of the SYSCAT statement with the high-level qualifier of your TCDB, if you do not want to use the default (SYS1).

  > **Note:** The LOAD*xx* member can reside in SYS1.PARMLIB or SYS*n*.IPLPARM. When used, SYS*n*.IPLPARM must reside on the IODF volume. If you perform an IPL on your system using the SYSCATLG member of SYS1.NUCLEUS, the respective update is done there.

- **COFVLF*xx* (optional)**: Add the volume catalogs to the IGGCAS class definitions where you have other ICF catalogs.

- **ALLOC*xx* (optional)**: Add policies for tape automation.
- **IECIOS*xx* (optional)**: Set values for Missing Interrupt Handler (MIH).

SCHED*xx* member of SYS1.PARMLIB

SCHED*xx* is used to define programs that require special attributes that are to be included in the Program Property Table (PPT):

```
PPT   PGMNAME(CBROAM)  /* OAM ADDRESS SPACE
         KEY(5)           /* USE DFP PROTECT KEY
         NOSWAP           /* NONSWAPPABLE
         SYST             /* PROGRAM IS SYSTEM TASK--WILL NOT BE TIMED
```

You must add the OAM module. If you already use OAM for object support, you might not need to change this member. We recommend that you review the definition.

IGDSMS*xx* member of SYS1.PARMLIB

IGDSMS*xx* contains the definitions for SMS. It is updated with information about OAM. If you already use OAM for object support, you might not need to change this member. We recommend that you review the definition:

```
OAMPROC(OAM)
OAMTASK(ATLOAM)
DB2SSID(NONE)
```

OAMPROC specifies the name of the procedure that is to start the OAM address space when SMS is initialized. You must specify this keyword if you want the OAM address space started during IPL. The procedure name can be from one to eight characters.

OAMTASK is optional. Use it if you prefer to use an identifier other than the procedure name when starting the OAM address space.

DB2SSID (NONE) is also optional. Use it if your installation does not use OAM to store objects but uses OAM for tape library management only.

IEFSSN*xx* member of SYS1.PARMLIB

Use IEFSSN*xx* to define the primary and secondary subsystems to create at system initialization:

```
SUBSYS SUBNAME(OAM1) INITRTN(CBRINIT) INITPARM('MSG=EM')
```

OAM1 is the name by which the subsystem is known, and CBRINIT is the name of the OAM initialization program. It is mandatory to specify the CBRINIT keyword. The MSG parameter is optional. It allows you to control the format of OAM messages. EM represents mixed-case (for example, Mixed Case) English, and EU represents uppercase (for example, UPPERCASE) English. If you omit MSG, EU is the default.

CONSOL*xx* member of SYS1.PARMLIB

You update the CONSOL*xx* member only if you want to receive library messages at a specific console:

```
CONSOLE   DEVNUM(device number)
             NAME(library console name)
             UNIT(terminal type)
             AUTH(SYS,IO)
             (...)
```

You must also define this console name during ISMF library definition to SMS (refer to 9.2.7, “Defining the library through ISMF” on page 256). The library console name is the name that is used when you define the TS3500 logical Library Manager partitions to SMS through the ISMF panels. We recommend that you authorize the console for SYS and IO; this authorization allows an operator to issue z/OS MODIFY and VARY commands.

DEVSUP*xx* member of SYS1.PARMLIB

DEVSUP*xx* controls installation-wide default tape device characteristics using the following parameters:

```
COMPACT = YES,
VOLNSNS = YES,
MEDIA1  = xxxx,
MEDIA2  = xxxx,
MEDIA3  = xxxx,
MEDIA4  = xxxx,
MEDIA5  = xxxx,
MEDIA6  = xxxx,
MEDIA7  = xxxx,
MEDIA8  = xxxx,
MEDIA9  = xxxx,
MEDIA10  = xxxx,
ERROR   = xxxx,
PRIVATE = xxxx
```

The descriptions are:

- **COMPACT = YES**: With COMPACT set to YES, the installation uses the compaction feature. With COMPACT set to NO by default, the installation does not use the compaction feature of the tape drive. The Job Control Language (JCL) parameter (TRTCH) and DATACLAS override this setting. DATACLAS cannot override the JCL parameter if specified.
- **VOLNSNS = YES**: This parameter is only necessary if you have different generations of the same device type installed, such as a mix of 3592-J1A and 3592-E05. It allows cartridges to be relabeled from a device that cannot read the actual label (for example, EFMT2 is relabeled to EFMT1). The relabel process to a higher format (for example, EFMT1 to EFMT2) is always possible, regardless of what this parameter specifies.

To partition the tape library into logically independent libraries, the following parameters are available. Use these parameters only if you are planning to share the library among other systems. You use the DEVSUP*xx* parameters to specify volume category codes for library partitioning:

- **MEDIA1 = *xxxx***: Specifies a 2-byte hexadecimal value to use as the 3490 CST scratch volume category code. The default value is 0001.
- **MEDIA2 = *xxxx***: Specifies a 2-byte hexadecimal value to use as the 3490 ECCST scratch volume category code. The default value is 0002.
- **MEDIA3 = *xxxx***: Specifies a 2-byte hexadecimal value to use as the 3590 high performance cartridge tape scratch volume category code. The default value is 0003.
- **MEDIA4 = *xxxx***: Specifies a 2-byte hexadecimal value to use as the 3590 high performance extended length cartridge tape scratch volume category code. The default value is 0004.
- **MEDIA5 = *xxxx***: Specifies a 2-byte hexadecimal value to use as the 3592 Enterprise Tape Cartridge scratch volume category code. The default value is 0005.

- **MEDIA6 = *xxxx***: Specifies a 2-byte hexadecimal value to use as the 3592 Enterprise WORM Tape Cartridge scratch volume category code. The default value is 0006.
- **MEDIA7 = *xxxx***: Specifies a 2-byte hexadecimal value to use as the 3592 Enterprise Economy Tape Cartridge scratch volume category code. The default value is 0007.
- **MEDIA8 = *xxxx***: Specifies a 2-byte hexadecimal value to use as the 3592 Enterprise Economy WORM Tape Cartridge scratch volume category code. The default value is 0008.
- **MEDIA9 = *xxxx***: Specifies a 2-byte hexadecimal value to use as the 3592 Enterprise Data Extended Tape Cartridge scratch volume category code. The default value is 0009.
- **MEDIA10 = *xxxx***: Specifies a 2-byte hexadecimal value to use as the 3592 Enterprise Data Extended WORM Tape Cartridge scratch volume category code. The default value is 0010.
- **ERROR = *xxxx***: Specifies a 2-byte hexadecimal value to use as the error volume category code. The default value is 000E.
- **PRIVATE = *xxxx***: Specifies a 2-byte hexadecimal value to use as the private volume category code. The default value is 000F.

Note: The value of *xxxx* must be a four-character hexadecimal value within the 0010 to FEFF range. Specification of the appropriate default category, 0001-000F, is also allowed; however, for library partitioning, it is best to use non-default categories. To avoid conflicting volume categories with platforms other than z/OS, only use the 0010 through 007F range, or use the second digit of the four-character field, for example, 0201, 0202, 0301, and so on. This specification is significant in large installations where the library can be partitioned and connected to many z/OS hosts.

Do not use categories that are reserved for other platforms. Refer to Appendix C, “Library Manager volume categories” on page 471 for the volume categories that other platforms use.

You might need to update member IEASYS*xx* to point to a new DEVSUP*xx* member.

If a syntax error occurs because of a missing comma in DEVSUP*xx*, no error message is issued, and your partitioning efforts will yield unpredictable results.

Note that updating DEVSUP*xx* can require an IPL, which you might want to schedule in advance.

COMMND*xx* member of SYS1.PARMLIB

When defining the tape drives to the HCD, the specification of OFFLINE on the Define Device Parameters / Features panel (Figure 8-21 on page 220) controls whether the devices are brought online automatically at IPL time:

```
COM='VARY dddd,ONLINE'
```

It is a common practice not to bring tape drives online at IPL time, but rather to vary them online with the COMMND*xx*.

If the drives are defined in the HCD to come online at IPL, and no cartridge is mounted in the drive, the drive is not ready and remains OFFLINE. We recommend that you add VARY statements for all drives that need to be online to a particular system after it runs its IPL.

GRSCNF*xx* member of SYS1.PARMLIB (optional)

If you are going to share the tape library among two or more systems in an SMS complex, create a global resource serialization ring to include all sharing systems, which allows OAM to serialize the cartridge entry process. The global resource serialization (GRS) configuration is defined in member GRSCNF*xx* of SYS1.PARMLIB. You can learn more about GRS in *z/OS MVS Initialization and Tuning Reference,* SA22-7592.

OAM sends a SYSTEMS level enqueue around the global resource serialization ring, so there is no need to include the QNAME or RNAME in the system inclusion RNL. The QNAME and RNAME are provided here for documentation purposes:

```
QNAME-SYSZCBR
RNAME-CARTRIDGE_ENTRY_libname
```

SYSZCBR is the major resource name given to OAM. CARTRIDGE_ENTRY_*libname* is the minor resource name. The libname is the friendly SMS name given to the library when it is defined to SMS through the ISMF panels.

If you do not use GRS to control resource serialization in a multisystem environment, review the documentation and make the appropriate changes to ensure that the use of CBRUXENT is correctly serialized. You can find relevant information in the *z/OS DFSMS Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries*, SC35-0427.

LOAD*xx* member of SYS1.PARMLIB (optional)

Update columns 64 through 71 of the SYSCAT statement with the high-level qualifier of your TCDB, if you do not want to use the default (SYS1). Use:

```
1       10       20                                     64
SYSCAT  CATRES   SYS1.MASTER.CATALOG                    USERHLQ1
```

USERHLQ1 is any name that is not used as an alias entry in the master catalog.

Updating LOAD*xx* can require an IPL, which you might want to schedule in advance.

COFVLF*xx* member of SYS1.PARMLIB (optional)

Add the volume catalogs to the IGGCAS class definitions as shown here:

```
/*                                                          */
CLASS NAME(IGGCAS)               /* CATALOG in Data space   */
      EMAJ(ICFCAT.USERCAT)       /* User Catalog            */
      EMAJ(SYS1.VOLCAT.VGENERAL) /* SMT general VOLCAT      */
      EMAJ(SYS1.VOLCAT.VT)       /* SMT specifc VOLCAT      */
      MAXVIRT(256)               /* MAXVIRT = 256 4K blocks */
                                 /*         = 1Mb (minimum value) */
```

Because a VOLCAT can have many updates against volume entries, use the virtual lookaside facility (VLF) with caution. The F CATALOG,REPORT,VLF command displays the hit rates for each catalog defined for VLF use. If hit rates are below 50% for a catalog, we recommend that you do not use VLF for that catalog.

ALLOC*xx* member of SYS1.PARMLIB (optional)

When you introduce automation, you must review the settings of the ALLOC*xx* members. By default, most of the parameters cause write to operator with reply (WTOR) messages. They must be automated to achieve real lights-out operation. The parameters that affect tape handling are explained in the following sections.

VOLUME_ENQ POLICY (WTOR|CANCEL|WAIT)

This parameter specifies the installation policy for enqueuing on volumes when an allocation request has to wait for a volume or a series of volumes:

- **WTOR**: The installation policy is to issue the message and let the operator make the decision about the allocation request. The system displays one of the following messages on the operator's console:
  - IEF690I - `The following volumes are unavailable to` *`jobname.`*
  - IEF235D - *`jobname`* `is waiting for volumes.`

  To cancel wait, reply no. In addition, the system issues message IEF369D `Invalid reply` in response to an invalid reply to IEF235D.
- **CANCEL**: The installation policy is to cancel a job that needs an unavailable volume.
- **WAIT**: The installation policy is to let a job that needs an unavailable volume wait until the volume is available.
- **CAUTION**: When WAIT is used as the default, tape volumes can encounter deadlocks with other jobs in the system.
- **Default**: WTOR

VOLUME_MNT POLICY (WTOR|CANCEL)

This parameter specifies the installation policy for mounting a volume when an allocation request requires a volume to be mounted:

- **WTOR**: The installation policy is to issue the message and let the operator make the decision about the volume mount. The system displays one or more of the following messages on the operator's console:
  - IEF233A - `Mount volume` *`ser.`*
  - IEF233D - `Mount volume` *`ser`* `or respond to the IEF455D message.`
  - IEF455D - `Mount` *`ser`* `on` *`device`* `for` *`jobname,`* `or reply no.`

  In addition, the system issues message IEF369D `Invalid reply` in response to an invalid reply to IEF455D.
- **CANCEL**: The installation policy is to cancel a job that needs a volume mounted.
- **Default**: WTOR

SPEC_WAIT POLICY (WTOR|WAITHOLD|WAITNOH|CANCEL)

This parameter specifies the installation policy to follow when an allocation request must wait for a specific volume or unit:

- **WTOR**: The installation policy is to issue the message and let the operator make the decision about the wait request. The system displays one or more of the following messages on the operator's console:
  - IEF238D - `Reply device name, wait, or cancel.`
  - IEF244I - `Unable to allocate` *`nnn`* `units. At least` *`nnn`* `allocated or offline units are needed.`
  - IEF433D - `Wait requested, reply hold or nohold.`
  - IEF488I - `Must wait for a unit, or a volume on a unit.`

In addition, the system issues one or more of the following messages in response to an invalid reply to the preceding messages:

– IEF434D - `Invalid reply` (to message IEF433D). `Reply hold or nohold.`
– IEF490I - `Invalid reply` (to message IEF238D) `for one of the following reasons:`

  - `Device is not accessible (no paths available, boxed, or cannot be assigned).`
  - `Required system-managed volume is not available.`
  - `Required volume is not available.`
  - `Replied device is not eligible.`
  - `Device is found in an offline library.`
  - `Coupling facility error.`

- **WAITHOLD**: The installation policy is for the system not to release any of the devices that have already been allocated to this job before the job waits for the required units or volumes.

> **Note:** Use of WAITHOLD might result in deadlock; particularly, when the device is used by a job that is going to wait. The system does not release any non-direct access storage devices that have already been allocated to the job before it waits for required units and volumes.
>
> To avoid this problem, do not specify WAITHOLD. When devices for a job are held during a wait, and a device that was eligible for allocation to the job becomes ineligible for allocation (because of its use by a system utility, for example), the job can fail, because it does not have enough devices to complete successfully. Message IEF700I in the job log identifies this failure. Refer to message IEF700I for information about how to respond to this failure.

- **WAITNOH**: The installation policy is to let the job wait while not holding the obtained resources. The system releases those devices that have been allocated to this job but cannot be shared with other jobs. For an example of the WAITHOLD compared to WAITNOH options, consider Job A that owns an automatically switchable device and is waiting for a printer. Job B owns the printer that Job A needs and is waiting for the automatically switchable device that Job A owns.

  If the reply is WAITHOLD for each job, the two jobs wait until one job is canceled. This deadlock can be even more complex, depending on the number of jobs waiting.

  If the reply is WAITNOH for each job, allocation responds on a first-come, first-served basis. After the first job finishes using a resource, the resource is available to the second job.

- **CANCEL**: The installation policy is to cancel the allocation request. If a TSO/E user issued the allocation request, the user receives an error message. If a batch job or started task issued the request, the system cancels the job or task.
- **Default**: WTOR

MAXNWAIT(nnn):

This parameter specifies the number of WAITNOH decisions allowed to be made for the specific volume or unit allocation request before the default specified on the POLICYNW parameter takes effect. The WAITNOH decisions counted are those that are specified either through the default on the POLICY parameter or through an installation exit. WAITNOH decisions made by the operator are not included in the MAXNWAIT count. The value range is 1 to 255.

The default is 5.

POLICYNW (CANCEL|WTOR)

This parameter specifies how the system handles the allocation request under the following circumstances:

- Either WAITHOLD or WAITNOH is specified on the POLICY parameter, and the system does not allow the job to wait for resources.
- The system is to either cancel the allocation request (CANCEL) or issue a WTOR. When CANCEL is selected, the system cancels the allocation request depending on how the request was issued. If a TSO/E user issued the allocation request, the user receives an error message. If a batch job or started task issued the request, the system cancels the job or task.

The default is WTOR.

Figure 9-3 shows a sample ALLOC*xx* member in an unattended environment. Only those parameters that affect tape allocation are shown.

```
VOLUME_ENQ    POLICY(CANCEL)       /*Always cancel job*/

VOLUME_MNT    POLICY(WTOR)         /*Always issue the WTOR*/

SPEC_WAIT     POLICY(WAITNOH)      /*Wait while
                                       not holding resources*/
              MAXNWAIT(7)          /*7 "wait nohold"
                                     decisions allowed*/
              POLICYNW(CANCEL)     /*Cancel if wait is
                                     not allowed*/

ALLC_OFFLN    POLICY(WAITNOH)      /*Wait
                                      while not holding resources*/
              MAXNWAIT(7)          /*7 "wait nohold"
                                     decisions allowed*/
              POLICYNW(CANCEL)     /*Cancel if wait is
                                     not allowed*/
```

Figure 9-3 Sample ALLOCxx member

IECIOS*xx* member of SYS1.PARMLIB (optional)

Update or set the values for the Missing Interrupt Handler (MIH).

The IBM 3592 drives return the recommended MIH timeout values to the host operating system in Read Configuration Data. Therefore, it is not necessary to specify MIH timeout values for IBM 3592 devices. The device-supplied values handle all MIH timeouts.

The VTS, as well as the TS7700, emulates 3490E devices and does not automatically upload the MIH timeout values to the host operating system in Read Configuration Data. Therefore, you must specify the MIH timeout values for IBM 3490E devices.

If you currently specify your own MIH timeout values for non-3592 tape devices, we recommend that you review your procedures to see whether to use a timeout value other than the IBM-supplied default of three minutes. If so, specify the time-out for each device. You specify MIH timeout values only by class (for example, all tapes) or on an individual device basis. Specification of a MIH timeout value for the entire tape class negates the 3592 device's recommended values and adversely affects MIH recovery processing on 3592 devices. You can specify the MIH values either in PARMLIB member IECIOS*xx* or with the OS/390® operator command SETIOS.

Figure 9-1 shows how to specify MIH values for:

- IBM 3480 devices (addresses 800 through 807)
- IBM 3490E drives using CST cartridges (addresses 900 through 907)
- IBM 3490E drives with ECCST cartridges (addresses 9E0 through 9EF)
- VTS virtual drives (A40 through A5F) at 25 minutes
- Virtual drives for PtP VTS or Two Cluster Grid (1000 through 10FF) at 45 minutes

This is a starting point. Under certain conditions, you might experience missing interrupts at 25 minutes. If you experience missing interrupts, increase the time to 45 minutes.

Example 9-1 MIH values

```
MIH DEV=(0800-0807),TIME=03:00
MIH DE =(0900-0907),TIME=10:00
MIH DEV=(09E0-09EF),TIME=20:00
MIH DEV=(0A40-0A5F),TIME=25:00
MIH DEV=(1000-10FF),TIME=45:00
```

9.2.2 Defining security profiles

You must prevent unauthorized users from modifying or using information in the system-managed tape environment. In this section, we explain how to use the Resource Access Control Facility (RACF) to establish authorization levels for protecting these functions, datasets, and commands. There are five areas of protection that you might want to implement.

ISMF

You can use RACF to limit access to individual ISMF applications, such as TAPE LIBRARY CONFIGURATION or STORAGE CLASS DEFINITION. You can also protect ISMF line operators, such as AUDIT.

For example, you can protect the EJECT line operator as shown here:

```
RDEFINE PROGRAM DGTFEJ01 UACC(NONE) +
        ADDMEM('loadlib'/VOLSER/NOPADCHK)
PERMIT DGTFEJ01 CLASS(PROGRAM) ACCESS(READ) ID(user ID)
```

Refer to the *z/OS DFSMSdfp Storage Administration Reference*, SC26-7402, for a complete list of all profiles and command-to-program tables.

SMS constructs

You can restrict the use of SMS Storage Classes and Management Classes to certain users in a system-managed tape environment.

STGADMIN

To control the ability to perform functions associated with storage management, define profiles in the FACILITY class for those profile names that begin with STGADMIN. For tape library operations, the important profiles are:

- Control the ability to activate an SMS configuration:

```
RDEFINE FACILITY STGADMIN.IGD.ACTIVATE.CONFIGURATION UACC(NONE)
PERMIT STGADMIN.IGD.ACTIVATE.CONFIGURATION CLASS(FACILITY)
       ACCESS(READ) ID(user ID)
```

- Control the ability to DEFINE, DELETE, or ALTER library and volume entries in a tape library (TCDB updates):

```
RDEFINE FACILITY STGADMIN.IGG.LIBRARY UACC(NONE)
PERMIT STGADMIN.IGG.LIBRARY CLASS(FACILITY)
       ACCESS(READ) ID(user ID)
```

For a complete list of RACF profiles that protect storage administration functions, refer to the *z/OS DFSMSdfp Storage Administration Reference*, SC26-7402.

DFSMSrmm

By defining RACF profiles, you authorize DFSMSrmm users to various levels of access:

- Access to information in the DFSMSrmm control dataset:

```
REDFINE FACILITY STGADMIN.EDG.MASTER UACC(NONE)
PERMIT STGADMIN.EDG.MASTER CLASS(FACILITY)
       ACCESS(CONTROL) ID(user ID)
```

- Use of the INIT and ERASE functions:

```
REDFINE FACILITY STGADMIN.EDG.OPERATOR UACC(NONE)
PERMIT STGADMIN.EDG.OPERATOR CLASS(FACILITY)
       ACCESS(UPDATE) ID(user ID)
```

- Ability to change information recorded by DFSMSrmm during O/C/EOV processing:

```
REDFINE FACILITY STGADMIN.EDG.FORCE UACC(NONE)
PERMIT STGADMIN.EDG.FORCE CLASS(FACILITY)
       ACCESS(UPDATE) ID(user ID)
```

For a complete list of RACF profiles that protect DFSMSrmm resources, refer to the *z/OS DFSMSrmm Implementation and Customization Guide*, SC26-7405.

z/OS operator commands

You can audit the use of commands and limit the use of commands by operator and console. You can restrict access to z/OS commands, such as LIBRARY or VARY SMS, which affect the operation of your TS3500 Tape Library and 3953 Tape System:

- Access to the z/OS LIBRARY command:

```
REDFINE OPERCMDS MVS.LIBRARY UACC(NONE)
PERMIT MVS.LIBRARY CLASS(OPERCMDS) ACCESS(UPDATE) ID(user ID)
```

- Access to the z/OS VARY SMS command:

```
REDFINE OPERCMDS MVS.VARY.SMS UACC(NONE)
PERMIT MVS.VARY.SMS CLASS(OPERCMDS) ACCESS(UPDATE) ID(user ID)
```

Stacked volume

As long as a TS3500 has installed native drives with the same device capabilities, there is a slight chance that stacked volumes from a VTS can be corrupted. A user, who can bypass label processing, still can mount them on a native drive.

With the RACF facility class TAPEVOL, you can restrict any access from any user. Stacked volumes are not needed by any z/OS application directly, so this is an additional protection. In our example, all volumes that begin with any character and have “P” for the second character are restricted by native usage:

```
SETR CLASSACT(TAPEVOL) GENERIC(TAPEVOL) GENCMD(TAPEVOL)
RDEFINE TAPEVOL %P* UACC(NONE)
```

Refer to *z/OS Security Server RACF Command Language Reference*, SA22-7687, and *z/OS V1R3.0 MVS Planning: Operations*, SA22-7601, for a complete list of RACF profiles to protect z/OS commands and for more information.

9.2.3 Allocating the tape configuration database

The TCDB consists of one or more volume catalogs that contain information about the tape libraries and tape volumes. Two types of entries are maintained: library records and volume records.

Each *library record* contains information related to a logical Library Manager partition or a VTS library. Each *volume record* contains information related to a system-managed tape volume.

The library record is also contained in the SMS control dataset. Table 9-1 on page 246 shows the contents of the TCDB library and volume records.

Table 9-1 Contents of the TCBD library and volume record

Library record	Volume record
Library name	Volume serial number
LIBRARY-ID	Volume use attribute
Library description	Volume error attribute
Library device type	Write protection status
Number of slots	Checkpoint volume indicator
Number of empty slots	Tape device selection information
Number of scratch volumes	Library name
Scratch volume message threshold	Storage group name
Library Console Name	Volume location code
	Shelf location
	Volume owner information
	Volume record creation date
	Last entry or eject date
	Last mounted date
	Last written date
	Volume expiration date

You must allocate the TCDB before you define the logical libraries under the 3953 Library Manager to the system. Define one general VOLCAT in a system-managed tape SMSplex.

Figure 9-4 shows a sample job to allocate the TCDB.

```
//DEVCAT   JOB ...
  //STEP1   EXEC PGM=IDCAMS
  //SYSPRINT  DD SYSOUT=*
  //SYSIN     DD *
    DEFINE USERCATALOG -
           (NAME(SYS1.VOLCAT.VGENERAL) -
           VOLCATALOG -
           VOLUME(VOLSER)-
           CYLINDERS (30,30))
  /*
```

Figure 9-4 Creating a general SYS1.VOLCAT.VGENERAL

> **Note:** Instead of SYS1, you can use a different high-level qualifier. To do so, you must update the LOAD*xx* member in PARMLIB. Select the HLQ name carefully. There is no documented easy way to rename the VGENERAL after you have defined it and used it.

In a multihost environment, allocate a general VOLCAT on a shared volume and use the IDCAMS IMPORT CONNECT command on all other z/OS systems in the SMSplex to define the VOLCAT to the respective master catalogs.

The volume catalogs are defined with SHAREOPTIONS(3,4), so the TCDB can be fully shared among two or more systems. For exclusive control of the catalog's volume, a task in any accessing system issues the RESERVE macro. If multiple systems share the library (and therefore, share the TCDB), we recommend strongly that you use global resource serialization (GRS) or another means to serialize access to tape drives. Figure 9-5 on page 247 shows a sample job to connect the TCDB to a shared system.

```
//SYSMVCT EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=A
//SYSIN    DD *
      IMPORT CONNECT -
             VOLCATALOG -
             OBJECTS((hlq.VOLCAT.VGENERAL -
                DEVICETYPE(3390) -
                VOLUMES(VOLSER))) -
             CATALOG(SYSB.MASTER.CATALOG)
/*
```

Figure 9-5 Import connect TCDB

Optionally, you can define one or more specific VOLCATs. For example, consider SYS1.VOLCAT.V*x*, where *x* represents the first character of the tape volume serial numbers to be stored in this specific volume catalog. It must have a valid character value (A to Z and 0 to 9). A specific volume catalog might be appropriate due to:

- Performance considerations
- Multisystem considerations

  Note: A tape configuration database (TCDB) with volume records (recording technology and media type) can coexist with lower level systems. OAM's existing coexistence support will prevent the lower level system from retrieving and displaying an unsupported volume record.

- The application's use of confined tape ranges

Figure 9-6 shows a sample job that defines a specific VOLCAT. This VOLCAT contains all of the system-managed tape volume entries starting with the character T.

```
//DEVCAT   JOB ...
//STEP1   EXEC PGM=IDCAMS
//SYSPRINT  DD SYSOUT=*
//SYSIN     DD *
    DEFINE USERCATALOG -
           (NAME(SYS1.VOLCAT.VT) -
           VOLCATALOG -
           VOLUME(VOLSER)-
           CYLINDERS (30,30))
/*
```

Figure 9-6 Creating a specific SYS1.VOLCAT.VT

Notes: Library records cannot be stored in a specific volume catalog. And, in a multihost environment, the same considerations apply as for a general VOLCAT.

Sizing the tape configuration database

To estimate the size of the TCDB, calculate 275 bytes for each volume entry. Therefore, for 10 000 volumes, 2.75 MB or about three cylinders of 3390 disk space are required. For 100 000 volumes, about 32 cylinders are required. Because there are typically a small number of library records in the configuration, their role in the calculation needs to be minor. With z/OS V1R5, factor in 2000 bytes for each library record. When estimating, allow room for growth so that secondary extents are not created.

9.2.4 Preparing and starting OAM

To allow communication with your TS3500 Tape Library, you must start the OAM address space. The start procedure from OAM must be added to one of your procedure libraries. You can use CBRAPROC in SYS1.SAMPLIB to create the OAM procedure in PROCLIB (refer to Figure 9-7).

```
//OAM PROC OSMC=YES,MAXS=2,UNLOAD=9999,EJECT=LRW,RESTART=YES
//IEFPROC EXEC PGM=CBROAM,REGION=OM,
// PARM=('OSMC=&OSMC,APLAN=CBROAM,MAXS=&MAXS,UNLOAD=&UNLOAD',
//    'EJECT=&EJECT','RESTART=&RESTART')
//SYSABEND DD SYSOUT=A
```

Figure 9-7 OAM procedure example

If you already use OAM for object access, you might not have to change this member. However, we recommend that you review the definition.

The RESTART parameter is important to tape library users. It allows you to indicate whether you want the OAM address space to automatically restart when the SCDS is activated. A restart from OAM through an SCDS activation performs these tasks:

- Transfers to OAM relevant SMS definitions and constructs to the OAM address space
- Sets all of the defined libraries to the defined state in SMS, regardless of their current operational states
- Disables the object interface to DB2 if you have object support enabled

Therefore, if your SCDS changes rarely affect the tape library-related constructs, you might want to specify RESTART=NO, and the OAM address space stays up during an SCDS activation. If you added information that affects OAM, you can subsequently issue the command:

```
F OAM,RESTART
```

Note: A manual restart of OAM differs slightly from a restart that is scheduled through SCDS activation. If a library is set off-line for a reason, such as maintenance, a manual restart does not set it online again. A restart caused by SCDS activation sets the specific library online.

First start of OAM and considerations

When you start OAM for the first time, no library records or tape records are available. OAM asks for the SMS-activation, because there is no information available for tape processing. After you introduce the logical libraries through ISMF and restart OAM, the library comes online for the first time.

If you updated the IGDSMS*xx* member accordingly, OAM starts automatically during IPL.

9.2.5 Customizing OAM

Through the CBRXLCS general use programming interface, an application program can:

- Change the use attribute of a cartridge (CUA®)
- Eject a cartridge from the library (EJC)
- Query whether a cartridge is present in a library (QVR)
- Test a cartridge’s eligibility to be mounted (TVE)

OAM provides four installation-wide exits that take control at various processing points. They promote and verify changes:

- Cartridge entry exit (CBRUXENT)

  When a volume is entered into an IBM automated or manual tape library, the cartridge entry installation exit (CBRUXENT) is invoked to approve or deny an enter request and to set or verify the recording technology to be associated with a volume.

  If you need to code this exit routine, you can use SYS1.SAMPLIB member CBRSPUXE as a model.

- Cartridge eject exit (CBRUXEJC)

  The cartridge eject installation exit routine is called to approve or disapprove ejecting a cartridge from a library. It also determines the TCDB volume disposition and contents for each volume to eject. If you need to code this exit routine, you can use SYS1.SAMPLIB member CBRSPUXJ as a model.

- Change use attribute exit (CBRUXCUA)

  The change use attribute installation exit routine is called when the use attribute of a volume is to be changed (S → S, S → P, P → P, P → S). The exit is called to approve or disapprove of the change. The exit is called before the TCDB volume record or the Library Manager database record is updated. If you need to code this exit routine, use SYS1.SAMPLIB member CBRSPUXC as a model.

- Volume not in library exit (CBRUXVNL)

  The volume not in library installation exit routine is invoked when there is a request to process tape volumes that do not reside in a library but must reside for processing to continue. This exit routine is invoked to give you the opportunity to insert a volume into a tape library to prevent job failures. If you need to code this exit routine, you can use SYS1.SAMPLIB member CBRSPUXV as a model.

These installation exits are provided by DFSMSrmm. If your installation is not using DFSMSrmm and your tape management vendor has not supplied an exit, OAM provides sample exits in SAMPLIB that you can customize to fit your needs.

Note: Support for MEDIA9 and MEDIA10 requires release z/OS V1R5 or later.

Use of the installation-wide exits is optional. However, if you use a tape management system, you need the exits to invoke your tape management system. For example, if the CBRXLCS eject interface or an operator command is issued to eject a cartridge from a library, the CBRUXEJC exit notifies DFSMSrmm that the cartridge has been ejected from the library, so that DFSMSrmm can update its location.

If the tape management system does not use CBRUXCUA or CBRUXEJC, changes made at the z/OS console through the LIBRARY command or through the ISMF volume application are not forwarded to the tape management system. Cartridges can end up in unpredictable states.

If you use DFSMSrmm as your tape management system, the exits are fully provided by DFSMSrmm. They are installed in SYS1.LINKLIB during the SMP/E installation of DFSMSrmm. You do not need to customize anything at all.

If you use any other tape management system, contact your software vendor. Most software vendors support some or all OAM exits.

Note: With the introduction of Advanced Policy Management (APM) for VTS, the exits have changed to support this new function. However, if you do not use APM, changing your existing exits is unnecessary.

For detailed information about the exit routines, refer to *z/OS V1R10 DFSMS Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries,* SC35-0427.

9.2.6 Updating and customizing your tape management system

Next, we discuss updating and customizing your tape management system.

DFSMSrmm

Depending on the management system that you use, functions exist for a highly improved system-managed tape environment. This section refers only to DFSMSrmm, which is the IBM tape management system and an optional feature of z/OS. DFSMSrmm records all tape dataset and volume information and provides utilities to perform expiration processing and vaulting. It retains information about volumes regardless of whether they are in a library, a part of system-managed tape, on-site, or off-site.

DFSMSrmm interacts directly with the OAM/Library Control System (LCS) interfaces and exits. Ejects, change location, and other commands referring to a physical location movement create an immediate action in the library. The easiest way to be consistent between the DFSMSrmm control dataset and the TCDB is to use DFSMSrmm panels or the DFSMSrmm TSO subcommands for movement processing instead of ISMF. We recommend that you define your physical cartridges, or, when implementing a VTS or PtP VTS, your logical volumes, to DFSMSrmm first before you insert them into the tape library.

Note: For TS1130 support, a toleration/coexistence APAR is required for z/OS V1R6 and later releases (all supported releases that can coexist with z/OS V1R7). This APAR must be installed on all DFSMSrmm systems in an RMMplex prior to the introduction of the new function PTF for this SPE. Unlike other z/OS components changed for 3592 Model E06 support, this coexistence support is needed in RMM even if the 3592 Model E06 drive is *not* being used.

This section provides the required customization steps, as well as additional information, about:

- Tape initialization
- Scratch pooling
- Duplicate volume serial numbers

To implement a TS3500 Tape Library with DFSMSrmm, you must define cartridge entry rules for cartridge entry processing with DFSMSrmm. This step is required. The following additional steps are not mandatory, but very useful in live production:

- Define library-resident cartridges to DFSMSrmm:
  - New cartridges
  - Existing DFSMSrmm-managed cartridges
- Define procedures to eject cartridges.
- Define procedures to ensure database synchronization with the TCDB.

Defining cartridge entry rules for entry processing with DFSMSrmm

When cartridges are inserted into the TS3500 Tape Library and assigned to their respective logical libraries, the Library Manager then sends a message to all attached hosts. When OAM receives this message, it checks with DFSMSrmm through the entry exit (CBRUXENT) to see whether DFSMSrmm approves or disapproves. REJECT statements in the EDGRMM*xx* member of PARMLIB control this process. You can use the REJECT parameter to control entry into the library and to use the cartridge for input processing only.

In the example RMM REJECT statements in Figure 9-8, cartridges starting with `DD3` are not allowed in the library. Cartridges starting with `CC12` are used for input processing only. REJECT ANYUSE(*) is used to prevent any cartridges unknown to DFSMSrmm from getting added to the TCDB. If both OUTPUT and ANYUSE are specified, ANYUSE overrides OUTPUT. Therefore, in the final example, all tapes starting with `PR` (with the exception of those starting with `PRD`) are available for input processing only. When a cartridge matches the REJECT ANYUSE statement, a return code of 12 is set in the CBRUXENT exit, which tells OAM to leave this cartridge to be processed by another host.

If a cartridge is not rejected, the entry processing is approved, and a TCDB entry for the volume and an RMM entry (if not already available) are created. Depending on the settings for cartridge entry processing (ISMF), the cartridge is handled as private or scratch.

If the cartridge is handled as scratch, the Library Manager gives this cartridge the appropriate MEDIA*x* category value, specified in DEVSUP*xx*. For more information about categories, refer to Appendix C, “Library Manager volume categories” on page 471.

```
REJECT ANYUSE(DD3*)
REJECT OUTPUT(CC12*)
REJECT ANYUSE(*)
REJECT ANYUSE(PRD*),OUTPUT(PR*)
```

Figure 9-8 RMM REJECT statements in EDGRMMxx

Important: Missing EDGRMM entries can cause you many problems if you share a library among multiple z/OS users. We strongly recommend that you do *not* implement new sharing partners without reviewing the EDGRMM member of all of the users of this library.

Defining library resident cartridges to DFSMSrmm

You can perform this step for new and existing cartridges.

New cartridges

If the EDGRMM*xx* PARMLIB member is correctly specified and activated, there is no need to specify the new cartridges in DFSMSrmm. The entry process also creates TCDB and DFSMSrmm entries.

Existing DFSMSrmm-managed cartridges

We recommend that you define your private volumes to DFSMSrmm before you enter them in the TS3500 Tape Library by using the DFSMSrmm ADDVOLUME command. However, the location is automatically updated during insert processing.

Cartridges that are already defined to DFSMSrmm are accepted into the library according to the insert policies that you defined, and their LOCATIONs are updated in DFSMSrmm. If you want the home location of a cartridge to be in a library, use the CHANGEVOLUME command with the LOCATION subparameter by issuing multiple commands or by using the

DFSMSrmm CLIST function to build a list of the cartridges in the library using the DFSMSrmm SEARCHVOLUME command.

You can use the CHANGEVOLUME command to specify a Storage Group name for private volumes so that DFSMSrmm can provide the Storage Group name during cartridge entry processing. Although a blank Storage Group name is valid in system-managed tape environments, group your private volumes according to the policies specified in the ACS routines.

Defining procedures to eject cartridges

If volumes are ejected from the library through the z/OS LIBRARY command or the ISMF volume application, the eject exit, CBRUXEJC, is called to inform DFSMSrmm and update the storage location accordingly.

An additional step or job to add to the DFSMSrmm housekeeping run is to eject from the library cartridges that were assigned new destinations as part of vital record processing. This additional step or job uses the CHANGEVOLUME EJECT command. The cartridge can be sent to either the bulk output station or the convenience station. You can use SEARCHVOLUME to build a list of volumes to be ejected (RMM EJECT sample step in Figure 9-9).

```
//SEARCH   EXEC PGM=IKJEFT01
//SYSTSPRT DD  SYSOUT=*
//SYSTSIN  DD  *
 RMM SEARCHVOLUME VOLUME(*) OWNER(*) LOCATION(ATL) DESTINATION(*) -
     INTRANSIT(NO) LIMIT(*) -
     CLIST('RMM CV ',' EJECT')
 EX EXEC.RMM.CLIST
```

Figure 9-9 RMM EJECT sample step

Note: DFSMSrmm sets the INTRANSIT(YES) flag for ejected volumes as soon as EJECT is performed. You must then issue the CONFIRMMOVE command just as you do without a TS3500 Tape Library.

Tape initialization

For volumes in an automated tape library data server, you have the option to use DFSMSdfp™ OPEN processing as an alternative to using DFSMSrmm EDGINERS or IEHINITT to label scratch volumes.

Note: Initialization for either stacked or logical volumes is not required with the VTS. Stacked and logical volumes are initialized transparently to the user and host at the time of the first use. Also, initialization for native 3592 drives is not required. Scratch cartridges are initialized from the drive if a label is detected that does not match the external label or has a different recording format.

If the automated tape library data server is fully functional (if the vision system works) and the VOL1 label for a scratch volume does not match the external label, DFSMSdfp rewrites the VOL1 label with the correct VOLSER.

DFSMSrmm turns off the initialize action to defer the labeling to OPEN processing under DFSMSdfp control if you request the initialization before entering a scratch volume into the automated tape library data server. DFSMSrmm automatically replies to the messages issued at open time that are due to label changes that are allowed and supported by DFSMSrmm. DFSMSrmm automatically replies to label messages when:

- A label change is allowed by DFSMSrmm.
- The volume is not rejected by DFSMSrmm.
- DFSMSrmm is not running in record mode.

DFSMSrmm does not reply when the wrong volume is mounted, unless the volume is in a library and the mounted volume's barcode matches.

DFSMSrmm for initialization

If you want to use DFSMSrmm instead of DFSMSdfp to initialize new tapes in a library, follow the steps in this procedure:

1. Perform one of the following actions:
   - Enter the undefined volumes into the TS3500 while DFSMSrmm is active.
   - Define the volumes as scratch to DFSMSrmm with LOCATION(*atlname*), and enter the volumes into the TS3500 with DFSMSrmm active.
2. Volumes must now be defined to DFSMSrmm with SCRATCH status. They must be known to be in the library.
3. Use the RMM CV VOLSER INIT(Y) command to set the initialize action for each volume. Use the following command to build the commands:

   `RMM CV VOL(*) STATUS(SCRATCH) LOC(`*`atlname`*`)`
4. Run EDGINERS in automatic mode.

   In the sample DFSMSrmm EDGINERS (Figure 9-10 on page 254), an automatic run of EDGINERS is scheduled to find and initialize up to 99 volumes residing in an automated tape library data server called MYATL. All tape cartridges are labeled as appropriate for the drive type on which they are mounted and for their current media characteristics.
5. DFSMSrmm temporarily sets the TCDB status to PRIVATE for the tapes to be initialized, because no specific mounts (as they are required for labeling a cartridge) are allowed for SCRATCH tapes inside a library.

> **Note:** The automatic synchronization between DFSMSrmm and the TCDB works only if DFSMSrmm runs in PROTECT mode.

EDGINERS determines whether a volume in a system-managed tape library can be mounted on the current system. If the volume cannot be mounted, possibly because it is defined in a TCDB on another system, DFSMSrmm skips that volume.

The control statement description is:

- Tape DD and SYSIN DD are not required for a system-managed tape environment.
- PARM values request initialization of 99 cartridges in library MYATL. No verification is done. Verification causes each cartridge to be mounted twice: once for initialization and once for verification.

DFSMSrmm ensures that volumes in a system-managed tape library that are to be initialized or erased are in the private category, because the automated tape library data server does not support specific mounts of scratch volumes. You must define a volume in a system-managed tape library to DFSMSrmm before you can initialize or erase it. Any volume that is not defined to DFSMSrmm is requested to be mounted on the drive that is allocated by the TAPE DD statement in the JCL for EDGINERS as long as the drive is not in a system-managed library.

During demount processing, DFSMSrmm ensures that errors detected on volumes mounted in an automated tape library are reflected in the TCDB. For example, DFSMSrmm ensures that the TCDB contains information about write-protected, wrong volume, and wrong label type errors. DFSMSrmm skips the volume rather than having the operator correct the error.

```
//STEP1 EXEC PGM=EDGINERS,
//     PARM='COUNT(99),LOCATION(MYATL),INITIALIZE,NOVERIFY'
//SYSPRINT  DD  SYSOUT=A
```

Figure 9-10 Sample DFSMSrmm EDGINERS

EDGINERS and encrypted data

EDGINERS can be sensitive to whether a volume contains encrypted data and therefore, might not need to be erased. Instead, you can select to use the hardware ability to shred the encryption key used for the data so that the data can no longer be decrypted. When DFSMSrmm erases volumes, it uses the hardware security erase feature when it is available. When erasing volumes, DFSMSrmm also re-initializes them so that the correct volume labels are written and the volumes are ready for reuse. When the data key shred feature is not available, a hardware security erase is performed. If the hardware security erase feature is not available, DFSMSrmm overwrites volumes with a bit pattern of hex FF, which takes a substantial amount of time.

Erasing encrypted tapes

The ERASE release action can now be configured to selectively perform a data key shred, a secure erase, or a combination. When the ERASE release action is pending for an encrypted tape volume, and the volume is mounted for ERASE on an encryption-capable tape drive, and the appropriate ERASE option is selected, the EDGINERS utility attempts a data key "*shred*" action on the volume. This shred action renders the data incapable of being decrypted. EDGINERS ERASE processing also supports options to use a combination of secure erase with shred or to force a secure erase even for encrypted volumes.

This enhancement is being provided with RMM support for the TS1130 (on a subset of the releases; z/OS V1R8 and later) and is supported on both the TS1130 and the TS1120.

Scratch pooling

System-managed tape does not support multiple scratch pools of a single media type in its current release. The libraries can contain multiple types of scratch cartridges. Refer to Table 9-2 on page 255.

Table 9-2 Media type descriptions

Media type	Name	Device type	Recording format	WORM or R/W	Cartridge capacity
MEDIA1	Cartridge System Tape (CST)	3490 or VTS	32-track	R/W	400 MB
MEDIA2	Enhanced Capacity Cartridge System Tape (ECCST)	3490 or VTS	32-track	R/W	800 MB
MEDIA3	IBM 3590 High Performance Cartridge Tape (HPCT)	3590	128-track 256-track 384-track	R/W R/W R/W	10 GB 20 GB 30 GB
MEDIA4	IBM 3590 Extended High Performance Cartridge Tape (EHPCT)	3590	128-track 256-track 384-track	R/W R/W R/W	20 GB 40 GB 60 GB
MEDIA5	IBM 3592 Enterprise Tape Cartridge (ETC)	3592	EFMT1 EFMT2 EEFMT2 EFMT3 EEFMT3	R/W R/W R/W R/W R/W	300 GB 500 GB 500 GB 640 GB 640 GB
MEDIA6	IBM 3592 Enterprise Tape WORM Cartridge (ETWC)	3592	EFMT1 EFMT2 EEFMT2 EFMT3 EEFMT3	WORM WORM WORM WORM WORM	300 GB 500 GB 500 GB 640 GB 640 GB
MEDIA7	IBM 3592 Enterprise Tape Economy Cartridge (ETEC)	3592	EFMT1 EFMT2 EEFMT2 EFMT3 EEFMT3	R/W R/W R/W R/W R/W	60 GB 100 GB 100 GB 128 GB 128 GB
MEDIA8	IBM 3592 Enterprise Tape Economy WORM Cartridge (ETEWC)	3592	EFMT1 EFMT2 EEFMT2 EFMT3 EEFMT3	WORM WORM WORM WORM WORM	60 GB 100 GB 100 GB 128 GB 128 GB
MEDIA9	IBM 3592 Extended Tape Cartridge (EETC)	3592	EFMT1 EFMT2 EEFMT2 EFMT3 EEFMT3	R/W R/W R/W R/W R/W	500 GB 700 GB 700 GB 1 TB 1 TB
MEDIA10	IBM Extended Tape WORM Cartridge (EETWC)	3592	EFMT1 EFMT2 EEFMT2 EFMT3 EEFMT3	WORM WORM WORM WORM WORM	500 GB 700 GB 700 GB 1 TB 1 TB

The scratch cartridges are selected according to Data Class definitions for non-specific allocations. If you have two or more systems attached to a library, and you do not want to have a common pool for scratch volumes, you have to partition the library as explained in 6.2.4, “System z tape library partitioning” on page 156.

Both the DFSMSrmm control database and the TCDB maintain the RECORDINGFORMAT information. Regardless of the tape management software that you use, you must record the recording format of each tape volume.

Note: For specific details about the changes in DFSMSrmm for the new IBM TotalStorage Enterprise Tape Media models support, refer to the *z/OS DFSMS Software Support for IBM System Storage TS1130 and TS1120 Tape Drives (3592),* SC26-7514.

Duplicate volume serial numbers

For system-managed tape, all VOLSERs in the same SMSplex must be unique across tape and DASD.

DFSMSrmm does not support duplicate VOLSERs and cannot manage volumes that are not defined to it. By defining a RACF profile named STGADMIn.EDG.IGNORE.** with access of read, you allow specific users to bypass this check by use of the JCL parameter EXPDT=98000. If you even have a duplicate VOLSER in RMM that resides in an IBM robot, you must add the parameter STORCLAS=DUPTØSMS as shown in Example 9-2.

Example 9-2 Duplicate VOLSER residing in IBM robot

```
//TAPE1       DD DSN=E40488.SASLDBE1,
//             DISP=OLD,UNIT=TAPEV,EXPDT=98000,
//             VOL=SER=676620,LABEL=(,BLP)    ,STORCLAS=DUPTØSMS
```

Within the IBM TS3500, all volumes, including native, stacked, and logical, must be unique. You have to use distinct volume serial number ranges for the three volume types.

9.2.7 Defining the library through ISMF

You define your 3953 logical libraries to the system through the ISMF library application. As discussed in previous chapters, the TS3500 offers two levels of partitioning for System z attachment. The first level is the TS3500 logical partitions that are each managed by a 3953 Library Manager; these TS3500 logical libraries are not known to the host. The second level of partitioning is the logical libraries defined under one 3953 Library Manager; these logical libraries need to be defined to the host through ISMF (similar to logical libraries in a 3494 Tape Library).

Remember that for a PtP VTS, you must define three libraries:

- One Composite Library
- Two Distributed Libraries

A TS7700 is similar to the PtP VTS when you define it in ISMF:

- A Single Cluster Grid is defined as one Composite Library and one Distributed Library.
- A Two Cluster Grid is defined exactly as a PtP VTS.
- A Three Cluster Grid is defined as one Composite Library and three Distributed Libraries.

Note: The ISMF definition dialog works only if OAM is active.

For details about defining your library, refer to the *z/OS DFSMSdfp Storage Administration Reference*, SC26-7402.

When you define your library, you specify:

- **LIBRARY-ID**: This is the five-character ID associated with a logical library defined under the 3953 Library Manager.
- **Console name**: This is the optional z/OS console name if you defined an optional z/OS console name in SYS1.PARMLIB member CONSOL*xx.*
- **Entry default Data Class**: This specifies the name of the Data Class that you want as the default for tape cartridges entered into the library that you define.
- **Entry default use attribute**: This specifies the use attribute for cartridges that are entered into the library (SCRATCH or PRIVATE).
- **Eject default**: This is the default action for the TCDB volume record when a tape cartridge is ejected from the library (PURGE or KEEP).
- **Scratch threshold**: This specifies the threshold below which a message is issued to the operator requesting that the operator enter scratch volumes of the specified media type into the library.
- **Initial online status**: This specifies whether the library is online, off-line, or not connected to the systems or system groups in the SMSplex each time that the SCDS is activated. We recommend that you specify `online` to ensure that the library is accessible after the activation of an updated SCDS.

> **Note:** When you connect a TS3500 Tape Library to a system group rather than to a system, you lose the ability to vary that library online or off-line to the individual system in the group. We recommend strongly that you connect the TS3500 Tape Library to individual systems only.

Defining the library (example)

This section demonstrates how to define a library:

1. Choose option **10** (**Library Management**) on the ISMF PRIMARY OPTION MENU display. Then, the Library Management Selection Menu appears.
2. Choose option **3** (**Tape Library**). The TAPE LIBRARY APPLICATION SELECTION panel appears as shown in Figure 9-11 on page 258.

```
Panel  Utilities  Help
------------------------------------------------------------------------------
                      TAPE LIBRARY APPLICATION SELECTION
Command ===>

To Perform Library operations, Specify:

  CDS Name  . . . . . . . 'SMS.SCDS'
                                (1 to 44 Character Data Set Name or 'Active')
  Library Name  . . . . . LIBLCL          (For Tape Library list, fully or
                                          Partially Specified or * for all)

Select one of the following options  :
  1  1. List    - Generate a list of Libraries
     2. Display - Display a Library
     3. Define  - Define a Library
     4. Alter   - Alter a Library

If List option is chosen,
   Enter "/" to select option   _  Respecify View Criteria
                                _  Respecify Sort Criteria

Use ENTER to Perform Selection;
Use HELP Command for Help; Use END Command to Exit.
```

Figure 9-11 TAPE LIBRARY APPLICATION SELECTION panel

3. In the Library Name field, enter the SMS friendly name for your tape library. This name relates your tape library to your SMS tape Storage Group, which you define later. There is a minor restriction when you name the library.

> **Restriction:** The first character of a library name must not be `V` or one of the DFSMSrmm-defined locations (LOCAL, REMOTE, or DISTANT).

4. Choose option **3** (**Define**) to display the TAPE LIBRARY DEFINE panel as shown in Figure 9-12 on page 259 and Figure 9-13 on page 259.

> **Note:** Deleting a tape library from this window has no effect on the TCDB. Instead, the library definition is removed only from the specified SCDS. To delete a tape library from the TCDB, use the IDCAMS DELETE command.

```
   Panel  Utilities  Scroll  Help
--------------------------------------------------------------------------------
                               TAPE LIBRARY DEFINE                  Page 1 of 2
Command ===>

SCDS Name  . : Y421252.MYSCDS
Library Name : TP1

To Define Library, Specify:
  Description ==>
              ==>
  Library ID . . . . . . . . . . .  10435    (00001 to FFFFF)
  Console Name . . . . . . . . . .  MC01
  Entry Default Data Class . . . .  ECCST
  Entry Default Use Attribute  . .  S        (P=PRIVATE or S=SCRATCH)
  Eject Default  . . . . . . . . .  P        (P=PURGE or K=KEEP)

  Media Type:  Scratch Threshold        Media1  . . . . 0_____    (0 to 999999)
    Media2  . . . . 100___              Media3  . . . . 0_____    (0 to 999999)
    Media4  . . . . 0_____              Media5  . . . . 0_____    (0 to 999999)
    Media6  . . . . 0_____              Media7  . . . . 0_____    (0 to 999999)
    Media8  . . . . 0_____              Media9  . . . . 0_____    (0 to 999999)
    Media10 . . . . 0_____
  Use ENTER to Perform Verification; Use DOWN Command to View next Panel;
  Use HELP Command for Help; Use END Command to Save and Exit; Cancel to Exit.
```

Figure 9-12 TAPE LIBRARY DEFINE panel (page 1 of 2)

```
Panel  Utilities  Scroll  Help
------------------------------------------------------------------------------
                              TAPE LIBRARY DEFINE                 Page 2 of 2
Command ===>

SCDS Name  . : SCDS.TEMP.PRIMARY
Library Name : LIB1

Initial Online Status (Yes, No, or Blank):
*SYSPLX01 ===> YES  *SYSPLX02 ===>     *SYSPLX03 ===> NO   *SYSPLX04 ===>
 SYSSTM01 ===> YES   SYSSTM08 ===> YES   SYSSTM15 ===>      SYSSTM22 ===>
 SYSSTM02 ===>       SYSSTM09 ===>       SYSSTM16 ===>      SYSSTM23 ===>
 SYSSTM03 ===>       SYSSTM10 ===>       SYSSTM17 ===>      SYSSTM24 ===>
 SYSSTM04 ===>       SYSSTM11 ===>       SYSSTM18 ===>      SYSSTM25 ===>
 SYSSTM05 ===>       SYSSTM12 ===>       SYSSTM19 ===>      SYSSTM26 ===>
 SYSSTM06 ===>       SYSSTM13 ===>       SYSSTM20 ===>      SYSSTM27 ===>
 SYSSTM07 ===>       SYSSTM14 ===>       SYSSTM21 ===>      SYSSTM28 ===>
WARNING:
  When you connect a tape library to a system group rather than a system,
  you lose the ability to vary that library online or offline to the
  individual systems in the system group.  It is strongly recommended that
  the tape library be connected to individual systems only.
Use ENTER to Perform Verification; Use UP Command to View Previous Panel;
Use HELP Command for Help; Use END Command to Save and Exit; CANCEL to Exit.
```

Figure 9-13 TAPE LIBRARY DEFINE panel (page 2 of 2)

5. Specify the following information for the tape library:
   - **Description**: This is a 120-byte field that allows you to enter a description of the library definition for use by the installation. There are no restrictions on its content.

- **LIBRARY-ID**: Specify the ID associated with the logical library defined under the 3953 Library Manager. This ID must match the Library Sequence Number given to each logical library during the 3953 Library Manager configuration, as well as the LIBRARY-ID number used in the HCD definition.
- **Console name**: Specify the name of the z/OS console associated with the tape library that you define in the CONSOL*xx* PARMLIB member.
- **Entry default Data Class**: Specify the name of the Data Class that you want as the default for tape cartridges entered into this tape library.
- **Entry default use attribute**: Specify the default cartridge use attribute for the cartridges entered into this library:
  - PRIVATE: Use these tape cartridges to satisfy specific cartridge requests.
  - SCRATCH: Use these tape cartridges to satisfy non-specific cartridge requests.
- **Eject default**: Specify the default action for the TCDB cartridge record when a tape cartridge is ejected from this library:
  - PURGE: The cartridge record is deleted from the TCDB.
  - KEEP: The cartridge record is kept in the TCDB.
- **Scratch threshold**: Specify the minimum acceptable number of scratch cartridges for each media type in this library. There are ten recognized media types, which are listed in Table 9-2 on page 255.

  Note: When the number of scratch cartridges in the library falls below the scratch cartridge threshold for that media type, an operator action message is issued requesting that the operator enter scratch cartridges of the required media type into the library. When the number of scratch cartridges exceeds twice the scratch cartridge threshold for that media type, the message disappears. In the case of a VTS, these numbers apply to the number of logical cartridges (CST or ECCST) available inside the VTS.

- **Initial online status**: Specify whether the library that you define is online (`YES`), offline (`NO`), or not connected (blank) to each system in the SMSplex defined by this SCDS each time that it is activated. `YES` is equivalent to `VARY SMS,LIBRARY(`*`libname`*`),ONLINE`. We recommend that you set the initial state to `online`.

  After you enter all of the information, an entry containing that information is added to the TCDB.

  Note: Only one SCDS can be activated at any time. Activating another SCDS or reactivating the current SCDS while OAM is running causes OAM to restart. During this restart, all libraries are set to either online or off-line according to the attributes that are defined in the SCDS that caused the restart. After the restart completes, display all libraries to verify that they are set to the desired operational status. Use care when you restart OAM with actions pending that have not been accepted by the Library Manager, for example, mass ejects. These actions might be discarded during the restart.

9.2.8 Defining SMS constructs through ISMF

To direct allocations to system-managed tape, you have to define SMS constructs through ISMF. In the Data Classes, you specify the media type, the recording technology, and whether to use hardware compaction when allocating a system-managed tape dataset.

You do not have to specify new Storage Classes. You can use existing classes. The *Storage Class* is used only to indicate that this is an allocation to a system-managed tape library. However, we recommend that you create new Storage Classes for tape, so that you can select Storage Groups on the basis of the Storage Class assignment and keep the automatic class selection (ACS) routines simple.

As for system-managed DASD allocations, the Management Class is optional. System-managed tape uses only the expiration attributes and retention limit parameters. If you use a tape management system, specify a retention limit of NOLIMIT.

You need to define a tape Storage Group and specify which libraries belong to that Storage Group. You also define the Storage Group status.

Although a blank Storage Group is allowed for system-managed tape volumes, we strongly recommend that you assign a Storage Group to private volumes when they are entered into the TS3500 Tape Library. The blank Storage Group is always enabled for all attached systems. You can specify the Storage Group during the definition of an existing private volume to DFSMSrmm or during cartridge insert processing.

For information about TS7700 and Outboard Policy Management or VTS and Advanced Policy Management, refer to:

- *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312
- *IBM TotalStorage Virtual Tape Server Planning, Implementing, and Monitoring,* SG24-2229
- *IBM TotalStorage Peer-to-Peer Virtual Tape Server Planning and Implementation Guide,* SG24-6115
- *z/OS DFSMS Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries*, SC35-0427

Compared to the implementation of DFSMS for DASD, system-managed tape has the following differences:

- Tape datasets do not have to be cataloged. If they are to be cataloged, you catalog them at step termination time.
- System-managed tape is the management of tape cartridges, not tape datasets. No dataset-related information is stored in the TCDB.
- A DASD (type POOL) Storage Group comprises one or more DASD volumes.

  A tape (type TAPE) Storage Group comprises one or more tape libraries. Cartridge information is stored in the TCDB, not in the SMS active control dataset (ACDS).
- Tape volumes are not preassigned to Storage Groups. They are assigned a Storage Group when their status changes to PRIVATE. Scratch volumes do not have a Storage Group assigned.
- A blank Storage Group is allowed for system-managed tape.

The following sections discuss the SMS constructs and their role in the system-managed tape support.

Defining Data Classes

A *Data Class* provides the tape device selection information or tape datasets. The attributes that you can specify are:

- The type of media to use
- Whether the data is to be compacted
- Recording technology (18 track, 36 track, 128 track, 256 track, 384 track, EFMT1, EFMT2, EEFMT2, EFMT3, or EEFMT3)
- The maximum volume count that your dataset can span

Use ISMF panels to define your Data Classes:

1. Choose option **4** (**Data Class**) on the ISMF PRIMARY OPTION MENU display. The DATA CLASS APPLICATION SELECTION panel appears.
2. On the DATA CLASS APPLICATION SELECTION panel, specify the SCDS name and the name of the Data Class that you are about to define.
3. Choose option **3** (**Define**) to create a new Data Class or option **4** (**Alter**) to change an existing Data Class on the panel. Figure 9-14 shows the panel where you specify the Data Class name.

```
  Panel  Utilities  Help
------------------------------------------------------------------------------
                       DATA CLASS APPLICATION SELECTION

To perform Data Class Operations, Specify:
  CDS Name . . . . . . 'DFSMS150.SCDS.SYS32'
                               (1 to 44 character data set name or 'Active' )
  Data Class Name  . . HSMDCL1M  (For Data Class List, fully or partially
                                  specified or * for all)

Select one of the following options  :
  4  1. List    - Generate a list of Data Classes
     2. Display - Display a Data Class
     3. Define  - Define a Data Class
     4. Alter   - Alter a Data Class

If List Option is chosen,
   Enter "/" to select option      Respecify View Criteria
                                   Respecify Sort Criteria


Command ===>
 F1=Help    F2=Split   F3=End     F4=Return  F7=Up      F8=Down    F9=Swap
F10=Left   F11=Right  F12=Cursor
```

Figure 9-14 Data Class Application Selection panel

4. Now, the first page of the DATA CLASS DEFINE or DATA CLASS ALTER panel appears as shown in Figure 9-15 on page 263. The panels are the same for both Data Class Define and Data Class Alter; in the our example, we chose Data Class Alter.

```
  Panel  Utilities  Scroll  Help
 ------------------------------------------------------------------------------
DGTDCDC1                     DATA CLASS ALTER                Page 1 of 5

SCDS Name . . . : DFSMS150.SCDS.SYS32
Data Class Name : HSMDCL1M

To ALTER Data Class, Specify:
  Description ==> DATA CLASS TAPE MEDIA 5, EE2 TRACK, COMPACTED, ENC, SCALED
              ==>
  Recfm . . . . . . . . . . ____        (any valid RECFM combination or blank)
  Lrecl . . . . . . . . . . _____       (1 to 32761 or blank)
  Space Avgrec  . . . . . . _           (U, K, M or blank)
        Avg Value . . . . . _____       (0 to 65535 or blank)
        Primary . . . . . . ______      (0 to 999999 or blank)
        Secondary . . . . . ______      (0 to 999999 or blank)
        Directory . . . . . ______      (0 to 999999 or blank)
  Retpd or Expdt  . . . . . __________  (0 to 9999, YYYY/MM/DD or blank)
  Volume Count  . . . . . . 1__         (1 to 255 or blank)
  Add'l Volume Amount . . . _           (P=Primary, S=Secondary or blank)
Command ===> 
 F1=Help    F2=Split   F3=End     F4=Return  F7=Up      F8=Down    F9=Swap
F10=Left   F11=Right  F12=Cursor
```

Figure 9-15 Data Class Alter panel (1 of 5)

5. Specify the following information for the Data Class definition in the current SCDS:
   - **Retpd or Expdt**: Specify how long the datasets in this Data Class remain valid (Figure 9-22 on page 271).
   - **Volume Count**: Specify the maximum number of cartridges that you expect to use to store a dataset in this Data Class.

> **Note:** Coding a small value in the volume count parameter can cause job abends, which is especially true if you migrate from a native 3592 environment to a VTS solution without changing your JCL. This job abend occurs, because the cartridge capacity is significantly different between the 3592 and the 3490E.

6. Figure 9-16 on page 264 shows the second page of the Data Class definition process. You use this panel to specify compaction.

```
DGTDCDC2                      DATA CLASS ALTER                 Page 2 of 5

SCDS Name . . . : DFSMS150.SCDS.SYS32
Data Class Name : HSMDCL1M

To ALTER Data Class, Specify:

  Data Set Name Type  . . . . . _____   (EXT, HFS, LIB, PDS, Large or blank)
    If Ext  . . . . . . . . . . _       (P=Preferred, R=Required or blank)
    Extended Addressability . . N       (Y or N)
    Record Access Bias  . . . . _       (S=System, U=User or blank)
  Space Constraint Relief . . . N       (Y or N)
    Reduce Space Up To (%)  . . __      (0 to 99 or blank)
    Dynamic Volume Count  . . . __      (1 to 59 or blank)
  Compaction  . . . . . . . . . Y       (Y, N, T, G or blank)
  Spanned / Nonspanned  . . . . _       (S=Spanned, N=Nonspanned or blank)



Command ===> _________________________________________________________________
 F1=Help     F2=Split    F3=End      F4=Return   F7=Up       F8=Down     F9=Swap
F10=Left    F11=Right   F12=Cursor
```

Figure 9-16 Data Class Alter panel (2 of 5)

- **Compaction**: Specify whether to use data compaction for datasets assigned to this Data Class. Improved Data Recording Capability (IDRC) uses a binary arithmetic compression algorithm and is used by 3490E tape drives; the Ziv-Lempel algorithm (IBMLZ1) is used by 3590 tape drives. A modified and more efficient Ziv-Lempel algorithm, Stream Lossless Data Compression (SLDC), is used by 3592 tape drives. We recommend that you always set the compaction to `Y`, especially when you use a VTS. The compaction attribute overrides the system default located in PARMLIB member DEVSUP*xx*, but it is overridden by JCL specification TRTCH. The valid Data Class values for the compaction attribute are Y, N, T (TCOM), G(GEN), and blank. TCOM and GEN do not apply to tape.

7. On the third page of the Data Class definition (Figure 9-17 on page 265), you provide the Media Type and Recording Technology. The EFMT3 and EEFMT3 formats have been added here.

```
 DATA CLASS ALTER                 Page 3 of 5
Command ===>
SCDS Name . . . : DFRMM1.SCDS.TEST
Data Class Name : DCFORE3

 To ALTER Data Class, Specify:

   Media Interchange
     Media Type . . . . . . . 5    (1, 2, 3, 4, 5, 6, 7, 8, 9, 10 or blank)
     Recording Technology . . E3   (18,36,128,256,384,E1,E2,EE2,E3,EE3 or ' ')
     Performance Scaling  . . Y    (Y, N or blank)
     Performance Segmentation      (Y, N or blank)
   Block Size Limit  . . . .             (32760 to 2GB or blank)
   Recorg  . . . . . . . . .             (KS, ES, RR, LS or blank)
   Keylen  . . . . . . . . .             (0 to 255 or blank)
   Keyoff  . . . . . . . . .             (0 to 32760 or blank)
   CIsize Data . . . . . . .             (1 to 32768 or blank)
   % Freespace CI  . . . . .             (0 to 100 or blank)
             CA  . . . . .             (0 to 100 or blank)
 Use ENTER to Perform Verification; Use UP/DOWN Command to View other Panels;
```

Figure 9-17   Data Class Alter panel (3 of 5) extended with the EFMT3 and EEFMT3 format

– **Media Type**: Specify the tape cartridge type that you use for datasets associated with this Data Class. If you do not enter anything for this field (the field is blank), the library that has the most SCRATCH cartridges is selected. This field is optional if you only use one media type within a TS3500 library.

  However, the definition is mandatory to allow selection of a media pool for non-specific mounts if multiple media types are present. For a description of the existing media types, refer to Table 9-2 on page 255.

  > **Note:**
  >
  > - Logical volumes in a TS7700 or in a VTS are 3490 volumes and, therefore, MEDIA1 with 400 MB of uncompressed capacity or MEDIA2 with 800 MB. Larger logical volumes are supported in the TS7700 and with VTS Release 7.4, which provides support for 1000, 2000, and 4000 MB logical volumes.
  > - MEDIA3 and MEDIA4 are not valid in a TS3500 Tape Library, because the library only supports 3592 media types.
  > - Support for MEDIA9 and MEDIA10 requires release z/OS V1R5 or later.

  If you use a VTS, you must verify the type of logical volumes that you have defined on the Library Manager and select the MEDIA accordingly (MEDIA1 or MEDIA2 only). Refer to *IBM TotalStorage Virtual Tape Server Planning, Implementing, and Monitoring,* SG24-2229.

– **Recording Technology**: Specify the recording technology for tape cartridges that are used for datasets that are associated with this Data Class. For the TS3500 Tape Library, which supports only 3592 drives and, therefore, MEDIA5 - MEDIA10 types, this value is either E1, E2, EE2, E3, or EE3.

– **Performance Scaling**: The 3592 tape drives allow you to record the data on the initial one-fifth (20% per default) of the media when performance is your main consideration. If you want fast access to the Media5 or Media9 3592 data cartridge, the option **Performance Scaling=y** allows you to keep the data on the initial 60 GB (for EFMT1), 100/128 GB (for EFMT2/EFMT3) with MEDIA5, or 140/200 GB (for EFMT2/EFMT3) with MEDIA9 at the beginning of the media. This function is dynamic. If the tape is returned to scratch and later reused, the cartridge is reformatted to its scaled or full capacity as indicated through the Data Class assigned.

– **Performance Segmentation**: Performance segmentation, if selected, divides the tape into two segments: One segment is a fast access segment to be filled first, and the other segment is additional capacity to be filled after the fast access segment:

  - With the 3592 Model J1A and EFMT1 (or the 3592 Model E05 and EFMT1), the MEDIA5 cartridge can be segmented into a 60 GB fast access segment and a 200 GB slower access segment.
  - With the 3592 Model E05 and EFMT2, the MEDIA5 cartridge can be segmented into a 100 GB fast access segment and a 333 GB slower access segment.
  - With the TS1120 Tape Drive, the MEDIA9 cartridge can be segmented into a 140 GB fast access segment and a 466 GB slower access segment.
  - With the 3592 Model E06 and EFMT3, the MEDIA5 cartridge can be segmented into a 128 GB fast access segment and a 426 GB slower access segment.
  - With the TS1130 Tape Drive, the MEDIA9 cartridge can be segmented into a 200 GB fast access segment and a 667 GB slower access segment.

> **Note:** Performance scaling and performance segmentation are mutually exclusive functions. You can define either one for a cartridge, but not both.

8. Press F8 after you have entered or updated the Recording Technology.

On the following panel, you also need to enter the Key Labels and the Encoding for both Key Labels as shown in Figure 9-18.

```
DGTDCDC8                      DATA CLASS ALTER                Page 4 of 5

SCDS Name . . . : DFSMS150.SCDS.SYS32
Data Class Name : HSMDCL1M

To ALTER Data Class, Specify:

  Encryption Management
    Key Label 1 . . .      (1 to 64 characters or blank)
    tape sol tst shr pvt 1024 lbl 01
    Key Label 2 . . .
    tape sol tst shr pvt 1024 lbl 02

  Encoding for Key Label 1  . . . . . . L          (L, H or blank)
  Encoding for Key Label 2  . . . . . . H          (L, H or blank)



Command ===>
 F1=Help    F2=Split   F3=End     F4=Return  F7=Up      F8=Down    F9=Swap
F10=Left   F11=Right  F12=Cursor
```

Figure 9-18 Data Class Alter panel (4 of 5)

If you change existing Data Classes, verify your Data Class ACS routine to make sure that you are assigning the correct constructs. If you create new Data Classes, update your Data Class ACS routine to have the new constructs assigned to those tape datasets that you want to have encrypted.

To activate the new SMS definitions:

- Translate the Data Class ACS routine.
- Validate the ACS routines.
- Activate the SMS SCDS.

In addition to using a Data Class construct or instead of using a Data Class construct, you can also request Tape Encryption through JCL as shown in Example 9-3.

Example 9-3 Sample JCL to write an encrypted cartridge

```
//CO2STRW1   JOB  CONSOLE,
//        MSGCLASS=H,MSGLEVEL=(1,1),CLASS=B,
//        TIME=1440,REGION=2M
/*JOBPARM SYSAFF=*
//*
//* ENC KEY MASTER JOB
//*
//CREATE1  EXEC PGM=IEBDG
//SYSPRINT DD SYSOUT=*
//SEQ001   DD DSN=TAPE.CO2M5CX2.PC5.NOPOOL.CO2STRS1.MASTER,
//         KEYLABL1='TAPE_SOL_TST_SHR_PVT_1024_LBL_02',
//         KEYENCD1=L,
//         KEYLABL2='TAPE_SOL_TST_SHR_PVT_2048_LBL_03',
//         KEYENCD2=H,
//         LABEL=(1,SL),UNIT=CO2M5CX2,DISP=(,CATLG),
//         DCB=(DSORG=PS,RECFM=FB,LRECL=2048,BLKSIZE=6144)
//SYSIN  DD *
    DSD OUTPUT=(SEQ001)
    FD  NAME=A,STARTLOC=1,LENGTH=10,FORMAT=ZD,INDEX=1
    FD  NAME=B,STARTLOC=11,LENGTH=13,PICTURE=13,'PRIMER RECORD'
    CREATE QUANTITY=25,FILL='Z',NAME=(A,B)
    END
/*
```

The job log for the job in Example 9-3 lists the keys that were used. Refer to Figure 9-19 on page 268.

```
 SDSF OUTPUT DISPLAY C02STRW1 JOB05753  DSID     2 LINE 0       COLUMNS 11- 90
 COMMAND INPUT ===> _                                          SCROLL ===> CSR
********************************* TOP OF DATA **********************************
            J E S 2  J O B  L O G  --  S Y S T E M  P C 5    --  N O D E  T U C

JOB05753 ---- THURSDAY,  21 SEP 2006 ----
JOB05753  IRR010I  USERID BARISKA  IS ASSIGNED TO THIS JOB.
JOB05753  $HASP373 C02STRW1 STARTED - INIT AS   - CLASS B - SYS PC5
JOB05753  IEF403I C02STRW1 - STARTED - TIME=14.06.57
JOB05753  IEF233A M 0780,J1G151,,C02STRW1,CREATE1
JOB05753  IEC205I SEQ001,C02STRW1,CREATE1,FILESEQ=2, COMPLETE VOLUME LIST,  150
          VOLS=J1G151,LISTED VOL(S) HAVE BEEN DATA ENCRYPTED,KL1CD:L,KL2CD:H,
          KL1=tape_sol_tst_shr_pvt_1024_lbl_01,
          KL2=tape_sol_tst_shr_pvt_1024_lbl_01,TOTALBLOCKS=9
JOB05753  IEF234E K 0780,J1G151,PVT,C02STRW1,CREATE1
JOB05753  JOB=C02STRW1 STEP=CREATE1  PGM=IEBDG    CC=0000
JOB05753  IEF404I C02STRW1 - ENDED - TIME=14.07.38
JOB05753  $HASP395 C02STRW1 ENDED
S2 JOB STATISTICS ------
2006 JOB EXECUTION DATE
  23 CARDS READ
  71 SYSOUT PRINT RECORDS
  F1=HELP      F2=SPLIT     F3=END       F4=RETURN    F5=IFIND     F6=BOOK
  F7=UP        F8=DOWN      F9=SWAP     F10=LEFT     F11=RIGHT    F12=RETRIEVE
```

Figure 9-19 MSGIEC205I indicates the key labels and key codes used

Note: The JCL data definition (DD) statements overwrite encryption specifications in the Data Class. If only one KEYLABL1 statement and only one KEYENCD1are coded in the JCL, a second key label and key code with the same information will be generated on the cartridge automatically. Whenever the first standard label (SL) on a cartridge contains encrypted data, all following SL file data is encrypted. Therefore, you do not need any more JCL or Data Classes to write encrypted data to the same cartridge. Using this method, you can prepare cartridges for encryption purposes by writing a small file with 'LABEL=(1,SL)' to a cartridge.

9. In the fifth page of the Data Class definition (Figure 9-20 on page 269), there are no options that apply to tape datasets. We merely provide this panel for your convenience.

```
DGTDCDC6                     DATA CLASS ALTER                Page 5 of 5

SCDS Name . . . : DFSMS150.SCDS.SYS32
Data Class Name : HSMDCL1M

To ALTER Data Class, Specify:

  Shareoptions Xregion  . . . _     (1 to 4 or blank)
               Xsystem  . . . _     (3, 4 or blank)
  Reuse . . . . . . . . . . . N     (Y or N)
  Initial Load  . . . . . . . R     (S=Speed, R=Recovery or blank)
  BWO . . . . . . . . . . . . __    (TC=TYPECICS, TI=TYPEIMS, NO or blank)
  Log . . . . . . . . . . . . _     (N=NONE, U=UNDO, A=ALL or blank)
  Logstream Id  . . . . . . . __________________________
  FRlog . . . . . . . . . . . _     (A=ALL, N=NONE, R=REDO, U=UNDO or blank)
  RLS CF Cache Value  . . . . A     (A=ALL, N=NONE, U=UPDATESONLY)
  RLS Above the 2-GB Bar  . . N     (Y or N)
  Extent Constraint Removal   N     (Y or N)
Command ===> _________________________________________________________________
 F1=Help     F2=Split    F3=End      F4=Return   F7=Up       F8=Down     F9=Swap
F10=Left    F11=Right   F12=Cursor
```

Figure 9-20 Data Class Alter panel (5 of 5)

> **Note:** Remember that the Data Class ACS routine is driven for both system-managed and non-system-managed datasets.

Defining Storage Classes

A dataset is system-managed only when a Storage Class is assigned to it. For tape datasets, specialized performance and availability services are not required (refer to Figure 9-21 on page 270).

```
Panel  Utilities  Scroll  Help
------------------------------------------------------------------------------
                              STORAGE CLASS DEFINE             Page 1 of 2
Command ===>

SCDS Name . . . . . : SMS.SCDS
Storage Class Name  : SCTAPLCL
To DEFINE Storage Class, Specify:
  Description ==>
              ==>
  Performance Objectives
   Direct Millisecond Response . . . .             (1 to 999 or blank)
   Direct Bias . . . . . . . . . . . .             (R, W or blank)
   Sequential Millisecond Response . .             (1 to 999 or blank)
   Sequential Bias . . . . . . . . . .             (R, W or blank)
   Initial Access Response Seconds . .             (0 to 9999 or blank)
   Sustained Data Rate (Mb/sec)  . . .             (0 to 999 or blank)
  Availability . . . . . . . . . . . . N           (C, P, S or N)
  Accessibility  . . . . . . . . . . . N           (C, P, S or N)
   Backup  . . . . . . . . . . . . . .             (Y, N or Blank)
   Versioning  . . . . . . . . . . . .             (Y, N or Blank)

Use ENTER to Perform Verification; Use DOWN Command to View next Page;
Use HELP Command for Help; Use END Command to Save and Exit; CANCEL to Exit.
```

Figure 9-21   STORAGE CLASS DEFINE panel (1 of 2)

You can define the Storage Class with defaults, because none of the attributes applies to system-managed tape. The one and only purpose of STORCLAS is to drive the ACS routines and assign a STORGROUP with connected tape libraries to the dataset that is allocated.

If you do not want a dataset to be system-managed, such as a dataset that belongs to a job with special requirements, you can assign a null (blank) Storage Class by ACS routine filtering.

The *Initial Access Response Time* (IART) is used for cache management if you have a VTS or TS7700 subsystem installed. If you want to hold virtual volumes longer in cache than other volumes, specify an Initial Access Response Seconds value of 0 seconds. To choose volumes that are unlikely to be recalled for migration first, assign a Storage Class with an IART value of 100 or greater. Refer to Table 9-3. Using IART requires FC4000, Advanced Function.

Table 9-3   Cache group preference summary

Cache group preference	IART	Management technique
0	100 seconds or more	Preferred removal of cache, largest first
1	Less than 100 seconds	Removal of volumes after group 0, least recently used

With the introduction of Advanced Policy Management (sometimes referred to as *Outboard Policy Management* (OPM)) for VTS or TS7700, cache management has been moved outboard.

Defining Management Classes

Because no Management Class attributes are available for tape cartridges, defining Management Classes is optional and not recommended. Follow these steps:

1. Choose option **3** (**Management Class**) on the ISMF PRIMARY OPTION MENU panel. The MANAGEMENT CLASS APPLICATION SELECTION panel appears.
2. On the MANAGEMENT CLASS APPLICATION SELECTION panel, specify a name for Management Class Name.
3. Choose option **3** (**DEFINE**) on the panel. The MANAGEMENT CLASS DEFINE panel (Figure 9-22) appears.

```
Panel  Utilities  Scroll  Help
------------------------------------------------------------------------------
                         MANAGEMENT CLASS DEFINE              Page 1 of 5
Command ===>

SCDS Name . . . . . . : SMS.SCDS
Management Class Name : MCTAPE

To DEFINE Management Class, Specify:

  Description ==>
              ==>

  Expiration Attributes
    Expire after Days Non-usage  . . NOLIMIT     (1 to 9999 or NOLIMIT)
    Expire after Date/Days . . . . . NOLIMIT     (0 to 9999, yyyy/mm/dd or
                                                 NOLIMIT)

  Retention Limit  . . . . . . . . . NOLIMIT     (0 to 9999 or NOLIMIT)



Use ENTER to Perform Verification; Use DOWN Command to View next Panel;
Use HELP Command for Help; Use END Command to Save and Exit; CANCEL to Exit.
```

Figure 9-22 MANAGEMENT CLASS DEFINE panel (1 of 5)

4. The SCDS Name and Management Class Name are output fields that you specified in the MANAGEMENT CLASS APPLICATION SELECTION panel:
   - **Expiration Attributes**: The attributes are required values that indicate when a dataset becomes eligible for expiration. They have no impact on tape data.
   - **Retention Limit**: This is a required value that limits the use of retention period (RETPD) and expiration date (EXPDT) values. RETPD and EXPDT are:
     - Explicitly specified in JCL
     - Derived from Data Class definitions

     If the value of a user-specified RETPD or EXPDT is within the retention limit value, it is saved for the dataset. If values specified by users or the Expiration Attributes values exceed the Retention Limit value, the retention limit is saved. If the retention limit is 0, any user-specified or Data Class values are ignored, and the expiration attributes of the Management Class are used.

If the JCL has something similar to RETPD=180 or EXPDT=99365, and the Retention Limit value is set to a value, such as 10 or 0, the actual retention assigned will be lowered to the Retention Limit. An informational message (IGD17364I) will be issued to the joblog.

We recommend that you use the tape management system to control the retention policy. Do not assign a Management Class or define a Management Class retention limit of NOLIMIT.

Note: If you use DFSMSrmm, you can use the Management Class name to select vital record specifications (VRSs) for the cartridge.

With the introduction of Advanced Policy Management and Outboard Policy Management for VTS, you can use the Management Class to create a selective dual copy for virtual volumes and to control the PtP VTS copy modes for logical volumes. The definitions for these functions are not done in the SMS-Management Class directly, but the assigned Management Class value is transferred to the Library Manager.

If there is a matching construct (the same name) defined in the OPM, the defined values for dual copy or peer-to-peer copy mode are used. The control of the peer-to-peer copy mode is based on a single volume. That way, you can control the copy mode (some workloads are handled in IMMED mode, and others in DEFERRED mode) for different workloads, unless you assign a Management Class and introduce the OPM.

Note: For more information about Management Classes, APM, and OPM, refer to *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312, or *IBM TotalStorage Virtual Tape Server Planning, Implementing, and Monitoring,* SG24-2229, for detailed information.

Defining Storage Groups

The Storage Group type TAPE is provided to classify tape cartridges in DFSMS. A tape Storage Group consists of tape libraries and the tape cartridges associated with them. A tape Storage Group can contain one to eight tape libraries specified by their library name. One tape library can contain more than one tape Storage Group. Figure 9-23 on page 273 shows the relationships among libraries and Storage Groups with four defined Storage Groups.

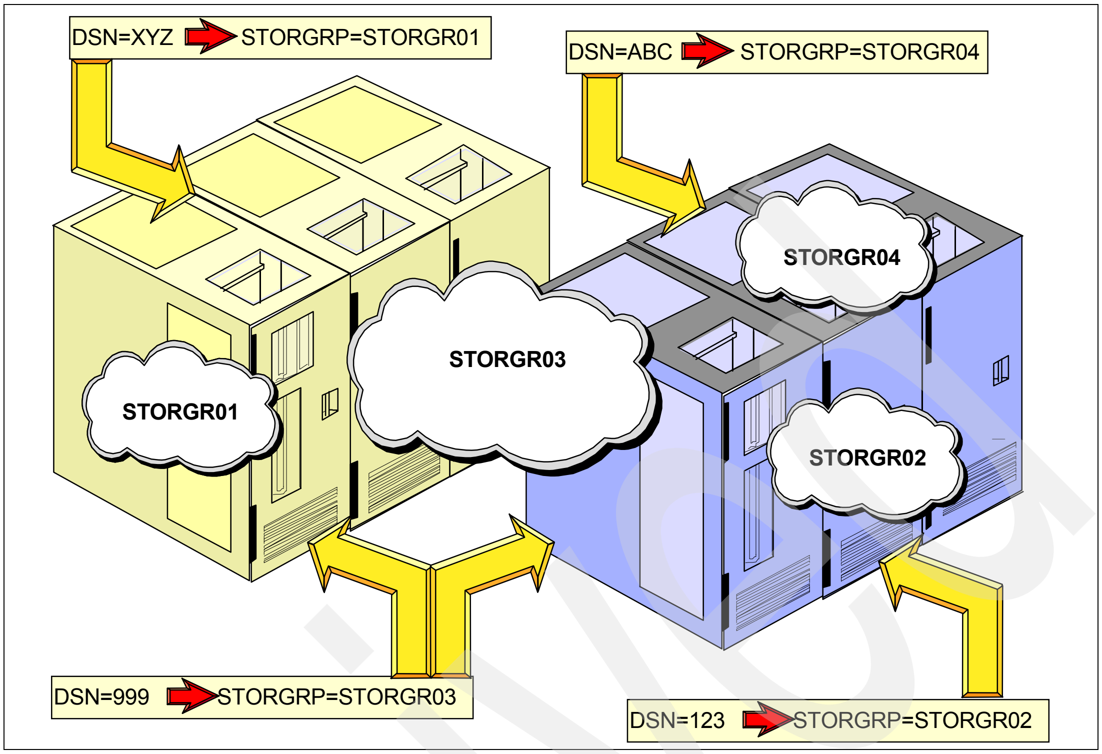


Figure 9-23 Relationships among libraries and Storage Groups

With the defined Storage Groups that are shown in Figure 9-23, the following actions occur:

- Dataset `XYZ` is assigned `STORGR01` and written on a volume residing in the left tape library.
- Dataset `123` is assigned `STORGR02` and written on a volume residing in the right tape library.
- Dataset `999` is assigned `STORGR03`, which is associated with both tape libraries, and is written in either tape library depending on the availability of tape drives and the number of available scratch volumes.
- Dataset `ABC` is assigned `STORGR04` and written on a volume residing in the right tape library.

To define a Storage Group, you must complete the following steps:

1. Choose option **6** (**Storage Group**) on the ISMF PRIMARY OPTION MENU panel. The STORAGE GROUP APPLICATION SELECTION panel (Figure 9-24 on page 274) appears.

```
 Panel  Utilities  Help
 ------------------------------------------------------------------------------
                      STORAGE GROUP APPLICATION SELECTION
 Command ===>

 To perform Storage Group Operations, Specify:
   CDS Name  . . . . . . . 'SMS.SCDS'
                               (1 to 44 character data set name or 'Active' )
   Storage Group Name  . . SGTAPLCL           (For Storage Group List, fully or
                                              partially specified or * for all)
   Storage Group Type  . . TAPE               (VIO, POOL, DUMMY, OBJECT, OBJECT
                                              BACKUP, or TAPE)

 Select one of the following options  :
   1  1. List    - Generate a list of Storage Groups
      2. Define  - Define a Storage Group
      3. Alter   - Alter a Storage Group
      4. Volume  - Display, Define, Alter or Delete Volume Information

 If List Option is chosen,
    Enter "/" to select option      Respecify View Criteria
                                    Respecify Sort Criteria
 Use ENTER to Perform Selection;
 Use HELP Command for Help; Use END Command to Exit.
```

Figure 9-24 STORAGE GROUP APPLICATION SELECTION panel

2. On the STORAGE GROUP APPLICATION SELECTION panel, specify the Storage Group Name and a Storage Group Type (TAPE, in our case).
3. Choose option **2** (**Define**). The TAPE STORAGE GROUP DEFINE panel (Figure 9-25) appears.

```
 Panel  Utilities  Help
 ------------------------------------------------------------------------------
                          TAPE STORAGE GROUP DEFINE
 Command ===>

 SCDS Name . . . . . : SMS.SCDS
 Storage Group Name  : SGTAPLCL

 To DEFINE Storage Group, Specify:

   Description ==> My local tape library
               ==>

   Library Names  (1 to 8 characters each):
     ===> LIBLCL    ===>          ===>          ===>
     ===>           ===>          ===>          ===>

===> DEFINE SMS Storage Group Status . .... N  (Y or N)

 Use ENTER to Perform Verification and Selection;
 Use HELP Command for Help; Use END Command to Save and Exit; CANCEL to Exit.
```

Figure 9-25 TAPE STORAGE GROUP DEFINE panel

The explanations of the parameters are:

– **Description**: This is a 120-byte field that allows you to enter a description of the tape Storage Group that you create. There are no restrictions on its content.
– **Library Names**: Use this field to specify the name of the tape library or libraries to which the cartridges will be assigned. A value must appear in this field to generate a new list. An asterisk (*) or the last used value displays for this field.
– **DEFINE SMS Storage Group Status**: Use this field to indicate that the SMS STORAGE GROUP STATUS DEFINE panel is to display after you press Enter. You can enable up to 32 systems to the Storage Group. Additional systems show on page 2 of 2.

4. Choose `Y` for the DEFINE SMS Storage Group Status field. Then, the SMS STORAGE GROUP STATUS DEFINE panel (Figure 9-26) appears.

```
Panel  Utilities  Scroll  Help
------------------------------------------------------------------------------
                      SMS STORAGE GROUP STATUS DEFINE
Command ===>

SCDS Name  . . . . : SMS.SCDS
Storage Group Name : SGTAPE
Storage Group Type : TAPE
To DEFINE Storage Group System/                          ( Possible SMS SG
Sys Group Status, Specify:                             Status for each:
                                                       - Pool SG Type
 System/Sys      SMS SG    System/Sys      SMS SG        NOTCON, ENABLE
 Group Name      Status    Group Name      Status        DISALL, DISNEW
 ----------      ------    ----------      ------        QUIALL, QUINEW
 MVS1       ===> ENABLE    MVS2       ===> ENABLE      - Tape SG Type
 *SYSPLX1   ===> NOTCON               ===>               NOTCON, ENABLE,
            ===>                      ===>               DISALL, DISNEW )
            ===>                      ===>
            ===>                      ===>             * SYS GROUP = sysplex
            ===>                      ===>               minus Systems in the
            ===>                      ===>               Sysplex explicitly
            ===>                      ===>               defined in the SCDS
Use ENTER to Perform Verification; Use DOWN Command to View next Panel;
Use HELP Command for Help; Use END Command to Save and Exit; CANCEL to Exit.
```

Figure 9-26 SMS STORAGE GROUP STATUS DEFINE panel

5. The explanations of these fields are:
– **System/Sys Group Name**: The column lists the names of systems known to SMS through the base configuration definition.
– **SMS SG Status**: Use this field to define or alter the relationship between the Storage Group and each system in the same SMSplex. Normally, you need to specify `ENABLE` for all systems that are going to use the library. A Storage Group can share up to 32 systems. Each system must be physically connected to the storage devices in its group. To change the status of a system, type one of the values described.

Use care when you must connect multiple libraries to the same Storage Group. The algorithm that is used to select a library and a drive takes into account the following information at the time of allocation:

- A list of tape device pools is built for all tape libraries that belong to the Storage Group.

  A *device pool* is a collection of tape drives attached to one controller that is part of a system-managed tape library.
- Based on SMS DATACLAS attributes for MEDIA for this allocation, drives that cannot satisfy the request are removed from the list.
- The preferred tape device pools belong to tape libraries that are above their scratch volume threshold.
- Drives with an active cartridge loader of the appropriate media type get a high priority.
- The ordered list of tape device pools is used to select the tape drive, randomizing the library selection.

Not considered in the allocation process are:

- Number of available drives inside the library, as long as there are enough drives to satisfy the total number of concurrent allocation requests
- Number of available scratch cartridges, as long as the library is above the defined threshold
- Busy condition of control unit or accessor
- Busy condition of VTS subsystem or its components

> **Note:** With the introduction of APM in the VTS, the Storage Group name is passed to the Library Manager. If a matching construct in OPM is coded, *physical volume pooling* is available, which means that specific logical volumes reside only in certain pools of physical volumes. For more information, refer to *IBM TotalStorage Virtual Tape Server Planning, Implementing, and Monitoring*, SG24-2229.

9.2.9 Pre-ACS installation exit

The pre-ACS routine exit (IGDACSXT) enables a tape management system to influence ACS routine construct selection. This exit can, for example, be used to direct allocation requests into or outside of a tape library by using the tape management system software functions.

Through this interface, four new read-only variables can be set by your tape management system and then can be used in Data Class, Management Class, and Storage Class ACS routine processing:

- Pool name (&MSPOOL)
- Policy name (&MSPOLICY)
- Destination name (&MSPDEST)
- User parameter information (&MSPARM)

The tape management system can use these variables to direct new allocations to a particular tape library and to coordinate vaulting runs for backups or off-site storage. Prior to invoking the ACS routines, the exit is called through dynamic exit services, which provides an opportunity for the tape management system to set the read-only variables.

Clients use their tape management system as a repository for movement rules of tape datasets to vaults or backup centers.

For environments with multiple system-managed tape libraries and complex vaulting requirements, allocation to a particular library or VTS must be matched to the vaulting requirements of the allocated datasets. Because this information is already available within the tape management system, this exit provides a way to make this information accessible to the ACS routines.

Note: DFSMSrmm does not use this exit. An equivalent interface exists (EDGUX100).

For more information regarding this pre-ACS routine exit, refer to *z/OS DFSMS Installation Exits*, SC26-7396.

9.2.10 Writing ACS routines

To direct new tape allocations to a TS3500 Tape Library, you have to update your ACS routines. For system-managed DASD, new datasets that have an assigned Storage Class are allocated to system-managed devices.

Refer to *z/OS DFSMS: Implementing System Managed Storage*, SC26-7407, for more information about the implementation and activation of SMS. We discuss only those steps necessary to implement system-managed tape.

You can use ACS routines to direct a new dataset to a Storage Group according to the ACS variables and SMS constructs that you have created. An active configuration must have only one set of ACS routines. To update ACS routines, follow these steps:

1. Choose option **7** (**Automatic Class Selection**) from the ISMF PRIMARY OPTION MENU panel. The ACS APPLICATION SELECTION panel appears.
2. On this panel, select option **1** (**Edit**) and press Enter to update the ACS routines.

Table 9-4 through Table 9-7 on page 278 present sample attributes for the Data Classes, Storage Groups, Management Classes, and Storage Classes that are used in the ACS routine examples in the following section.

Table 9-4 Sample Data Class attribute

Data Class name	Compaction	Media type	Recording technology
DCTAPEX	No	1	36
DCTAPSM	Yes	2	36
DCTAPLR	Yes	3	128
DCTAP5E	Yes	5	E1
DCTAP5H	Yes	9	E2
DCTPA5EX	Yes	4	256

Table 9-5 Sample Storage Group attribute

Storage Group name	Library name	Accessible system
SGTAPLCL	LIBLCL	MVS1, MVS2
SGTAPRMT	LIBRMT	MVS1, MVS2

Table 9-6 Sample Management Class attribute

Management Class name	Retention limit
MCTAPE	NOLIMIT

Table 9-7 Sample Storage Class attribute

Storage Class name	Availability	Accessibility	Guaranteed space
SCTAPLCL	NOPREF	NOPREF	NO
SCTAPRMT	NOPREF	NOPREF	NO

For the ACS routines, we make the following assumptions:

- 3490E, 3590, and 3592 subsystems are configured in this installation, which has 3494 and TS3500 libraries installed. Native 3490 and 3590 tape drives are contained in the 3494 libraries, and native 3592 and virtual 3490E drives (TS7700) are contained in the TS3500 libraries.
- The following combinations of media type and recording technology are possible:

MEDIA1, MEDIA2	36 track
MEDIA3, MEDIA4	128, 256, and 384-track Read/Write
MEDIA5 - MEDIA8	EFMT1, EFMT2/EEFMT2, and EFMT3/EEFMT3
MEDIA9, MEDIA10	EFMT2/EEFMT2 and EFMT3/EEFMT3

- DASD DFSMS is not described, and the ACS routines in our example do not necessarily assign all constructs that were defined.
- The libraries contain DFSMShsm-owned data.
- The libraries are in different buildings: local (LCL) and remote (RMT).

Data Class ACS routine

The Data Class ACS routine (refer to Example 9-4) is driven for both system-managed and non-system-managed datasets. NON-IDRC must be specified on datasets used by applications that invoke the READ BACKWARDS commands or datasets that are shipped to facilities that do not have IDRC-capable drives.

> **Note:** The following examples are simple. They only provide basic information about how ACS routines are coded. The ACS routines in your environment will contain many more definitions for tape support. With the introduction of APM, the ACS routines must be redone.

Example 9-4 Sample Data Class ACS routine

```
PROC DATACLAS
/****************************************************/
/* DEFINE TAPE DATA SETS FILTERING CATEGORY         */
/****************************************************/
FILTLIST CSTTAPE INCLUDE('3490',348%,'3590-1','CART','LIBLCL')
FILTLIST LARGE_TAPE INCLUDE(GSNATE.*.DBSAV*, **.*TAG*.**, ADA%.SAVE.**)
FILTLIST VITALREC INCLUDE(**.LEGAL.**)
FILTLIST EXCHANGE INCLUDE(PORTABLE.**,CITI*.**,SWISSBNK.CORP.**)
FILTLIST HSM     INCLUDE(*.HMIGTAPE.DATASET, *.BACKTAPE.DATASET)
FILTLIST HSMCOPY  INCLUDE(*.COPY.HMIGTAPE.DATASET, *.COPY.BACKTAPE.DATASET)
FILTLIST DUMPATL INCLUDE(*.DMP.*.V*.D*.T*)
                    EXCLUDE(*.DMP.OUTLIB.V*.D*.T*)
FILTLIST PGMATL INCLUDE('ADRDSSU',I%%GENER)
FILTLIST ABARS INCLUDE(outputdatasetprefix.%.C%%V%%%%)
```

```
FILTLIST TAPEDC INCLUDE(DCTAP*)
FILTLIST TAPESC INCLUDE(SCTAP%%%)
/**************************************************/
/* SELECT DATA CLASS FOR DATA SET GOOD FOR ATL    */
/**************************************************/
SELECT
     WHEN (&DATACLAS = &TAPEDC && &UNIT = &CSTTAPE)
       DO
         SET &DATACLAS = &DATACLAS    /* Allow users to specify */
         EXIT                         /* data class for tape */
       END
     WHEN (&UNIT = 'LIBLCL')
       DO
         SET &DATACLAS = DCTAPLR      /* Allow users to specify */
                                      /* unit for atls */
         WRITE 'DC: DEFAULT DC ASSIGNED DUE TO ATL UNIT SPECIFICATION'
         EXIT
       END
    WHEN (&UNIT = &CSTTAPE)
      DO
         SELECT
           WHEN (&DSN = &LARGE_TAPE | &DSN = DFSMShsm | &DSN = &HSMCOPY)
              DO
                SET &DATACLAS = 'DCTAP5H'       /* 3592 tapes for large datasets*/
                EXIT
              END
           WHEN ( &DSN = &DUMPATL | &DSN = &ABARS)
             DO
               SET &DATACLAS = 'DCTAPSM'       /* Abars on 3490, with compaction */
               EXIT
             END
           WHEN ...
             ...
             ...
             END
           WHEN ( &PGM = &PGMATL )
             DO
               SET &DATACLAS = 'DCTAPLR'    /* Route        */
               EXIT                         /* specified pgms  */
             END                            /* to atl    */
           WHEN (&DSN = &EXCHANGE )
             DO
               SET &DATACLAS = 'DCTAPEX'       /* tapes to exchange get NO Compaction */
               EXIT
             END
           END
   END
/*******************************************************************/
   OTHERWISE
       DO
         SET &DATACLAS = ''
         EXIT
       END
   END
END
```

Storage Class ACS routine

If you do not want datasets to be system-managed, you can assign a null (blank) Storage Class to them by using ACS routine filtering. Because the disposition processing for tape datasets is not changed with system-managed tape, the DISP parameter affects the entry point to the ACS routines. Example 9-5 shows a sample Storage Class ACS routine.

Example 9-5 Sample Storage Class ACS routine

```
PROC STORCLAS
/****************************************************/
/* DEFINE TAPE DATA SETS FILTERING CATEGORY         */
/****************************************************/
/*ALL FILTERLISTS COPIED FROM DATACLAS ROUTINE TO   */
/*ENSURE CONSISTENCY                                */
FILTLIST CSTTAPE INCLUDE('3490',348%,'3590','CART','LIBLCL')
FILTLIST LARGE_TAPE INCLUDE(GSNATE.*.DBSAV*, **.*TAG*.**, IOOOO.**.SARTAPE.T*)
FILTLIST VITALREC INCLUDE(**.LEGAL.**)
FILTLIST EXCHANGE INCLUDE(PORTABLE.**,CITI*.**,SWISSBNK.CORP.**)
FILTLIST HSM     INCLUDE(*.HMIGTAPE.DATASET, *.BACKTAPE.DATASET)
FILTLIST HSMCOPY INCLUDE(*.COPY.HMIGTAPE.DATASET, *.COPY.BACKTAPE.DATASET)
FILTLIST DUMPATL INCLUDE(*.DMP.*.V*.D*.T*)
                 EXCLUDE(*.DMP.OUTLIB.V*.D*.T*)
FILTLIST PGMATL INCLUDE('ADRDSSU',I%%GENER)
FILTLIST ABARS INCLUDE(outputdatasetprefix.%.C%%V%%%%)
FILTLIST TAPEDC INCLUDE(DCTAP*)
FILTLIST TAPESC INCLUDE(SCTAP%%%)
/****************************************************/
/* SELECT STORAGE CLASS FOR DATA SET GOOD FOR TS3500  */
/****************************************************/
SELECT
     WHEN (&DSN = &HSMCOPY | &DSN = &DUMPATL) /* this data is kept in the remoteLib*/
       DO
         SET &STORCLAS = 'SCTAPRMT'
         EXIT
       END
     WHEN (&DSN = DFSMShsm )
       DO
         SET &STORCLAS = 'SCTAPLCL'             /* this data is kept in the locallib */
         EXIT
       END
     WHEN (&DATACLAS = DCTAP* )                 /* this data is kept in the locallib */
       DO
         SET &STORCLAS = 'SCTAPLCL'
         EXIT
       END
/****************************************************/
/* ABARS OUTSIDE Tape Library                       */
/****************************************************/
WHEN (&DSN = &ABARS )
       DO
         SET &STORCLAS = ''
         EXIT
       END
/****************************************************/
/* We do not intend manage anything elseTape Library*/
/****************************************************/
OTHERWISE
       DO
         SET &STORCLAS = ''
         EXIT
```

```
       END
   END       /*End of Data set selection */
END             /*End of storage Class PROC for dataset*/
```

Management Class ACS routine

You can use the Management Class ACS routine (Example 9-6) to assign a MGMTCLAS to each tape allocated under system-managed tape. For detailed coverage of how MGMTCLAS works with system-managed tape; refer to Figure 9-22 on page 271.

Example 9-6 Sample Management Class ACS routine

```
PROC MGMTCLAS
/*****************************************************/
/* DEFINE TAPE DATA SETS FILTERING CATEGORY         */
/*****************************************************/
/*****************************************************/
/* SELECT MGMT CLASS FOR DATA SET GOOD FOR TS3500  */
/*****************************************************/
SELECT
     WHEN (&DATACLAS = DCTAP* ) DO
       SET &MGMTCLAS = 'MCTAPE'
       EXIT
     END
/*****************************************************/
/* WE DO NOT INTEND MANAGE ANYTHING ELSE            */
/*****************************************************/
     OTHERWISE
         DO
           SET &MGMTCLAS = ''
           EXIT
         END
   END        /* END OF DATA SET SELECTION              */
END           /* END OF MGMT CLASS PROC FOR TAPE DATA SET */
```

Storage Group ACS routine

The Storage Group ACS routine (Example 9-7) determines the tape cartridge group and the library name group for a dataset. If the user requests z/OS to catalog the dataset, unlike DASD, the dataset is cataloged at disposition time, rather than at allocation time.

Example 9-7 Sample Storage Group ACS routine

```
PROC STORGRP
/*****************************************************/
/* DEFINE TAPE DATA SETS FILTERING CATEGORY         */
/******************************************************/
/* Since all filtering is done in the SC routine, no */
/* additional code is needed                         */
/******************************************************/
/* DETERMINE STORAGE GROUP FOR DATA SET GOOD FOR ATL */
/******************************************************/
SELECT
      WHEN (&STORCLAS = 'SCTAPLCL')
        DO
          SET &STORGRP = 'SGTAPLCL' /*this storagegroup contains the locallib*/
          EXIT
        END
      WHEN (&STORCLAS = 'SCTAPRMT')
        DO
```

```
        SET &STORGRP = 'SGTAPRMT' /*this storagegroup contains the remotelib*/
        EXIT
      END
   END       /* END OF DATA SET SELECTION */
END         /* END SG PROC               */
```

Translating and validating ACS routines

After updating the ACS routines, you translate them into an executable form. A successful translation places the ACS routine object in the SCDS that you specified.

After translation is successfully completed and syntax checking is performed, you validate your routines against the constructs and libraries defined. You can validate an entire SCDS or a specific set of constructs within an SCDS. Follow these steps:

1. Select option **3** from the ACS APPLICATION SELECTION panel.
2. In the SCDS Name field, specify the name of your SCDS.
3. Enter an asterisk (*****) in the ACS Routine Type field to indicate that you want to validate the entire SCDS.

The validation process reports any logical errors. If it is not successful, it prevents the activation of the configuration.

Testing ACS routines

You can write and execute test cases using option **4** in the ACS APPLICATION SELECTION panel. The input test cases are saved in a partitioned dataset. You can edit its contents directly without going through the panels. Just add the variables as you use them in the ACS routines. Refer to Example 9-8.

Example 9-8 ACS test sample member

```
DESCRIPTION1:
TESTCASE FOR HSM DATA
DSN: HSM.HMIGTAPE.DATASET
ACSENVIR: ALLOC
PGM: ARCCTL
UNIT: 3490
LABEL: SL
FILENUM: 1
```

We recommend that you prepare a set of test cases for all applications that are system-managed on either DASD or tape. Using this kit of test cases, you can verify the logic of your ACS routines after introducing changes and updates. In this way, errors can be detected before you activate a new configuration and run into any trouble that might affect your production environment. Refer to 9.2.16, “Testing ACS logic with NaviQuest” on page 294 for additional information about testing ACS routines.

The ACS TESTING RESULTS panel in Figure 9-27 on page 283 shows the result of checking the specified input against the SCDS.

```
                                ACS TESTING RESULTS

CDS NAME         : SMS.SCDS0
ACS ROUTINE TYPES: DC SC MC SG
ACS TEST LIBRARY : SMS.TESTCASES.DATA

  ACS TEST
  MEMBER       EXIT CODE   RESULTS
  ---------    ----------  ------------------------------------
  NONLIB1               0  DC = NULL VALUE ASSIGNED
    MSG : ANY-MESSAGE-YOU-WRITE-IN-THE-ACS-ROUTINES
                        0  SC = NULL VALUE ASSIGNED
    NOTE: MC AND SG NOT EXECUTED WHEN ACS READ/WRITE VARIABLE STORCLAS = ''

  TAPE1                 0  DC = DCTAPLR
                        0  SC = SCTAPLCL
                        0  MC = MCTAPE
                        0  SG = SGTAPLCL

  TAPE2                 0  DC = DCTAPSM
                        0  SC = SCTAPRMT
                        0  MC = MCTAPE
                        0  SG = SGTAPRMT
```

Figure 9-27 ACS TESTING RESULTS panel

9.2.11 Activating the SMS configuration and restarting OAM

You must activate the SMS configuration before you can start to use your TS3500 Tape Library. Activating an SCDS validates its contents and copies the contents into the ACDS specified in IGDSMS*xx*. If the SCDS is not valid, activation fails.

Note: If you are activating another SCDS or reactivating the current SCDS while OAM is running, OAM restarts if the Restart parameter in the Started Task is set to YES. During this re-initialization, *all* logical libraries defined in the TS3500 are set either to off-line or online according to the tape library definition in the active SCDS.

If the library was defined as *online* during library definition, it is brought online as part of the OAM address space initialization. Otherwise, vary the library online by using this z/OS operator command:

```
VARY SMS,LIBRARY(libname),ONLINE
```

Note: Before you activate the SCDS or vary the TS3500 Tape Library online, make sure that the tape management system is active and customized. Refer to 9.2.6, “Updating and customizing your tape management system” on page 250.

9.2.12 JES3 customization

For information about JES3 customization, refer to Appendix D, “JES3 examples and information” on page 481.

9.2.13 DFSMShsm customization

The most significant change resulting from the support of system-managed tape units and tape volumes is the transition of device selection capabilities. Refer to *z/OS DFSMShsm Implementation and Customization Guide*, SC35-0418, for detailed information about how to customize DFSMShsm for system-managed tape.

The following DFSMShsm functions can use tape library devices when writing output to tape:

- Migration
- Backup
- Spill
- Backup of the DFSMShsm CDSs and journal
- Recycle for migration and backup tapes
- Full volume dump
- ABARS
- Tape copy for migration and backup tapes
- Duplex tape for migration and backup tapes

> **Note:** The IBM TotalStorage Enterprise Tape Cartridge 3592 WORM and Economy WORM cannot be used by HSM. Also, because these cartridges cannot be overwritten, it defeats the purpose of the recycle function of HSM. Otherwise, the IBM TotalStorage Tape Cartridge 3592 WORM and Economy WORM can be used with ABARS.

DFHSM considerations using TS1130 tape drives

We have collected all the TS1130-related considerations under this heading.

Media utilization

The TS1130 can utilize scratch MEDIA5, MEDIA7, and MEDIA9 tapes for all DFSMShsm functions and also MEDIA6, MEDIA8, and MEDIA10 tapes for ABARS. Because the TS1130 drive can write both in its native EFMT3 and in the older EFMT2 recording technologies, the recording technology used on scratch media will be controlled by the Data Class assigned to the tape by the ACS routines. EFMT3 is the default if no recording technology is specified.

The ACS routines often use the single file format tape dataset name to make the Data Class selection. This control is transparent to DFSMShsm.

Output to partial tapes

When the TS1130 uses a partial tape for output, the existing data on the tape can be in either the EFMT2 or the EFMT3 recording technology. The tape will be extended in the same format. The choice of the correct recording technology will be transparent to DFSMShsm. MEDIA6, MEDIA8, and MEDIA10 tapes are normally only used by ABARS and only as scratch tapes.

The 3592-J1A and TS1120 drives also consider using the same partial tapes. The 3592-J1A or the TS1120 operating in J1A Emulation mode must not select EFMT2, EEFMT2, EFMT3, or EEFMT3 partial tapes. The TS1120 must not select EFMT3 or EEFMT3 partial tapes. The TS1130 must not select EFMT1 partial tapes.

Input tapes

DFSMShsm can utilize the following media types:

- MEDIA5, MEDIA7, and MEDIA9 can be input for all functions.
- MEDIA6, MEDIA8, and MEDIA10 can be used with the ABARS function.

- MEDIA5, MEDIA6, MEDIA7, and MEDIA8 tapes can be in either the EFMT1, EFMT2, or EFMT3 recording technology.
- The MEDIA9 and MEDIA10 tapes can only be in the EFMT2 or EFMT3 recording technology.

The choice of the correct recording technology when they are mounted on a TS1130 will be transparent to DFSMShsm.

Duplex tape considerations

For duplexed tapes, make sure that the Data Class selects the same media type and recording technology for the original and the alternate copy. Failure to be consistent can result in failure either when the duplex tape is mounted for output or when using the alternate copy after a tape replace.

HSMplex considerations

In an HSMplex, all systems in the HSMplex must have full support for the 3592 Model E06 tape subsystem before any instance of DFSMShsm uses the 3592 Model E06. If any system does not fully support the 3592 Model E06 in an HSMplex using E06 drives, a request for tape input can fail, because a 3592 Model E06 device is not available on that system.

Allocation

With system-managed tape, DFSMShsm has no decisive role for unit allocation. If the ACS routines direct a DFSMShsm allocation request to a library, the DFSMShsm unit names have no affect on allocation. However, the names are passed to the ACS routines. Refer to the DFSMShsm unit parameters in Table 9-8 on page 286 for a complete list of all of the parameters that have unit options. For SMS-managed output tape selection, DFSMShsm performs a non-specific allocation; it then finds an acceptable output tape for the already allocated drive. If you use a 3590-1 generic that contains mixed devices, refer to APAR OW57282 for information about disabling the 3590-1 mixed device checking and the corresponding ARC0030I failure message. If the tape is not system-managed, the unit name retains the control.

> **Note:** If you use the &UNIT-variable in your ACS routines to select hierarchical storage management (HSM) datasets as candidates for the library, you must explicitly specify a unit name in the respective HSM parameters.

Table 9-8 DFSMShsm unit parameter

Command	Parameter
ABACKUP	UNIT(*tape-unitname*)
ADDVOL	UNIT(*tape-unitname*)
ARECOVER	UNIT(*tape-unitname*) TARGETUNIT(*tape-unitname*)
DEFINE	UNIT(*tape-unitname*) ABARSUNITNAME(*tape-unitname*) ARECOVERML2UNIT(*tape-unitname*) ARECOVERUNITNAME(*tape-unitname*) BACKUPTAPE(*tape-unitname*) CDSVERSIONBACKUP(UNITNAME(*tape-unitname*)) MIGUNITNAME(*tape-unitname*) RECYCLEOUTPUT(BACKUP(*tape-unitname*) migration(*tape-unitname*)) SPILL(TAPE(*tape-unitname*)) TAPEMIGRATION(DIRECT(TAPE(*tape-unitname*)) - ML2TAPE(TAPE(*tape-unitname*)) - NONE(ROUTETOTAPE(*tape-unitname*))) TAPEUTILIZATION(UNITNAME(*tape-unitname*)) UNITNAME(*tape-unitname*)
TAPECOPY	ALTERNATEUNITNAME(*tape1-unitname,tape2-unitname*) ALTERNATE3590UNITNAME(*tape1-unitname,tape2-unitname*)
TAPEREPL	ALTERNATEUNT(*tape-unitname*)

The Data Class MEDIA TYPE and RECORDING TECHNOLOGY parameters are honored. They are used to select the allocation of a library device. They override parameter settings in the ARCCMD*xx* member of PARMLIB. TAPEHARDWARECOMPACT only relates to 3480 output and is superseded by the Data Class. If no Data Class is assigned to a DFSMShsm-generated tape inside of a library, compaction is the default.

When you want to implement DFSMShsm functions in a tape library, you must determine which functions will use it. Then, set up the ACS routines to assign a Storage Class, a Data Class for IDRC and recording format, and a Storage Group for tape.

To define the tape environment (global scratch pool or DFSMShsm-specific scratch pool), make the required updates to the following DFSMShsm commands:

- **SETSYS SELECTVOLUME(SCRATCH)**: For performance reasons, use a global scratch pool for a DFSMShsm function that uses the library. If you use a DFSMShsm-specific scratch pool (tape volumes already defined to DFSMShsm with the ADDVOL), you must assign a private category to the scratch tape volumes for DFSMShsm to use when they are added to the tape library.
- **SETSYS TAPEDELETION(SCRATCHTAPE)**: This option tells DFSMShsm to return recycled migration and backup tapes, along with expired dump tapes, to a global scratch pool.
- **SETSYS PARTIALTAPE(MARKFULL|REUSE)**: Migration and backup tapes that are partially filled during tape output processing are marked full if you specify the MARKFULL option. MARKFULL enables a scratch tape to be selected the next time that the same function begins. When total tape-media use and low recycle overhead are more important, specify PARTIALTAPE(REUSE). A REUSE environment fully uses tapes and reduces the amount of recycle processing.

We recommend that you use PARTIALTAPE(MARKFULL) for VTS logical volumes. It enables the VTS to use “Fast Ready” allocation in the Tape Volume Cache. MARKFULL is also required if TAPECOPY is used to make off-site copies of HSM media.

Dataset names

Output device selection is based on the dataset name given to the ACS routines. The dataset name here is the name of the single-file dataset on tape. It is related to the DFSMShsm function that performs the output (for example, MIGRATE or BACKUP). This dataset name has no relationship to the original DASD level 0 user’s dataset name. Because the 3592-E05 can write in either of two recording formats (EFMT1 or EFMT2) to MEDIA5, MEDIA6, MEDIA7, MEDIA8, MEDIA9, and MEDIA10 cartridges, you must modify your installation’s ACS routines to select the recording format to use on blank media (through the Data Class assigned to the tape) if you want the 3592 Model E05 drives to use EFMT1.

The 3592-E06 can write in either of two recording formats (EFMT2 or EFMT3) to MEDIA5, MEDIA6, MEDIA7, MEDIA8, MEDIA9, and MEDIA10 cartridges. You must modify your installation’s ACS routines to select the recording format to use on blank media (through the Data Class assigned to the tape) if you want the 3592 Model E06 drives to use the EFMT2 format; the default is format EFMT3.

Here is a list of the dataset names that are used for tape allocation with BACKUP, MIGRATION, DUMP, DUPLEX, and TAPECOPY:

- backup_prefix.BACKTAPE.DATASET (backup)
- migration_prefix.HMIGTAPE.DATASET (migration)
- backup_prefix.DMP.dclass.V*VOLSER*.D*yyddd*.T*ssmmhh* (dump)
- backup_prefix.COPY.BACKTAPE.DATASET (tapecopy, duplex of backup)
- migration_prefix.COPY.HMIGTAPE.DATASET (tapecopy, duplex of migration)

Here is a list of the dataset names that are used for tape allocation with control dataset backups:

- *uid*.BCDS.BACKUP.V*nnnnnnn* (DATAMOVER=HSM)
- *uid*.MCDS.BACKUP.V*nnnnnnn* (DATAMOVER=HSM)
- *uid*.OCDS.BACKUP.V*nnnnnnn* (DATAMOVER=HSM)
- *uid*.JRNL.BACKUP.V*nnnnnnn* (DATAMOVER=HSM)
- *uid*.BCDS.BACKUP.D*nnnnnnn* (DATAMOVER=DSS)
- *uid*.MCDS.BACKUP.D*nnnnnnn* (DATAMOVER=DSS)
- *uid*.OCDS.BACKUP.D*nnnnnnn* (DATAMOVER=DSS)
- *uid*.JRNL.BACKUP.D*nnnnnnn* (DATAMOVER=DSS)

If you use Multi Cluster control datasets (supported for both MCDS and BCDS, if the control dataset size increases beyond one volume), the dataset name changes for the backup copies as follows:

- *uid*.BCDS.BACKUP.DS*y*.D*nnnnnnn* (DATAMOVER=DSS)
- *uid*.MCDS.BACKUP.DS*y*.D*nnnnnnn* (DATAMOVER=DSS)
- *uid*.OCDS.BACKUP.DS*y*.D*nnnnnnn* (DATAMOVER=DSS)
- *uid*.JRNL.BACKUP.DS*y*.D*nnnnnnn* (DATAMOVER=DSS)

Each low-level qualifier must be preceded by *DSy* where *y* is a number from 1 to 4, representing the number of volumes in the Multi Cluster CDS.

Here is a list of the dataset names that are used for tape allocation with ABARS:

- outputdatasetprefix.C.C*cc*V*nnnn* (control file)
- outputdatasetprefix.D.C*cc*V*nnnn* (data file)
- outputdatasetprefix.I.C*cc*V*nnnn* (instruction file)
- outputdatasetprefix.O.C*cc*V*nnnn* (internal data file)

If you request PARTIALTAPE(REUSE), the tape volume selected after allocation of a unit is one that can be mounted on the allocated unit. The use of the specific scratch pool with DFSMShsm is still supported with system-managed tape.

When input datasets are allocated for DFSMShsm, the situation is more strictly controlled. A tape unit within the proper library is always selected for a library-resident volume. It is not possible to use a tape unit in one library for tapes that reside in another library.

9.2.14 Library parameters

These parameters and options are related to, or are used with, tape library operations:

- SETSYS TAPEUTILIZATION(LIBRARYBACKUP PERCENTFULL(*pct*))
- SETSYS TAPEUTILIZATION(LIBRARYMIGRATION PERCENTFULL(*pct*))
- SETSYS TAPESPANSIZE(*nnn*)
- SETSYS DUPLEX(BACKUP(Y|N))
- SETSYS DUPLEX(MIGRATION(Y|N))
- DEFINE ABARSTAPES(STACK|NOSTACK)
- DEFINE DUMPCLASS (*dclass* STACK(*nn*))
- BACKVOL SG(*sgname*)|VOLUMES(*VOLSER*) DUMP(*dclass* STACK(*nn*))

SETSYS TAPEUTILIZATION PERCENTFULL(*pct*)

DFSMShsm writes to 97% of the capacity of MEDIA5, MEDIA6, MEDIA7, MEDIA8, MEDIA9, and MEDIA10 tapes unless otherwise specified. Other percentages can be specified through the SETSYS TAPEUTILIZATION command, depending on the particular needs of the installation. DFSMShsm uses the reported cartridge type on the physical device to determine the tape's capacity. The LIBRARYMIGRATION and LIBRARYBACKUP parameters apply to system-managed tape library tapes only.

If you copy the contents of one tape to another tape with the TAPECOPY command or use the concurrent creation option, DUPLEX, minor inconsistencies can exist in the length of cartridge-type tapes. Because the TAPECOPY command copies the entire contents of one tape to another tape, enough media *must* be available to copy the entire source tape to its target. Therefore, when you are copying tapes with the TAPECOPY command, use the default options (the equivalent of specifying the TAPEUTILIZATION command with the PERCENTFULL option of 97%).

DFSMShsm marks the end of volume when tapes are 97% full. When you use the DUPLEX option, we recommend that you use the 97% value to ensure that you can write the same amount of data to both tapes. During duplexing, the NOLIMIT parameter of TAPEUTILIZATION is converted to the default of 97%.

If you use virtual tapes in an IBM VTS system for your backup or migration volumes, and if the backups or migration (and any duplexing) in IBM libraries are done exclusively to a VTS/TS7700 by this instance of DFSMShsm, we recommend that you specify the PERCENTFULL(*pct*) option for the LIBRARYBACKUP and LIBRARYMIGRATION parameters with the values shown in Table 9-9 on page 289. Specifying PERCENTFULL allows DFSMShsm to fill a virtual 3490 tape to its logical capacity, rather than assuming the presence of inter-record gaps and other tape formatting blocks not actually written to a virtual tape.

DFHSM Percent Full recommendations

Problems can arise when using DFHSM's Tape Copy Utility if the target volume signals that it is almost full with additional data still to be copied. The TS7700 (or any tape device) indicates that the tape volume is almost full by signaling a unit exception shortly before the tape drive has reached the end of the volume.

The part of a tape volume between when the unit exception begins to be reported and when a physical end of volume error is reported is called the Logical End of Volume (LEOV) region. For most tape drives, the LEOV region can store between 100s of KBs to a few MBs. For the VTS/TS7700, it is 8 MBs. The amount that the region can store is more than enough for the host application to write its last few records and close the volume with necessary trailer labels. So, it is expected that when an application sees the unit exception, it finishes the writes that it needs and closes the volume. This method is the typical way end of volume handling is performed.

For HSM, when it is writing its original volume, it handles the LEOV indication as expected. This results in a volume that has just a little more data on it past the LEOV point. For HSM tape copy, it treats the LEOV indication as a failure condition, thinking that it has run out of space and that the target volume is too small.

To avoid this issue, the Percent Full Utilization values that were recommended in the past need to be changed so that HSM will consider a volume full before it enters the LEOV region. Then when it copies the volume, there will be no issues with encountering the LEOV region.

To complicate this a bit, the Percent Full values need to take into account the media type and the logical volume size being used. Virtual volumes appear to HSM as either Media 1 or Media 2 (determined at insert time when the virtual volume was created). HSM has no knowledge of the larger logical volume sizes that can be assigned to virtual volumes through APM or OPM and must be told to fill them greater than 100%.

These are the maximum Percent Full Utilization values that can be used by media type and volume size to avoid reaching the LEOV region. There is a safety margin of a little over 2 MB in these values.

Table 9-9 Recommended DFHSM Percent Full values for VTS and TS7700

Insert media type	Virtual volume size	Percent Full HSM	Volume size
Media 1	400 MB	106	406 614 300
Media 2	800 MB	107	820 905 540
Media 1	1000 MB	270	1 035 720 784
Media 1	2000 MB	543	2 082 837 888
Media 1	4000 MB	1090	4 180 893 500
Media 2	1000 MB	135	1 035 720 784
Media 2	2000 MB	271	2 078 999 196
Media 2	4000 MB	545	4 180 893 500

SETSYS TAPESPANSIZE

This parameter can be set to get a balance between the amount of tape that remains unused and the number of cases where a dataset goes to two volumes. The value is best described as the *smallest size data* that you are willing to allow to *span multiple tapes*. Knowing the statistical distribution of the dataset sizes can help you set this value.

If you have an excessive number of spanning datasets, consider specifying a larger value in the SETSYS TAPESPANSIZE command. A larger absolute value is needed to represent the same amount of unused capacity on a percentage basis when the tape has a larger total capacity. For example, to allow 2% unused tape for a MEDIA5 tape on, for example, a 3592 Model E05 device (no performance scaling), specify a TAPESPANSIZE of 9999 MB. All size calculations for scaled tapes are based upon the scaled size and not the unscaled size.

The tape volumes created by DFSMShsm migration and backup functions can contain datasets that span from one tape volume to another. Each case of a dataset spanning volumes in this manner is said to create a *connected group*. Every succeeding connection from the second volume to a third volume, and so on, extends the size of the connected volume group. An FEOV between datasets reduces the occurrence of datasets spanning tape volumes.

If SETSYS TAPEUTILIZATION(NOLIMIT) is specified, no action is taken to reduce dataset tape volume spanning. We recommend that you avoid NOLIMIT for several reasons, many of which relate to recycle.

SETSYS DUPLEX

You can use this function to create concurrent copies of either backup or migration tapes. The resulting structure and dataset names are exactly the same as though you used TAPECOPY to copy the tape asynchronously. Using ACS routines, it is simple to route duplicate output to a different library that might be located in an off-site location.

For duplexed tapes, ensure that the Data Class selects the same media type and recording technology for the original and the alternate copy. Not doing so can result in failure when the duplex tape is mounted for output, or when using the alternate copy after a tape replace. If different media or machine types are needed for the original and alternate tapes, refer to APARs OW52309, OA04821, and OA11603 for more information.

If you use TS7700 Multi Cluster Grid or PtP VTS, consider using duplexing based on OPM.

ABARSTAPES(STACK|NOSTACK)

If a native 3592 is used with ABARS output tapes, use this parameter to force ABARS to use a single tape for its four types of output files created during ABACKUP.

DEFINE DUMPCLASS (dclass STACK(50)) or BACKVOL SG(*sgname*)|VOLUMES(*VOLSER*) DUMP(dclass STACK(50))

Using the STACK keyword with the AUTODUMP definitions allows DFSMShsm to exploit the capacity of 3592 cartridges. Multiple volume dumps are written to a single tape. The value of 50 causes DFSMShsm to write dump copies of 50 DASD volumes to a single cartridge, thus maximizing tape usage.

The value can be increased or decreased, depending on the average disk capacity used, the number of tape drives available, and also the capacity of the output tape. For 3592 tape drives, this capacity of the output tape can be 300 GB using EFTM1, 500 GB using EFTM2, or even 1 TB using EFMT3. Recovery times can be impacted if the stack value is too high and you have too many disk dump volumes on one cartridge, because you can only recover one volume from one tape at a time.

Enhanced list functions

When only a subset of DFSMShsm migration or backup tapes is in a library, it is important to know which tapes are connected to which tapes. All tapes that are connected must be in a single library. The LIST TTOC command has several parameters to help in this situation:

- SELECT(CONNECTED)
- SELECT(NOTCONNECTED)
- SELECT(CONNECTED(*VOLSER*))

The SELECT parameter can indicate that all connected groups are listed or that all unconnected volumes are listed. You can also use the SELECT parameter to request only a listing of the volumes that are connected to a known volume. When a connected group is listed, the listing also indicates where inconsistencies exist, for example, if one of the volumes is within a library and the other volumes are outside it.

The LIST TTOC SELECT(LIB|NOLIB) command can list only original backup or migration volumes that are in libraries or volumes that are outside of all libraries.

The LIST TTOC SELECT(LIB(ALT)|NOLIB(ALT)) command can list information about original volumes whose alternate tape is or is not in a library.

The LIST TTOC SELECT(FULL|NOTFULL|EMPTY) command can list migration and backup tape volumes with full, partially full, or empty status.

The LIST TTOC SELECT(ALTERNATEVOLUME) command can list tape volumes that are marked full and have an alternate volume. This command provides the capability to identify the full backup and migration tape volumes that have an alternate tape. LIST TTOC SELECT(NOALTERNATEVOLUME) lists all volumes that are full but have no alternate volume and thus need to be copied.

You can also use the LIST TTOC command to display tapes of a particular recording technology. LIST TTOC SELECT(EFMT1) or LIST TTOC SELECT(EFMT2 or EFMT3) lists all volumes recorded in EFTM1, EFMT2, or EFTM3 format respectively.

The library dependency parameter is also available when listing dump volumes.

Using RECYCLE to move DFSMShsm data

To move your DFSMShsm backup and ML2 data to a library, use the RECYCLE command. To direct the recycled data to a library, use the SETSYS RECYCLEOUTPUT command and direct future migrations and backups to the library.

Using RECYCLE SELECT (INCLUDE(RANGE(*nnnnn:mmmmm*))) or RECYCLE SELECT (EXCLUDE(RANGE(*nnnnn:mmmmm*))) for RECYCLE input can be helpful while selecting and migrating data to and from an IBM TS3500 or a VTS. Its immediate purpose is to enable you to set up volume ranges for various media types and various emulation types, such as VTS logical volumes and 3490-emulated cartridges.

You can direct the data to a 3592 tape subsystem by assigning a new Data Class that specifies:

- The desired media type
- The desired recording technology
- Whether performance scaling is desired
- Whether to set compaction to YES

DFSMShsm takes full advantage of the capacity of the 3592 tape cartridge. Recycling to a library containing high capacity cartridges entails moving more data for each cartridge when using the same thresholds as for the previous cartridges. This process can extend the RECYCLE time, even though fewer tape mounts occur. Therefore, a single cartridge can take longer to become subject to recycling. If your recycling window is limited, review your recycle thresholds carefully.

To reduce unnecessary recycling of migration tapes, especially on high capacity media, consider implementing Fast Subsequent Migration. The Fast Subsequent Migration function allows an unchanged dataset that is recalled from a single ML2 tape (for input processing only) to be reconnected to that ML2 tape. This function eliminates unnecessary data movement and tape mounts during remigration. It also reduces the need to recycle the tape. Reconnecting can take place during individual dataset migration or during volume migration.

Without Fast Subsequent Migration, when a dataset that has been migrated to ML2 tape is recalled, the migration copy of the dataset remains on the tape. DFSMShsm CDS records recognize that copy as an invalid copy. When the dataset that is recalled is pre-migrated in the usual manner, it is copied to a new tape. Eventually, tapes with invalid datasets are recycled, and only the still-valid data is consolidated onto new tapes. Fast subsequent migration is enabled by specifying the RECONNECT subparameter of the SETSYS TAPEMIGRATION command. For more information about this parameter, refer to *DFSMShsm Storage Administration Reference*, SC35-0422.

RECYCLEINPUTDEALLOCFREQUENCY(BACKUP(*bfreq*) MIGRATION(*mfreq*)) is an optional parameter. You use it to periodically deallocate an input unit during recycle processing. This situation is especially true in a tape environment where contention for tape drives might be a consideration. This dynamically changeable parameter prevents DFSMShsm from possibly keeping an input unit allocated for hours.

BACKUP(*bfreq*) and MIGRATION(*mfreq*) specify that, during recycle processing of backup or migration volumes, deallocation of an input unit occurs after the specified number of input connected sets representing single-file-format cartridges are processed. Specifying 0 retains the input unit until recycle processing has completed. For example, to deallocate the input unit every 20 input backup connected sets, specify:

```
SETSYS RECYCLEINPUTDEALLOCFREQUENCY(BACKUP(20))
```

Use the following statement to deallocate the input unit after each input migration connected set is processed:

```
SETSYS RECYCLEINPUTDEALLOCFREQUENCY(MIGRATION(1))
```

Always use a value of 1 if the command processes physically incompatible cartridges that claim to be the same, such as true 3490 cartridges compared to emulated 3490 cartridges.

An alternative way of moving ML2 and user tape data to a new media or tape library is to use ABARS. ABACKUP MOVE in combination with ARECOVER REPLACE can move data into a TS3500 Tape Library or a VTS. ABARS has the advantage that you can specify dataset name patterns that will be moved into a device.

Inserting existing DFSMShsm-owned volumes into the library

Because DFSMShsm CDSs keep only VOLSER information about owned volumes, they do not care whether the volumes are in the library. Therefore, you can move existing owned volumes into the library. However, some DFSMShsm-owned volumes are multivolume datasets, and all the volumes of a set must reside in the same library and in the same Storage Group. To identify connected volumes, use the LIST command shown in DFSMShsm LIST:

```
LIST TTOC SELECT(CONNECTED(TH0300)) ODS(LIST)
```

A sample result is shown here:

```
-DHFSMS-CONTROL DASET-TAP VOLUME TTOC-LISTING - AT 09:45:23 ON 03/03/03
VOLSER   UNIT      VOL     REUSE     VALID    PCT   VOL    RACF     PREV   SUCC
         NAME      TYPE    CAPACITY  BLKS     VALID STATUS          VOL    VOL
TH0300   3590-1    ML2     04130300  01344806 33    PART   NO       *NONE* *NONE*
```

When you enter the selected DFSMShsm-owned tape volumes, assign them the attribute of PRIVATE and the appropriate Storage Group.

Consider using SETSYS TAPESPANSIZE and SETSYS TAPEUTILIZATION to reduce the number of connected volumes. TAPESPANSIZE determines whether a dataset is small or large. A dataset smaller than the specified value must fit on the tape that is processed.

If DFSMShsm calculates that the dataset will span to another tape, it issues an FEOV and starts writing the whole dataset to a new tape. A large dataset is allowed to span volumes. Do not specify TAPEUTILIZATION(NOLIMIT), because that value prevents TAPESPANSIZE from taking effect. SETSYS TAPEUTILIZATION(PERCENTFULL(97)) is a good value.

9.2.15 Verifying the installation

This section covers the software areas that you need to consider testing as part of your library and system-managed tape implementation project. Table 9-10 lists the testing tasks.

Table 9-10 System-managed tape testing

Task	Comment
Vary library drives online and offline.	N/A
Allocate a standard SMS dataset in the TS3500.	N/A
Allocate an SMS multivolume dataset in the TS3500.	N/A
Allocate several SMS datasets as multifile (LABEL=) in the IBM TS3500.	N/A
Allocate an SMS dataset and reuse it with DISP=MOD.	N/A
Allocate SMS datasets with various legal UNIT=AFF processing.	N/A
Allocate various SMS datasets according to your ACS routines.	Make a list, identify what results you expect in advance, and compare.
Allocate a non-SMS dataset outside of the library.	N/A
Allocate non-SMS multivolume datasets outside of the library.	N/A
Reuse with DISP=MOD one of the first datasets of a multifile tape.	This is impossible.

Task	Comment
Allocate non-SMS datasets in the IBM TS3500.	This is impossible.
Allocate an SMS dataset outside of the IBM TS3500.	This is impossible.
Allocate an SMS-managed dataset and a non-SMS-managed dataset with UNIT=AFF.	This is impossible.
Initialize cartridges using IEHINITT, EDGINERS (DFSMSrrm), or a utility supplied by the vendor of your tape management system.	Refer to “Tape initialization” on page 252.
Watch for whether automatic relabelling processing occurs.	This processing is only applicable at migration time.
Test drive sharing for drives in the IBM TS3500.	This drive sharing is only applicable if you introduced ATS STAR or a vendor product.
Check if enqueue-processing against TCDB and other control datasets (RMM, HSM, and so forth) is done correctly in a multiple systems environment.	RESERVE if no GRS is introduced, or if the enqueue is not converted. This processing is only applicable in new environments.
Test the stand-alone procedure with the IBM TS3500.	This procedure is not applicable for cartridges that are owned by a TS7700 or a VTS.
Test the vaulting procedures.	N/A

9.2.16 Testing ACS logic with NaviQuest

You can generate and execute test cases using ISMF. When you select ISMF option **7.4**, you will see the ACS TEST SELECTION panel that is shown in Figure 9-28. The input from the test cases is saved in a dataset. For an example, refer to Figure 9-31 on page 296.

```
               ACS TEST SELECTION
COMMAND ===>

SELECT ONE OF THE FOLLOWING OPTIONS ===>

  1  DEFINE          - Define an ACS Test Case
  2  ALTER           - Alter an ACS Test Case
  3  TEST            - Test ACS Routines


IF OPTION 1 OR 2 CHOSEN ABOVE, SPECIFY:

  ACS TEST LIBRARY ===> 'DFRES1.TCASE1.CNTL'
  ACS TEST MEMBER  ===> TAPE1




USE ENTER TO PERFORM SELECTION;
USE HELP COMMAND FOR HELP; USE END COMMAND TO EXIT.
```

Figure 9-28 ACS TEST SELECTION panel

In addition to basic ISMF functions, NaviQuest provides several functions to ease and automate the creation and comparison of test cases for the entire SMS environment. There is a special function in NaviQuest where it sets up test cases based on volume mount analyzer (VMA) data taken from your site. Because this function is closely related to the implementation of a library, we discuss it briefly here. For more information, refer to the *NaviQuest Demonstration and Hands-On Usage Guide,* SG24-4720.

The steps are:

1. To access NaviQuest if it is installed in your environment, select option **11** from the ISMF Primary Menu. Then, you see the NaviQuest PRIMARY OPTION MENU panel (Figure 9-29).

```
                           NaviQuest PRIMARY OPTION MENU

ENTER SELECTION OR COMMAND ===>

SELECT ONE OF THE FOLLOWING:

  1  GENERATE TEST CASES      - Generate test cases from saved lists/records
  2  ACS COMPARISON TEST      - Compare the BASE and NEW ACS listings
  3  GENERATE ACS XREF        - Enhanced XREF ACS test listing
  4  UPDATE TEST CASE RESULTS - Update test cases with expected results
  5  GENERATE SMS REPORTS     - Create reports from ISMF lists or DCOLLECT
  6  GENERATE MODEL COMMANDS  - Generate model commands from ISMF or DCOLLECT









USE HELP COMMAND FOR HELP; USE END COMMAND TO EXIT.
```

Figure 9-29 NaviQuest PRIMARY OPTION MENU panel

2. Select option **1** (**GENERATE TEST CASES**). Next, you see a menu to select the type of test case data for NaviQuest to use. To build test cases from VMA data, select option **4**.

   The panel in Figure 9-30 on page 296 appears, where you can choose:

   – Number of test cases to create
   – Member name prefix for the resulting members
   – Selection filter to be applied against the input data

   > **Note:** The input to this process is not raw SMF data but VMA-extracted SMF data. Refer to “Volume mount analyzer (VMA) reporting for tape utilization” on page 445 for more information.

```
 BULK GENERATION OF TEST CASES FROM VMA EXTRACT FILE
COMMAND ===>

TO GENERATE TEST CASE LIBRARY, SPECIFY:
  DATA SET NAME CONTAINING VMAXTRT DATA
    ===> 'NAVIQ1.GFTAXTR.DATA'

  NUMBER OF TEST CASES      ===> 10      (1 to 9999, blank)
  MEMBER NAME PREFIX        ===> HSM     (1 to 4 alphabets)
  PROGRAM NAME TO FILTER ON ===> ARCCTL

  TEST CASE PDS      ===> 'DFRES1.TCASE1.CNTL'
    REPLACE EXISTING PREFIX ===> Y (Y or N)


Note:  Before running this function you must have run GFTAXTR from
       your saved SMF type 14,15,21, and type 30 records.




USE ENTER TO PERFORM GENERATION;
USE HELP COMMAND FOR HELP; USE END COMMAND TO EXIT.
```

Figure 9-30 Test case generation from VMA

3. The output written to the specified dataset has the same format as output generated without NaviQuest. However, NaviQuest generates more detailed information and enables you to test with real-life data instead of a randomly generated subset of examples. We show two test cases: one test case for DFSMShsm data (Figure 9-31) and one test case for DFSMSdss data (Figure 9-32 on page 297).

```
DESCRIPTION1:
From VMA EXTRACT file 'NAVIQ1.GFTAXTR.DATA' on 08/03/96 at 7:08pm
DSN: HSM.COPY.BACKTAPE.DATASET
DSTYPE: PERM
DSORG: PS
ACSENVIR: ALLOC
SIZE: 179328
EXPDT: 1999365
VOL: 01
100017
JOB: HSM
DD: SYS0512
PGM: ARCCTL
UNIT: 348X
```

Figure 9-31 NaviQuest-generated test case: DFSMShsm

```
DESCRIPTION1:
From VMA EXTRACT file 'NAVIQ1.GFTAXTR.DATA' on 08/03/96 at 7:08pm
DSN: GSMVSE.DATA.SAVDAY
DSTYPE: GDS
DSORG: PS
ACSENVIR: ALLOC
SIZE: 0
EXPDT: 1995033
VOL: 01
100369
JOB: SAVTS001
DD: OUTDD1
PGM: ADRDSSU
UNIT: 348X
```

Figure 9-32 NaviQuest-generated test case: DFSMSdss

4. The result of checking the specified input against the SCDS that you are about to test looks similar to Figure 9-33. DSS0017 and HSM0001 are the member names created by Naviquest. You see the classes that are assigned to the specified dataset names, and you can check to see if these assignments are what you intended.

```
                     ACS TESTING RESULTS

CDS NAME         : SMS.SCDS0
ACS ROUTINE TYPES: DC SC MC SG
ACS TEST LIBRARY : SMS.TESTCASES.DATA

  ACS TEST
  MEMBER       EXIT CODE   RESULTS
  ---------    ----------  ------------------------------------
                        0  SG = SGTAPLCL

  DSS0017               0  DC = DCTAPLR
                        0  SC = SCTAPLCL
                        0  MC = MCTAPE
                        0  SG = SGTAPLCL

  HSM0000               0  DC = DCTAPLR
                        0  SC = SCTAPLCL
                        0  MC = MCTAPE
                        0  SG = SGTAPLCL

  HSM0001               0  DC = DCTAPLR
                        0  SC = SCTAPRMT
                        0  MC = MCTAPE
                        0  SG = SGTAPRMT
```

Figure 9-33 ACS TESTING RESULTS panel

5. However, you cannot see the dataset names and other input criteria in the list. That is why you go back to NaviQuest and select option **3** (**GENERATE ACS XREF**) to generate the ACS CROSS REFERENCE REPORT (Figure 9-34 on page 298).

```
                      ACS CROSS REFERENCE REPORT
COMMAND ===>

TO GENERATE REPORT, SPECIFY:
  ISMF TEST CASE LISTING
    ===> 'DFRES1.LISTING'

  DSN FOR CROSS REFERENCE LISTING
    ===> 'DFRES1.XREF.LISTING'
    REPLACE CONTENTS IF DSN EXISTS ===> Y (Y or N)

  VARIABLES TO INCLUDE IN REPORT:        (Y or N)
    DSN   ===> Y        UNIT    ===> N       SIZE    ===> N
    EXPDT ===> N        JOBNAME ===> Y       PROGRAM ===> N






USE ENTER TO PERFORM GENERATION;
USE HELP COMMAND FOR HELP; USE END COMMAND TO EXIT.
```

Figure 9-34 NaviQuest-generated ACS CROSS REFERENCE REPORT panel

6. The input is the ACS test output listing dataset, and the output is a new listing dataset as shown in Figure 9-35. You can specify which columns you want NaviQuest to add. If you are not using the program name in your ACS routines to make decisions, you might not need it on the output listing.

```
                               ACS TESTING RESULTS

CDS NAME         : SMS.SCDSO
ACS ROUTINE TYPES: DC SC MC SG
ACS TEST LIBRARY : SMS.TESTCASES.DATA

ACS TEST
MEMBER    EXIT CODE   RESULTS        DSNAME                    PROGRAM
--------- ----------  -----------    -------------------       -------

DSS0017            0  DC = DCTAPLR   GSMVSE.DATA.SAVDAY        ADRDSSU
                   0  SC = SCTAPLCL
                   0  MC = MCTAPE
                   0  SG = SGTAPLCL

HSM0000            0  DC = DCTAPLR   HSM.BACKTAPE.DATASET      ARCCTL
                   0  SC = SCTAPLCL
                   0  MC = MCTAPE
                   0  SG = SGTAPLCL

HSM0001            0  DC = DCTAPLR   HSM.COPY.BACKTAPE.DATASET  ARCCTL
                   0  SC = SCTAPRMT
                   0  MC = MCTAPE
                   0  SG = SGTAPRMT
```

Figure 9-35 ACS TESTING RESULTS panel

The obvious results are:

- HSM and DSS datasets are assigned Data Class `DCTAPLR`, which comprises 36-track, MEDIA2 cartridges.
- DSS save and HSM backup datasets are directed to Storage Group `SGTAPLCL`, which is the local tape library.
- HSM TAPECOPY datasets are directed to Storage Group `SGTAPRMT`, which is the remote tape library.

10

Software implementation: Other System z platforms

This chapter explains how to implement and run the IBM tape environment in System z server environments other than z/OS. It describes software requirements, implementation, customization, and platform-specific considerations about operations and monitoring.

This chapter examines the following platforms:

- z/VM native support
- z/VSE 3.1, 4.1, or 4.2 native support
- z/VSE as a guest under z/VM
- Linux on System z
- Native Transaction Processing Facility (TPF) environment with TPF 4.1 or z/TPF

10.1 General support information

All operating systems do not support IBM tape libraries and Virtual Tape Server (VTS) solutions. Table 10-1 shows a summary of supported tape solutions for non-z/OS environments.

Table 10-1 Supported tape solutions for non-z/OS platforms in System z environments

Platform/Tape system	IBM TS3500 Tape Library	IBM TS7700	IBM 3494 VTS or TS7700	IBM 3494 PtP VTS or TS7700	3592-J1A and TS1120 tape drives	TS1130 tape drives
z/VM native	Yes	Yes [a]	Yes	Yes [a]	Yes	No
z/VSE 3.1 and z/VSE 4.1 native	Yes	Yes	Yes	No	Yes	No
z/VSE 3.1 or z/VSE 4.1 under z/VM	Yes	Yes[a]	Yes	Yes [a]	Yes	Yes
z/VSE 4.2 native	Yes	Yes	Yes	No	Yes	Yes
Linux for System z native	No	No	No	No	Yes	Yes
Linux for System z under z/VM	No	No	No	No	Yes	No[b]
TPF 4.1 or zTPF	Yes	Yes	Yes	No	Yes[c]	No[b]

a. With restrictions, refer to 10.1.1, “Other System z platforms and virtualization subsystem support” on page 302.
b. Support will available post GA of the TS1130.
c. IBM TPF 4.1 only supports 3592-J1A. zTPF supports 3592-J1A and TS1120-E05, including tape encryption.

10.1.1 Other System z platforms and virtualization subsystem support

Even though z/VM and z/VSE can use the TS7700 Virtualization Engine, VTS, or Peer to Peer (PtP) VTS, there are restrictions that you must consider.

Restriction for all TS7700 Virtualization Engine environments

Neither z/VM nor z/VSE is able to provide System Managed Storage (SMS) constructs to the Library Manager. Therefore, these platforms cannot use the functions that Outboard Policy Management (OPM) provides for the TS7700 Virtualization Engine. However, you can use dedicated physical pools in a TS7700 environment. After insert processing of virtual volumes, you can define a default construct to the volume range. We do not recommend this approach for z/OS, but this approach is the only solution to provide physical pooling for non-z/OS platforms. Also, refer to *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312.

Restriction: Outboard Policy Management functions are not supported by non-z/OS platforms.

Restrictions in a Multi Cluster TS7700 Grid environment

As you can see from Table 10-1, TS7700 Virtualization Engine is supported with restrictions in a z/VM or z/VSE under z/VM environment. In both operating systems, there is no difference from the host point of view between a Multi Cluster Grid and a Single Cluster Grid TS7700 configuration. Neither z/VM nor z/VSE under z/VM knows about the Composite Library and can monitor the entire environment.

Restriction in all VTS environments

The same restrictions described for the TS7700 Virtualization Engine apply to all VTS environments. Also, refer to *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring,* SG24-2229, and *IBM TotalStorage Peer-to-Peer Virtual Tape Server: Planning and Implementation Guide,* SG24-6115.

> **Note:** Advanced Policy Management (APM) for VTS is functionally equivalent to the OPM functions of the TS7700 Virtualization Engine.

Restrictions in a PtP VTS environment

The same restrictions described for a Multi Cluster TS7700 Grid apply to a PtP VTS environment. In addition, neither z/VM nor z/VSE is able to handle unsolicited messages and actions (for example, intervention required and hardware messages). To be able to run a PtP VTS, you must have a z/OS environment connected to the same PtP VTS as your z/VM or z/VSE under z/VM environment.

Remember that the PtP VTS is not supported in native z/VSE environments.

> **Important:** You must have a z/OS environment connected to the same PtP VTS as your z/VM or z/VSE under z/VM environment.

10.1.2 Linux on System z and tape libraries

Linux on System z has limited capabilities with respect to tape drives. Although it can access a tape drive directly that is attached using either ESCON/FICON protocol or Fibre Channel Protocol (FCP), it does not have the ability to manage a library by itself. Now, in today's environment, it is impractical to access tape drives attached directly, because in the mainframe environment, all drives are usually contained in a library. This is also true in an Open Systems environment, where the drives are FCP-attached, because Linux on System z coexists usually in large Open Systems environments. So, what is needed is a method to manage the library. Tivoli Storage Manager or iRMM can be used to manage the library and move the appropriate tape cartridge to and from the drive. Tivoli Storage Manager is best for small to medium installations. iRMM is best for medium to large installations. Both solutions only support FCP-attached libraries. There is *no* library support for FICON-attached libraries.

Encryption for Linux on System z is supported using Library-Managed Encryption.

10.2 z/VM native support

In this section, we briefly describe support and how it is provided for the TS3500 Tape Library in a z/VM native environment. We explain how to customize the DFSMS/VM Removable Media Services (RMS) service machine and introduce considerations for using a TS3500 Tape Library with native VM.

We also provide information about third-party vendor tape management systems. We include test cases for verifying your installation and considerations for data migration. Plus, we discuss information about drive allocation and how to report hardware errors.

For the necessary software support, refer to 7.3.3, "Software requirements for z/VM" on page 190.

10.2.1 Basic functionality

DFSMS/VM Function Level 221 (FL221) is the only means for a z/VM system to communicate with a 3953 Library Manager. DFSMS/VM FL221 is part of z/VM.

The RMS function of DFSMS/VM FL221 provides TS3500 Tape Library support in z/VM environments. The RMS support code runs in a service virtual machine called the *removable media services master* (the default name is RMSMASTR). Based on requests from a user's virtual machine (the mount requester is typically your tape management system), RMSMASTR provides the following services:

- Mounts a specific volume or a volume from a scratch category to a library tape device
- Demounts a volume currently mounted on a specific device
- Queries information about the 3953 Tape System resources, including volumes, devices, categories, and overall inventory
- Associates a specific scratch pool with a library tape device and resets that association
- Assigns a category to a specific volume

In practice, Figure 10-1 shows the required sequence of steps when you want to use a volume inside the tape library.

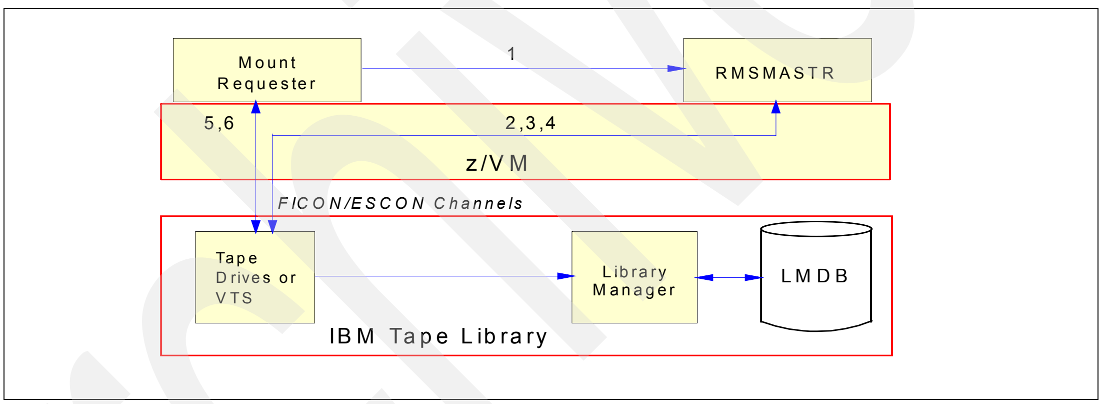


Figure 10-1 z/VM using DFSMS/VM

The explanation of the process (illustrated by corresponding numbers) shown in Figure 10-1 is:

1. **Request for library function:** A user sends a request (such as mount a volume) for a library function to RMSMASTR.
2. **Tape drive assigned:** RMSMASTR uses the 3490 device specified on the request or attempts to find an available device if there is no device specified. If a specific device is requested and that device is unavailable, the request fails. If a specific device is not requested, and no available device can be found, the request fails.
3. **Library command issued:** If the specified device is available (or if another device is free for a non-device-specific request), the device is attached to RMSMASTR. The library control command is issued to the Library Manager through the device path.
4. **Status returned:** A status is returned to RMSMASTR when the command completes.

5. **Device attached:** If a free device is used and no mount request is issued, the device is detached. If it is a mount request, the device is detached from RMSMASTR with the LEAVE option to avoid rewind and unload. It is then attached to the requester.
6. **Data transfer:** The requester of the tape library device does its own data transfer. RMSMASTR is not involved.

Access to the 3953 Library Manager is provided by an interface that includes both RMS commands, DFSMSRM for interactive control, and callable services library (CSL) routines for program control. You can call RMS CSL routines (FSMRM*xxx*) from a program that is written in any of these programming languages:

- REXX™
- C
- Assembler
- COBOL (IBM COBOL II and OS/VS COBOL program products)
- PL/I
- VS FORTRAN
- VS Pascal

RMS functions do not include tape management system services, such as maintaining a removable media inventory, performing tape label verification, performing authorization access checks at the volume level, or managing and selecting tape drives. RMS functions are designed to interface with a tape management system. For systems without a tape management system, you can add tape management system-like functions by means of tailoring installation-wide exits.

10.2.2 Library Manager interface

The interface to the TS3500 Tape Library is through RMSMASTR, which provides removable media services to requesting virtual machines. The requesting virtual machine communicates with RMSMASTR by use of RMS commands or the CSL programming interface.

With RMS, you can:

- Assign volumes (either one volume or a list of volumes) to categories, DFSMSRM SET VOLCAT.
- Assign a particular category of volumes to a tape drive, DFSMSRM SET DEVCAT. You typically use the SET DEVCAT command to assign a category of scratch volumes to a tape drive equipped with an integrated cartridge loader (ICL) or Automatic Cartridge Facility (ACF), because scratch performance is increased by preloading the scratch tapes into the ICL or ACF. For tape drives in a TS3500 Tape Library, which has neither an ICL nor an ACF, the command still works. The tape drive simply becomes reserved for use by only that category. By default, at the end of this command, the tape drive is not attached to any user. However, a command option can attach the tape drive to the command issuer or another user ID.
- Query the library's inventory using DFSMSRM Query Library or Q LIB (potentially, this can query all volumes in a library).
- Assign a volume to a category.
- Perform security checking by means of a supplied exit.

For more information about RMS, refer to the *DFSMS/VM Function Level 221 Removable Media Services User's Guide and Reference,* SC35-0141.

10.2.3 Controlling datasets

RMS maintains data about the tape drive configuration in its internal storage. It recreates the data, if necessary, by rereading the RMCONFIG DATA file.

10.2.4 Customizing the DFSMS/VM RMS service machine

This section provides the required steps to customize RMS to provide support for a TS3500 Tape Library. If you already use DFSMS/VM for minidisk and space management, part of the customization is already complete.

CP directory entry and PROFILE EXEC

The RMS service machine requires a CP directory entry (refer to Figure 10-2). The user ID of RMSMASTR must be the same as the ID defined in DFSMS_MASTER_VM. Refer to “DGTVCNTL DATA” on page 307.

```
USER RMSMASTR password 32M 32M BG
 ACCOUNT 12345678
 MACHINE XA
 STDEVOPT LIBRARY CTL
 IPL CMS
 IUCV ALLOW
 IUCV *IDENT RESANY GLOBAL REVOKE
 OPTION MAXCONN 400 QUICKDSP ACCT
 SHARE RELATIVE 1300
 CONSOLE 009 3215 T DFSMS
 SPOOL 00C 2540 READER *
 SPOOL 00D 2540 PUNCH  A
 SPOOL 00E 1403 A
 MDISK 0191 3390 scyl 001 RMSDISK MR
 LINK DFSMS 01B5 0192 RR
 LINK MAINT 0190 0190 RR
 LINK MAINT 019E 019E RR
```

Figure 10-2 Sample RMS service machine CP directory entry

The PROFILE EXEC for the RMS service machine is placed on its A disk during the installation of DFSMS/VM. In the CP directory entry, modify the device type, starting cylinder, and device ID of the disk.

RMSMASTR ATL authorization

To authorize RMSMASTR to interact with the IBM 3494 Tape Library, add the STDEVOPT control card to its CP directory entry as shown in the following statement:

```
STDEVOPT LIBRARY CTL
```

DFSMS/VM control files

There are three control files:

- DGTVCNTL DATA
- RMCONFIG DATA
- RMB*nnnnn* DATA

All of these files are in the shared file system VMSYS:DFSMS.CONTROL directory. The use of the RMB*nnnnn* DATA file is optional.

DGTVCNTL DATA

The DGTVCNTL DATA file is where you define:

- DFSMS RMS machine name
- Logical library name and LIBRARY-ID
- Name of the Advanced Program-to-Program Communication (APPC) resource to use
- Name of the DFSMS work directory
- Default scratch pool
- Severity level of messages to write to the RMS console
- Severity level of messages to write to the RMS machine log file
- Whether to queue library requests in the Library Manager
- Whether to enable write protection when a tape is mounted

As shown in the following example, the DFSMS_MASTER_VM parameter defines the name of the RMS machine. The name is one to eight characters long and must be unique. The default name is RMSMASTR.

```
DFSMS_MASTER_VM  RMSMASTR
```

The RM_AUTO_LIBRARY parameter defines the name and sequence number (for information about sequence numbers, refer to 7.1.4, “Plan your naming conventions” on page 178) of every logical library that you use.

In the following example, the “friendly” name of the logical library is `MARVIN`, the library sequence number is `12345`, and messages relating to RMS processing will be sent to the `OPER` user ID:

```
RM_AUTO_LIBRARY MARVIN 12345 OPER
```

The defined library sequence number can be evaluated on the Welcome Page of the ETL Specialist; refer to Figure 13-1 on page 382.

As shown in the following example, the GLOBAL_RESOURCE_ID parameter defines the name of the global APPC resource by which DFSMS/VM is to be known. The name must be unique. If it is not, DFSMS/VM does not start. There is no default, but the sample name used is `DFSMS001`.

```
GLOBAL_RESOURCE_ID DFSMS001       * Global APPC Resource
```

The WORK_DIRECTORY parameter, as shown in the following example, defines the name of the work directory that DFSMS will use. The first five characters must be DFSMS. The file pool must be enrolled and running before DFSMS can start.

```
WORK_DIRECTORY VMSYSU:DFSMS.WORK
```

The RM_DEFAULT_SCRATCH_POOL parameter, shown in the following example, is optional. It defines the default scratch pool to be used for the SCRATCH category.

```
RM_DEFAULT_SCRATCH_POOL SCRATCH0
```

The RM_ACCOUNTING parameter, shown in the following example, is optional. It defines whether RMS needs to provide accounting information. The default is that accounting is turned off.

```
RM_ACCOUNTING  N
```

You can obtain more information about accounting in the *DFSMS/VM Function Level 221 Removable Media Services User’s Guide and Reference,* SC35-0141.

The RM_LOG_TO_CONSOLE parameter defines the severity of messages that are to be sent to the RMS machine. The message severity levels are:

- **0**: No messages are logged.
- **1**: Severe messages are logged.
- **2**: Severe and error messages are logged.
- **3**: Severe, error, and warning messages are logged.
- **4**: Severe, error, warning, and informational messages are logged.

RM_LOG_TO_CONSOLE and RM_LOG_TO_FILE are paired parameters. You cannot code 0 for both parameters. We recommend that you code 4 at least once to aid in problem determination. The following example shows a sample RM_LOG_TO_CONSOLE parameter:

```
RM_LOG_TO_CONSOLE   3    * Messages logged to console
```

The RM_LOG_TO_FILE parameter defines the severity of messages to be written to the RMS machine's log file and the name of the directory that will contain the log file. Because DFSMS holds this file open, to browse it, use XEDIT with the NOLOCK option. The message severity levels are the same as for the RM_LOG_TO_CONSOLE parameter. Here is a sample of an RM_LOG_TO_FILE parameter:

```
RM_LOG_TO_FILE  4  DFSMS.WORK   * Messages logged to file
```

The RM_REQUEST_QUEUING parameter defines whether requests sent to the Library Manager are queued if the IBM 3494 Tape Library is in pause mode. Y is the default and the recommended value as shown in the following example:

```
RM_REQUEST_QUEUING   Y
```

The RM_WRITE_PROTECT parameter defines the default write protect mount if it is not specified on the mount request. Acceptable values are READONLY and READWRITE. The default and recommended value is READONLY, which sets logical write protection on in the tape control unit. See the following example:

```
RM_WRITE_PROTECT   READONLY
```

RMCONFIG DATA

RMS maintains data about the tape drive configuration in its internal storage by rereading the RMCONFIG DATA file. Figure 10-3 on page 309 shows an example of an RMSCONFIG DATA file.

```
* +---------------------------------------------------------------
* Ã DFSMS RM MASTER CONFIGURATION FILE
* +---------------------------------------------------------------
*
* ================================================================
*      Required file name, type, and location:
*      RMCONFIG DATA in VMSYS:DFSMS.CONTROL.
* ================================================================
*      Required record format: Fixed
* ================================================================
*      Maximum logical record length: 255
* ================================================================
*      Comments:
*
*      Comments begin with an asterisk (*).
*      Comments do not span lines.  That is, a comment is
*      considered to be completed when the end of line (logical
*      record length) is reached.  To continue a comment on the
*      next line, start the next line with the comment indicator.
*      Comments can start anywhere on the line.  However, anything
*      following the comment indicator is considered to be a
*      comment.
* ================================================================
*      Blank Lines:       Blank lines are ignored.
* ================================================================
*
*      Formats of entries:
*
*      Each non-comment entry in this file is a single device
*      address, or a range of addresses.
*      If a range, the beginning and ending addresses of the range
*      must be separated by a dash (-), and optionally by one or
*      more spaces.  Ranges cannot span lines.
*      The ending address of the range must be greater than the
*      beginning address.
*
* ================================================================

*180                   * Sample entry for a single device
*181 - 18F             * Sample entry for a range of devices

 3B0 - 3B1             * Live entry for library devices
```

Figure 10-3 Sample RMSCONFIG DATA file

RMB*nnnnn* DATA

DFSMS/VM can use RMS bulk processing files to define the category in which to place volumes when they are entered into the TS3500 Tape Library. There is one bulk processing file for every TS3500 Tape Library known to the RMS machine. The files are used for either automatic-insert or on-request bulk processing.

An automatic-insert file name is of the form RMB*nnnnn* DATA where *nnnnn* is a library sequence number that is defined in the RM_AUTO_LIBRARY parameter. The file is located in VMSYSU:DFSMS.WORK or a directory that is defined by the RM_WORK_DIRECTORY parameter. Notification of insert processing is sent to the user ID that is specified in RM_AUTO_LIBRARY.

An on-request bulk processing file can have any name and be in any directory accessible to RMSMASTR and the requesting user. On-request bulk processing is initiated through either the DFSMS SET VOLCAT BULK command or a CSL call to RMS.

Figure 10-4 shows an example of an RMS bulk configuration file when the host is notified that cartridges are in the Library Manager INSERT category. RMS sets the cartridges defined in RMB*nnnnn* to the defined category. Volumes that are not defined in the RMB*nnnnn* DATA file are ignored, and insert processing can be completed on other hosts. In this example, we set cartridges with VOLSERs in ranges 000001 through 000849 and VM0000 through VM0099 to the VOLUME SPECIFIC or private category. We also set cartridges with VOLSERs in range UN0000 to UN0099 to the EJECT category, which enables you to stop cartridges from entering the TS3500 Tape Library. We recommend that you assign all volumes to the VOLUME SPECIFIC category. Then, the tape management system can assign a cartridge's true Library Manager category.

```
000001-000849     VOL      INSERT
  VM0000-VM0099     VOL      INSERT
  UN0000-UN0099     EJECT    INSERT
```

Figure 10-4 Sample RMBnnnnn DATA file

RMS does not keep a record of the volumes in the 3953 Library Manager. RMS is provided as an interface to a 3953 Library Manager and not for the management of volumes within a library. The Library Manager stores the information for the volumes. A tape management system provides management of volumes for z/VM users, keeping an inventory of volumes and their location (for example, the library name or off-site location in which a volume is stored).

RMS security

You can protect RMS functions by using RACF/VM. Simply set up RMS so that it uses the RACROUTE interface. You need to authorize users through the use of the STGADMIN or a user-defined group.

10.2.5 Using a TS3500 Tape Library in a VM/ESA environment

Here are points to consider when you use the TS3500 Tape Library in a VM/ESA environment:

- RMS does not check that the internal label of a volume matches the external label.
- An installation-wide exit, FSMRMSHR, provides the facility to check that a request is for a volume or category that the requester is allowed to use. Use this exit when you share the library with more than one system.
- Automatic insert processing does not immediately occur when a volume is placed into the input station, because RMSMASTR cannot receive unsolicited interruptions of cartridge insertion without a tape drive attached. RMSMASTR periodically queries the insert category to find out whether there are volumes in it.

  Automatic insert processing occurs when the insert category is not empty and:

  – RMSMASTR is initially started.
  – RMSMASTR is restarted.
  – RMSMASTR receives a valid MOUNT command.
  – RMSMASTR receives a valid SET DEVCAT command.

  In the last two cases, automatic insert processing is totally independent of the actual command issued, but the command must be valid.

Automatic insert processing uses a different tape device address, which RMSMASTR selects. If an unused tape device address is not available when insert processing starts, the process does not continue. Because insert processing most likely starts before the MOUNT (or SET DEVCAT) finishes with its tape device, another device must be available for this insert processing. If a device is not free, you can move volumes from the insert category to the category of choice by using the SET VOLCAT BULK command.

> **Note:** You can disable automatic insert processing simply by not having an automatic-insert file of the name RMB*nnnnn* DATA. You might want to disable automatic insert processing on a particular VM/ESA system when you share your Library Manager partition with multiple VM/ESA systems.

- It is not possible to create an SMSplex between a z/VM system and a z/OS system.
- RMS does not provide tape management functions. Several software vendor products provide VM tape management functions. However, you can use the Programmable Operator (PROP) facility of VM to intercept commands to the operator interface originating from a tape management system. PROP can then redirect the commands to RMS for processing.

You can find additional information in *Lights Out! Advanced Tape Automation Using VM/ESA,* GG24-4347.

10.2.6 Tape management systems

Table 10-2 shows the third-party tape management systems that we know of that provide support for the TS3500 in the z/VM environment. Other products might exist, or new products might have been announced since the publication of this book.

Table 10-2 z/VM tape management software support

Product name	Vendor name	Web site for more information
BVS VM/ESA	Pfeilschifter GmbH (Germany)	http://www.pfeilschifter-gmbh.de/en/index.htm
Dynam/T	Computer Associates International, Inc.	http://www.ca.com
Brightstor VM:TAPE, VM:BACKUP, VM:RESTORE	Computer Associates International, Inc.	http://www.ca.com

10.2.7 Cartridge processing

In the following sections, we describe the interaction among z/VM, the tape management system that you installed, and the actions regarding cartridges:

- Cartridge insert processing
- Cartridge eject processing
- Return to scratch

Cartridge insert processing

If you have z/VM and have implemented bulk insert processing, cartridges entered into the library have their Library Manager categories set automatically. To complete insert processing, run the tape management system procedure to synchronize its database with the Library Manager database.

Cartridge eject processing

Ejecting cartridges is the responsibility of the tape management system. The tape management system vendor provides a mechanism to send the appropriate commands to the Library Manager to move cartridges from storage cells to the I/O stations. This mechanism is usually included as part of the existing vaulting procedures.

Return to scratch

The Library Manager category indicates whether a cartridge is private or scratch. The Library Manager automatically updates a cartridge to a private category when it is used. It is the responsibility of the tape management system to instruct the Library Manager to change a cartridge category back to scratch. This task is normally carried out as part of the tape management system return-to-scratch processing, which is invoked with either an operator command or a batch job.

10.2.8 Testing procedures

Table 10-3 lists the testing tasks to prove that the tape management system and the library are communicating and that you can successfully read and write data to library-resident drives. IBM does not provide a tape management system for z/VM, so we cannot provide detailed information about how to carry out these tests. You can use these tests to develop operational procedures, which you need to complete before the library is used for production work.

Table 10-3 z/VM testing procedures

Task	Comment
Check that automatic insert processing works as expected.	N/A
Check that the Library Manager category and tape management system catalog synchronize correctly.	This is done either by a command or a batch job.
Check the tape management system vaulting procedures. They need to eject cartridges from the library.	N/A
Check that the tape management system operator commands work as expected with the library.	Operator commands might not exist for your tape management system.
Allocate a standard dataset in the TS3500 Tape Library.	N/A
Allocate a multivolume dataset in the TS3500 Tape Library.	N/A
Allocate several datasets as multifile on one cartridge in the TS3500.	N/A
Modify a previously written dataset.	N/A
Initialize a new cartridge (if you will use new media).	N/A
Reinitialize an already initialized cartridge (if the drive model changes).	N/A

10.2.9 Data migration considerations

In a z/VM environment, tape allocation is controlled through the tape management system. Therefore, the details of a migration project differ, depending on which tape management system you installed. When migrating to a library, you must take several common migration considerations into account:

- Which categories of tape data are involved?
- Are there cartridges that are not managed by the tape management system?
- Must the data be read by a different tape technology at another location?
- Is managing multiple tape formats and recording technologies involved?
- What is the data migration sequence?
- How do you plan to verify that data is successfully migrated?
- How do you plan to manage the library resource if it is shared with another platform? Refer to 6.1, "Introduction to partitioning and sharing" on page 150.

10.2.10 Drive allocation and selection

With tape drives that emulate another device type, the unit type becomes ambiguous when there are actual drives of the same type that are host-attached. For example, any IBM TotalStorage Enterprise 3590 Tape Drive that is in 3490E emulation mode has the same unit type as an actual 3490E drive. A 3590 Model H or Model E that is in 3590 emulation mode has the same unit type as an actual 3590 Model B (in 3590 mode), which is also true for a 3592 defined as a 3590 model in the hardware configuration definition (HCD).

Application software maintains the relationships between pieces of media and the subset of drives on which they can be mounted. In turn, the software influences the selection of an appropriate tape drive.

> **Note:** The operating system does not manage device allocation.

10.2.11 Media capacity exploitation

z/VM commands and functions for writing tape data can fully use 3590 and 3592 media capacity. Specifying the largest possible block size when issuing CMS commands ensures optimum use of media capacity and promotes the best exploitation of 3590 and 3592 performance.

10.2.12 SIM and MIM presentation

Service Information Messages (SIMs) and Media Information Messages (MIMs) report hardware-related problems to the operating system. Refer to the *Statistical Analysis and Reporting System User Guide,* S7000247, which you can find on the Web at:

http://www-1.ibm.com/support/docview.wss?uid=ssg1S7000247

SIMs and MIMs are reported as HCP6359I and HCP6357I messages and in the EREP reports.

10.3 VSE/ESA native support (VSE 2.7.*x*)

VSE/ESA 2.7 has been withdrawn from marketing and support ended on 28 February 2007, but it is still used in many client sites. However, it does not support the 3592 drives and, therefore, it does not support the TS3500 Tape Library.

10.4 z/VSE native environments with Tape Library Support

z/VSE supports the IBM TS3500 Tape Library natively through its Tape Library Support (TLS). The LCDD support is still available; however, new functionality, such as 3592 drive support, is only implemented in TLS. TLS allows support for the tape library using the /390 channel command interface commands; therefore, there is no need any longer for the XPCC/APPC communication protocol that was required with the old interface. The external interfaces, LIBSERV JCL and LIBSERV macro, remain unchanged.

Define library support

First, you must define the type of support that you use by specifying the SYS ATL statement. You can define:

TLS Tape Library Support, which provides full support
VSE LCDD, which does not support 3592 drives
VM VM Guest Support

For native support under VSE, select TLS.

> **Note:** There is a skeleton in ICCF LIB 59 to tailor and submit.

Define tape libraries

You must define your tape library or libraries. Use a batch job to define your tape library or libraries as shown in Example 10-1.

Example 10-1 Define libraries

```
* $$ JOB JNM=TLSDEF,CLASS=0,DISP=D
* $$ LST CLASS=A
// JOB TLSDEF
// EXEC LIBR,PARM='MSHP'
   ACCESS S=IJSYSRS.SYSLIB
   CATALOG TLSDEF.PROC REPLACE=YES
    LIBRARY_ID TAPELIB1 SCRDEF=SCRATCH00 INSERT=SCRATCH00             --- default library
    LIBRARY_ID TAPELIB2                * SECOND LIB DEF
    DEVICE_LIST TAPELIB1 460:463       *  DRIVES  460 TO 463
    DEVICE_LIST TAPELIB2 580:582       *  DRIVES  580 TO 582
    QUERY_INV_LISTS LIB=TLSINV         * MASTER INVENTORY FILES
    MANAGE_INV_LISTS LIB=TLSMAN        * MANAGE FROM MASTER
 /+
```

LIBSERV

The communication from the host to the Library Manager is through the LIBSERV JCL or macro interface. Example 10-2 on page 315 shows a sample job that uses LIBSERV to mount volume `123456` for writing on device address `480` and, in a second step, to release the drive again.

Example 10-2 Sample LIBSERV JCL

```
$$ JOB JNM=BACKUP,CLASS=0,DISP=D
$$ JOB BACKUP
// ASSGN SYS005,480
// LIBSERV MOUNT,UNIT=480,VOL=123456/W
// EXEC LIBR
BACKUP S=IJSYSRS.SYSLIB TAPE=480
/*
// LIBSERV RELEASE,UNIT=480
/&
$$ EOJ
```

LIBSERV provides the following functions:

Query all libraries for a volume
LIBSERV AQUERY,VOL=123456

Mount from category LIBSERV CMOUNT,UNIT=480,SRCCAT=SCRATCH01

Query count of volumes LIBSERV CQUERY,LIB=TAPELIB1,SRCCAT=SCRATCH01

Query device LIBSERV DQUERY,UNIT=480

Query inventory of library LIBSERV IQUERY,LIB=TAPELIB1,SRCCAT=SCRATCH01

Query library LIBERV LQUERY,LIB=TAPELIB1

Manage inventory LIBSERV MINVENT,MEMNAME=ALL,TGTCAT=SCRATCH01

Change category LIBSERV SETVCAT,VOL=123456,TGTCAT=SCRATCH01

Query library for a volume LIBSERV SQUERY,VOL=123456,LIB=TAPELIB1

For additional information, refer to the *z/VSE System Administration Guide*, SC33-8224, and the *z/VSE System Macros Reference*, SC33-8230.

10.4.1 Migration from LCDD to TLS

Because all macros and commands remain unchanged, the migration is easy. You must switch the statement in the SYS ATL statement from VSE to TLS and execute an IPL. If you encounter any problems, you change the statement again and process another IPL. However, we performed migrations without problems.

After the migration, you can eliminate the no longer necessary XPPC/APPC statement in a second step.

10.4.2 Tape management systems

Table 10-4 shows the third-party tape management systems that we know of that provide support for the TS3500 Tape Library in the VSE environment. Other products might exist, or new products might have been announced since the publication of this book.

Table 10-4 z/VSE tape management software support

Product name	Vendor name	Web site for more information
BIM-EPIC	CSI International	http://www.bimoyle.com/
BVS VSE/ESA	Pfeilschifter GmbH (Germany)	http://www.pfeilschifter-gmbh.de/en/index.htm
Brightstor CA-EPIC for VSE	Computer Associates International, Inc.	http://www.ca.com
BrightStor CA-Dynam/T Tape Management for VSE	Computer Associates International, Inc.	http://www.ca.com

10.4.3 Cartridge processing

The following sections describe the interaction among z/VSE, the tape management system that you installed, and the actions regarding cartridges:

- Cartridge insert processing
- Cartridge eject processing
- Return to scratch

Cartridge insert processing

If you are working in a native z/VSE environment, it is the responsibility of the tape management system to complete insert processing after new cartridges have been entered into the library.

Cartridge eject processing

Ejecting cartridges is the responsibility of the tape management system. The tape management system vendor provides a mechanism, usually included as part of existing vaulting procedures. This mechanism sends the appropriate commands to the Library Manager to move cartridges from storage cells to the I/O stations.

Return to scratch

The Library Manager category indicates whether a cartridge is private or scratch. The Library Manager automatically updates a cartridge to a private category when it is used. It is the responsibility of the tape management system to instruct the Library Manager to change a cartridge category back to scratch. This task is normally carried out as part of the tape management system return-to-scratch processing, which is invoked with either an operator command or a batch job.

10.4.4 Testing procedures

Table 10-5 lists the testing tasks to prove that the tape management system and the library are communicating and that you can successfully read and write data to library-resident drives. IBM does not provide a tape management system for VSE, so we cannot give detailed information about how to carry out these tests. You can also use these tests to develop operational procedures, which you need to complete before the library is used for production work.

Table 10-5 z/VSE testing procedures

Task	Comment
Check that automatic insert processing works as expected.	N/A
Check that the Library Manager category and tape management system catalog synchronize correctly.	This is done either by a command or by a batch job.
Check the tape management system vaulting procedures. They need to eject cartridges from the library.	N/A
Check that the tape management system operator commands work as expected with the library.	Operator commands might not exist for your tape management system.
Allocate a standard dataset in the TS3500 Tape Library.	N/A
Allocate a multivolume dataset in the TS3500 Tape Library.	N/A
Allocate several datasets as multifile on one cartridge in the TS3500 Tape Library.	N/A
Modify a previously written dataset.	N/A
Initialize a new cartridge (if you use new media).	N/A
Reinitialize an already initialized cartridge (if the drive model changes).	N/A

10.4.5 Data migration considerations

In a z/VSE environment, tape allocation is controlled through the tape management system. The details of a migration project, therefore, differ depending on which tape management system you install. When migrating to a library, take these common migration considerations into account:

- Which categories of tape data are involved?
- Are there cartridges that are not managed by the tape management system?
- Does the data have to be read by a different tape technology at another location?
- Is managing multiple tape formats and recording technologies involved?
- What is the data migration sequence?
- How do you plan to verify that data was successfully migrated?
- How do you plan to manage the library resource if it is shared with another platform? Refer to "Introduction to partitioning and sharing" on page 150 also.

10.4.6 Media capacity exploitation

Typically, applications use the physical end-of-volume to determine that a tape is full. Applications fully use the capacity of the media, regardless of emulation mode or track density.

10.4.7 SIM and MIM presentation

SIMs and MIMs report hardware-related problems to the operating system. Refer to the *Statistical Analysis and Reporting System User Guide*, S7000247, which you can download from the Web at:

http://www-1.ibm.com/support/docview.wss?uid=ssg1S7000247

SIMs and MIMs are presented in z/VSE through OP64I, OP65I, and OP20 messages, as well as EREP reports.

10.4.8 Related documentation

Refer to the IBM z/VSE home pages on the Internet for general information:

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

10.5 General information about z/VSE under z/VM

The Tape Library support (TLS) for VSE under z/VM can be implemented in various ways. Also, the choice of tape management can impact the implementation. Therefore, we describe several possibilities:

- Tape management systems from other vendors
- Using TLS
- Using Dynam/T

Table 10-6 shows an overview of the interfaces that you need for various releases and any restrictions that you must consider.

Table 10-6 Supported solutions for z/VSE under z/VM

Platform	Needed software interfaces	Restriction
z/VSE 3.1, z/VSE 4.1, and z/VSE 4.2	VGS, RMSMASTR	None
z/VSE 3.1, z/VSE 4.1, and z/VSE 4.2	TLS	Devices must be defined static to the VSE and cannot be shared with other hosts.[1]
z/VSE or VSE/ESA with Dynam/T	None[2]	None

[1] Refer to section 10.4, “z/VSE native environments with Tape Library Support” on page 314.
[2] Refer to section 10.5.3, “VSE/ESA and z/VSE under z/VM using Dynam/T” on page 319.

10.5.1 Tape management systems for all implementations

Table 10-7 shows the third-party tape management systems that we know of that provide support for the TS3500 Tape Library in the VSE environment under VM. Other products might exist or new products might have been announced since the publication of this book.

Table 10-7 z/VSE tape management software support

Product name	Vendor name	Web site for more information
BIM-EPIC	CSI International	http://www.bimoyle.com/
BVS VSE/ESA	Pfeilschifter GmbH (Germany)	http://www.pfeilschifter-gmbh.de/en/index.htm
Brightstor CA-EPIC for VSE	Computer Associates International, Inc.	http://www.ca.com
BrightStor CA-Dynam/T Tape Management for VSE	Computer Associates International, Inc.	http://www.ca.com

10.5.2 z/VSE under z/VM using TLS

With z/VSE 3.1, 4.1, or 4.2, you can also use TLS under z/VM. However, the TLS does not support the attach or detach process. Therefore, with TLS, you cannot share the tape devices with other VSE instances, or z/VM, which for a native environment, is a restriction. For a VTS, which provides up to 128 virtual devices, you might consider defining dedicated devices to your environment. You must measure the easy implementation against the benefit of sharing devices.

10.5.3 VSE/ESA and z/VSE under z/VM using Dynam/T

Dynam/T uses its own interface, instead of VGS or TLS. Therefore, it does not use any of the mentioned interfaces. Figure 10-5 shows the information flow with Dynam/T.

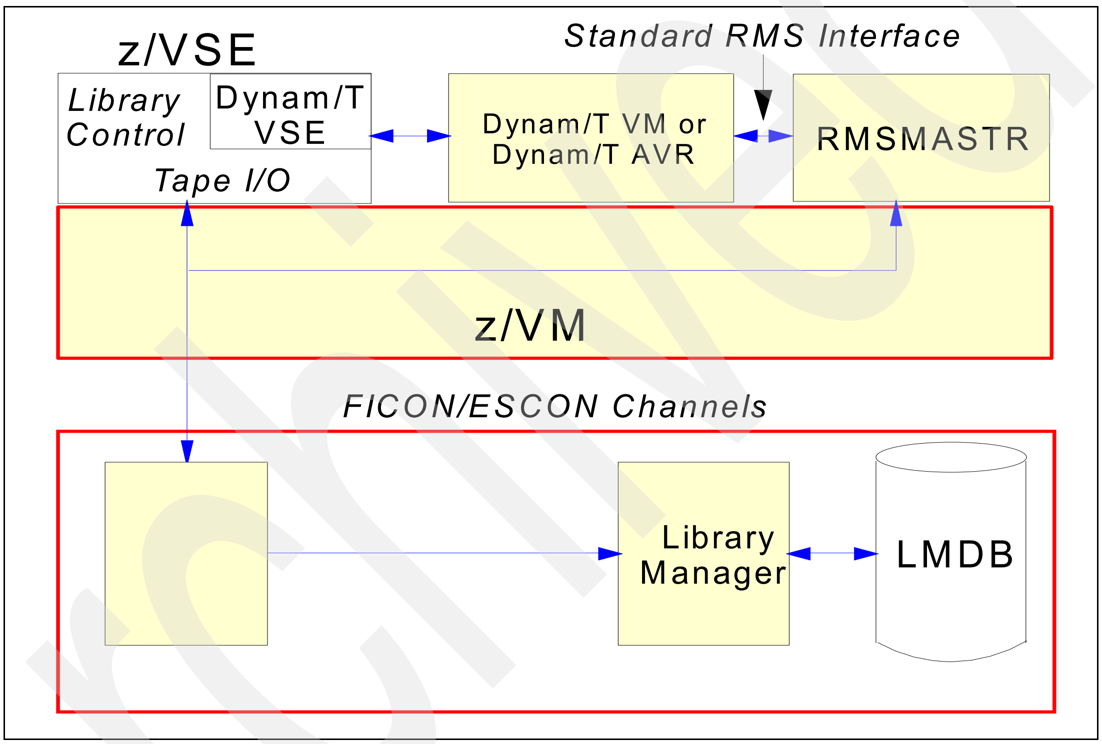


Figure 10-5 z/VSE and z/VM using Dynam/T

10.6 z/VSE as a guest using VSE Guest Server (VGS)

This section describes z/VSE support of the TS3500 Tape Library when z/VSE is running as a guest of z/VM. It introduces the required software releases, information about VSE Guest Server support and TLS, as well as considerations and information about the tape management system that you might want to use.

For information about data migration considerations and testing procedures, refer to 10.4.4, “Testing procedures” on page 316 and 10.4.5, “Data migration considerations” on page 317 in the z/VSE native section.

For information about necessary software support, refer to 7.3.4, “Software requirements for VSE/ESA and z/VSE” on page 190.

10.6.1 Basic functionality

When a z/VSE guest machine uses a tape drive in the tape library, the tape drive must be attached to that machine, and the tape volume must be mounted on the drive. Because z/VSE as a virtual machine cannot communicate with the Library Manager to request a tape mount, RMSMASTR must attach the tape drive and mount the volume. z/VSE cannot use RMSMASTR directly, because RMS functions run only in CMS mode. Therefore, the z/VSE guest typically uses the CMS service machine called the VSE Guest Server (VGS) to communicate with RMSMASTR. Certain vendor tape management support scenarios do not use the VGS but communicate directly with RMSMASTER through CSL calls.

z/VSE communicates with the VGS through an application programming interface (API) provided by the LBSERV macro of VSE/ESA. The library control API uses VSE's cross-partition communication capability (XPCC) to invoke APPC/VM to communicate with the VGS.

RMSMASTR handles all requests to the Library Manager. z/VSE uses tape drives inside the library in the same way that it uses drives outside of the library. This operation is the same as in z/VSE native support. To enable z/VSE guest support on z/VM, PTFs to both z/VSE and z/VM provide an API in z/VSE and the VGS.

> **Note:** The VGS provides the only way to communicate between RMSMASTR and the z/VSE guest machine. There is no direct interface from the VGS to the 3953 Tape System or the tape drive inside the library.

Figure 10-6 shows the z/VSE guest support for the 3953 Tape System. Although we show only a single z/VSE guest machine here, multiple z/VSE guests can share one VGS machine.

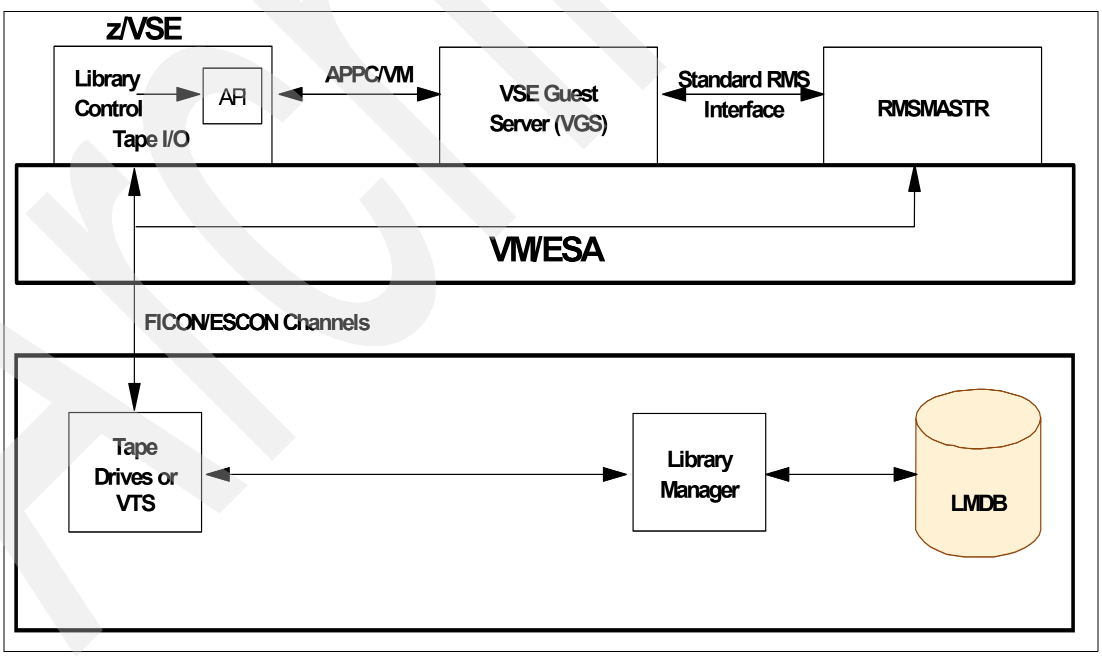


Figure 10-6 z/VSE as z/VM guest using the VSE Guest Server

The VGS supports a full set of library functions, including inventory functions, which entail reading and updating inventory lists that reside on z/VSE as librarian members. Because the interactions required for processing the inventory functions are elaborate and can run for a long time, a secondary VGS for inventory support is required to exploit these functions on the

CMS side. In addition, a librarian server runs in a z/VSE partition. Figure 10-7 shows the flow of an inventory request (the numbers correspond to the numbers in Figure 10-7):

1. The inventory request is sent by means of the LBSERV macro API from the VSE/ESA guest to the VGS.
2. The VGS presents the inventory request to the inventory support server machine.
3. The inventory support server requests the librarian server on z/VSE to read a librarian-managed file in the z/VSE librarian files, and the inventory support server gets the result.
4. The inventory support server sends the request to RMSMASTR.
5. RMSMASTR sends the request to the Library Manager and gets the result.
6. RMSMASTR returns the result (inventory list for query, result for changing volume category) to the inventory support server.
7. The inventory support server sends the result to the librarian server on z/VSE, and the librarian server writes a new copy of the librarian file.
8. The inventory support server notifies the VGS that processing is complete.
9. The VGS replies to the LBSERV macro request.

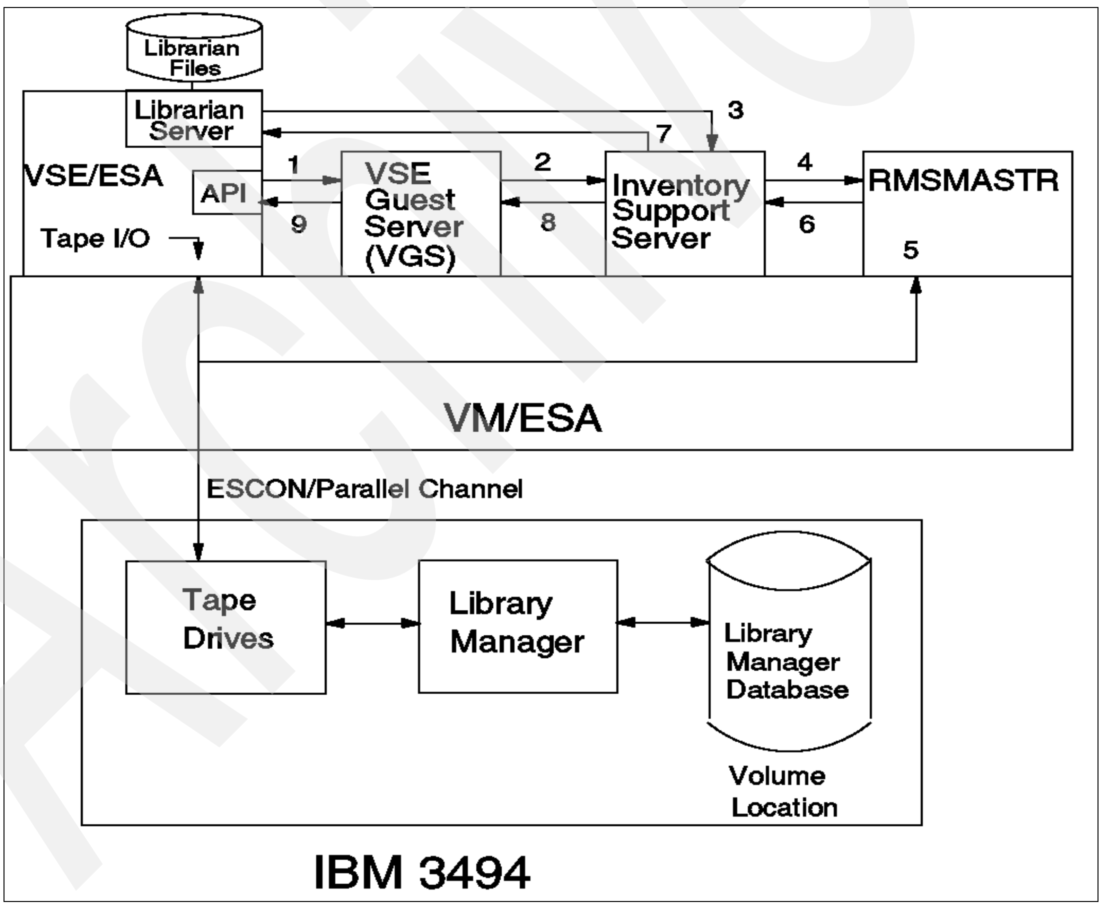


Figure 10-7 VSE Guest support: Flow of an inventory request

10.6.2 Library Manager interface

The z/VSE LBSERV macro is used to access volumes in a TS3500 Tape Library. LBSERV can request a mount, query a specific volume's location, release a drive, cancel a previous request, and eject a volume from the TS3500 Tape Library. The LBSERV macro is used under program control, and LIBSERV attention routines (ARs) and JCL statements are available external interfaces. Other functions, such as insert and category management, are performed through existing DFSMS/VM RMS library control interfaces.

The LBSERV macro accepts requests from VSE application programs, as well as LIBSERV ARs and JCL statements, and sends them to the VGS. VGS, in turn, passes them on to the 3953 Library Manager through DFSMS/VM RMS.

The VGS supports the following types of requests for library control:

- Query a volume, checking a single library
- Query a volume, checking all attached libraries
- Query a category count
- Query status of the 3953 logical library
- Query status of a drive
- Mount a volume
- Mount from a category
- Release a drive
- Cancel a mount
- Eject a volume
- Set a volume category
- Query the inventory
- Manage the inventory

> **Note:** The VGS uses the inventory support server as a secondary VGS when processing a query and managing inventory requests.

An interface for explicit demount is intentionally not provided. The TS3500 Tape Library automatically queues demount operations at rewind and unload time.

The VGS is given privilege class B to perform these functions and to attach and detach tape drives to and from z/VSE.

10.6.3 Control datasets

The VGS keeps a file (on a CMS minidisk) of in-process and completed work. The VGS keeps a file, LIBCONFG LIST, that contains the z/VSE library names and the corresponding DFSMS/VM library names. This file is optional where only one 3953 with only one logical library is installed.

The inventory support server (as a secondary VGS) uses a LIBRCMS SRVNAMES file in its 191 minidisks to handle library control for multiple z/VSE guests.

The librarian server on z/VSE uses the z/VSE librarian files for inventory processing, such as query and manage.

The tape management system is responsible for keeping an inventory of volumes in the TS3500 Tape Library belonging to z/VSE.

> **Note:** The VGS customization exit, FSMRMVGC, is highly important and just as critical to the system as the previously mentioned control datasets.

10.6.4 Considerations

Here are points to consider when you introduce z/VSE as a guest under VM:

- Multiple z/VSE guests can share one VGS machine.
- A VGS machine can manage more than one 3953 logical library.
- z/VSE guests have access to the same set of scratch pools that RMS uses.
- z/VSE can eject volumes from the library by direct command and can change the category of volumes in the insert category. However, a z/VSE guest lacks the capability to be automatically notified that new volumes are inserted. Also, no IBM-provided mechanism exists to check whether new volumes are inserted.
- IBM-supplied tape management system products are not available for z/VSE.

10.7 Software implementation in TPF

This section describes the support for an IBM TS7700 in a native Transaction Processing Facility (TPF) environment with TPF 4.1 or z/TPF. The TPF control program and several new and modified TPF E-type programs support the TS7700. The support is limited to a command-based interface.

Because TPF does not have a tape management system or a tape catalog system, clients usually rely on z/OS to manage this function. In a TPF environment, most tape data is passed between the systems. In general, 90 percent of the tapes are created on TPF and read on z/OS. The remaining 10 percent are usually created on z/OS and read on TPF.

We recommend that you use the normal z/OS and TS7700 installation process.

> **Note:** At the time of writing this book, TS1130 support was delayed until after general availability (post GA).

Specifics to TPF and z/OS with a shared TS7700

From the virtual drive side, TPF must be allocated certain drive addresses, which depend upon what tape functions are needed on TPF and which vary with the client. So, the TS7700 will have tape addresses allocated to multiple TPF and z/OS systems.

Using the TS7700 with TPF

TPF uses virtual volumes from the z/OS scratch pools and shares the Library Manager scratch categories with z/OS. The z/OS host performs the insert processing for these virtual volumes and continues to manage them based on the input obtained from TPF. TPF has a set of commands (ztplf) that make it possible to load the volumes in TPF-allocated virtual drives.

After a volume is loaded into a TPF drive, you need to have an automated solution in place that passes the VOLSER, the tape data set name, and the expiration date over to z/OS to have the volume processed automatically.

On z/OS, you need to update the tape management system's catalog and the TCDB, which allows z/OS to process virtual volumes that have been created by TPF. After the TPF-written volumes have been added to the z/OS tape management system catalog and to the TCDB, normal expiration processing applies. When the data on a virtual volume has expired and the volume is returned to scratch, the Library Manager and the TS7700 information are updated according to volume information maintained in z/OS.

Tapes that are created on z/OS and read into TPF

Tapes that are created on z/OS and read into TPF use the same z/OS process for creating tapes. Now, when TPF wants to read this z/OS-created tape, TPF does a specific mount of the tape VOLSER into a TPF-allocated drive using the TPF (ztplf) commands.

TS7700 performance for TPF

You can use the normal TPF Data Collection and Reduction reports that summarize read and write activity to the TPF allocated drive. For TS7700-specific performance, use the normal TS7700 statistics that are off-loaded to z/OS by using the TS7700 Bulk Volume Information Retrieval (BVIR) function.

Support of large (2 GB and 4 GB) virtual volumes for TPF

TPF does not use functions, such as Data Class, to control the cartridge volume size for specific cartridges. For more information about using OPM with TPF, refer to *IBM Virtualization Engine TS7700 Planning, Implementation and Monitoring,* SG24-7312.

In summary, consider when implementing a TS7700 in a TPF environment:

- Reserving a tape category does not prevent another host from using that category. It is the user's responsibility to monitor the use of reserved categories.
- Automatic insert processing is not provided in TPF.
- Currently, no IBM tape management system exists for TPF.

APM is supported in TPF through a user exit. The exit is called any time that a volume is loaded into a drive. At that time, the user can specify through the TPF user exit whether the volume inherits the attributes of an existing volume using the clone VOLSER attribute, or the code can elect to specifically set any or all of the Storage Group, Management Class, Storage Class, or Data Class construct names. If the exit is not coded, the volume attributes remain unchanged while the volume is used by TPF. For the two levels of TPF, there are two APARS that are required for this support. For TPF 4.1, the APAR number is PJ31643 and for zTPF 1.1, the APAR is PJ31394.

Library Manager interface

The only TPF operator interface to the TS7700 is a new TPF functional message, ZTPLF. The various ZTPLF functions that are provided allow the operator to manipulate the tapes in the library as operational procedures require. These functions include Reserve, Release, Move, Query, Load, Unload, and Fill. Refer to *IBM TotalStorage 3494 Tape Library: A Practical Guide to Tape Drives and Tape Automation*, SG24-4632.

Control data sets

The TPF host does not keep a record of the volumes in the TS7700 Tape Library or manage the tape volumes in it. You can use the QUERY command to obtain information about the tape volumes held in the IBM TS3500/3952 Tape Library.

SIM and MIM presentation

SIMs and MIMs report hardware-related problems to the operating system. Refer to the *Statistical Analysis and Reporting System User Guide*, which you can access on the Web at:

http://www-1.ibm.com/support/docview.wss?uid=ssg1S7000247

SIMs and MIMs are presented in TPF by the messages CEFR0354I, CEFR0355W, CEFR0356W, CEFR0357E, CEFR0347W, CDFR0348W, and CDFR0349E, as well as EREP reports.

11

Running z/OS production systems

Running and improving a tape environment in z/OS is a ongoing task. This chapter provides a collection of useful tasks and information. These tasks include:

- Managing different 3592 device models in a z/OS environment
- Tape device selection criteria
- Cartridge processing and interaction with object access method (OAM) exits
- Interactive Storage Management Facility (ISMF) Alter command
- Tape configuration database (TCDB) considerations and resynchronization of removable media manager (RMM) control dataset (CDS) or RMM-CDS
- Exploitation of new capabilities

11.1 Managing various 3592 models in a TS3500 Tape Library

Sometimes, clients install new drive models for migration purposes. After the migration, only the new drive model is left in a library. However, a mix of drive models can exist for a longer period of time. Depending on your purpose, you need to consider your options.

If you have various 3592 models installed (3592-J1A, 3592-E05, or 3592-E06, or if Encryption is enabled on a subset of the 3592-E05, one of the following implementation steps applies:

- To direct new tape allocations to a specific drive model, you need to define a Data Class. On the panel that is shown in Figure 11-1, specify **Recording Technology** with the appropriate value for each model. Also, update the automatic class selection (ACS) routines for new tape allocations accordingly to assign the new Data Class.
- You also request Tape Encryption through the Data Class construct. The Recording Technology specified in the Data Class determines whether a cartridge is written in native TS1120 format (E2 or E3) or in encrypted format (EE2 or EE3).

  Refer to the Data Class definition (shown in Figure 9-14 on page 262) for a detailed description of the Data Class.
- To allow *scratch cartridges* to be relabeled as a down-level drive, include the VOLNSNS=YES definition in the SYS1.PARMLIB member DEVSUP*xx*.

  Refer to “DEVSUPxx member of SYS1.PARMLIB” on page 237 for a detailed description of DEVSUP*xx*.

```
-------------------------------------------------------
    MOUNTABLE TAPE VOLUME LIST
                                   Scroll ===> CSR
                            Entries 1-13 of 40
low:                        Data Columns 8-12 of 20

 MEDIA   RECORDING              SPECIAL    LAST
 TYPE    TECHNOLOGY  COMPACTION  ATTRIBUTE  WRITTEN DATE
 -(8)--  ---(9)----  ---(10)---  --(11)---  ---(12)---
MEDIA3  128TRACK     ---         --------   ----------
MEDIA3  128TRACK     ---         --------   ----------
MEDIA3  128TRACK     ---         --------   ----------
MEDIA3  128TRACK     YES         --------   ----------
MEDIA3  256TRACK     ---         --------   ----------
MEDIA3  256TRACK     YES         --------   ----------
MEDIA3  256TRACK     YES         --------   ----------
MEDIA3  128TRACK     ---         --------   ----------
MEDIA5  EFMT1        ---         --------   2005/10/10
MEDIA5  EFMT1        ---         --------   ----------
MEDIA5  EFMT1        ---         --------   ----------
MEDIA7  EFMT2        ---         --------   ----------
MEDIA7  EFMT2        ---         --------   ----------
```

Figure 11-1 ISMF MOUNTABLE TAPE VOLUME LIST panel

In addition to browsing through ISMF panels, you can list the information in the tape configuration database (TCDB) by using the LISTC command. To verify volume entries, specify the VOLUMEENTRIES parameter as shown in the LISTC command in Figure 11-2 on page 327. This example lists all tape volume entries whose names begin with `V1` in the `ATLLIB1` tape library.

```
-------------------------  TSO COMMAND PROCESSOR  ---------------------
ENTER TSO COMMAND, CLIST, OR REXX EXEC BELOW:

===> tso listcat volumeentries(v1*) library(atllib1) all



                       LISTING FROM CATALOG -- SYS1.VOLCAT.VGENERAL

VOLUME-ENTRY-----------V123456
    DATA-VOLUME
      LIBRARY----------ATLLIB1     LOCATION-----------LIBRARY
      RECORDING--------256TRKS     MEDIATYPE-----------MEDIA2
      STORAGE-GROUP---*SCRTCH*     USE-ATTRIBUTE------SCRATCH
      CHECKPOINT-------------Y     ERROR-STATUS-------NOERROR
      SHELF-LOCATION------------(NULL)
      OWNER---------------(NULL)

    CREATION-DATE---1991-01-01   ENT-EJ-DATE---1990-01-01
    COMPACTION------------NONE   SPEC-ATTRIBUTE -----NONE
    EXPIRATION------2000-12-31   LAST-MOUNTED--1991-01-01
    WRITE-PROTECTED----------N   LAST-WRITTEN--1991-01-01
```

Figure 11-2 LISTC command for library entry

The default of this parameter is SPECIALATTRIBUTE(NONE), (SPEC-ATTRIBUTE -----NONE in the display in Figure 11-2). There is a high probability that you need to update it in your system. You can update it either through IDCAMS ALTER VOLENTRY or using DFSMSrmm if this is your tape management system. The IDCAMS command for volume 123456 looks like this example:

```
ALTER V123456 VOLUMEENTRY SPECIALATTRIBUTE(READCOMPATIBLE)
```

HSM and OAM with OSMC considerations

No actions are required when you are using both TS1120 and TS1130 tape drives, because the TS11130 drive can write in TS1120 format. However, if you want to start recording in TS1130 format and do not want to fill existing cartridges, you must set all of the volumes that are in the “FILLING” state to FULL.

If you want to use the TS1130 drives with hierarchical storage management (HSM) or Object Access Method (OAM) Storage Management Component (OSMC), and if you are migrating from J1A drives, you must set all volumes that are in the “FILLING” state at the moment to FULL. Otherwise, HSM and OSMC mount the tapes to fill them up on the new drives. Then, they discover the down-level label and issue an error message.

To overcome this situation, you need to perform the following steps for HSM and OAM:

- For HSM:
  a. Find out which volumes are in “filling” status. Enter:

     ```
     LIST TTOC SELECT(ML2 NOTFULL) ODS(SMS.LIST.TTOC2)
     ```

     You can also specify BACKUP or BOTH instead of ML2.

b. Set the volumes to 100% full. Enter:

```
HSEND DELVOL VOLSER MIGRATON(MARKFULL)
```

You receive message ARC0260I `Migration Volume volser entry marked FULL`.

Clients, who currently use MEDIA5 or MEDIA9 tapes both with and without the Performance Scaling option, might want to reclaim the performance-scaled tapes for full capacity use and start using MEDIA7 tapes for high performance functions. For example, perhaps you use MEDIA5 60 GB or MEDIA9 140 GB for ML2 and MEDIA5 300 GB or MEDIA9 700 GB for backup and dump. ML2 migration and recycle output can be redirected to MEDIA7 and all of the MEDIA5 or MEDIA9 ML2 tapes can be either specifically recycled by VOLSER or marked full and recycled generically. The released MEDIA5 or MEDIA9 tapes can then be used to their full capacity for backup and dump processing. All HSMs in an HSMplex need to have the DFSMShsm full support PTFs installed if any HSM in the HSMplex has access to MEDIA6, MEDIA7, MEDIA8, MEDIA9, or MEDIA10 tapes. This PTF support prevents accidentally mounting WORM tapes for DFSMShsm functions and avoids including MEDIA7 tapes with MEDIA5 or MEDIA9 tapes for recycle reuse capacity calculations.

- For OAM:

a. Find out which volumes are in "filling" status. The OAM/OSMC system programmer must perform this task. The OAM/OSMC system programmer extracts a volume table from DB2 for you; the volume table shows the volume and filling state.

b. Set the volumes in filling state to FULL. Enter:

```
F OAM,UPDATE,VOL,volumeserialnumber,FULL,Y
```

c. Set the volume to read-only. Enter:

```
F OAM,UPDATE,VOL,volumeserialnumber,WRITABLE,N
```

Perform these actions before you change the ACS routines to direct HSM or OAM and OSMC traffic to the new drive models.

11.2 Tape device selection criteria

With DFSMS/MVS™ support for tape libraries, there are two or three databases or catalogs that contain information about tape volumes and the datasets on the volumes. The z/OS system catalog retains its role as the dataset catalog. You are not required to catalog the tape datasets in the z/OS catalog.

To see how the information in these databases is used when a job reads or writes a dataset on a tape volume, you need to consider the three most common cases:

- Reading an old cataloged dataset
- Reading an old uncataloged dataset
- Writing a new dataset and cataloging it

This section explains these cases, the process of tape device selection, and how the Library Manager manages the order for scratch volumes from the host.

11.2.1 Reading a dataset

Figure 11-3 shows the procedure that z/OS allocation uses to locate and read a dataset. We explain the procedure in the following steps (the numbers correspond to the numbers in Figure 11-3):

1. Find the VOLSER:
   - If a dataset is cataloged, you can find the dataset name in the z/OS dataset catalog. The VOLSER is extracted from the catalog entry, which is shown in Figure 11-3.
   - When the dataset is not cataloged, you must indicate its VOLSER through JCL or parameters in a dynamic allocation request. Searching the z/OS dataset catalog is bypassed.
2. The tape configuration database (TCDB) is searched to find the volume entry for the volume. If the volume entry is found, and it indicates that the volume is within a library (and not in SHELF), the library name, Storage Group, recording format (EFMT1, EFMT2, EEFMT2, EFMT3, or EEFMT3), and device type are extracted from the TCDB entry. They are used in allocating a tape unit for reading the dataset.

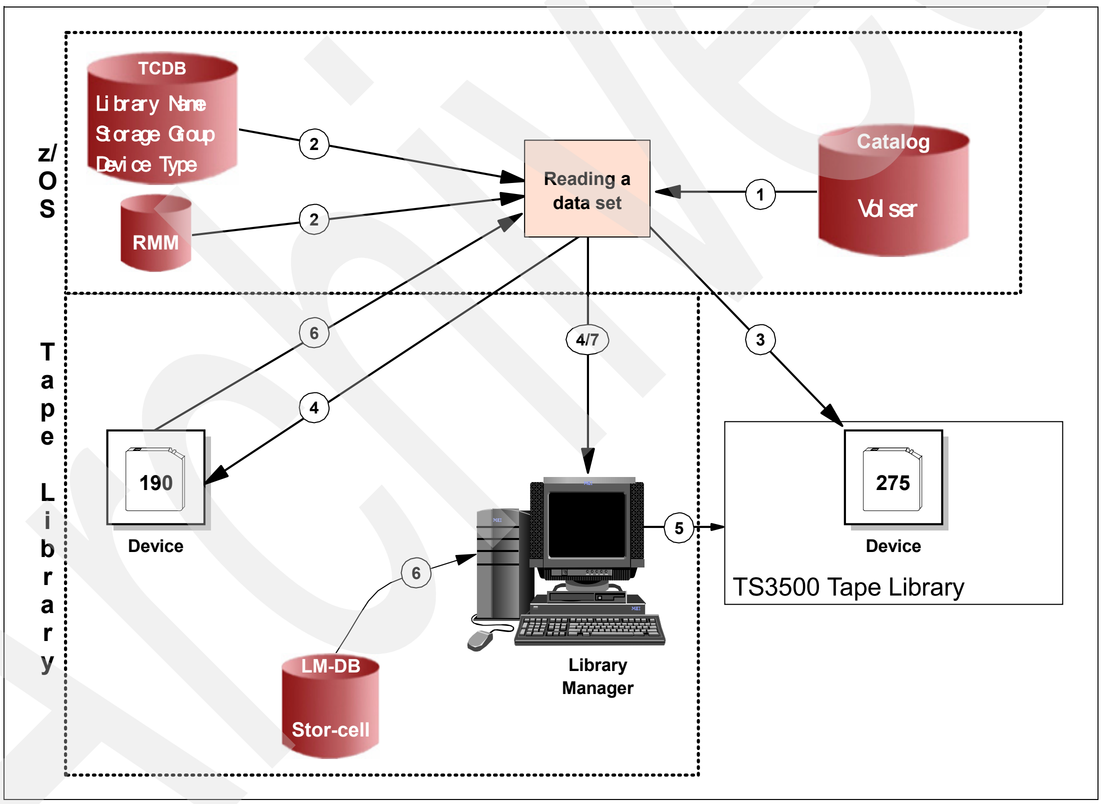


Figure 11-3 Process flow to read a dataset

Note: If a volume entry is found in the TCDB and the LOCATION indicates LIBRARY, allocation always goes inside a tape library. When a foreign tape comes to your system with a VOLSER that already is in a tape library, since DFSMS 1.4.0 and later, we recommend that you read it this way on a tape device outside the library:

```
STORCLAS=DUPT@SMS,DISP=OLD,VOL=SER=xxxxxx (specific mount)UNIT=uuuu
(non-system-managed tape devices)
```

This action bypasses System Managed Storage (SMS) checks against the TCDB and so forth, and the UNIT parameter is honored, which drives the allocation to a non-system-managed tape device.

Prior to DFSMS 1.4, you must use Bypass Label Processing (BLP) in your JCL. Remove the existing volume entry from the TCDB. After you read the foreign tape, add the volume entry to the TCDB using IDCAMS commands.

3. If the volume entry is not found in the TCDB, and the volume that is not in the library installation exit (CBRUXVNL) does not prompt the operator to enter the volume into the library, allocation is directed to a device that is outside the library.
4. Next are allocation or OPEN requests to mount the volume on the selected unit. For a discussion of device selection, refer to 11.2.4, "Device and library selection in a z/OS and Tape Library environment" on page 332. In the case of a library, this request is transformed into a channel command, which requests that the Library Manager mount the volume.
5. The Library Manager transfers the mount request to the TS3500 Tape Library. The Library Manager constantly keeps its database up-to-date and records the fact that the volume has been moved to the tape unit.
6. When the dataset is opened, the correctness of the tape volume selection is verified with information from the volume and dataset labels on the tape. Next, the user's right to access the tape volume and the dataset is verified with RACF through the System Authorization Facility (SAF). The fact that the volume and the dataset have been used is reflected in the TCDB and DFSMSrmm database by updating the relevant records there.
7. When the dataset is closed after it has been used, and a volume "KEEP" is processed, a request is made to the Library Manager to move the volume from the tape unit to a storage cell in a library. The Library Manager transfers that request to the TS3500 Tape Library.

11.2.2 Writing a new dataset

Figure 11-4 on page 331 shows the procedure to write a new dataset.

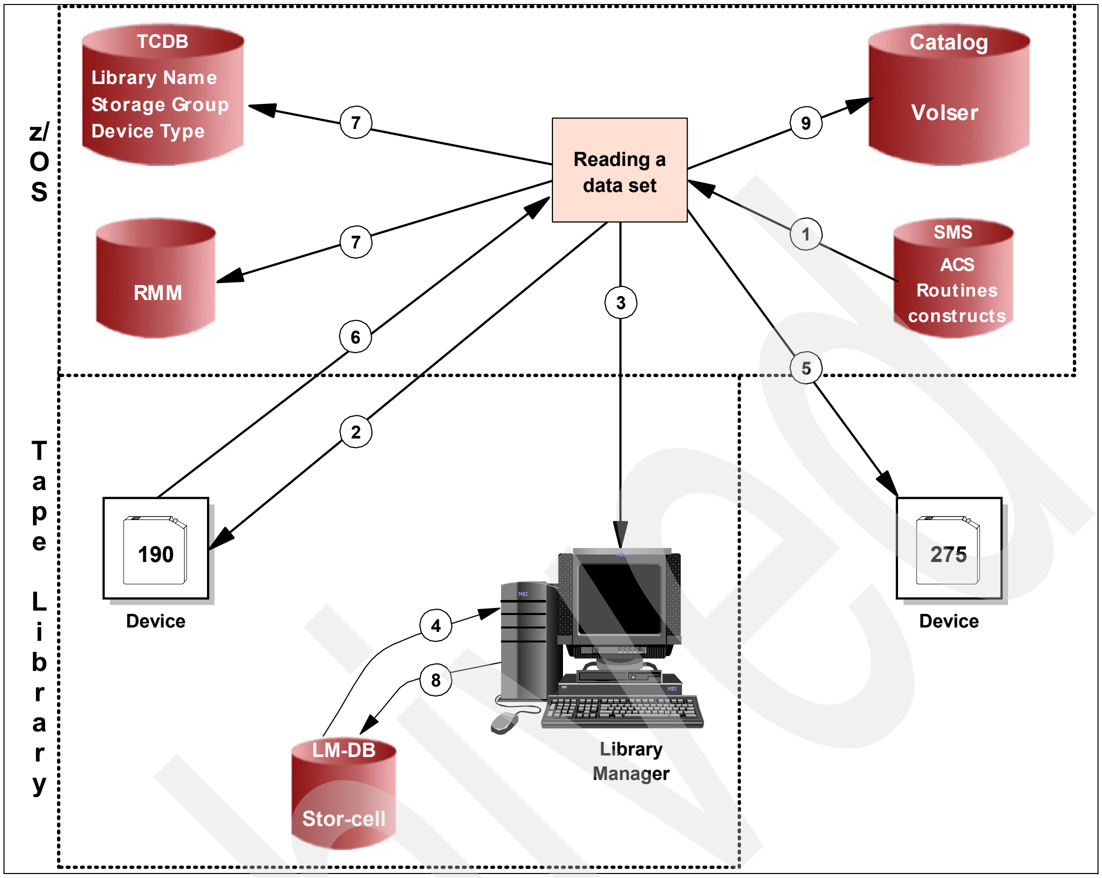


Figure 11-4 Process flow to write a dataset

We explain the procedure in these steps (these numbers correspond to the numbers in Figure 11-4):

1. From the dataset name and other information given in JCL or a dynamic allocation request and the Data Class, the System Managed Storage (SMS) ACS routines derive a Storage Class and a Storage Group for the dataset. The Storage Class and the Storage Group for the dataset determine the allocation to a suitable unit in a tape library.
2. Allocation determines on which device to mount the scratch volume. For a discussion of device selection, refer to 11.2.4, “Device and library selection in a z/OS and Tape Library environment” on page 332.
3. OPEN requests that the Library Manager mount a scratch volume.
4. The Library Manager selects a volume from the scratch category and sends the mount request to the TS3500 Tape Library.
5. If no Storage Class is derived from SMS, the dataset is written on a device outside of the tape library.
6. The dataset is opened. Again, the user’s right to access the volume is checked, based on the VOLSER, which now becomes known to z/OS.
7. The TCDB, RACF database, and DFSMSrmm CDS are accessed to verify authorization. The volume must be known to DFSMSrmm, and it must be a scratch volume. The CDS is updated to indicate the new dataset on the tape volume, to record the SMS classes assigned, and to indicate the changed status (scratch or private). The update to the TCDB also indicates which Storage Group is selected for the volume and the changed status.

8. The Library Manager database is updated to indicate the changed category of the volume (from scratch to private).
9. If cataloging is requested for the dataset, it is performed at disposition time. The z/OS dataset catalog is updated to indicate the dataset name and its VOLSER.
10. After the close process, the demount request is given to the Library Manager and transferred to the TS3500 for the demount of the tape.

> **Important**: Information about real mounts and demounts is only true if a native cartridge is read or written. If a virtual volume is read, a real mount of a physical cartridge is dependent on whether the volume is already in cache or not. If a virtual volume is written, neither real mount nor demount is processed.

11.2.3 Tape device selection information (TDSI)

With the 3590 Model E and H, there were read-compatibility considerations that required the client to indicate on a volume or job basis that the request for a volume was for read-only purposes, which enabled a higher technology device that was downward-read-compatible to be considered eligible for the request. This flexibility was particularly important if a client had upgraded all of the drives in the library to the new recording technology, and it was a way to indicate that the volume was going to be used for read-only purposes.

With the 3592 Model E05 being both downward-read and write compatible with EFMT1, explicit specification of the read-compatible special attribute indicator or usage of the LABEL=(,,,IN) on the DD statement of JCL was not required for the EFMT1 recording format. The same rule applies with the 3592 Model E06 and the EFMT2/EEFMT2 recording formats. However, because the 3592 Model E06 is only downward-read and not write compatible with the EFMT1 format, explicit specification of the read-compatible special attribute indicator (in the tape configuration database) or usage of the LABEL=(,,,IN) on the DD statement of JCL is needed to enable the 3592 Model E06 drive to be considered eligible for an EFMT1 request.

11.2.4 Device and library selection in a z/OS and Tape Library environment

Device selection within a library or across libraries in the same Storage Group is determined by weighing how well each device meets the needs of the request that is processed and then selecting the device that best meets those needs. For specific mount requests, the device selection is limited to the drives in the library where the volume resides. Each device is looked at from various viewpoints.

The higher the viewpoint is in the priority list, the higher the assigned weight for the device is. The weights given for each viewpoint are added together. The device with the highest sum is selected for allocation.

> **Note:** The following considerations are not taken into account for device selection:
>
> - Number of available drives
> - Busy condition of control unit or library accessor

11.3 Cartridge processing

The following sections describe the interaction between z/OS OAM exits and actions regarding cartridges:

- Cartridge insert processing
- Cartridge eject processing
- Cartridge return to scratch status

For additional information about the OAM exits, refer to 9.2.5, “Customizing OAM” on page 248.

For more information about the operating instructions for inserting and ejecting cartridges, refer to 13.5.3, “Inserting physical volumes in the IBM TS3500” on page 417 and 13.5.6, “Removing data cartridges” on page 425.

11.3.1 Cartridge insert processing

When cartridges are entered into the tape library, the TS3500 Tape Library checks the VOLSER and media type. If the barcode is readable and the VOLSER is unique, a record is added to the TS3500 Tape Library database. If the cartridge was not predefined by the Cartridge Assignment Policy (CAP) process, the cartridge remains in the status *Unassigned*. If a CAP was predefined and is related to a System z-attached logical library partition, the cartridge is now offered to the defined 3953 Library Manager. The 3953 Library Manager adds the cartridge to its database and places the cartridge in the INSERT category. A message goes to all hosts informing them that a cartridge is in the INSERT category. The Library Control System (LCS) component of OAM builds the TCDB record with information that the tape management system verifies by using the cartridge entry installation exit CBRUXENT.

The return code of CBRUXENT controls whether the cartridge is accepted into the library, ejected from the library, or left for another host to process (refer to 11-1). If the exit sets a return code of zero, the cartridge is accepted in the library, and the TCDB and Library Manager records are updated.

The new media types are supported in the IBM TS3500 Tape Library and also in the manual tape library (MTL). When a volume is entered into a library, the cartridge entry installation exit (CBRUXENT) is invoked to approve or deny an enter request and to set or verify the recording technology to associate with the volume. If a volume record for the entered MEDIA5, MEDIA6, MEDIA7, MEDIA8, MEDIA9, or MEDIA10 volume (scratch or private) does not exist in the TCDB, the cartridge-dependent recording technology (EFMT1, EFMT2, EEFMT2, EFMT3, or EEFMT3) is passed to the exit.

If the exit returns with a recording technology for a MEDIA5, MEDIA6, MEDIA7, MEDIA8, MEDIA9, or MEDIA10 volume, and the recording technology is not either EFMT1, EFMT2, EEFMT2, EFMT3, or EEFMT3, this action is considered an invalid action, and the exit is disabled.

If a volume record for the entered MEDIA5, MEDIA6, MEDIA7, MEDIA8, MEDIA9, or MEDIA10 volume exists in the TCDB and if the system that processes the entry request does not support this media type, the volume is left in the Library Manager insert category to be processed by a system that understands this media type.

If CBRXLCS FUNC=MCE is used to enter a MEDIA5, MEDIA6, MEDIA7, MEDIA8, MEDIA9, or MEDIA10 volume into an MTL, and the media type is not supported on the system, the request fails with corresponding return code LCSFAIL (12) and corresponding reason code LCSFNSUP (310). If the CBRUXENT exit returns a media type that is not supported in the MTL (an up-level media type), the entry of the volume also fails.

Table 11-1 CBRUXENT return codes

Return code	Meaning
0	Perform the cartridge entry as requested. No changes are made to the parameter list (CBRUXEPL). Use what existed at the time that the installation exit was called. Perform the entry as requested.
4	Perform the cartridge entry and note that one or more fields in the parameter list (CBRUXEPL) have changed.
8	Do not allow this cartridge to be entered. For an automated tape library data server, OAM schedules the cartridge to be ejected.
12	Ignore the cartridge entry request. For an automated tape library data server, OAM leaves the cartridge in the library (volume left in the insert category).
16	Reject the cartridge entry request. The cartridge will be ejected from the tape library.

Note: If an invalid return code is passed back, OAM discontinues cartridge entry processing.

After OAM is told not to invoke the installation exit again (return code 16), or cartridge entry processing is discontinued, the only way to reactivate the exit is to stop and restart OAM or to issue the LIBRARY RESET,CBRUXENT command.

The cartridge entry installation exit has two major purposes. The first purpose is to verify and change information on cartridges as they are inserted into the library. The information is transferred through the CBRUXENT. With the introduction of Advanced Policy Management (APM) (for Virtual Tape Server (VTS)) or Outboard Policy Management (OPM) (for TS7700), there are many new parameters on the parameter list. For a detailed list of the parameters of this exit, refer to *z/OS V1R8 DFSMS Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries,* SC35-0427. The second purpose is, in an environment where multiple hosts share a library, to ensure that the current host has access to its cartridges only. If more than one SMSplex and tape management system share a library, the entry exit must be common across members of a SMSplex. If practical, use the same exit across all members of all SMSplexes. Code the entry exit so that the return code set causes a tape to be accepted into or ejected from the library. If any non-SMS hosts use the library, their volumes must be ignored. If a cartridge remains unclaimed by the attached hosts, it remains in the library manager INSERT category. If there is no TCDB entry for a cartridge, it cannot be ejected from the library through ISMF, the LIBRARY command, or the CBRXLCS macro.

11.3.2 Cartridge eject processing

Cartridges are ejected from the library when the library manager changes the category to an EJECT category. There are two EJECT categories:

- FF10 for the convenience I/O station
- FF11 for the high capacity output facility

When the cartridge is ejected from the library, the cartridge record in the TCDB can be kept or purged, which is controlled by the EJECT DEFAULT on the ISMF LIBRARY DEFINE panel or on the parameter that is used when ejecting the volume.

The installation-wide exit CBRUXEJC approves or disapproves of a cartridge from the library.

11.3.3 Cartridge return to scratch status

Cartridges are returned to scratch status in the library by having their Library Manager category changed from *Private* to one of the scratch media categories, which are specified in the appropriate DEVSUP*xx* member of SYS1.PARMLIB. The category is changed by the OAM macro CBRUXLCS or the ISMF mountable-tape volume list ALTER command. The installation-wide change use attribute exit, CBRUXCUA, is called to approve or disapprove the requested change.

DFSMSrmm uses the change use attribute exit. Therefore, if a volume is changed through ISMF and the change is approved by the DFSMSrmm database, DFSMSrmm is updated to reflect the change in the TCDB. Not all tape management systems use the change of use exit. Therefore, you must be careful handling the unit from which updates are controlled. We recommend that you do *not* use ISMF for anything other than displaying information in any installation where the tape management system does not use all of the OAM exits.

11.4 ISMF ALTER command

ISMF enables you to alter the use attribute, Storage Group, shelf location, and owner information of a single tape volume or a volume list through the use of the ALTER line operator or the ISMF ALTER command. These commands are used from the MOUNTABLE TAPE VOLUME LIST panel (refer to Figure 11-14 on page 350).

ISMF is an important part of the altering scheme when used in conjunction with the ALTER command, because it allows you to start with an entire tape volume list. Then, by using sorting and filtering capabilities, you can reduce that list to a subset of volumes, for example, all of the volumes in a single Storage Group. Use the ALTER command against the subset list to change information for all of the volumes on the list at the same time. You can also use the ALTER command to take the volume out of the error category in the Library Manager inventory.

When you invoke the ALTER command on the MOUNTABLE TAPE VOLUME LIST panel, you alter the use attribute, Storage Group, shelf location, and owner information values for all of the volumes in the list (refer to Figure 11-5 on page 336).

```
  Panel  Utilities  Help
-------------------------------------------------------------------------------
                   MOUNTABLE TAPE VOLUME ALTER ENTRY PANEL
Command ===>


Number of Volumes to be Altered:  10

Specify New Values for the Following Fields (Blank means no change):

  Use Attribute  . .      (P - Private, S - Scratch, or blank)

  Storage Group  . .

  Shelf Location . .

  Owner Information
    ===>

Use ENTER to Perform ALTER;
Use HELP Command for Help; Use END Command to Exit.
```

Figure 11-5 ALTER command from the MOUNTABLE TAPE VOLUME ALTER ENTRY panel

When the ALTER line operator is entered from the MOUNTABLE TAPE VOLUME LIST panel, the next MOUNTABLE TAPE VOLUME ALTER ENTRY panel (Figure 11-6) is displayed to enable you to enter the new values for the specific volume requested. The panel examples in Figure 11-6 through Figure 11-9 on page 339 provide more information regarding the ALTER function for a specific tape volume.

```
   Panel  Utilities  Help
-------------------------------------------------------------------------------
                   MOUNTABLE TAPE VOLUME ALTER ENTRY PANEL
Command ===>

Tape Volume : VOL101

Specify New Values for the Following Fields:       (leave as-is if no change)

Use Attribute:  Old Value   : SCRATCH
                New Value . . P         (P - Private or S - Scratch)

Storage Group:  Old Value   :
                New Value . .

Shelf Location: Old Value   :
                New Value . .

Owner Information:
    Old Value:
New Value  . .

Use ENTER to Perform ALTER;
Use HELP Command for Help; Use END Command to Exit.
```

Figure 11-6 Next MOUNTABLE TAPE VOLUME ALTER ENTRY panel

When the volume was entered into the library, if no values were specified for Storage Group name, shelf location, or owner information, the Old Value fields on this panel are blank. The tape volume record reflects blanks in these fields in the TCDB. You then add the values for owner information, Storage Group, and shelf location into the New Value fields and press Enter. The fields are updated in the TCDB, and the next time that the volume displays, the new information appears in the Old Value fields. The New Value fields are primed with the same information (refer to Figure 11-7).

```
   Panel  Utilities  Help
------------------------------------------------------------------------------
                   MOUNTABLE TAPE VOLUME ALTER ENTRY PANEL
Command ===>

Tape Volume: VOL101

Specify New Values for the Following fields:      (leave as-is if no change)

Use Attribute:  Old Value   : PRIVATE
                New Value . . P        (P - Private or S - Scratch)

Storage Group:  Old Value   : SGTAPLCL
                New Value . . SGTAPLCL

Shelf Location: Old Value   : BASEMENT1
                New Value . . BASEMENT1

Owner Information:
    Old Value: CENTER
New Value  . . CENTER

Use ENTER to Perform ALTER;
Use HELP Command for Help; Use END Command to Exit.
```

Figure 11-7 Both old values and new values are assigned to the volume

If you type blanks over the New Value for Storage Group, shelf location, or owner information, the corresponding field in the tape volume record is set to blank. Then, the New Value fields appear as blank the next time that the record is displayed (refer to Figure 11-8).

```
Panel  Utilities  Help
------------------------------------------------------------------------------
                   MOUNTABLE TAPE VOLUME ALTER ENTRY PANEL
Command ===>

Tape Volume: VOL101

Specify New Values for the Following Fields:       (leave as-is if no change)

Use Attribute:  Old Value   : PRIVATE
                New Value . . P        (P - Private or S - Scratch)

Storage Group:  Old Value   :
                New Value . .

Shelf Location: Old Value   : BASEMENT1
                New Value . . BASEMENT1

Owner Information:
    Old Value: CENTER
New Value  . . CENTER

Use ENTER to Perform ALTER;
Use HELP Command for Help; Use END Command to Exit.
```

Figure 11-8 New value blanked out for Storage Group

Note that both the Old Value fields and the New Value fields for Storage Group are now blank. To add a Storage Group again, indicate the new value for Storage Group in the New Value field and press Enter (refer to Figure 11-9).

```
 Panel  Utilities  Help
 ------------------------------------------------------------------------------
                   MOUNTABLE TAPE VOLUME ALTER ENTRY PANEL
 Command ===>

 Tape Volume: VOL101

 Specify New Values for the Following Fields:       (leave as-is if no change)

 Use Attribute:  Old Value   : PRIVATE
                 New Value . .          (P - Private or S - Scratch)

 Storage Group:  Old Value   :
                 New Value . . SGTAPRMT

 Shelf Location: Old Value   : BASEMENT1
                 New Value . . BASEMENT1

 Owner Information:
     Old Value: CENTER
 New Value  . . CENTER

 Use ENTER to Perform ALTER;
 Use HELP Command for Help; Use END Command to Exit.
```

Figure 11-9 New Storage Group assigned to blank Storage Group

ISMF validates the New Value input for the use attribute to allow only `P` or `S`. The New Value input for Storage Group is validated on the same selection entry panel. However, blanks are acceptable in this field.

ISMF does not validate the existence of the Storage Group in the active configuration. However, if the tape volume is library-resident, OAM provides the validation to ensure that:

- The volume's Storage Group is defined in the current active control dataset (ACDS) as a tape Storage Group.
- The volume's library is defined in the specified Storage Group.
- The volume's library is defined in the current ACDS as a valid tape library.

> **Note:** If the tape volume is shelf-resident, only the first check occurs.

If OAM detects an error in any of these conditions, neither the use attribute nor the Storage Group changes. However, shelf location and owner information can be altered even though a storage error is detected.

When an error occurs during the ALTER function, a message is stored in the message history for the entry. You can issue the message line operator to obtain the error information.

When you press Enter to perform the alter operation, the CONFIRM ALTER REQUEST panel (Figure 11-10) appears. It shows the number of volumes to be altered. Change `N` to `Y` and press Enter to confirm the alter request.

```
Panel  Utilities  Help
------------------------------------------------------------------------------
                             CONFIRM ALTER REQUEST
Command ===>


Number of Volumes to be Altered: 10



   Enter "/" to select option   Y Perform Alter







Use ENTER to Perform Operation;
Use HELP Command for Help; Use END Command to Exit.
```

Figure 11-10 CONFIRM ALTER REQUEST panel

11.4.1 Changing the use attribute from private to scratch

You can use the ALTER command to specify a new value of *scratch* for the use attribute when any of the volumes on the list are private with an expiration date that has not yet passed. When you do this, the PRIVATE TO SCRATCH CONFIRMATION panel (Figure 11-11 on page 341) appears for *each* volume whose expiration date has not yet passed.

> **Note:** When DFSMSrmm is installed, any attempt to alter the use attribute from private to scratch is rejected unless DFSMSrmm already shows the volume as scratch. The change-of-use attribute installation exit (CBRUXCUA) is invoked whenever there is an attempt to change the use attribute for a tape volume. It can override the request or change the values. Refer to 9.2.5, "Customizing OAM" on page 248 for more information about this installation-wide exit. If your tape management system does not support CBRUXCUA, we recommend that you do not use ISMF to change the status of library-resident volumes.

```
Panel  Utilities  Help
------------------------------------------------------------------------------
                    PRIVATE TO SCRATCH CONFIRMATION PANEL
Command ===>


                      Confirm Alter of Volume:  VOL101

        Currently this Volume is Private and
        Its Expiration Data has not yet Passed.

Enter "/" to select option   _  Do you still want to change it to scratch?

        You may specify that all private volumes on
        the list should be changed to scratch whether
        or not their expiration dates have passed.
        If you do, the volumes will be changed without
        redisplaying this confirmation panel.

Enter "/" to select option   _  Allow All Private Volumes to be
                                Changed to Scratch?

Use ENTER to Perform Operation;
Use HELP Command for Help; Use END Command to Exit.
```

Figure 11-11 PRIVATE TO SCRATCH CONFIRMATION panel

If the response is the (/) character on either confirmation panel, OAM changes the following items:

- The use attribute changes to S in the TCDB.
- The Storage Group name becomes *SCRTCH* in the TCDB.
- The expiration date in the TCDB becomes blanks.
- The volume error status resets to NO ERROR in the TCDB.
- The Library Manager category of the cartridge changes from private to scratch.

11.4.2 Changing the use attribute from scratch to private

Using the ALTER line operator or the ALTER command to change the use attribute for tape volumes to private updates these fields in the TCDB:

- The use attribute changes to P in the TCDB.
- The volume error status resets to NO ERROR in the TCDB.
- The category of the cartridge or cartridges changes from scratch to private.

The changes to the TCDB volume record occur immediately. When the line operator or command completes, you return to the MOUNTABLE TAPE VOLUME LIST panel with the appropriate success or failure message. If the volume or volumes successfully change, use the ISMF REFRESH command to display the new values in the tape volume record.

Note: If DFSMSrmm is installed, its CDS is updated to reflect these changes.

11.4.3 Using ISMF ALTER to change the volume category

Sometimes, especially in consolidation phases, outsourcing activities, or migration tasks, it is necessary to change the MEDIA categories in DEVSUP*xx* to support new numbering conventions or to consolidate systems. If you must change the MEDIA*x* value, make sure there is no movement from the cartridge. The following steps describe the easiest way to change the MEDIA*x* value:

1. Change DEVSUP*xx* MEDIA*x* to the new value.
2. Perform an IPL on the system. After the IPL, no scratch volumes are left, because there are no volumes in the new scratch category.
3. Go to ISMF. Create a list of all of the volumes that you influenced through the MEDIA change. Choose by volume prefix and Storage Class *SCRTCH*.
4. Enter `ALTER` on the command line. Then, the message `MOUNTABLE TAPE VOLUME ALTER ENTRY PANEL` appears on the panel. Do not make any changes on that panel. Press Enter.
5. On the confirmation panel that displays, press Enter.

   The system alters one volume after the other volume. Therefore, the process can take several minutes, depending on the number of volumes. No information is really altered in z/OS, but the new scratch category is transferred to the Library Manager. After you process the ALTER command, you have the same number of scratch cartridges that you had before the IPL.

For more detailed information about the panels, refer to the *DFSMS/MVS DFSMSdss Storage Administration Guide*, SC26-4930.

11.5 TCDB considerations

Your TS3500 Tape Library installation depends heavily on the availability of your TCDB. An extended outage of a TCDB can be extremely disruptive, because tape data stored in the IBM TS3500 Tape Library cannot be retrieved without access to the TCDB. TCDB tasks, which we outline in Table 11-2, include functions to detect and correct out-of-sync conditions.

Table 11-2 TCDB tasks

Task	Comment
Schedule job to save the TCDB.	Refer to 11.5.1, “TCDB backup” on page 343.
Restore or rebuild the TCDB after destruction.	Refer to 11.5.2, “TCDB recovery using ICFRU” on page 343.
Move the TCDB to a different volume.	Refer to 11.5.4, “Moving a TCDB to another volume” on page 347.
List information in the TCDB.	Refer to 11.5.5, “Listing information in the TCDB” on page 348.
Verify consistency between the TCDB and the tape management system.	Refer to 11.6, “Resynchronizing RMM CDS” on page 353.
Verify the location of the tape volumes in your tape libraries.	Refer to 11.5.6, “Library Manager database and TCDB synchronization” on page 349.
Perform manual updates against the TCDB.	Refer to 11.5.7, “TCDB manual update” on page 352.

11.5.1 TCDB backup

Your most important task is to make sure that the TCDB is included in the backup job or job stream for catalogs. We suggest that you run IDCAMS EXPORT for the backup. You can use other programs, such as DFSMShsm or DFDSS, to back up your TCDB. However, if you want to use ICFRU for recovery, too, IDCAMS is the backup program to use.

If you use general and specific VOLCATs and you use DFSMSdfs for backup, a backup of all of the VOLCATs at the same time is required for consistency reasons. If you use IDCAMS EXPORT, a backup of all of the VOLCATs at the same time is not required, but it can reduce your outage. For example, there might be a disaster with a direct access storage device (DASD) where the VOLCATs reside, and you can only sample the correct SMF data one time.

> **Note:** We recommend that you place at least one backup of all TCDBs on DASD. If you lose the TCDB, and the backup is on a tape in a library environment (including native, TS7700, or VTS), you must perform manual reconstruction to access the library with the backup tape. Performing a backup on DASD is the easiest way to avoid this manual intervention.

11.5.2 TCDB recovery using ICFRU

For TCDB recovery, you can use ICFRU or a similar product that uses SMF records to perform forward recovery against a point-in-time backup copy. ICFRU relies on the fact that catalog management routines log each catalog change to SMF. These SMF records contain images of catalog records that can be combined with the catalog records from an IDCAMS EXPORT copy of a catalog. The combined catalog records are reloaded through IDCAMS IMPORT, so that the catalog is recovered to the point of failure.

ICFRU requires that all SMF type 61, 65, and 66 records are recorded. You must ensure that SMF parameters specify recording for these record types for all jobs. Check the SMFPRM*xx* member in SYS1.PARMLIB.

To perform a full TCDB recovery, complete the following steps:

1. Deny access to the TCDB from all systems except the system that you use for recovery.
2. Stop tape activity and vary the tape library offline.
3. Save a copy of the damaged TCDB for future use (for example, for diagnostics).
4. Initiate the close of the TCDB in the recovery system.
5. Record the date and time when it is confirmed that the TCDB is closed on all systems. This is the stop date and time, which you need as input for the ICFRRSV program.
6. Switch and dump the SMF dataset on all systems that had access to the TCDB. The SMF records for the TCDB are necessary for forward recovery of the TCDB.
7. Identify an EXPORT backup copy of the TCDB. This is the EXPIN dataset for ICFRRAP.
8. Establish a start date and time for forward recovery, which is necessary as input for the ICFRRSV program. You can obtain the date and time from message IDC0594I in the export job that creates your backup copy of the TCDB.
9. Identify the SMF data necessary for forward recovery. The concatenation of all SMF datasets is the SMFIN DD statement for ICFRRSV.
10. Execute the ICFRRSV program, using the start and stop times and dates that you determined previously. ICFRRSV collects all SMF TCDB records and writes them to an output file.

11. Using DFSORT™ or a similar facility, sort the SMF output from ICFRRSV.
12. Execute the ICFRRAP program, using the output from the sort as input, with the EXPORT copy identified.
13. Use IDCAMS to delete the TCDB for RECOVERY.
14. Import the EXPORT copy that was produced by ICFRRAP.
15. Back up the TCDB to start a new recovery cycle.
16. Vary the tape library online.

IBM recommends that you have a ready and tested procedure prepared on your system. A prepared set of procedures decreases the downtime for the tape configuration.

The procedure shown in Figure 11-12 on page 345 is similar to a normal ICF catalog recovery. For a complete description of a TCDB recovery, refer to the *ICF Catalog Backup and Recovery: A Practical Guide,* SG24-5644.

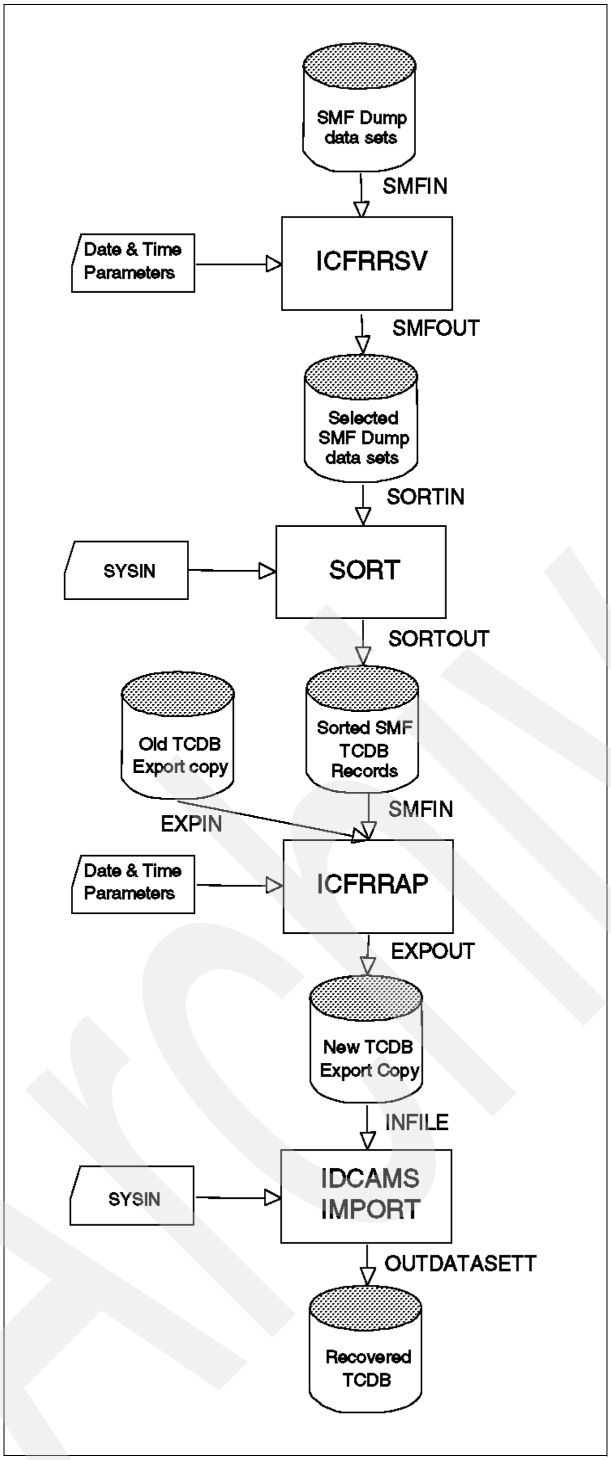


Figure 11-12 Using ICFRU to recover a TCDB

11.5.3 TCDB recovery using REXX

An alternate approach to using ICFRU is to obtain the Library Manager database and use this data as input to a tool that creates IDCAMS volume entry information.

A REXX program was developed to create the IDCAMS CREATE VOLUMEENTRY COMMANDS from the IBM 3953 Library Manager database list. Refer to Appendix F, “REXX utility to recover TCDB” on page 507.

Recover your TCDB using the REXX utility by using the following steps:

1. Obtain the 3953 Library Manager database list:
   a. On the 3953 Library Manager, use the Database menu, and select **List database**.
   b. For the output column, select **VOLSER**, **Category**, and **Media type**.
   c. Insert a formatted disk into drive A: and note that the output file is in a text format.

   Note: You perform this function in library offline mode. The library does not have to be in service mode to perform this function.

2. Upload the file to your host system.
3. Modify the REXX program.

   Note: This program was designed for VM. However, you can make small modifications to execute the REXX program on MVS. In addition to these changes, you must enter your tape category code, which is defined in the DEVSUP*xx* PARMLIB member, and the library name. This program reads an input file named 'TCDBRECV INFILE A'. If you use another name, you are required to make a small change to the source program. Enter the following code:

   ```
   'EXECIO * DISKR TCDBRECV INFILE A TCDBRECV OUTFILE A'
   ```

4. Execute the REXX program:

   Allocate a new VOLUME CATALOG (TCDB) as shown in Example 11-1.

   Example 11-1 Allocating a new volume catalog

   ```
   //TCDBALLOC EXEC PGM=IDCAMS
   //SYSPRINT DD SYSOUT=A
   //SYSIN    DD *
      DEFINE UCAT(NAME(TEST.VOLCAT.VGENERAL) -
                VOLCATALOG -
                VOLUME(VOL001) -
                CYLINDER(10 1))
     /*
   ```

5. Create the library entry.

   Creating a library definition outside of ISMF is *only* for recovery purposes. Therefore, this example shows only certain parameters. However, in certain cases, more than the required parameters are necessary. The best preparation for this recovery is to prepare a job with all of the library information in advance. The list output from the IDCAMS TCDB List library entry is the best source. Refer to Example 11-2.

   Example 11-2 TCDB recovery with REXX: Creating a library entry

   ```
   //STEP2  EXEC PGM=IDCAMS
   //SYSPRINT DD SYSOUT=*
   //SYSIN DD *
      CREATE LIBRARYENTRY   -
      (NAME(LIBATL1) LIBID(F4001)

      CREATE LIBRARYENTRY   -
   ```

```
   (NAME(LIBVTS1) LIBID(22051) -
SCRATCHTHRESHOLD(MEDIA2(10))
```

6. Create the volume entries as shown in Example 11-3.

Example 11-3 TDCB recovery with REXX: Creating volume entries

```
//STEP3  EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSIN    DD DISP=SHR,DSN=DBLIST   <= THE OUTPUT OF REXX PROGRAM/*
```

11.5.4 Moving a TCDB to another volume

Follow these steps to move the TCDB (SYS1.VOLCAT.VGENERAL) to another volume:

1. Stop all tape activity and vary all tape libraries offline using the command shown here:

   `V SMS,LIB(libname),OFFLINE        /* this is the command on one system*/`

   The library *must* be offline to all of the systems that share the TCDB that you want to move.
2. Restrict access to a catalog when you are performing maintenance procedures that involve redefining the catalog (Example 11-4). If you do not restrict access to the catalog by locking it, terminating user sessions, or using another method, users might be able to update the catalog during maintenance and create a data integrity exposure.

Example 11-4 Moving the TCDB: Locking the TCDB

```
   //LOCKCAT EXEC PGM=IDCAMS
   //SYSPRINT DD SYSOUT=A
   //SYSIN    DD *
     ALTER SYS1.VOLCAT.VGENERAL LOCK
   /*
```

3. Verify whether the integrity and structure of the VOLCAT help you to determine and solve problems in the actual TDCB before you move it. Refer to Example 11-5.

Example 11-5 Moving the TCDB: Verifying the structure of the TCDB

```
//IDCAMS   EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSIN    DD *
EXAMINE  NAME(SYS1.VOLCAT.VGENERAL) ITEST NODTEST  ELIMIT(99)
.
//IDCAMS   EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSIN    DD *
EXAMINE  NAME(SYS1.VOLCAT.VGENERAL) DTEST NOITEST  ELIMIT(99)
.
//IDCAMS   EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//DIAGDD   DD DSN=SYS1.VOLCAT.VEGNERAL,DISP=SHR
//SYSIN    DD *
DIAGNOSE -
                ICFCATALOG -
                INFILE(DIAGDD)
```

4. Export the TCDB with the EXPORT command (refer to Example 11-6 on page 348).

Example 11-6 Moving the TCDB: Exporting the TCDB

```
//IDCAMS   EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSIN    DD *
EXPORT 'SYS1.VOLCAT.VGENERAL' DISCONNECT
/*
```

The catalog must be disconnected from all of the systems in a SMSplex.

5. Import the TCDB to the new volume (refer to Example 11-7). If you want the attributes of the catalog to change, define the catalog with the attributes that you want on newvol. Then, import the original catalog into the newly defined catalog. If the import is successful, the old, exported catalog is deleted.

Example 11-7 Moving the TCDB: Importing the TCDB

```
//IDCAMS   EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//EXPORTDS DD DSN=hlq.VOLCATMV.EXPORT,DISP=SHR
//SYSIN    DD *
    IMPORT INFILE(EXPORTDS) -
     OUTDATASET('SYS1.VOLCAT.VGENERAL')-
     OBJECTS(('SYS1.VOLCAT.VGENERAL' VOLUMES(NEWVOL))) -
     UNLOCK
/*
```

You connect the catalog again to all master catalogs. The import only connects automatically to one master catalog (where the import was executed).

6. Vary all tape libraries online. You must vary all libraries online again to all systems in the SMSplex. Enter the following command:

   `V SMS,LIB(`*`libname`*`),ONLINE`

11.5.5 Listing information in the TCDB

In addition to browsing through ISMF panels, you can list the information in the TCDB by using the LISTC command. To see the library entry only, use the LIBRARYENTRIES parameter. When you want to see the volume entries, specify the VOLUMEENTRIES parameter as shown in Figure 11-13 on page 349. This example lists all tape volume entries whose names begin with the letters `VA` in the `ATLLIB1` tape library.

```
-------------------------  TSO COMMAND PROCESSOR  ---------------------
 ENTER TSO COMMAND, CLIST, OR REXX EXEC BELOW:

 ===> tso listcat volumeentries(va*) library(atllib1) all




                         LISTING FROM CATALOG -- SYS1.VOLCAT.VGENERAL

VOLUME-ENTRY-----------VAL0001
      DATA-VOLUME
        LIBRARY----------------ATLLIB1      LOCATION--------------LIBRARY
        RECORDING----------------EFMT1      MEDIATYPE-------------MEDIA5
        STORAGE-GROUP---------*SCRTCH*      USE-ATTRIBUTE---------SCRATCH
        CHECKPOINT-------------------Y      ERROR-STATUS----------NOERROR
        SHELF-LOCATION--------------(NULL)
        OWNER------------------(NULL)

      CREATION-DATE------2004-01-01         ENT-EJ-DATE-------2004-01-01
      COMPACTION---------------NONE         SPEC-ATTRIBUTE ---------NONE
      EXPIRATION---------2004-12-31         LAST-MOUNTED------2004-01-01
      WRITE-PROTECTED-------------N         LAST-WRITTEN------2004-01-01
```

Figure 11-13 LISTC command for library entry

11.5.6 Library Manager database and TCDB synchronization

Because system-managed tape uses three repositories (Library Manager database, TCDB, and tape management system database), out-of-sync conditions are possible.

The manual way to search for single misplaced volumes in the library is to check and verify storage cell addresses from the Library Manager's Search Database for Volume. However, you must use the AUDIT command to search for misplaced volumes without stopping auto mode.

The AUDIT command helps you to verify the physical location of tape volumes within the library. It verifies whether a library volume resides in the location listed for that volume in the Library Manager inventory. The Library Manager maintains the library location of the cartridges in its inventory. The volume records in the TCDB identify the libraries where the volumes reside. If the TCDB records do not match the Library Manager inventory when an audit is performed, you must correct the TCDB records, the inventory, or both.

The AUDIT function does not perform any corrective actions. It issues messages and updates the volume error status field in each tape volume record. However, the purpose of the audit is for verification only. The AUDIT command requires storage administrator authority.

The AUDIT function provides three levels of auditing:

- Single volume audit (invoked by the AUDIT line operator)
- Volume list audit (invoked by the AUDIT command)
- Library audit (invoked by the AUDIT line operator)

AUDIT can be invoked as an ISMF line operator on the MOUNTABLE TAPE VOLUME LIST panel (single volume audit) or from the TAPE LIBRARY LIST panel (library audit).

AUDIT can also be invoked as an ISMF command to audit all eligible volumes on the MOUNTABLE TAPE VOLUME LIST panel (volume list audit). ISMF is an important part of the audit scheme, because it allows you to start with an entire tape volume list. Then, using sorting and filtering capabilities, you reduce that list to a subset of volumes, for example, all of the volumes in a single Storage Group. At that point, you can use the AUDIT command to request an audit of all of the volumes in that subset list.

You might want to use the following criteria when filtering a volume list:

- Fully or partially qualified VOLSER
- Fully or partially qualified Storage Group name
- Fully or partially qualified library name
- Other criteria using ISMF VIEW, SORT, and HIDE

Before you schedule an audit request for a library, ensure that the library meets the following criteria:

- The library must be defined in the SMS configuration.
- The library must be online, operational, and not pending offline.
- The library must not be in manual mode, and the vision system must be operative.

Enter the AUDIT line operator next to the row of the suspect VOLSER on the MOUNTABLE TAPE VOLUME LIST panel as shown in Figure 11-14.

```
Panel  List  Utilities  Scroll  Help
------------------------------------------------------------------------------
                           MOUNTABLE TAPE VOLUME LIST
Command ===>                                                  SCROLL ===> PAGE
                                                        Entries 1-11 of 11
Enter Line Operators Below:                             Data Columns 3-7 of 20

    LINE       VOLUME  USE      VOLUME              CHECKPT  LIBRARY  STORAGE
    OPERATOR   SERIAL  ATTR     ERROR STATUS        VOLUME   NAME     GRP NAME
   ---(1)----  -(2)--  --(3)--  -------(4)--------  --(5)--  --(6)--- --(7)---
               VOL01   PRIVATE  I/O ERROR           NO       SHELF    TAPE1
               VOL02   SCRATCH  UNEXPIRED SCRATCH   ---      SHELF    *SCRTCH*
               VOL101  SCRATCH  NO ERROR            NO       SHELF    *SCRTCH*
               VOL102  SCRATCH  PASSWORD CONFLICT   NO       LIB1     *SCRTCH*
               VOL103  SCRATCH  SECURITY CONFLICT   NO       LIB2     *SCRTCH*
               VOL104  PRIVATE  SCRATCH IN USE      ---      LIB2     TAPE1
               VOL105  PRIVATE  VOLSER MISMATCH     NO       LIB1     TAPE1
               VOL106  SCRATCH  CHCKPOINT CONFLICT  YES      LIB2     *SCRTCH*
               VOL107  SCRATCH  WRITE CONFLICT      YES      LIB1     *SCRTCH*
   AUDIT       VOL108  PRIVATE  VOLUME MISPLACED    NO       LIB1     TAPE1
               VOL109  PRIVATE  NO ERROR            NO       LIB1     TAPE1
   ----------  ------  -----------  BOTTOM  OF  DATA  -----  ----     -------
```

Figure 11-14 AUDIT line operator command from ISMF

The *library vision system* on a library verifies the external label on the volume at the physical location specified in the Library Manager database. The cartridge is neither mounted nor read. The library vision system only verifies the external label.

The following actions occur when you request an audit against volumes in a library:

- The system verifies that the tape volume has an entry in the Library Manager.
- The vision system verifies that the tape volume is in its assigned location in the library.

- The vision system verifies that the external cartridge label of the tape volume is present and readable.
- The system verifies that the tape is accessible in the library.

To perform a volume list audit from the MOUNTABLE TAPE VOLUME LIST panel, use the AUDIT command on the command line of the ISMF panel.

To perform a library audit from the TAPE LIBRARY LIST panel, use the AUDIT line operator next to the tape library name. When you specify a library audit, you audit all VOLSERs assigned to that library by the host.

Because a library audit and a volume list audit can take a long time to complete, a confirmation panel displays whenever you request these audits. This panel gives you the opportunity to confirm or cancel the audit request. To confirm, type `Y` and then press Enter. Refer to Figure 11-15 for the CONFIRM AUDIT REQUEST panel.

Note: In an environment with multiple systems at different DFSMS/MVS software levels but that share a common TCDB, perform library audits on the system with the highest software level of DFSMS/MVS. A library audit on a lower DFSMS/MVS software level does not include higher release level volumes if they are media types that are unknown to the lower level software.

```
Panel  Utilities  Help
------------------------------------------------------------------------------
                             CONFIRM AUDIT REQUEST

Command ===>

  Number of Volumes to be Audited:  5



Specify the Following:
   Enter "/" to select option   _ Perform Audit



   Note:  If audit is performed, audit requests will be interspersed with other
          requests, with the audit request having low priority.






Use ENTER to Perform Operation;
Use HELP Command for Help; Use END Command to Exit.
```

Figure 11-15 CONFIRM AUDIT REQUEST panel

Note: The audit operation can be a lengthy process. During AUDIT execution, other activity in the library is not quiesced, and AUDIT requests are given a lower priority than other requested functions. It might take several hours for you to receive notification that a full library audit or an extensive volume list audit has completed. Therefore, when scheduling an audit, take workload and time factors into consideration.

When the AUDIT is complete, a message indicating its success or failure is sent to your user ID. Refresh the list and check the VOLUME ERROR STATUS column for the following errors:

- `EXTERNAL LABEL ERR`
- `INACCESSIBLE`
- `NOT IN LIBRARY`
- `NOT IN SLOT`

Refer to the help index for an explanation of the volume error states.

During the audit process, if the vision system detects an unexpected volume in the specified cell address, it searches the Library Manager's database. If there is an entry in the database for the unexpected VOLSER, the database is updated to reflect its current cell location. If the unexpected volume is identified as a misplaced volume, all hosts are notified, and the TCDB is updated. If the vision system detects an empty cell, you might have to run the inventory process.

11.5.7 TCDB manual update

If any discrepancies are identified between the TCDB and the tape management system or Library Manager database, you might need to fix those VOLUMEENTRIES in the TCDB by using IDCAMS commands. Remember that you can change the contents of the tape management system database to synchronize the tape repositories.

You can change LIBRARYENTRIES as well to recover from catalog errors. The LIBRARYENTRY record entry exists in the SMS control dataset. Therefore, use the ISMF panels for normal tape library alter functions.

The following IDCAMS commands are available for tape library support:

- **ALTER LIBRARYENTRY**: Alters all tape library entry fields except the library name
- **ALTER VOLUMEENTRY**: Alters all tape volume entry fields except the tape VOLSER
- **CREATE LIBRARYENTRY**: Creates a tape library entry
- **CREATE VOLUMEENTRY**: Creates a tape volume entry
- **DELETE**: Deletes tape library and tape volume entries

Figure 11-16 shows how to alter the LIBRARYNAME of the tape volume entry for VOLSER `GRKB01`.

```
//ALTERVOL JOB  ...
  //STEP1    EXEC PGM=IDCAMS
  //SYSPRINT DD   SYSOUT=A
  //SYSIN    DD   *
       ALTER VGRKB01 -
             VOLUMEENTRY -
             LIBRARYNAME(ATL01)
```

Figure 11-16 TCDB alter volume entry

Figure 11-17 on page 353 shows an example of how to create a volume entry.

```
//ALTERVOL JOB  ...
//STEP01    EXEC PGM=IDCAMS
//SYSPRINT  DD SYSOUT=*
//SYSIN     DD   *
   CREATE VOLUMEENTRY -
         (NAME(VUK0000) -
         LIBRARYNAME(LIIBMETB)  -
         STORAGEGROUP(*SCRTCH*) -
         USEATTRIBUTE(SCRATCH)  -
         MEDIATYPE(MEDIA5)      -
         RECORDING(EFMT1)       -
         COMPACTION(YES)        -
         NOWRITEPROTECT         -
         LOCATION(LIBRARY))
```

Figure 11-17 TCDB creating a volume entry example for scratch volume

Refer to *z/OS DFSMS Access Method Services for Catalogs*, SC26-7394, for the syntax of the IDCAMS command.

11.6 Resynchronizing RMM CDS

It might be necessary to use the TCDB and Library Manager entries to update the Removable Media Manager (RMM) database. You update the RMM database with an EDGUTIL RMM utility.

You can use EDGUTIL with a verify option to discover whether there are differences between the information sources. Or, you can use EDGUTIL with the MEND option, because the process is the same as the verify option, except that it also fixes existing problems. The MEND option works only on an inactive CDS.

> **Important:** We recommend that you use the MEND option only under the guidance of a qualified IBM service support representative (SSR).

Release 2.10 enhanced the EDGUTIL process. Before Release 2.10, only the TCDB was referred (refer to Figure 11-18). Now, you can ask the Library Manager as an additional source (refer to Figure 11-19). Release 2.10 also introduced stacked volume support.

```
//UTIL     EXEC     PGM=EDGUTIL,PARM='VERIFY(VOLCAT)'
//SYSPRINT DD       utility message data set
//MASTER   DD       DISP=SHR,DSN=DFSMSrmm.MASTER.CDS
```

Figure 11-18 Sample DFSMSrmm VERIFY with VOLCAT (prior to Release 2.10)

```
//UTIL     EXEC     PGM=EDGUTIL,PARM='VERIFY(SMSTAPE)'
//SYSPRINT DD       utility message data set
//MASTER   DD       DISP=SHR,DSN=DFSMSrmm.MASTER.CDS
```

Figure 11-19 Sample DFSMSrmm VERIFY with SMSTAPE (Release 2.10 and later)

Refer to *DFSMSrmm Primer*, SG24-5983, and *z/OS DFSMSrmm Implementation and Customization Guide*, SC26-7405. For a vendor tape management system, use the functions provided with system-managed tape support.

11.7 Exploitation of new capabilities

Either installing new hardware with new functionality or implementing system-managed tape for the first time causes major changes to your actual production environment. To make your migration smoother and to avoid typical beginner problems, consider the following points of interest about education and readiness.

11.7.1 Education and the learning phase

New hardware (the first TS3500 Tape Library, TS7700 Virtualization Engine, Virtual Tape Server (VTS), or Peer-to-Peer (PtP) VTS) or new software (the first system-managed tape solution, TS7700 Management Interface, ETL Specialist, VMA reports, and so forth) impacts your data, production jobs, and the people who work with the new environment. Plan operator training and hands-on training for the TS3500 Tape Library, the 3953 Library Manager, and the corresponding Web interfaces. Offer SMS, TS7700 Virtualization Engine, TS7700 Multi Cluster Grid, VTS, or PtP VTS basic knowledge for operators and storage administrators. Discuss these topics in advance to ensure that the staff, depending on their jobs, can properly handle the new environment. Remember that education needs to occur in an adequate time frame *prior to* the production date. That is, education must not be months in advance or even a half year after going into production. The education level of the people handling and running the machine has a major influence on the availability of your production environment.

If the introduction of new hardware or software influences your installation-dependent routines (such as varying online or varying offline units, ejecting cartridges, and so forth), place the changed information together in a document and provide this information to all involved colleagues. Even hands-on training cannot provide the experience that is necessary to handle the environment without mistakes. Therefore, we recommend that you plan a learning phase in the first phase of migration (without user-critical data). The learning phase gives your operator and administrator the chance to gain experience with the new technology.

11.7.2 Achieving production readiness

Running your business, you might have established many of your own environment-dependent processes. These processes might have grown over the years to reach a high level of sophisticated production readiness. Here are several topics to consider:

- Message alerting and automation procedures
- Regular reports to management and trend analyses
- Planned service windows for maintenance and microcode upgrades
- Disaster recovery considerations
- Documentation of all environment-dependent processes

It is necessary to review all of these processes and determine new capabilities to establish the same level of quality (or even better) in a very short time for your new environment.

Message alerts and automation procedures

Even if a TS3500 Tape Library, TS7700, and VTS do not need much automation (typically, a message also needs manual intervention), you must perform alarm and escalation planning. Decide which messages you want to see and whether you want to see them on operator consoles, alarming boards, or pagers. Perhaps you want to create automatic e-mails for a particular reason. You can set up these procedures in the testing phase and in the first step of the migration phase.

Reports and trends

Think of weekly or monthly reports to use for trend analyses. For TS3500 Tape Library reports, refer to "Monitoring with the TS3500 Specialist" on page 437. For specific analysis of your overall tape usage, ask your IBM representative and visit the Tape tools Internet page where you can obtain tape tools at no charge:

ftp://ftp.software.ibm.com/storage/tapetool/

Be sure to update performance and trend analyses for management.

Planning service windows

A new machine might not need a service window directly. However, the intervals between microcode releases become shorter and shorter every year. The drive, controllers, Library Manager, and the AX0 controller in the PtP VTS might have microcode. Planning the introduction of the microcode and regularly maintaining the microcode improve and stabilize your environment.

Disaster recovery considerations

Every change in your environment can affect your disaster recovery location site (if you have a disaster recovery site) or at least your processes in a disaster. Part of the impact can be minor. But certain changes can have a dramatic effect, for example, changing from 3590 to 3592 drives. You might need additional hardware at your second location or trucks to bring cartridges from one location to another location. If you have a contract with a provider for a disaster recovery location, talk to the provider during the decision process about new hardware.

Writing documentation

Reviewing all of your existing documentation to implement the changes for the new environment is extremely important. Make sure that you take this opportunity to ensure completeness of the documentation. Documentation (handling, explanations, a short introduction, and so forth) must be ready at production start time.

12

Migration

Migration can vary from migrating data, cartridges, or already installed hardware into a new or already installed IBM TS3500 Tape Library. In addition, you can include implementation of new tape technologies or additional functions in the migration process. Because of the large variety of migration scenarios, we only discuss in detail the major migration scenarios for migrating Virtual Tape Server (VTS) and native IBM 3592-J1A tape drives into an IBM TS3500 Tape Library. Traditionally, the 3584 Tape Library was used for Open Systems while the 3494 was used for System z environments. With the announcement of the IBM 3953 Tape System, including the Library Manager for the TS3500 Tape Library, consider consolidating your tape automation requirements in TS3500 Tape libraries.

Special considerations apply when you integrate System z host partitions in an IBM TS3500 Tape Library that is already used by Open Systems hosts, or when you move Open Systems-attached IBM 3592 tape drives from an IBM 3494 to an IBM TS3500 Tape Library.

In this chapter, we discuss the following topics:

- Migration scenarios
- Migration tasks
- Migrations involving Open Systems hardware

12.1 Migration scenarios

Depending on your source configuration, you need to perform various actions to migrate to the target configuration. In certain cases, you have to upgrade or move your hardware components, and, in other cases, you have to copy your own data to the target configuration. According to the method that you choose, you can predict the duration of the outage due to the migration process, if there is an outage.

The first thing to determine is your source configuration and the target configuration.

Possible source configurations are:

- Non-IBM tape automation
- Stand-alone IBM 3590 tape drives or IBM 3592-J1A tape drives
- Native IBM 3590 tape drives inside of an IBM 3494 Tape Library and attached to IBM 3590-A60 or 3592-J70 tape controllers
- Native IBM 3592-J1A tape drives inside of an IBM 3494 Tape Library and attached to IBM 3590-A60 or 3592-J70 tape controllers
- Virtual Tape Server (VTS) attached to an IBM 3494 Tape Library with IBM 3590 tape drives
- VTS attached to an IBM 3494 Tape Library with IBM 3592-J1A or TS1120 tape drives
- VTS attached to an IBM 3494 Tape Library with both IBM 3590 and 3592-J1A or TS1120 tape drives
- Peer-to-Peer (PtP) VTS attached to IBM 3494 tape libraries
- PtP VTS attached to one IBM 3494 Tape Library and one TS3500 Tape Library

When migrating to one or more IBM TS3500 tape libraries, the following target configurations are possible:

- Native IBM 3592-J1A, TS1120, or TS1130 tape drives attached to IBM 3592-J70 Controller inside of the IBM TS3500 Tape Library
- Native IBM 3592-J1A, TS1120, or TS1130 tape drives attached to TS1120 Model C06 Controller inside of the IBM TS3500 Tape Library
- TS7700 Virtualization Engine (Single or Multi Cluster Grid configuration) attached to the IBM TS3500 Tape Library using TS1120 or 3592-J1A tape drives
- VTS attached to the IBM TS3500 Tape Library using 3592-J1A or TS1120
- PtP VTS attached to the IBM TS3500 Tape Library using 3592-J1A or TS1120

Note: The IBM 3494 Virtual Tape Server (VTS) and the IBM 3494 Peer-to-Peer (PtP) VTS can no longer be ordered. The replacement product is the IBM Virtualization Engine TS7700. We have kept the description of the VTS migration scenarios in this book since they may still be valid in special situations. Please verify with your IBM representative that the migration you are planning is supported.

Table 12-1 on page 359 lists the migration alternatives depending on the source and target configurations using the terms hardware migration, data migration, and PtP move. We discuss these terms fully and explain them later in this chapter.

Table 12-1 Migration scenarios matrix

Migration source configuration	3592-J70 in TS3500	TS7700 in TS3500	VTS in TS3500	PtP VTS in TS3500
Non-IBM-managed library	Data migration	Data migration	Data migration	Data migration
Stand-alone drives	Data migration	Data migration	Data migration	Data migration
3590 in 3494	Data migration	Data migration	Data migration	Data migration
3592 in 3494[a]	Hardware migration	Data migration	Data migration	Data migration
3494 VTS with 3590	Data migration	Data migration	Data migration	Data migration
3494 VTS with 3592	Data migration	Data migration	Cartridge relocation	Cartridge relocation
PtP VTS (3494 Tape Library)	Data migration	Data migration	Data migration	PtP VTS move

a. For the migration from 3592-J1A to TS1130, refer to 12.2.2, "Migration considerations for TS1130 tape drives" on page 362.

Note: Functions and instructions exist for the migration of a configuration consisting of a 3494 Model B10 or B20 VTS attached to a TS3500 Tape Library with 3592 drives (Model J1A or E05) to a configuration with a TS7700 Virtualization Engine connected to the same library and drives. With this migration, the TS7700 Virtualization Engine can access your previously written data from a prior generation of VTS without requiring any data migration.

Order the instructions and code level for the migration through request for price quotation (RPQ) 8B3411.

Data migration means that you copy data; *hardware migration* means that the movement involves existing hardware. In certain scenarios, you reuse existing hardware in the target configurations, but in other scenarios, copying the data is the only useful migration alternative.

You can summarize the migration scenarios in Table 12-1 in the following four scenarios:

- Data migration:

  You cannot reuse the hardware, or the library does not support the tape cartridges. The two tape libraries must be connected to the system, and, to perform the migration, you must copy the data from the source library to the target library. This scenario can be nondisruptive, because it only affects the data. The most important part, which determines the duration of this scenario, is copying your existing data. Do not forget that copying existing data takes a lot of time and resource. You can always migrate to different hardware with this scenario.

  Refer to 12.4.1, "Data migration scenarios" on page 366.

  Note: For detailed data migration information about migrating to a TS7700 Virtualization Engine, refer to *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312.

- Hardware migration:

  In this scenario, you can reuse parts of your existing hardware, as well as the cartridges. The most important task is to demount the components of the existing hardware and to merge them into the new tape library. This scenario is disruptive, because the two libraries have to be offline, and you cannot completely install the target library in advance because of the lack of components. The duration of the outage depends on the amount of time needed by the clients and the IBM service support representative (SSR) to perform the hardware installation and the configuration of the target library. To determine the outage, you also need to consider the time to move the hardware components if the two libraries are at different locations.

  Refer to 12.4.2, “Hardware migration scenario” on page 367.

- Cartridge relocation:

  Cartridge relocation is a combination of data and hardware migration. It means to move the cartridges and data from the Library Manager, and, if applicable, the VTS control datasets from one library to another empty tape library. Even if you can configure the target library in advance, this scenario is disruptive. To move cartridges and to merge databases, the target library needs to be offline, and the movement of cartridges can take a long time if your target library is at another location.

  Refer to 12.4.3, “Cartridge relocation scenario” on page 370.

- PtP VTS move:

  This scenario is *fast and secure* because of the PtP VTS configuration. The outage of this scenario is limited, because your data is still accessible during the merger of the cartridges for the first Distributed Library. The cartridges are merged into an already configured PtP VTS. The real outage occurs during the System Managed Storage (SMS) updates of the library configuration, assuming the switch of the PtP complexes.

  Refer to 12.4.4, “PtP VTS move scenario” on page 372.

Note: Each migration scenario requires different steps.

Additional hardware migration scenarios

Additional migration procedures have been developed over time. Every migration requires the VTS to use only 3592-J1A or TS1120 tape drives. The TS7700 only supports 4-Gbps switches although VTS allows you to use 2-Gbps or 4-Gbps fibre switches for the back-end drives. The migration procedures are described in more detail within *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312.

Note: Contact your IBM SSR for the available services and support for individual migration scenarios.

Additional migration scenarios include:

- PtP VTS B10 or B20 installed in a TS3500 migrated to a TS7700 grid in the TS3500
- VTS B10 or B20 stand-alone or Peer-to-Peer installed in a 3494 migrated to a TS7700 stand-alone or grid installed in a 3494
- VTS B10 or B20 stand-alone or Peer-to-Peer installed in a 3494 migrated to a TS7700 stand-alone or grid in the TS3500
- Two stand-alone VTS models B10 or B20 attached to a TS3500 migrated to a stand-alone TS7700 attached to the same TS3500

- Two stand-alone VTSs Model B10 or B20 attached to a 3494 migrated to a stand-alone TS7700 that is attached to the TS3500
- Add a new TS7740 to an existing Two Cluster Grid configuration to make a Three Cluster Grid that is attached to either library
- Add a new TS7740 to an existing stand-alone TS7700 to make a Two Cluster Grid configuration that is attached to either library
- Stand-alone VTS attached to a TS3500 migrated to a stand-alone TS7700 attached to a different TS3500
- Two stand-alone VTSs attached to a TS3500 migrated to a single cluster TS7700 that is attached to a different TS3500
- Two stand-alone VTSs Model B10 or B20 attached to a 3494 migrated to a stand-alone TS7700 that is attached to the same 3494
- Merge one existing TS7740 cluster to an existing two-way TS7700 configuration to form a three-way grid
- Merge one existing TS7700 cluster to an existing stand-alone TS7700 configuration to form a two-way grid
- Merge two PtP VTS Model B10 or B20 subsystems that are attached to a 3494 to form a grid TS7700 configuration in a TS3500
- Merge a PtP VTS Model B10 or B20 subsystem that is attached to a TS3500 to an already running grid TS7700 configuration in the same TS3500
- Two PtP VTS Model B10 or B20 subsystems that are attached to a TS3500 to form a grid TS7700 configuration in the same TS3500
- Two PtP VTS Model B10 or B20 subsystems that are attached to a 3494 to form a two way grid TS7700

12.2 Hardware migration steps

A hardware migration is possible when you can reuse part of the hardware of your source configuration in your target configuration, for example, IBM 3592 or TS1120 tape drives or the Model J70 or C06 controller.

12.2.1 Moving an IBM 3592 Tape Controller and IBM 3592 drives

Moving an IBM 3592 Tape Controller and IBM 3592 drives requires the following steps:

1. Uninstall the IBM 3592 drives in the IBM 3494 Tape Library.
2. Remove the IBM 3592-J70 Tape Controller from the IBM 3494 frame.
3. If you want to continue to use your IBM 3494 library, you need to also remove the drive cradles and install cartridge storage cells in the IBM 3494-D24 Frame where the IBM 3592 drives and controller had been installed.
4. Merge the IBM 3592 Model J70 into the IBM 3953 Library Manager.
5. Merge the IBM 3592 drives into the IBM TS3500 Tape Library and perform the setup tasks that are listed in 8.1, “IBM TS3500 library setup” on page 202 and 8.2, “IBM 3953 Library Manager setup” on page 208.

IBM SSRs perform the majority of these related tasks.

In order to reuse the tape controller and the IBM 3592 drives that are installed in your existing IBM 3494, you might need to uninstall them. You uninstall them by adding feature codes (FCs).

Tasks on the IBM 3494 Tape Library

The required actions for a 3592 Model J70 Controller are:

1. You must order one feature code for each drive that you remove. You do not need to remove the cradle, but you must do so if you want to continue to use the IBM 3494.
2. To remove an IBM 3592 Model J70 Tape Controller from a 3494 Model D14/D24 frame, you need to order a feature code for the 3494 frame.
3. You must then install the controller and the drives into the IBM TS3500 Tape Library. The IBM 3592 Tape Controller Model J70 must be installed in the IBM 3953-F05 Frame. The tape drives are installed in one of the TS3500 frames.

Tasks on the IBM 3953 Library Manager

You must order a new IBM 3953 Model F05 Frame, and you have to specify per feature code that you plan to field-merge a J70 controller into a new IBM 3953 Model F05 Frame. You must order a FC on the IBM 3592 Tape Controller Model J70 that indicates that you will field-install it. In an IBM TS3500 Tape Library, we recommend that you designate up to four drives as control paths for each logical library. Refer to the *IBM TotalStorage 3953 Tape Frame Model F05 and Library Manager Model L05 Introduction and Planning Guide*, GA32-0472, for any additional requirements.

Tasks on the IBM TS3500 Tape Library

The required actions are:

1. If you plan to install the IBM 3592-J1A drives in a new IBM TS3500 Tape Library frame, you need to order feature codes for each drive together with the mounting hardware for the drives.
2. If you plan to install the IBM 3592-J1A drives in the D22 frame of an existing IBM TS3500 Tape Library that is attached to Open Systems hosts, you must install two feature codes to permit the frame to support tape drives, to provide hardware and firmware required for the IBM 3592-J1A drives, and to provide a patch panel for the Fibre Channel (FC) host cables. After you install these feature codes, you can merge your drives into this Tape Library, as in step 1.

12.2.2 Migration considerations for TS1130 tape drives

With the 3590 family of drives, you typically upgraded all of the 3590 drives to the newer drive technology or at least all 3590 drives within a library. Because the newer technology 3590 drives were only downward-read compatible, you had to mark any partially filled tapes “full” or “not writable” to ensure that the application that owned and managed the volumes did not select the partially filled volume for a write request.

Because the 3592 Model E06 is downward-write compatible with the 3592 Model E05, this same concern does not exist for EFMT2/EEFMT2. However, because the 3592 Model E06 is not downward-write compatible with the EFMT1 format, you need to mark any partially filled tapes “full” or “not writable” while they migrate to the newer 3592 drive technology and no longer have any devices capable of writing EFMT1.

Also, because Open/Close/EOV (during EOV processing) maintains the same recording format across all volumes of a multi-volume data set, depending on the application, clients might also want to mark their EFMT2/EEFMT2 volumes full to force any new data being written to a new tape volume and the recording formats EFMT3/EEFMT3.

TS1120 and 3592-J1A tape drives both can be connected to the same controller, and then, the TS1120 can be operated in the emulation mode, reading and writing in J1 format. The TS1130 Tape Drive is not allowed to be connected to a controller with a TS1120 or 3592-J1A attached. There is no emulation mode for the TS1130 available, and therefore, no mix behind any controller. Therefore, you have to develop a specific migration plan when you plan for the replacement of TS1120 or 3592-J1A drives or for the expansion of your environment.

Replacing 3592-J1A tape drives

The replacement of 3592-J1A tape drives keeping the same controller requires the following steps:

1. Define the new TS1130 tape drives using hardware configuration definition (HCD).
2. Define new Data Classes with the new recording formats.
3. Change automatic class selection (ACS) routines if required.
4. Set the read-compatible special attribute in the tape configuration database (TCDB).
5. Mark your format 1 volumes full to force any new data that is being written to a new tape volume and the recording formats EFMT3/EEFMT3.
6. Remove the old drives and install the new drives within a maintenance window.
7. Vary the new drives online.

IBM SSRs perform the majority of these related tasks.

Replacing TS1120 in J1A Emulation mode and 3592-J1A tape drives

For this replacement, use the previous tasks.

Replacing TS1120 tape drives in native E05 mode

Replacing TS1120 tape drives while keeping the same controller requires the following steps:

1. Define the new TS1130 tape drives using HCD.
2. Define new Data Classes with the new recording formats.
3. Change ACS routines if required.
4. There is no need to mark your DFSMShsm or your multivolume data set format 2 volumes full, because TS1130 is able to write and append in this format (-1). However, you want to force any new data that is being written to a new tape volume and the recording formats EFMT3/EEFMT3.
5. Remove the old drives and install the new drives within a maintenance window.
6. Vary the new drives online.

IBM SSRs perform the majority of these related tasks.

12.2.3 Moving an existing VTS to the IBM TS3500/3953 Tape Library

IBM supports moving a stand-alone Model B10 or B20 VTS or a Model B10 or B20 VTS that is part of a PtP VTS from an IBM 3494 to an IBM TS3500 through RPQ 8B3378. This RPQ includes the required parts and the installation instructions to detach the VTS from the 3592-J1A drives and from the Library Manager in the IBM 3494 and then to reattach the VTS to the 3592-J1A (or TS1120-E05) drives in the IBM TS3500 and to the IBM 3953 Library Manager. You must order one RPQ 8B3378 for each VTS that you plan to move.

You cannot move a VTS with SCSI host attachment, because the IBM TS3500 Tape Library with the IBM 3953 Library Manager only supports ESCON and FICON host attachment. Open Systems hosts are not supported in this configuration. Because the VTS requires the Library Manager even when attached to an Open Systems host, you can attach a VTS to Open Systems hosts only if the VTS is installed in an IBM 3494 Tape Library.

RPQ 8B3378 does not include the removal of the IBM 3592-J1A tape drives from the IBM 3494 and their installation in the IBM TS3500 Tape Library. You can install new IBM 3592-J1A or TS1120 tape drives in the IBM TS3500 Tape Library and connect them to the VTS. Or, you must order the required feature codes for drive removal from the IBM 3494 and for field installation in the IBM TS3500 Tape Library if you want to move the 3592-J1A tape drives from the IBM 3494 together with the VTS.

Important: The IBM TS3500 Tape Library only supports IBM 3592 tape drives for System z attachment. Before you can move a VTS, you must migrate all VTS data to IBM 3592 media and disconnect any 3590 tape drives.

Moving an existing VTS also includes cartridge relocation. Whether or not you move the tape drives, plan time to remove the cartridges and place them in the IBM TS3500 Tape Library.

Note that you cannot move the Fibre Channel switches from the 3494-D22 Frame to the 3953-F05 Frame. You must order or provide two new switches in the IBM 3953-F05 Frame.

12.3 Data migration alternatives

Data migration is necessary when you have to migrate from an existing, incompatible hardware platform to the IBM TS3500 Tape Library with the IBM 3953 Library Manager, VTS, or 3592 media. Source configurations and target configurations are different technologies, and, therefore, are incompatible. Incompatible technologies mean that data that is written on the source hardware cannot be read on the target hardware, and the reverse is true also.

Before you can start migration, you must install the complete target hardware and make sure that it is operational. The necessary host definitions must be in place as well. You can then use one or a combination of migration alternatives.

Redirection of your new data

First, you need to populate the native library with scratch tapes.

Through the automatic class selection (ACS) routines, you can choose to migrate all of your new tape allocations at one time, or you can migrate step-by-step. You must consider which data you want to migrate first.

Movement of physical cartridges

You can only move physical cartridges if your data already resides on 3592 cartridges for use in a VTS or with native drives.

Select existing physical volumes to move. If you are moving from another library than an IBM library, you might have to remove existing external labels and add external barcode labels to cartridges that you insert into the IBM TS3500 Tape Library. Remember that the TS3500 Tape Library only supports the 3592 media type. Update the tape management system catalog and operating system catalogs to reflect the new locations of the tape volumes.

Copy existing data

Make a list of the data that you really want to copy and how you plan to accomplish this copy. Do not forget that copying existing data can be time-consuming. You might want to use a copy tool to help you in this task. There are several available products that are designed to copy data from one media to another media and that offer advantages compared to using operating system utilities. Using a tape copy product is optional, but using a tape copy product facilitates moving many tapes into the library or 3494 VTS.

Considerations when evaluating tape copy products are:

- Interaction with the tape management system and operating system tape catalogs (allows you to keep the original owner, creation date, and expiration date)
- Level of process automation
- Speed and efficiency of the copy operation
- Ease of use
- Ability to create a pull list for manual tape mounts
- Ability to handle multivolume datasets
- Ability to handle volume size changes whether from smaller to larger or larger to smaller
- Audit trail
- Ability to filter input datasets by wild cards or other criteria, such as expiration date or creation date

Table 12-2 lists several the tape copy products that might help you to migrate your data to the new configuration. Contact these suppliers for detailed information and supported environments.

Table 12-2 Tape copy product examples

Product name	Vendor name	More information
Tape copy Tool/ DFSMSrmm	IBM	Contact your IBM marketing representative for more information about this service offering.
Tape optimizer	Tivoli	http://www.ibm.com/software/tivoli/products/tape-optimizer-zos
Beta55	Beta Systems Software AG	http://www.betasystems.com
CA-1/TLMS Copycat	Computer Associates International, Inc.	http://www.cai.com
Rocket Tape Optimizer for z/OS	Rocket Software, Inc.	http://www.rocketsoftware.com/portfolio/tapemedia/
Tape/Copy	OpenTech Systems, Inc.	http://www.opentechsystems.com/tape-copy.php
TelTape	Cartagena Software Ltd.	http://www.cartagena.com
Zela	Software Engineering of America	http://www.seasoft.com/zela.asp

12.4 Migration tasks

Table 12-3 lists the major scenarios of migrations to IBM TS3500 tape libraries. These scenarios highlight the major steps to perform in your migration. Table 12-3 shows you examples of migrations.

Table 12-3 Four types of migration scenarios

Scenario	Description
Scenario one: Data migration	When a hardware migration is impossible or when you do not want to migrate the hardware.
Scenario two: Hardware migration	You move a 3592 in a 3494 to a 3592 in a TS3500 Tape Library.
Scenario three: Cartridge relocation	You migrate the VTS workload but not the complete hardware.
Scenario four: PtP move	You move a PtP VTS.

12.4.1 Data migration scenarios

This section describes a large part of scenario one, data migration. In this migration, your system must have your source configuration and target configuration connected as shown in Figure 12-1. Your source configuration can be a non-SMS-managed library, stand-alone drives, a native 3494 library, or a 3494 VTS with 3590-J1A drives. Many of these steps to migrate to an IBM TS3500 Tape Library are the same steps to migrate a 3494 VTS to a TS3500 Tape Library. You need to decide if you want to benefit from the advantages of this technology.

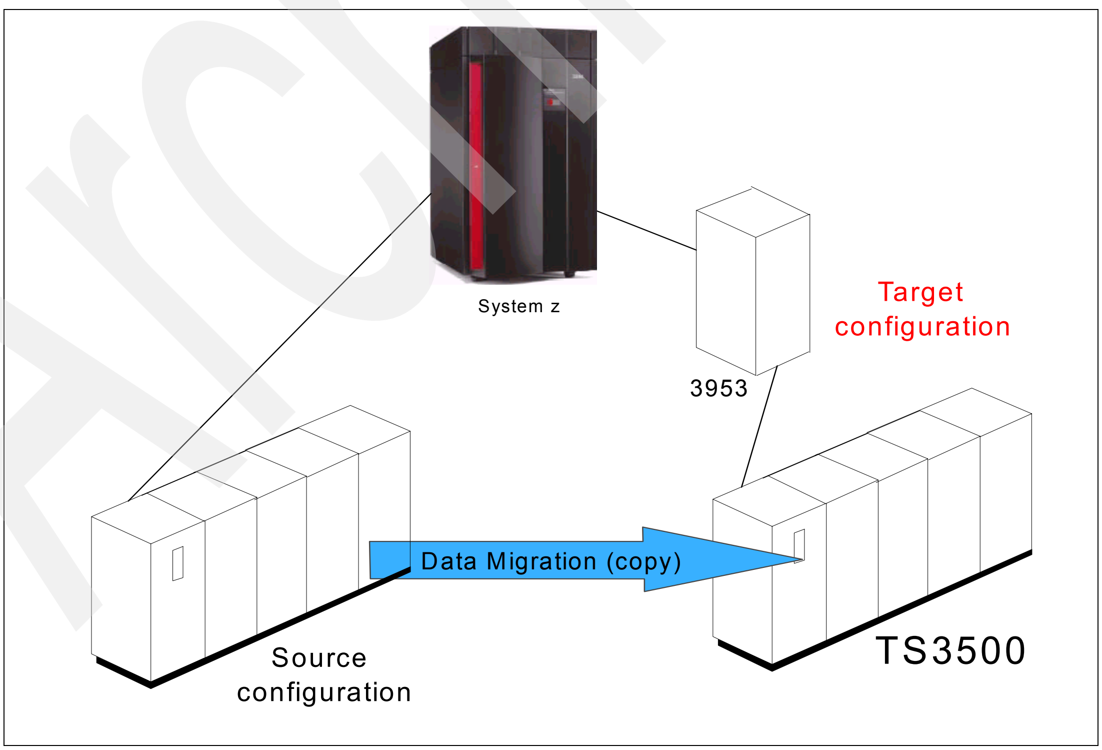


Figure 12-1 Data migration to IBM TS3500 Tape Library

Hardware installation

Install the IBM TS3500 Tape Library as described in Chapter 9, “Software implementation in z/OS” on page 229.

Software implementation

Customize your system to use the IBM TS3500 Tape Library as described in Chapter 9, “Software implementation in z/OS” on page 229.

In the case of non-SMS library-managed or stand-alone drives, refer to *IBM TotalStorage 3494 Tape Library: A Practical Guide to Tape Drives and Tape Automation*, SG24-4632, for further information about implementing an SMS tape library.

Data migration

To migrate your data:

- Identify the data that you want to migrate to the IBM TS3500 Tape Library.
- Activate your SMS configuration to redirect your new datasets using the updated automatic class selection (ACS) routines.
- Copy your old, static, archive datasets of your library to the IBM TS3500 using your own product or with the help of a tape copy tool.
- With products, such as hierarchical storage management (HSM), you only need to recycle your migration level 2 (ML2) or Backup cartridges to move to your new tape library. With the SELECT option, you can perform the recycle on a specific range of cartridges.

12.4.2 Hardware migration scenario

This section describes scenario two, the hardware migration, which is listed in 12.1, “Migration scenarios” on page 358. Because this method is disruptive, consider the duration of the outage and plan for sufficient downtime. This scenario also involves a data migration, because you move the cartridges from one tape library to the IBM TS3500. This method is a fast and secure way to move data, but moving cartridges requires special attention.

Figure 12-2 on page 368 summarizes the three components that you move:

- The cartridges from the 3494 to the TS3500 Tape Library
- The 3592 tape drives from a 3494 to the TS3500 Tape Library
- The 3592-J70 Tape Controller from the 3494 to a 3953-F05 Frame

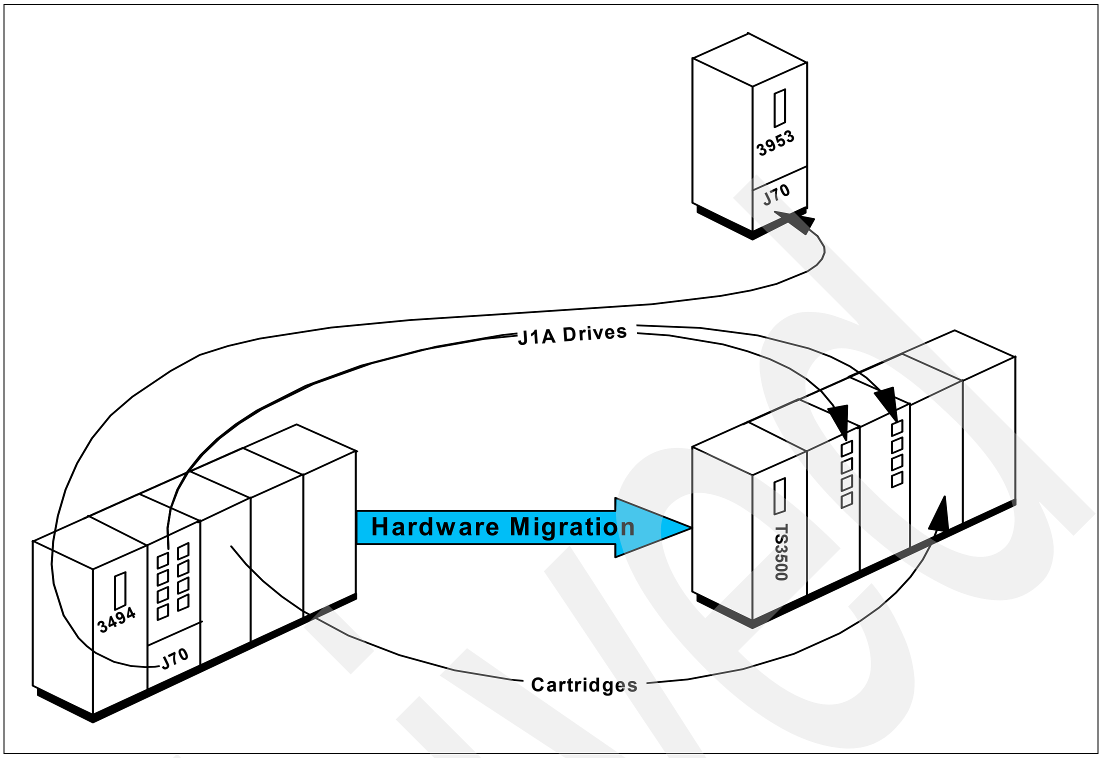


Figure 12-2 Hardware migration for a 3494 native library

Prerequisites

A hardware migration is possible only if all of the cartridges inside of the IBM 3494 are the IBM 3592 media type. If you have a mixed environment with both IBM 3590 and IBM 3592 tape drives and cartridges, you must copy all of the data that is on IBM 3590 cartridges onto the IBM 3592. You can perform this copy within the IBM 3494 Tape Library, or later, after you have moved the IBM 3592 cartridges and drives to the IBM TS3500 Tape Library.

Note: You cannot move 3590 drives and cartridges into an IBM TS3500 Tape Library, but you can still copy the data from 3590 to 3592 after you have integrated the 3592 drives into the IBM TS3500. Moving 3590 drives and cartridges into an IBM TS3500 Tape Library requires that both libraries and drive types are still attached to the same host system or that you can use shared disk subsystems as the intermediate storage.

Hardware installation

Install the IBM TS3500 Tape Library without the drives and the tape controller. You must prepare the TS3500 frames to receive the drives and the 3953-F05 frames to receive the controller with the appropriate feature codes:

- FC5875 on the IBM 3953-F05 Frame
- FC1674 and FC1503 on the IBM TS3500 L22 and D22 frames, which receive the drives

Software implementation

Your new library will most likely have a new LIBRARY-ID as well. If you want to keep the same device addresses for your native drives that you used before, you need to update your Hardware Configuration Definition (HCD) definitions with the new LIBRARY-ID and activate the input/output definition file (IODF) before powering on the TS3500 Tape Library configuration. You cannot make these changes before the drives are removed from the IBM 3494 Tape Library.

You can define the HCD configuration in advance to match the new configuration for the tape controller and drives, but you must not activate your IODF until you no longer use the drives in the source library.

You must also alter the SMS library definition using Interactive Storage Management Facility (ISMF). We recommend that you keep the eight character library name if you discontinue the use of the IBM 3494 Tape Library. In this case, you only have to alter the library definition by changing the five character LIBRARY-ID.

If you continue to use the IBM 3494 Tape Library, perform the following required steps:

1. Use ISMF to define a new tape library, which you can define in advance.
2. Prepare an IDCAMS job to change the volume records in the tape configuration database (TCDB) of those volumes that you will move to the IBM TS3500 Tape Library. You must update the library name to the name of the new library. Do not run this job as long as you continue to use the drives and cartridges inside of the IBM 3494 Tape Library.
3. Prepare to update your tape management system's catalog with the new volume location. Do not make these updates as long as the cartridges still reside inside of the IBM 3494 Tape Library.

Except for the library definition, we recommend that you make the updates in parallel with the hardware migration.

Hardware migration processes

An IBM SSR moves the IBM 3592-J1A tape drives and controller to the IBM TS3500 Tape Library configuration and perform tasks 3 to 13 of the required steps listed here:

1. Vary the drives offline.
2. Vary your 3494 library offline.
3. Pause the IBM 3494 Tape Library.
4. Remove the drives from the IBM 3494 Tape Library.
5. Remove the IBM 3592-J70 Tape Controller from the 3494.
6. Open the door of the IBM 3494 and take out the cartridges.
7. Merge the drives into the IBM TS3500 Tape Library.
8. After the IBM SSR installs the drives, discover the new hardware of the IBM TS3500 Tape Library. From the library touch panel, press **MENU** → **Settings** → **Configure Library** → **Discover New Hardware**, and press Enter.
9. Configure a logical library in the IBM TS3500 Tape Library using the Advanced Library Management System (ALMS). Assign cartridges and drives to the logical library. Refer to 8.1, "IBM TS3500 library setup" on page 202.
10. Merge the controller into the IBM 3953 Frame.
11. Configure the Library Manager to match your configuration.
12. Open the door and put the 3592-J1A cartridges in the tape library.

13. Close the door, and then, the tape library performs an inventory.
14. Activate your IODF configuration.
15. Update your SMS construct and your ACS routines.
16. Vary the library online.
17. Vary the drives online.
18. Activate your SMS configuration and verify that Object Access Method (OAM) has restarted.

12.4.3 Cartridge relocation scenario

A combination of data migration and hardware migration is required to migrate the workload of an existing IBM 3494 Tape Library VTS into another, empty VTS installed in an IBM TS3500 Tape Library. This process has been used multiple times with IBM 3494 tape libraries when moving data centers, for example.

Your IBM SSR can perform the installation and the configuration of a new VTS in the IBM TS3500 Tape Library well in advance.

Prerequisites

This migration is only possible if the data in the VTS is already written on 3592 media types. You can convert your data to this media by using Advanced Policy Management (APM). Refer to *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring,* SG24-2229, or the white paper titled *IBM TotalStorage Virtual Tape Server Using 3592 In a VTS* to perform this task.

> **Note:** The IBM TS3500 Tape Library supports only IBM 3494 Model B10 or B20 VTS systems.

Microcode level 2.32.740.*x* is required for the VTS to support the IBM 3953 Library Manager and IBM TS3500 Tape Library.

The VTS in the 3494 Tape Library must have 20 empty scratch cartridges available, and all the drives must be available.

Hardware installation

Your IBM SSR performs the following steps, which are required for the hardware installation:

1. Install IBM TS3500 Tape Library, including the 3953-F05 Tape Frame.
2. Connect the new VTS to the Library Manager and configure them.
3. Configure the logical library in the IBM TS3500 Tape Library.
4. The new target VTS must be taught and inventoried, even if there are no cartridges in it yet.

Note that you can move IBM 3592-J1A drives that are attached to a VTS from an IBM 3494 to a TS3500 Tape Library, but you cannot move the VTS or the switches that are installed in the 3494 Model D22 Frame. Order RPQ 8B3378 if you require the existing VTS from your 3494 Tape Library configuration. If you plan to move the IBM 3592-J1A drives, the hardware installation steps are the same steps that are listed in "Hardware migration processes" on page 369.

To perform the required feature configuration of the VTS, refer to *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring,* SG24-2229.

Software implementation

When moving cartridges (and drives) from one VTS to another VTS, you can keep the software definitions the same:

- We assume that you will continue to use the same five character LIBRARY-ID, which you used for the old VTS, with the new VTS; therefore, you do not have to update your HCD definitions.
- For the same reason, you do not need to define a new library, but you can continue to use the same SMS library definitions as before.
- There are no updates required to the tape management system.

If you want to use a different library name or LIBRARY-ID with the new VTS, the same software implementation steps are required that we described in “Software implementation” on page 369.

Data migration

This is an overview of the major tasks of the data migration. Your IBM SSR performs most of these tasks. Transporting the cartridges requires special care. The major tasks are:

1. Inhibit reclamation and disable inventory update on the source library to prevent VTS processes from interfering with data migration and backup.
2. Stop all production accessing the library on the host.
3. Vary the virtual drives offline at all attached hosts and vary the library offline.
4. Empty the VTS cache and back it up.
5. Back up the logical and stacked volume records of the Library Manager database.
6. If you have the Advanced Policy Management (APM) feature installed, back up the constructs.
7. Inhibit the reclamation update on the target library to prevent the VTS licensed internal code (LIC) from interfering with data migration and backup.
8. Copy the Library Manager database records to the 3953-L05 Library Manager.
9. If you have the Advanced Policy Management feature installed, restore the constructs.
10. Make sure that the required Cartridge Assignment Policies (CAPs) are defined on the IBM TS3500 library. Refer to 8.1.2, “Defining Cartridge Assignment Policies” on page 206 for details.
11. Remove the VTS physical cartridges from the source library and place them into cells within the IBM TS3500 Tape Library.
12. Close all open doors of the library frames to have the new cartridges automatically inventoried and, based on the CAPs, assigned in the TS3500 logical library.
13. Restore the VTS cache and bring up the VTS.
14. Reactivate reclamation.
15. Activate your IODF.
16. Update your SMS construct and your automated class selection (ACS) if needed.
17. Activate your SMS configuration and verify that OAM has restarted.

18. Vary the library online.

19. Vary the virtual drives online.

The expected outage is about eight hours. We based this estimation on a migration involving 50 000 logical volumes and 1000 stacked volumes. If you are moving native volumes as well, expect to add one hour per additional 1000 native volumes. This average time is only the time that is needed for backing up and restoring the Library Manager database.

Hardware migration processes

If you just want to move the VTS-attached drives and not the VTS from an IBM 3494 to an IBM TS3500 Tape Library, the hardware migration process for the drives is basically the same.

12.4.4 PtP VTS move scenario

You can connect the distributed VTSs of a PtP VTS to tape drives in different IBM tape libraries: One VTS can have its drives installed inside of an IBM 3494 Tape Library, and the other VTS can have its drives installed inside of an IBM TS3500 logical library managed by an IBM 3953-L05 Library Manager. Although a single IBM TS3500 Tape Library supports up to four IBM 3953-L05 Library Manager partitions, and, therefore, eight VTS systems, both distributed VTSs must have their drives installed inside of two physically separate tape libraries.

As for the stand-alone VTS, RPQ 8B3378 supports migrating an already installed VTS from an IBM 3494 to an IBM TS3500 Tape Library. However, in this scenario, we describe the migration using cartridge relocation for migration into an IBM TS3500 Tape Library configuration. It is also an efficient way to physically move your existing PtP VTS.

Scenario four, Peer-to-Peer VTS move, is the last of the scenarios that we summarized in 12.1, “Migration scenarios” on page 358. Although we describe the basic migration steps in this section, we recommend that you refer to the *IBM TotalStorage Peer-to-Peer Virtual Tape Server: Planning and Implementation Guide,* SG24-6115, for a detailed discussion of moving a PtP VTS.

This scenario describes the migration of both distributed VTS systems of a PtP VTS from two IBM 3494s to new VTS systems installed into two IBM TS3500 tape libraries.

Prerequisites

An IBM TS3500 configuration only supports the IBM 3494 Model B10 or B20 VTS.

All VTS data must be on 3592 cartridges, because for System z hosts, the IBM TS3500 Tape Library only supports IBM 3592-J1A or TS1120-E05 tape drives. You can migrate your data to 3592 (J1A or E05) drives and media by using APM. Refer to *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring*, SG24-2229, to perform this task.

LIC level 2.32.740.*x* is required for the VTS to support the IBM 3953-L05 Library Manager and IBM TS3500 Tape Library.

Hardware installation

Install each of the distributed Virtual Tape Servers of the PtP VTS complex into different IBM TS3500 tape libraries. Define the logical libraries in the IBM TS3500 tape libraries. These installation steps are the same for the stand-alone VTS. In addition, you must bring up the PtP VTS. For details, refer to *IBM TotalStorage Peer-to-Peer Virtual Tape Server: Planning and Implementation Guide,* SG24-6115.

Software implementation

We assume that we will use new device addresses for the logical drives of the PtP VTS; therefore, we can prepare the HCD definitions in advance. Use the new LIBRARY-ID of `98765` as shown in Figure 12-3 for the device definitions. You can activate the IODF any time, because the new definitions do not interfere with existing definitions for the source PtP VTS.

Define the two Distributed Libraries, `DistlibB1` and `DistlibB2`, to SMS. To minimize the migration efforts on the host, maintain the same library name, `LIBVTS1`, for the Composite Library so that you do not have to update the volume records in the TCDB.

Do not update the SMS Library Definition for LIBVTS1 before you shut down the source PtP VTS. Refer to Step 11 in "Hardware migration steps" on page 373.

Figure 12-3 shows you an overview of the source and the target configuration.

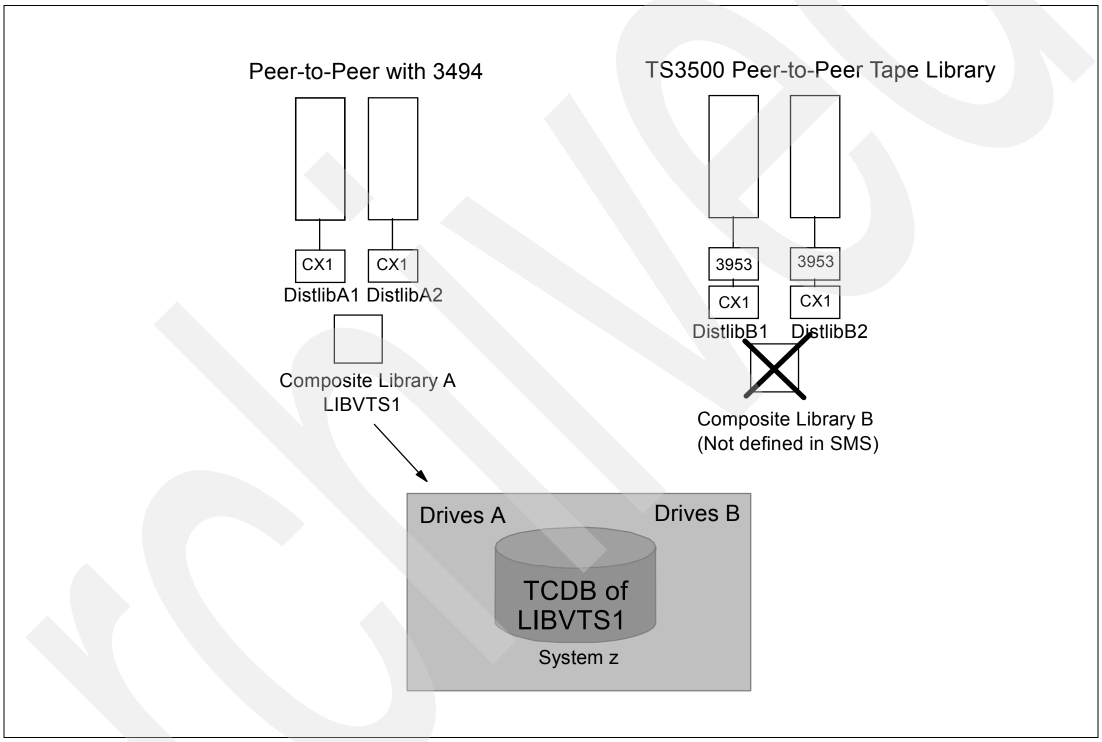


Figure 12-3 PtP VTS initial situation

Hardware migration steps

To migrate your hardware:

1. Implement the PtP VTS B in your system:
   - In the HCD definitions, the drives B will be assigned to the Composite Library B.
   - Define the SMS of the Distributed Libraries B1 and B2.

   You can create these definitions well in advance and activate your IODF, because we use a different range of drives and a different LIBRARY-ID.
2. Vary the drives of the Composite Library A offline.
3. Enter the Service prep mode on the Distributed Library A and set the Read-Only-Mode for the Distributed Library A2.
4. Vary the drives of the Composite Library A online.Your data is available, but you cannot write new data.

5. Empty and back up the VTS cache of the Distributed Library A, as well as the VTS and Library Manager database. If you have the APM feature, save the constructs.
6. Restore all of this data in the Distributed Library B1.
7. Move the cartridges from the Distributed Library A1 to Distributed Library B1.
8. Inventory the IBM TS3500 Tape Library of the Distributed Library B1.
9. Vary drives A1 of the Composite Library LIBVTS1 offline.
10. Vary Composite Library A1 offline.
11. Alter the SMS Definition of the Composite Library LIBVTS1 with the LIBRARY-ID of the new Composite Library 98765 (instead of the LIBRARY-ID of the old Composite Library 12345).
12. Activate the SMS configuration and verify that OAM restarted.
13. Vary the B1 Composite Library LIBVTS1 online.
14. Vary drives B1 of the Composite Library B online.
15. Empty and back up the VTS cache of the Distributed Library A2, as well as the VTS and Library Manager database. If you have the APM feature, save the constructs.
16. Restore all of this data in the Distributed Library B2.
17. Move the cartridges from the Distributed Library A2 to Distributed Library B2.
18. Inventory the IBM TS3500 Tape Library of the Distributed Library B2.
19. Resynchronize the PtP VTS.

Figure 12-4 shows you the configuration at the end of the PtP move.

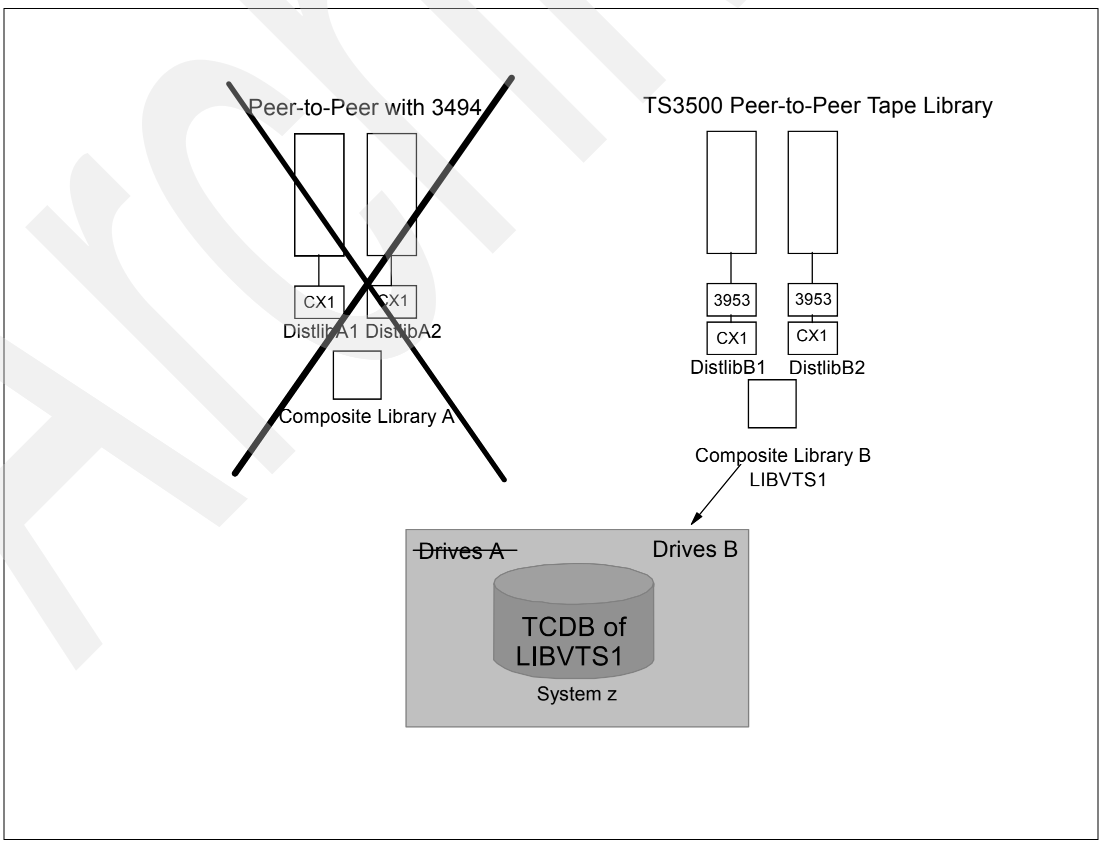


Figure 12-4 PtP VTS at the end of the move

The total outage time is highly dependent on the time necessary for the transportation of the cartridges from the source library location to the target library location. Your data is still available, but you cannot write new data in the PtP VTS.

The real outage occurs when the Composite Library is turned offline and when you have to update your SMS configuration.

12.4.5 Merging two stand-alone VTSs into a PtP VTS

The *IBM TotalStorage Peer-to-Peer Virtual Tape Server: Planning and Implementation Guide*, SG24-6115, discusses this entire scenario.

With the attachment of the VTS models B10 and B20 to IBM TS3500 Tape Library, no additional limitations are introduced for merging already installed VTS systems into a PtP VTS. You can install the physical VTS systems in one of the following three ways:

- Each VTS inside of a separate IBM 3494 library
- Each VTS inside of a physically separate IBM TS3500 library
- One VTS inside of an IBM 3494 and one VTS inside of an IBM TS3500 Tape Library configuration

12.5 Open Systems considerations

There are two common scenarios where you might need to migrate or upgrade Open Systems hardware:

- Moving drives from an IBM 3494 library (or elsewhere) into a new IBM TS3500 Tape Library
- Adding a System z host attachment to an installed IBM TS3500 Tape Library used by Open Systems hosts

In both cases, you must define logical libraries for the Open Systems hosts and the System z hosts, so that the management of the System z libraries is separate from the Open Systems.

12.5.1 Moving Open Systems drives

In the IBM 3494, the Open Systems drives are managed by the integrated Library Manager. In the IBM TS3500, they are not. The Open Systems hosts need different device drivers, and the driver that is recommended by the application software vendor might not be the IBM-supplied driver.

In order to physically move the IBM 3592-J1A Tape Drive hardware, in overview, you must:

1. Order the drive removal features for the IBM 3494, so that an IBM SSR can remove the drives.
2. Order the new IBM TS3500 with the Fibre Channel patch panel, drive mounting hardware features, and installation features that are sufficient for the number of drives that you plan to install.
3. Install the drives as part of the initial installation processes, along with the other new or migrated equipment. Note that this removal can occur in stages according to the production requirement for the Open Systems applications; you might choose to move, for example, half of the drives before switching over to the new system, if you are able to access both libraries at one time.

4. Use the IBM TS3500 Web Specialist to define at least two logical libraries: one logical library for the System z-attached IBM 3592 (J1A or E05) drives and one logical library for the Open Systems IBM 3592 (J1A or E05) drives. If you have diverse Open Systems hosts or applications using the tape drives independently, for example, Tivoli Storage Manager and Legato Networker, you must define a separate logical library for each host.
5. Add the drives that are attached to each host into each of the appropriate logical libraries by using the Web Specialist, and define the maximum cartridge slots that each logical library is allowed to use (a user-defined number).
6. Define CAPs, which define a discrete set of VOLSER ranges for each Open Systems host and each System z host. When the library detects a VOLSER in the I/O station or through the library inventory, the library assigns the VOLSER to the correct logical library.
7. Set up the Open Systems hosts with new device drivers to use the IBM TS3500. The atldd or equivalent IBM driver is not required for the IBM TS3500. Bring the new library online to the hosts and check communication.
8. Redefine the Open Systems host application to recognize the new library. Note that this task is disruptive to the application.
9. Move the cartridges into the IBM TS3500 and perform a library inventory. Check that the CAPs have assigned the volumes as expected.

12.5.2 Upgrading an installed IBM TS3500 for System z servers

In order to add a System z host attachment to an installed IBM TS3500 that is used by Open Systems hosts, you must order all of the System z hardware as an upgrade to the existing machine. You can install new additional frames or you can upgrade installed frames to house new IBM 3592-J1A or 3592-E05 drives. If the installed IBM TS3500 has only Linear Tape-Open (LTO) drives installed, you must add new IBM TS3500 Model D22 frames with the IBM 3592 drives, controllers, and sufficient cartridge storage for the planned System z hosts. If you do not plan to connect the drives, which you are installing, to an IBM 3494 VTS, you can install TS1130 drives as well.

In overview, you must:

1. Purchase and install the ALMS feature for the IBM TS3500, if it is not already installed.
2. Install the latest library firmware level through the Web Specialist: Select **Service Library** → **Firmware Update**. This step is straightforward. You do not need to call the IBM SSR to upgrade the library or tape drive firmware.
3. Install the ALMS license key. You cannot install the ALMS license key through the Web interface. You need to install the ALMS license key at the library through the library's Operator Panel. Installation instructions ship with the license key.
4. Activate ALMS on the TS3500 Specialist after you enter the license key. Refer to "Ensure that ALMS is enabled" on page 202 for details.
5. Migrate the Open Systems hosts to use ALMS, which is typically transparent to the host applications. The only observable difference is that the starting element address for the logical libraries and drives might not be the default address.
6. Ensure that the eight-digit VOLSER reporting is enabled. If ALMS was previously installed in the library, ensure that the incumbent Open Systems hosts can tolerate it. If the Open Systems applications do not use eight-digit VOLSERs, you must migrate the Open Systems hosts to use eight-digit VOLSERs before System z hosts can share the library.
7. Schedule and install the System z hardware upgrades to the IBM TS3500.
8. Use the IBM TS3500 Web Specialist to define the additional logical library for System z use.

9. Add the drives that are attached to the System z host into the appropriate logical libraries, using the Web Specialist, and define the maximum cartridge slots that the logical library is allowed to use (a user-defined number).
10. Define control path drives as required. For the 3953-L05 Library Manager partition, you must define four control path drives per VTS or IBM TS1120 Model C06 (or 3592-J70) Controller unless fewer than four drives are available. Refer to "Add control paths" on page 206 for details.
11. Define CAPs, which define a discrete set of VOLSER ranges for use by each Open Systems host and System z host. When the library detects a VOLSER in the I/O station or through the library inventory, the library assigns the VOLSER to the correct logical library.
12. Add System z cartridges to the library. Check that the CAPs have assigned the volumes as expected.
13. Set up the IBM 3953-L05 Library Manager.

12.5.3 Application migration

Open Systems-attached IBM 3592 tape drives are supported in an IBM TS3500 Tape Library, but they are not managed by the IBM 3953-L05 Library Manager. Unlike the IBM 3494 Library Manager, which manages all tape drives installed inside of the 3494 Tape Library, the IBM 3953-L05 Library Manager only manages System z host-attached tape drives.

The IBM 3494 Tape Library Emulation Support provides the ability to use applications that were written for the 3494 application programming interface (API) on host-attached SCSI Medium Changer libraries. The emulation supports any types of SCSI Medium Changer library and drives that are attached, such as a TS3500 Ultra™ Scalable Library with either 3592 or LTO Ultrium drives.

Using existing client scripts, the **mtlib** program, client applications, or ISV applications require no or minor changes, depending on the 3494 functions that you use.

You only need to recompile client applications and ISV applications with the new libibm.o object module in order to use the emulation support.

The **mtlib** 3494 user command line interface program, which has the same syntax and output on every operating system platform, provides a common utility for SCSI Medium Changer libraries also. Current operating system device driver utilities vary by syntax and output, require a knowledge of SCSI Medium Changers to use, and require multiple commands to perform a single **mtlib** command.

The 3494 Emulation support adds a **libsmc** extension to the current libibm.o object module with which applications compile for existing 3494 support. The **libsmc** extension contains the 3494 API Emulation support, which issues SCSI Medium Changer commands to the library using the operating system SCSI Medium Changer device driver.

13

Operation

In this chapter, we describe the major operational tasks on a TS3500 Tape Library, as well as on the 3953 Library Manager.

You can see that the functions of the IBM 3494 Library Manager and the functions of the IBM 3953 Library Manager are similar, because they share the same internal code. An operator who is familiar with the IBM 3494 Library Manager will recognize that the look and feel of the IBM 3953 Library Manager is similar. However, several functions differ, because the Library Manager is not in overall control of the entire IBM TS3500 Tape Library. The Library Manager controls only the Library Manager partitions.

In this chapter, we describe the operations with reference to:

- TS3500 Tape Library and 3953 Library Manager operator interfaces
- Operational modes and states
- Displaying component status
- Inserting System z volumes
- The manual mode of operation
- Stand-alone device usage

We also provide information regarding operations that you must never perform on the IBM TS3500 Tape Library or Library Manager Operator interfaces in an System z environment.

13.1 IBM TS3500 and 3953 Library Manager operator interfaces

Several interfaces are available to communicate with the TS3500 Tape Library and the 3953 Library Manager:

- IBM TS3500 Tape Library:
  - Operator Panel
  - IBM System Storage Tape Library Specialist (IBM TS3500 Tape Library Specialist)
- 3953 Library Manager:
  - Operator Panel
  - Tape Library Specialist

If a virtualization subsystem is installed, additional interfaces are available to communicate with those subsystems and provide information that is not available in the other tools:

- The TS7700 Management interface for Single or Multi Cluster TS7700 Grid
- The Enterprise Tape Library Specialist for Virtual Tape Server (VTS)
- The Peer-to-Peer (PtP) Virtual Tape Server (VTS) Specialist for PtP VTS

You can perform certain actions only on the Operator Panel directly. In this case, we explain the usage of this function on the Operator Panels. For all other functions, we explain the usage with the corresponding Web interface. For further information about using the Operator Panels, refer to the *IBM System Storage 3953 Library Manager Model L05 Operator Guide*, GA32-0558, or the *IBM System Storage TS3500 Tape Library Operator Guide*, GA32-0560.

You can access the various Web interfaces with the Microsoft Internet Explorer® Version 6.0 or a fully compatible alternative browser with Javascript and Java enabled.

13.1.1 General information about Web login IDs and passwords

You can access the Enterprise Tape Library (ETL) Specialist and the PtP VTS Specialist with the same user ID and password, which you can create on the Library Manager panel or through the ETL Specialist. The default user ID is *webadmin*, and the default password is *webadmin*.

There are additional user IDs and passwords that are required to access the following interfaces:

- TS3500 Tape Library Specialist. To activate security protection and define user IDs, refer to 13.3.5, "Web login IDs and passwords for the TS3500 Specialist" on page 390.
- TS7700 Management Interface (MI). The default user ID is *admin* and the default password is *admin*. To define user IDs, refer to *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312.

When defining any user ID, you can specify the area of the Web browser interface that the user can access by assigning a specific level of access or role to the user ID. Depending on the Web interface, you can assign access privileges or roles, such as:

- **General user**: Has access to all Web pages but cannot perform any changes
- **Operator**: Has access to monitoring information and can perform restricted actions, such as inserting logical volumes
- **Administrator**: Is the highest level of authority, including the authority to add or remove user accounts

- **Service**: Is reserved for IBM service support representatives (SSRs)
- **Role-based:** The TS3500 Tape Library Specialist allows you to define custom role-based users' accounts.

Note: The TS7700 Virtualization Engine Management Interface (MI) allows the administrator to name and define two additional custom roles by selecting individual tasks that are permitted by each custom role.

Tip: We strongly recommend that you control access to the administrative functions provided through the ETL Specialist, the TS7700 MI, the Peer-to-Peer VTS, and the TS3500 Tape Library Specialist panels.

13.1.2 IBM TS3500 Tape Library Specialist

The IBM System Storage Tape Library Specialist (IBM TS3500 Tape Library Specialist) provides management and monitoring of the TS3500 Tape Library-related items. Initially, the Web user interface to the IBM TS3500 Tape Library only supported a single user at any given time. Now, each Ethernet-capable frame on the TS3500 Tape Library allows five simultaneous users of the Web user interface, which allows multiple users to simultaneously access the library Web user interface.

Note that differently than the ETL Specialist and PtP VTS Specialist, the TS3500 Tape Library Specialist times out its session after a default time of ten minutes. You can change these default values by selecting **Access** → **Web Security** from the TS3500 Tape Library Specialist home page in the panel that is shown in Figure 13-1 on page 382.

13.1.3 Enterprise Tape Library Specialist

The IBM TotalStorage Enterprise Tape Library (ETL) Specialist is the Web-based user interface that you use to view the current status and configuration of the Library Manager. You can also use the ETL Specialist to perform limited control functions on the Library Manager.

The ETL Specialist provides display functions and nearly all control functions, which are also available from the Library Manager Console. Certain functions, especially the functions that require a physical presence at the tape library, are restricted to the Library Manager Console. The following pages are available on the ETL Specialist:

- A home page
- A set of Library Manager pages related to Library Manager-wide statistics and administrative tasks
- A set of library partition pages related to the three Library Manager partitions, which can exist within a single TS3500 logical library partition
- A set of VTS partition pages, if a TS7700 Virtualization Engine or VTS is installed, including the complete administration of the optional Advanced Policy Management (APM)
- A set of security pages to manage user IDs for all Web-based functions that are not strictly monitoring, for example, "Search Library Manager Database"
- Links to the TS7700 Virtualization Engine Management Interface (MI), if a Single Cluster TS7700 Grid or Multi Cluster TS7700 Grid is installed
- Links to the Peer-to-Peer VTS Specialist, if a PtP VTS is installed
- A link to the TS3500 Tape Library Specialist Web interface

Figure 13-1 shows the Welcome Page of the ETL Specialist.

Figure 13-1 ETL Specialist Welcome Page

The left side of the panel shows the general work items included in this special configuration. In the center, you see one VTS Partition, *VTS 1*. Clicking the link provides you with the status of this logical library. There can be another VTS partition (*VTS 2*) and a partition (*Native*) that includes all of the native IBM 3592 tape drives attached to a Model J70 or a TS1120 Model C06 Tape Controller and managed by this 3953 Library Manager.

During the installation process of the ETL Specialist, the IBM SSR sets up TCP/IP on the Library Manager to use your assigned TCP/IP host name and TCP/IP address (and router information, if necessary). You can help the installation process if you obtain the following information before the installation starts:

- TCP/IP host name
- TCP/IP address
- Subnet mask (or network mask)
- Router address (or Gateway address)*
- Domain name*
- Nameserver address*

*These items are optional. Their use depends on your system's local area network (LAN) configuration.

13.1.4 TS7700 Virtualization Engine Management Interface

The TS7700 Virtualization Engine Management Interface (MI) is the primary interface to monitor and administer a Single or Multi Cluster TS7700 Grid.

To access the Management Interface, you can use the link **Manage Virtualization Engine 1** from the ETL Specialist or simply point your Web browser to the IP address assigned to the TS7700 Virtualization Engine during installation. The login page for the Management Interface loads.

> **Note:** The TS7700 Virtualization Engine has its own user management system. You cannot use your ETL Specialist user ID unless it has been specifically defined to the TS7700 Virtualization Engine. The default user ID is *admin*, and the default password is *admin*.

After entering your password, you see the first Web page presented by the MI, the TS7700 Virtualization Engine Grid Summary, as shown in Figure 13-2.

Figure 13-2 shows a graphical summary of the TS7700 grid. Note that this page does not imply that you have a Multi Cluster TS7700 Grid. Each TS7740 is considered a grid. In our example, you see a Single Cluster Grid configuration.

In the center of the picture is the grid, which is composed of one or more clusters shown connected to the grid. The cluster to which you are currently connected is highlighted by a blue background with a light blue border. The clusters are also shown connected to the hosts.

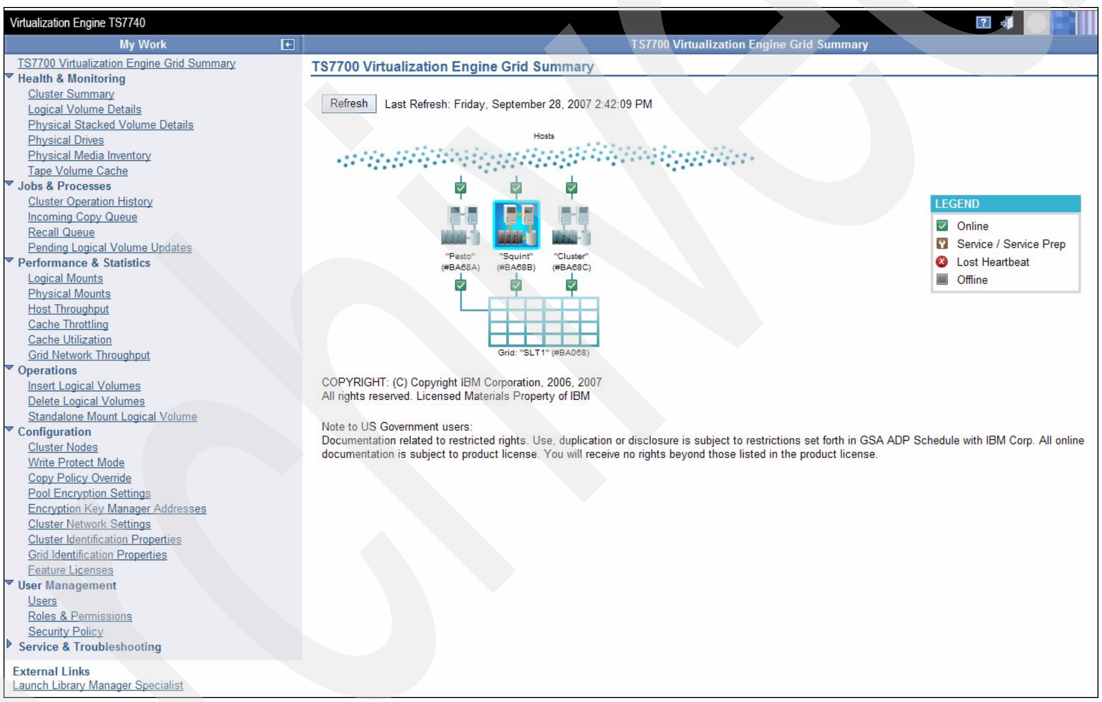


Figure 13-2 MI Virtualization Engine Grid Summary

From this Web page, you can perform all of the tasks that your user role allows you to perform.

For more information about the TS7700 Virtualization Engine Management Interface, refer to *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312.

13.1.5 Peer-to-Peer VTS Specialist

The Peer-to-Peer VTS Specialist (PtP VTS Specialist) is the Web-based user interface that you use to view the current status and configuration of the PtP VTS. You can also use this interface to perform limited control functions on the PtP configuration.

Note: The Peer-to-Peer VTS Specialist does not allow access to data that is stored on the logical tape volumes.

While the functions and panels of the Tape Library Specialist are also available through the Library Manager Console, the Peer-to-Peer VTS-related panels are only available through the Peer-to-Peer VTS Specialist. These functions include, for example, displaying the status of the overall Peer-to-Peer VTS complex, the status of logical volumes, and the volumes in the copy queue.

We recommend that you always implement the Peer-to-Peer VTS Specialist, because it is the only means for clients to access information from the Virtual Tape Controllers (VTCs).

13.1.6 Call Home function

The Call Home function generates a service alert automatically when a problem occurs with one of the following components:

- IBM 3953 Model L05 Library Manager
- IBM TS3500 Tape Library
- IBM 3592 Model J70 and TS1120 Model C06 controllers
- IBM TS7700 Virtualization Engine
- IBM 3494 VTS models B10 or B20

Error information is transmitted to the Master Console for service and then to the IBM Support Center for problem evaluation; the IBM Support Center can dispatch an IBM SSR to the client's site. Call Home can send the service alert to a pager service to notify multiple people, including the operator. The IBM SSR can deactivate the function through service menus if you prefer.

13.1.7 SNMP monitoring

The TS3500 Library Manager and the 3953 Library Manager provide a standard TCP/IP protocol called Simple Network Management Protocol (SNMP) to send alerts (called SNMP *traps*) over a TCP/IP LAN network (IPv4 or IPv6) to one or more SNMP monitoring stations. These monitoring stations, along with other user-supplied software, can alert operations staff to possible problems or needed operator interventions that occur at the TS3500 Tape Library or the 3953 Library Manager.

To activate this SNMP traffic, you must enable it in the TS3500 Tape Library, as well as in the 3953 Library Manager.

For further information, refer to:

- *IBM System Storage Tape Libraries Guide for Open Systems*, SG24-5946
- *IBM System Storage 3953 Library Manager Model L05 Operator Guide*, GA32-0558
- *IBM System Storage TS3500 Tape Library Operator Guide*, GA32-0560

13.2 Important tips for TS3500/3953 in a System z environment

The TS3500 Tape Library Specialist is designed to support Open Systems, as well as the System z environment. Several of the features that you use in the Open Systems environment must never be executed in a System z environment or only used under certain circumstances. There are other tasks that you must avoid in order to minimize the impact to the production environment.

Note that the TS3500 Tape Library cannot perform a validity check to verify that the task you execute is valid for a System z partition. So, the TS3500 Tape Library does not prevent you from executing the task, even if the task directly impacts your production environment.

Important: Several of the TS3500 Tape Library Specialist functions can have a direct impact on your production environment. Read the recommendations in this section carefully.

13.2.1 Actions that you must not perform

In the following list, we describe actions that you must *not* perform. These actions might or will impact your normal tape operation as indicated:

- Never disable the Advanced Library Management System (ALMS). You lose all definitions of all TS3500 logical libraries, and the System z-attached hosts are no longer able to run their tape production. To go back in production, you must call the IBM SSR. With a CE-Tool, it is possible to restore the definitions.
- Never delete a logical library on the TS3500 Tape Library when you are not 100% sure that this logical library is no longer needed. With the deletion of the logical library partition, all the definitions are lost, and the System z-attached hosts are no longer able to run their tape production.
- Never share drives among multiple TS3500 logical libraries for System z servers. This sharing is technically impossible (because of the missing connections between controllers, TS7700, VTS, drives, and the missing front-end FICON/ESCON attachment) and leads to unpredictable results. However, the panels allow that definition.
- Never reassign drives used by System z logical libraries to another logical library partition. Use the Tape Drive Assignment panel only during the first installation phase, when you implement new logical libraries, or when you enhance your existing environment with new drives.
- Never change the Drive Emulation Mode defined for a 3592-E05.

  Note: There is no such mode available for the TS1130 drive.

- Never insert more cartridges into empty cells than there are free cells indicated in the Operational Status window, because cartridges that are currently loaded on drives must have a cell available when they are unloaded from the drive.
- Never leave Manual mode until mounts that were started (cartridges that were physically placed in the feed slot of a drive) have been cleared from the Manual Mode window.
- Never place Exported Stacked Volumes in the I/O station or into free cells, because this action causes them to be inserted as scratch volumes, and the data on them is lost permanently.
- Never load a drive without the Library Manager telling you to do so (which occurs only in Manual mode).
- Never move an Exported Stacked Volume that is intended for use by the VTS Exported Volume Read Utility (provided by DITTO/ESA for MVS) with a native tape drive into the Insert category without checking the VOLSER ranges. The cartridge becomes a TS7700 Virtualization Engine or VTS Stacked Volume if it is in the VOLSER range for a VTS partition and is rewritten.

- Never change Fibre Channel Port settings without requesting an IBM SSR.
- Never change the Ethernet Address settings or Speed settings without requesting an IBM SSR.

13.2.2 Actions to avoid

This section contains a list of actions to avoid when operating the Library Manager but the consequences of which are less serious than those actions in the preceding list. Failure to follow these recommendations can still cause significant performance degradation:

- Avoid running a library inventory for all frames. During the inventory, no cartridge movements are executed, and this task delays all of the tasks in the work queue until the inventory run completes.
- Avoid leaving the I/O station door open.
- Avoid running with the tape library completely full. Running with a full tape library makes it impossible to insert any more cartridges. It also causes cartridges to be left in the I/O stations.
- Avoid running large database searches (for instance, searching for all VOLSERs in the Library Manager's logical library) from the Database window while the system is busy. This search can tie up the database and cause performance degradation.
- Avoid opening the enclosure doors without first pausing the cartridge accessors.
- Avoid any continuous action that causes a window to continuously use the Library Manager hard drive.
- Avoid moving cartridges. With ALMS enabled, moving a cartridge might not result in a physical move but request only a new element address.

13.3 Operating the TS3500 Tape Library

In the following section, we describe operator functions for the TS3500 Tape Library that are necessary for daily business routines. However, this description is merely an overview and not a complete set of TS3500 Tape Library operational instructions.

The IBM TS3500 Operator Panel and the TS3500 Tape Library Specialist provide information about the entire library, including any System z or Open Systems logical libraries' partitions. You control the Open Systems logical libraries by using the host application and the Operator Panel or the TS3500 Specialist. You can only control System z-attached logical libraries through the 3953 Library Manager.

We introduce the Operator Panel; however, we only describe the usage of the TS3500 Tape Library Specialist in more detail.

For further information, refer to the *IBM System Storage TS3500 Tape Library Operator Guide*, GA32-0560.

13.3.1 IBM TS3500 Operator Panel

The IBM 3494 and the IBM TS3500 both have Operator Panels on the front of the first frame, the L frame. However, the IBM TS3500 panel has an interactive dialog, because this interface is the only physical operator interface available for Open Systems logical libraries other than the Web interface.

The Operator Panel is the set of indicators and controls that lets you perform operations and determine the status of the library. The panel consists of the library power switch, a power-on indicator, the controller for the I/O stations, and a touch-sensitive liquid crystal display (LCD), which is illustrated in Figure 13-3. The Operator Panel controller is a circuit board that facilitates communication between the Operator Panel and the accessor controller.

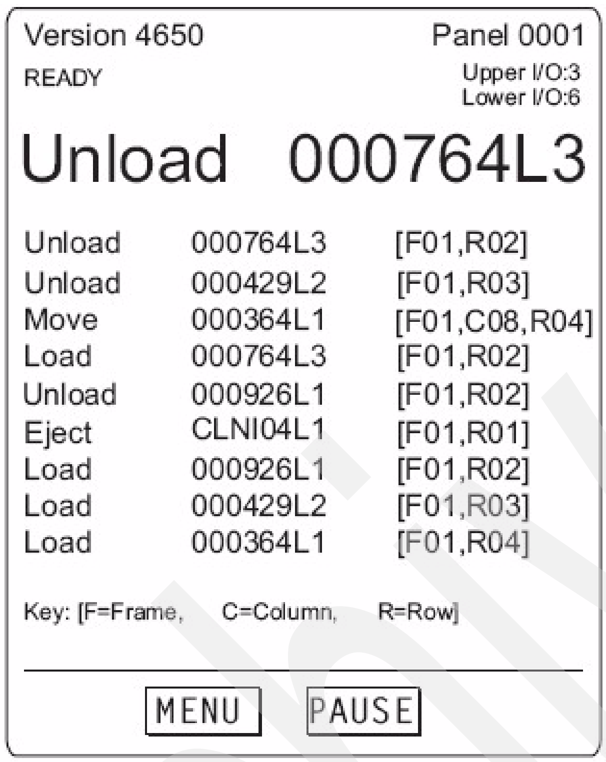


Figure 13-3 Liquid crystal display Operator Panel on IBM TS3500

The Activity panel is shown in Figure 13-3 and displays on the touch-sensitive LCD when the library is ready (that is, when the host applications can interact with the library). The first line on the panel shows the current level of library firmware and the panel (display) number. The left field on the second line indicates whether the library is ready, not ready (not interacting with host applications), or initializing. The right field indicates the status of one or more I/O stations. The display shows the current activity in a large font type and provides a history of preceding operations in a smaller font type. The operations list from top to bottom with the most recent operations at the top and the oldest operations at the bottom.

The information on the panel is automatically replaced by an error message when either a permanent error has occurred or cleaning has been requested and automatic cleaning is not possible, or disabled.

MENU and PAUSE are touch-sensitive buttons. The PAUSE button causes the cartridge accessor to park (to quickly resume operation later) to give you clear access to the library's interior if you need to open the front door. If you do not open a door, the pause status times out after 30 seconds, and the library automatically resumes operation. After you open a front door, the library rejects requests for new operations until you close the door and the inventory completes.

13.3.2 IBM TS3500 flowchart of the Operator Panel

The following chart (Figure 13-4) shows an overview of all available functions on the Operator Panel. Remember that not all functions are available from the Web interface.

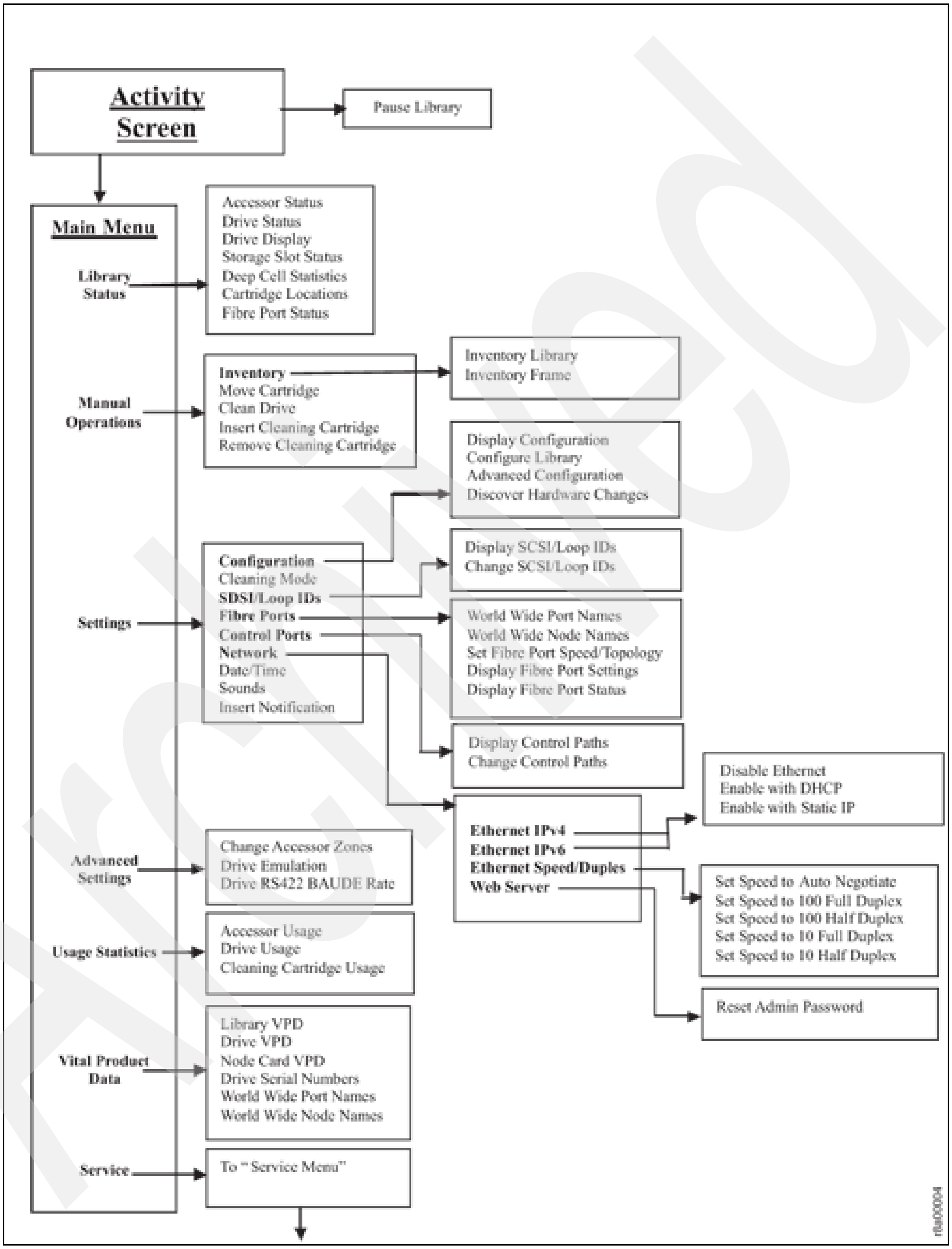


Figure 13-4 TS3500 Operator Panel flowchart

13.3.3 Operator Panel security

You can protect the Operator Panel. A login is necessary before you can perform actions. As opposed to the TS3500 Web Specialist (refer also to 13.3.5, “Web login IDs and passwords for the TS3500 Specialist” on page 390), you cannot specify multiple user IDs with different access levels. You can only apply a password to lock or unlock the Operator Panel. The password can be 15 characters long and can be changed on request.

13.3.4 IBM TS3500 Tape Library Specialist System Summary

In Figure 13-5, you see the TS3500 Specialist home page. You can now choose among the options on the Work Items pane on the left side of the panel or obtain additional status information by clicking the underlined items on the lower right part of the panel.

Figure 13-5 TS3500 Specialist System Summary Page

13.3.5 Web login IDs and passwords for the TS3500 Specialist

For management of the IBM TS3500 Tape Library through the TS3500 Specialist, you can choose whether you want to protect the TS3500 Specialist panels. To activate the security protection or to administer the user IDs, perform the following steps:

1. Type the Ethernet IP address on the Web site line of the browser and press Enter. The Welcome Page displays.
2. Select **Access** → **Web Security**.
3. If you have not already turned security on, the panel shown in Figure 13-6 appears.

   In order to turn on security, fill in the upper part of the panel and click **Apply.**

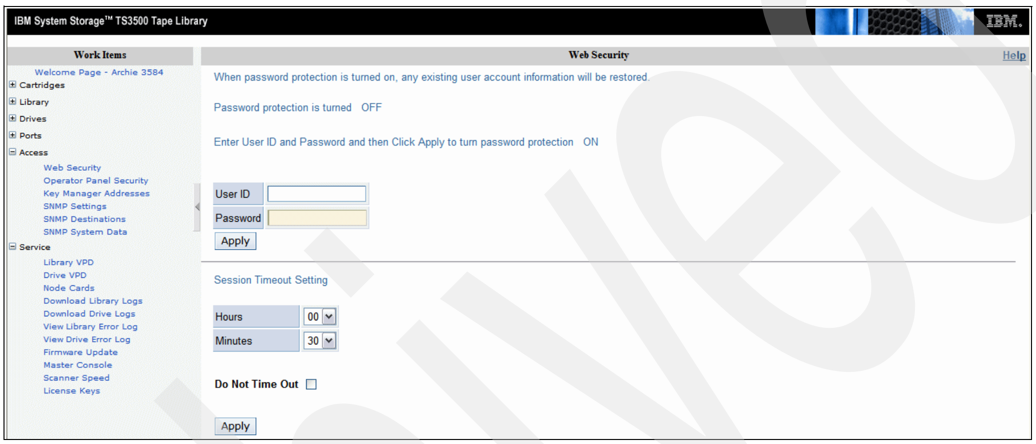


Figure 13-6 TS3500 Specialist Access: Web Security

Remember that for the TS3500 Specialist, the ETL Specialist, and PtP VTS Specialist, user ID and password are not sufficient, but a new, additional user ID and password are required.

To use the TS3500 Specialist, you can specify a list of users who can access various areas of the Web browser interface. You can specify up to 19 different user IDs. Each user has a 15 character login ID, a 15 character password, and an access level. The *access level* defines the level of Web access that the user is allowed. The TS3500 Specialist supports four levels of access, plus up to ten custom roles:

Monitor Monitor has access to all Web pages but cannot perform any changes, because all of the buttons are not available.

Service Service only has access to the service menu items and is mainly used by IBM service personnel.

Superuser Superuser can perform all of the tasks of a monitor or a service role, plus change library settings and perform library operations. This role can add user IDs, but it cannot change the passwords of other users, enable security, or disable security.

Admin Admin can do everything.

Custom Up to ten additional locally defined roles with customized permissions can be defined. Refer to the *IBM System Storage TS3500 Tape Library Operator Guide,* GA32-0560, for complete details concerning the use of custom-based roles.

With monitor and service login IDs, you cannot create, modify, or delete any login IDs. Any login ID is able to change its own password. The *admin* and the *superuser* can create new user IDs. However, only the login ID admin can reset the password of existing users and modify and delete all login IDs, except the admin ID. Also, only the admin user is able to disable the security.

If you have a superuser ID or an admin ID, you can access the panels to create new user IDs by performing these steps:

1. Type the Ethernet IP address on the Web site line of the browser and press Enter. The Welcome Page displays.
2. Select **Access** → **Users**.

13.3.6 Operational states of the TS3500 Tape Library

At any point in time, the overall library subsystem is defined by a combination of operational modes and states. The three operational modes of the TS3500 Tape Library are:

- **Ready**
  In this mode, the library works and accepts workloads from all attached hosts.
- **Pause**
  This mode allows the operator to open the tape library door and access the interior of the IBM TS3500. While the library is in Pause mode, requests are queued until the library returns to Ready. From Pause mode, you can change the library to Ready or Not ready. You can execute manual operations from the Library Manager only when the TS3500 Tape Library is in Pause mode. Refer to 13.6, “Manual mode of operation” on page 426.
- **Not ready**
  In this mode, the library is not working and does not accept workload from the attached hosts. The library is in this mode during a library inventory run.

13.3.7 Display the status and usage of components in the IBM TS3500

In this section, we describe how to determine the status of important components. All descriptions are valid for the TS3500 Specialist.

Determining the status and usage of the cartridge accessor

To determine whether tape cartridges are present in the cartridge accessor of the TS3500 Tape Library, use one of the following methods:

- Type the Ethernet IP address on the Web site line of the browser and press Enter. The Welcome Page displays.
- Select **Library** → **Accessor.** The accessor panel displays the state of operation for the accessor and its components (gripper, scanner, and calibration sensor). It also gives usage statistics. If you have a second accessor, the panel also displays status and usage information for this accessor.

If two accessors are available, they need to be both **Online.** All grippers must be **Operational**. If a status **Failed** is determined, the gripper has a hardware problem. You must inform the IBM SSR. When a **Failed** status is determined, a VOLSER might be reported, which means that a problem has occurred with that cartridge. Note that if the cartridge is locked in the gripper, this situation can lead to follow-on problems (for example, a mount request for this cartridge on a different drive, which cannot be satisfied).

This panel also provides information about the usage of the accessors, for example, in Figure 13-7 on page 392, the number of gets and puts for each gripper, as well as the travel meters for each accessor.

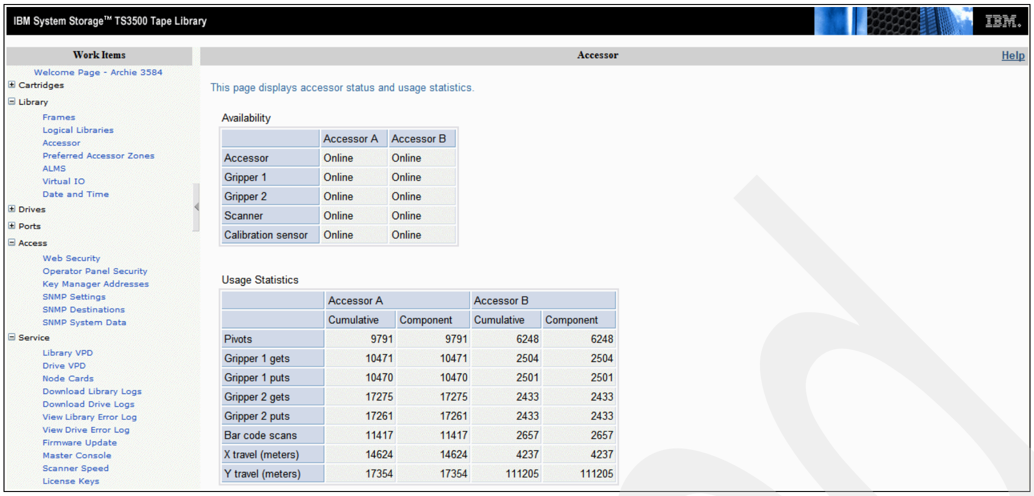


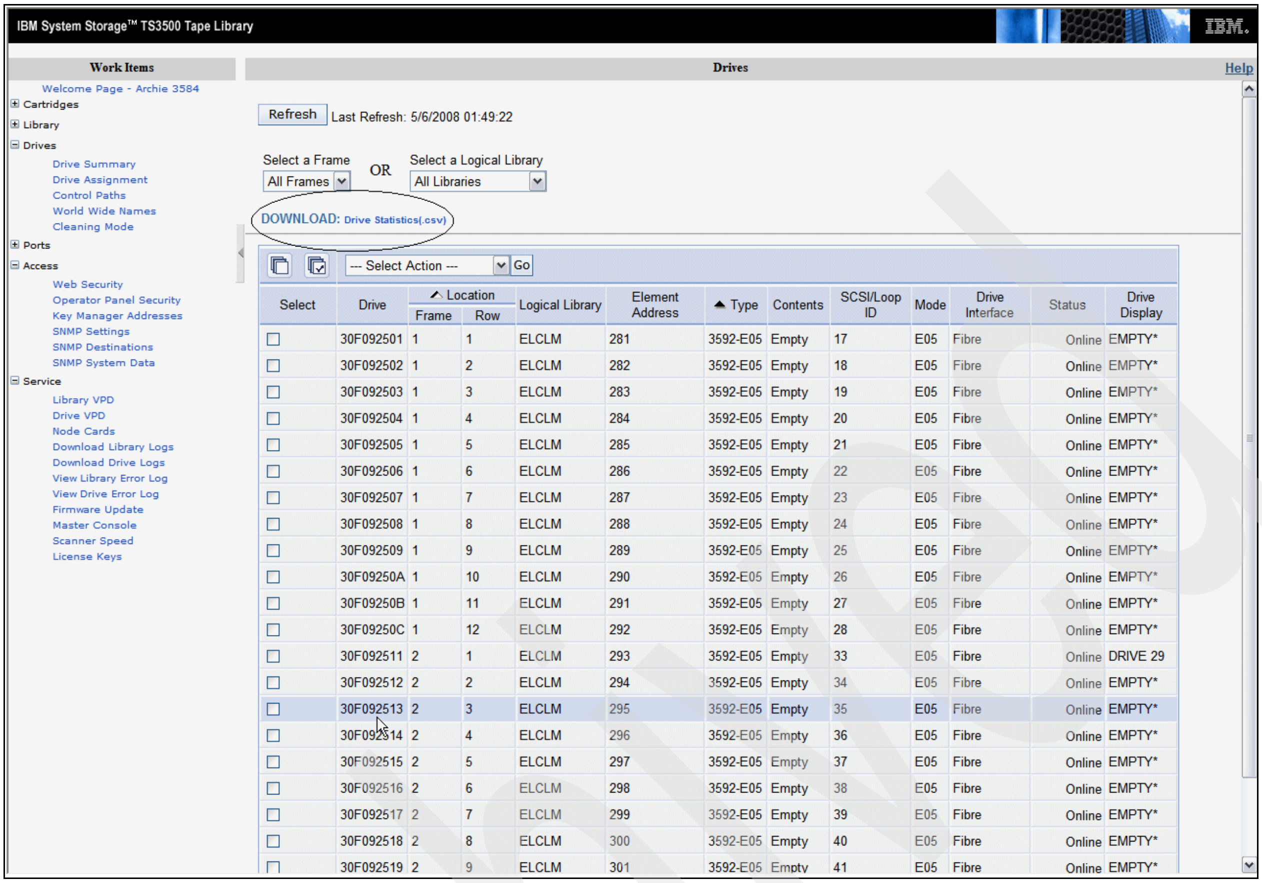
Figure 13-7 Accessor status and usage

Determining drive status and activity

To determine whether the tape drives in the TS3500 Tape Library function properly and if any drive-related activity is processing at the moment, perform the following steps:

1. Type the Ethernet IP address on the Web site line of the browser and press Enter. The Welcome Page appears.
2. Select **Drives** → **Drive Summary** (presents the drives by frames and logical libraries). The Drives panel displays the states of operation for all of the drives in the library.
3. You can now specify that you want to see all installed drives, drives residing in a specific frame, or drives belonging to a specific logical library partition.

As shown in Figure 13-8 on page 393, you see not only the status and current activity, but also the installed models and their assignments to TS3500 logical libraries.



Select	Drive	Location: Frame	Location: Row	Logical Library	Element Address	Type	Contents	SCSI/Loop ID	Mode	Drive Interface	Status	Drive Display
☐	30F092501	1	1	ELCLM	281	3592-E05	Empty	17	E05	Fibre	Online	EMPTY*
☐	30F092502	1	2	ELCLM	282	3592-E05	Empty	18	E05	Fibre	Online	EMPTY*
☐	30F092503	1	3	ELCLM	283	3592-E05	Empty	19	E05	Fibre	Online	EMPTY*
☐	30F092504	1	4	ELCLM	284	3592-E05	Empty	20	E05	Fibre	Online	EMPTY*
☐	30F092505	1	5	ELCLM	285	3592-E05	Empty	21	E05	Fibre	Online	EMPTY*
☐	30F092506	1	6	ELCLM	286	3592-E05	Empty	22	E05	Fibre	Online	EMPTY*
☐	30F092507	1	7	ELCLM	287	3592-E05	Empty	23	E05	Fibre	Online	EMPTY*
☐	30F092508	1	8	ELCLM	288	3592-E05	Empty	24	E05	Fibre	Online	EMPTY*
☐	30F092509	1	9	ELCLM	289	3592-E05	Empty	25	E05	Fibre	Online	EMPTY*
☐	30F09250A	1	10	ELCLM	290	3592-E05	Empty	26	E05	Fibre	Online	EMPTY*
☐	30F09250B	1	11	ELCLM	291	3592-E05	Empty	27	E05	Fibre	Online	EMPTY*
☐	30F09250C	1	12	ELCLM	292	3592-E05	Empty	28	E05	Fibre	Online	EMPTY*
☐	30F092511	2	1	ELCLM	293	3592-E05	Empty	33	E05	Fibre	Online	DRIVE 29
☐	30F092512	2	2	ELCLM	294	3592-E05	Empty	34	E05	Fibre	Online	EMPTY*
☐	30F092513	2	3	ELCLM	295	3592-E05	Empty	35	E05	Fibre	Online	EMPTY*
☐	30F092514	2	4	ELCLM	296	3592-E05	Empty	36	E05	Fibre	Online	EMPTY*
☐	30F092515	2	5	ELCLM	297	3592-E05	Empty	37	E05	Fibre	Online	EMPTY*
☐	30F092516	2	6	ELCLM	298	3592-E05	Empty	38	E05	Fibre	Online	EMPTY*
☐	30F092517	2	7	ELCLM	299	3592-E05	Empty	39	E05	Fibre	Online	EMPTY*
☐	30F092518	2	8	ELCLM	300	3592-E05	Empty	40	E05	Fibre	Online	EMPTY*
☐	30F092519	2	9	ELCLM	301	3592-E05	Empty	41	E05	Fibre	Online	EMPTY*

Figure 13-8 IBM TS3500 Specialist: Show drive status and activity

The following status information is valid:

Online Drive functions properly.

Offline Drive is offline for service purposes.

Not Responding There is no response to communication from the library.

An IBM SSR must be requested for a status of *Not Responding*.

The field Drive Display shows the actual display from the installed drive. The functional displays that might display are:

- READY
- WRITE
- READ
- @LOAD
- EMPTY
- CLEAN

A hyperlink DOWNLOAD: Drive Statistics(.csv), which is shown in Figure 13-8, allows you to download the Drive Statistics report, which is a .csv file that contains data about the Ultrium 2 Tape Drive, Ultrium 3 Tape Drive, Ultrium 4 Tape Drive, 3592 Tape Drive Model J1A, and 3592 Model E tape drives.

The following information displays:

- **WWNN**: The World Wide Node Name of the drive. Ignore the underscore that precedes each value.
- **Model**: The type of drive, as reported by the drive's Small Computer System Interface (SCSI) string. Ignore the underscore that precedes each value.
- **S/N**: The serial number of the drive. Ignore the underscore that precedes each value.
- **Valid**: A value of 1 in this column (and 0 in all Write or Read columns) means that commands were run, but there were no errors or there was no activity performed by the drive. A value of 0 in this column means that the entries in all columns are invalid.
- **Last Volser**: The volume serial number of the last cartridge demounted from the drive. Ignore the underscore that precedes each value.
- **Write MB Host Since**: The quantity of megabytes (MB) written by the host to all cartridges since the time stamp at the top of the report.
- **Write Error Corrected Since**: The quantity of write errors that the drive corrected since the time stamp at the top of the report.
- **Write Error Uncorrected Since**: The quantity of write errors that the drive was unable to correct since the time stamp at the top of the report.
- **Read MB Host Since**: The quantity of megabytes (MB) that the drive read since the time stamp at the top of the report.
- **Read Error Corrected Since**: The quantity of read errors that the drive has corrected since the time stamp at the top of the report.
- **Read Error Uncorrected Since**: The quantity of read errors that the drive was unable to correct since the time stamp at the top of the report.

Determining the status of an I/O station

You can determine whether one or more tape cartridges are present in an I/O station of the TS3500 Tape Library by performing these steps:

1. Type the Ethernet IP address on the Web site line of the browser and press Enter. The Welcome Page displays.
2. Select **Cartridges** → **I/O Station.** The I/O Station panel displays cartridges that are contained in available I/O stations.

The view shows either that the I/O slot is empty, or that it contains a volume. If a volume is present, the VOLSER (in the eight character VOLSER format) displays, and if a logical library is assigned, the logical library name for the VOLSER also displays.

Determining the location of a cartridge

You can determine the location of a tape cartridge from the Operator Panel and also from the TS3500 Specialist. On the TS3500 Specialist, you can locate a data cartridge by specifying its volume serial (VOLSER) in the Web interface. However, this function is not available from the Operator Panel.

Perform the following steps to locate a cartridge:

1. Type the Ethernet IP address on the Web site line of the browser and press Enter. The Welcome Page appears.
2. Select one of:
   - **Cartridges → Data Cartridges**
   - **Cartridges → Cleaning Cartridges**
   - **Cartridges → I/O Station**

Each panel displays a common format, title, and similar display options.

For the Cartridges panel, you can make selections to view cartridges by library, frame, logical library, or partial or entire VOLSER.

You can also view the cartridges initially sorted by volume serial (VOLSER) number, physical location, or SCSI element address.

Figure 13-9 shows the Cartridges Web page for the IBM TS3500 Specialist.

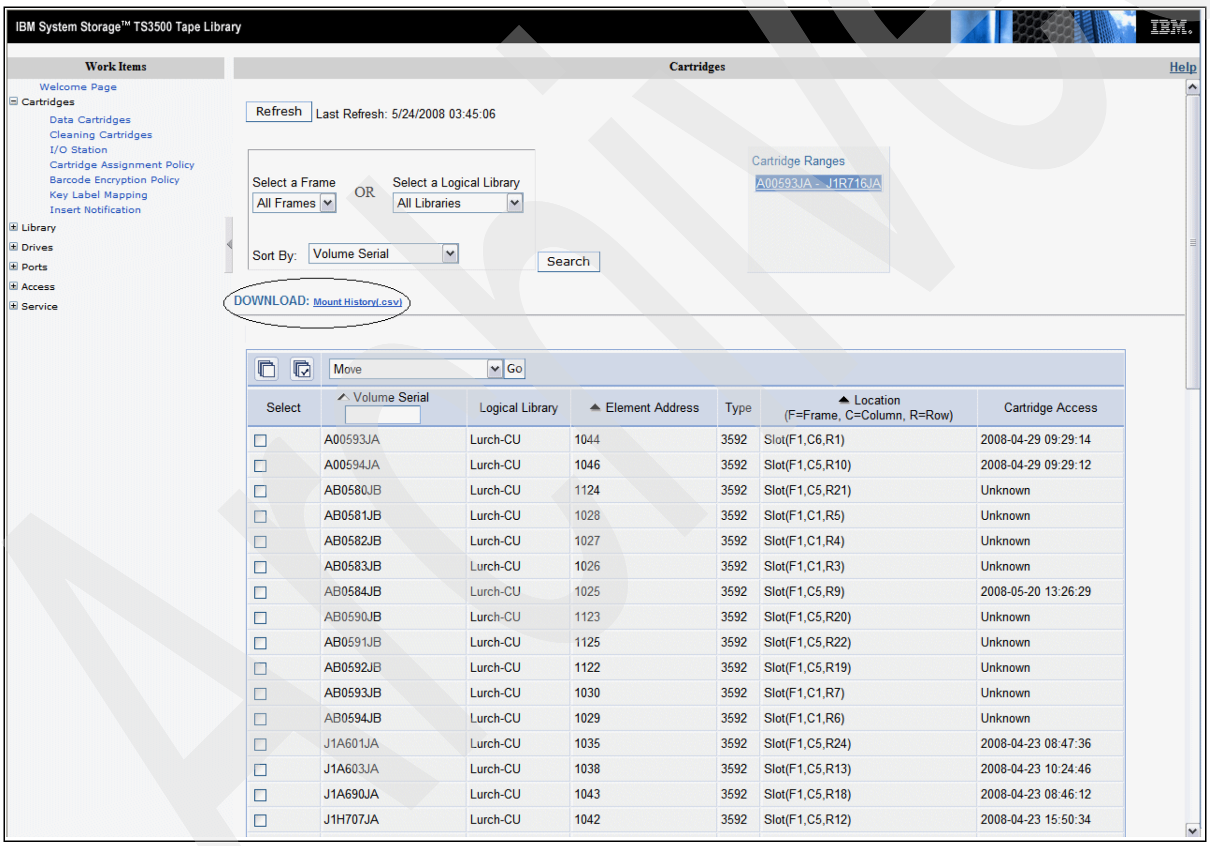


Figure 13-9 TS3500 Specialist Cartridge location

A hyperlink DOWNLOAD: Mount History(.csv), which is shown in Figure 13-9, allows you to download the Mount History report, which is a .csv file that contains a history of the last 100 demounted cartridges. It also shows you information about the 3592 Model E tape drives and the Ultrium 4 Tape Drive that is derived from the customer-centric Statistical Analysis and Reporting System (ccSARS).

The following information displays:

- **Date and Time**: The date and time that the cartridge was mounted into the drive. The format is *yyyy mm dd hh:nn:ss*, where *yyyy* equals the year, *mm* equals the month, *dd* equals the day, *hh* equals the hour, *nn* equals the minute, and *ss* equals the second.
- **VolSer**: The volume serial number of the cartridge (also known as VOLSER). The VOLSER is a unique identifier. Ignore the underscore that precedes the VOLSER.
- **Frame**: The number of the library frame from which the cartridge was demounted. Beginning with the base frame, frames are numbered 1 to 16, from left to right, and exclude the service bays.
- **Drive**: The number of the drive from which the cartridge was demounted. Drives are numbered 1 to 12, from top to bottom.
- **LogLib**: The name of the logical library to which the cartridge had been assigned.
- **EAddr**: The element address from which the cartridge had been demounted.
- **Mount Tape Alert Media**: The number of the most recent TapeAlert flag that was received by this drive and which pertained to this cartridge. To determine the meaning of the TapeAlert flag, refer to the chapter about TapeAlert flags in the *IBM System Storage TS3500 Tape Library Operator Guide,* GA32-0560.
- **Life Mounts Media**: The number of times that the cartridge has been mounted to a drive since it was manufactured.
- **Life WRetries Media**: During the life of the cartridge, the number of errors that have occurred when drives retried Write operations.
- **Life WPerms Media**: During the life of the cartridge, the number of permanent, unrecoverable errors that have occurred when drives performed Write operations.
- **Life RRetries Media**: During the life of the cartridge, the number of errors that have occurred when drives retried Read operations.
- **Life RPerms Media**: During the life of the cartridge, the number of permanent, unrecoverable errors that have occurred when drives performed Read operations.
- **Mount Rating Drive**: The overall measure of the drive’s condition. X'00' is unknown. The value ranges from X'01' (best) to X'FF' (worst). This value is a rating of the drive’s efficiency.
- **Mount Rating Media**: The overall measure of the condition of the cartridge that is currently mounted. X'00' is unknown. The value ranges from X'01' (best) to X'FF' (worst). This is a rating of the cartridge’s efficiency.
- **Mount Rating Ports**: The overall measure of the condition of the interface to the host server. X'00' is unknown. The value ranges from X'01' (best) to X'FF' (worst). This value is a rating of the interface’s efficiency.
- **Mount Rating Port0**: The overall measure of the condition of the Port 0 interface to the host server. X'00' is unknown. The value ranges from X'01' (best) to X'FF' (worst). This value is a rating of the efficiency of the Port 0 interface.
- **Mount Rating Port1**: The overall measure of the condition of the Port 1 interface to the host server. X'00' is unknown. The value ranges from X'01' (best) to X'FF' (worst). This value is a rating of the efficiency of the Port 1 interface.
- **Mount Rating Rsvd**: Reserved for the library interface.
- **Mount Write Perf**: The ratio of performance Write commands with respect to all Write-type commands. This value is a measure of the efficiency of write performance. The value is given as a percentage. A high percentage is best; a low percentage is worst.

- **Mount Write ERPs**: The measure of how the data rate performance impacts the error-recovery procedures (ERPs) on Write operations. The value is given as a percentage. A high percentage is best; a low percentage is worst.
- **Mount Write Burst**: For Write operations, the measure of the comparison between the window tape buffer rate to the average rate. The window rate is the amount of data moved divided by the time when ready in the mode (when data can be moved, but is not). The average rate is the amount of data moved divided by the overall time in the mode (including setup, overhead, and so forth). The value is given as a percentage. A high percentage is best; a low percentage is worst.
- **Mount Write Buffer**: The average tape-buffer efficiency on Write operations. This value is the streaming write efficiency. The value is given as a percentage. A high percentage is best; a low percentage is worst.
- **Mount Read Perf**: The ratio of performance Read-type commands with respect to all Read-type commands. The value is given as a percentage. A high percentage is best; a low percentage is worst.
- **Mount Read ERPs**: The measure of how the data rate performance impacts the error-recovery procedures (ERPs) on Read operations. The value is given as a percentage. A high percentage is best; a low percentage is worst.
- **Mount Read Burst**: For Read operations, the measure of the comparison between the window tape buffer rate to the average rate. The window rate is the amount of data moved divided by the time when ready in the mode (when data can be moved, but is not). The average rate is the amount of data moved divided by the overall time in the mode (including setup, overhead, and so forth). The value is given as a percentage. A high percentage is best; a low percentage is worst.
- **Mount Read Buffer**: The average tape-buffer efficiency on Read operations. This value is the streaming read efficiency. The value is given as a percentage. A high percentage is best; a low percentage is worst.
- **Mount Capacity Total**: The measure of the efficiency of static capacity. This measurement can be viewed as the percentage of recorded media that fits into the currently recorded area with respect to how much data can ideally fit in that area. The lower the percentage, the less capacity is available (due to recording error recovery, media defects, and so forth).
- **Mount Capacity Writes**: The measure of the efficiency of active capacity on Write commands. This measurement can be viewed as the sum of efficiency for Write operations on this mount. The value is given as a percentage. A high percentage is best; a low percentage is worst.
- **Mount Capacity Control**: The measure of the efficiency of active capacity on all other operations. The value is given as a percentage. A high percentage is best; a low percentage is worst.
- **Crypto Status**: Whether a cartridge is encrypted. Values are 1 (the media contains encrypted data), 0 (the media does not contain encrypted data), or a blank space if the drive was unable to determine whether the media contains encrypted data.
- **Crypto Rekey**: Whether a cartridge has been rekeyed. Values are 1 (the cartridge was rekeyed during the last mount) or 0 (the cartridge was not rekeyed during the last mount).

13.3.8 Display physical configuration information of the IBM TS3500

You can display configuration information about the library on the Operator Panel, as well as with the TS3500 Tape Library Specialist.

You can determine the following information:

- Number of installed frames for 3592 and Linear Tape-Open (LTO) technology
- Number of installed physical drives for 3592 and LTO technology
- Number of installed storage slots for 3592 and LTO technology
- Detailed frame information (quantity of physical drives, storage slots, and I/O slots)

To display the existing configuration with the TS3500 Specialist, perform the following steps:

1. Type the Ethernet IP address on the Web site line of the browser and press Enter. The Welcome Page appears.
2. Select **Library** → **Frame** for a physical configuration of the library.

Figure 13-10 shows the output of this action.

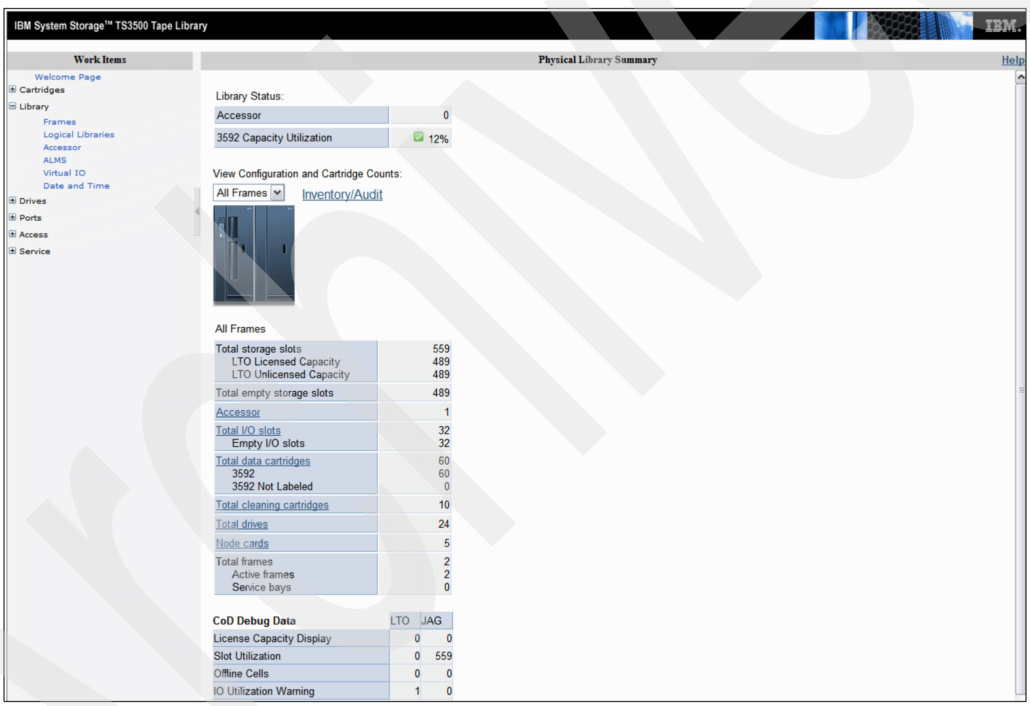


Figure 13-10 TS3500 Tape Library Specialist: Physical configuration display

13.3.9 Display logical configuration information of the IBM TS3500

You can also display the configuration information about the library on the Operator Panel, as well as with the TS3500 Tape Library Specialist.

This logical configuration information allows you to determine for each logical library partition:

- Name of the logical library partition
- Number of assigned drives
- Number of assigned cartridges
- Number of assigned virtual I/O slots

To display the existing configuration with the TS3500 Specialist, perform the following steps:

1. Type the Ethernet IP address on the Web site line of the browser and press Enter. The Welcome Page appears.
2. Select **Library** → **Logical Libraries** for a logical configuration of the library. Figure 13-11 shows the output of this action.

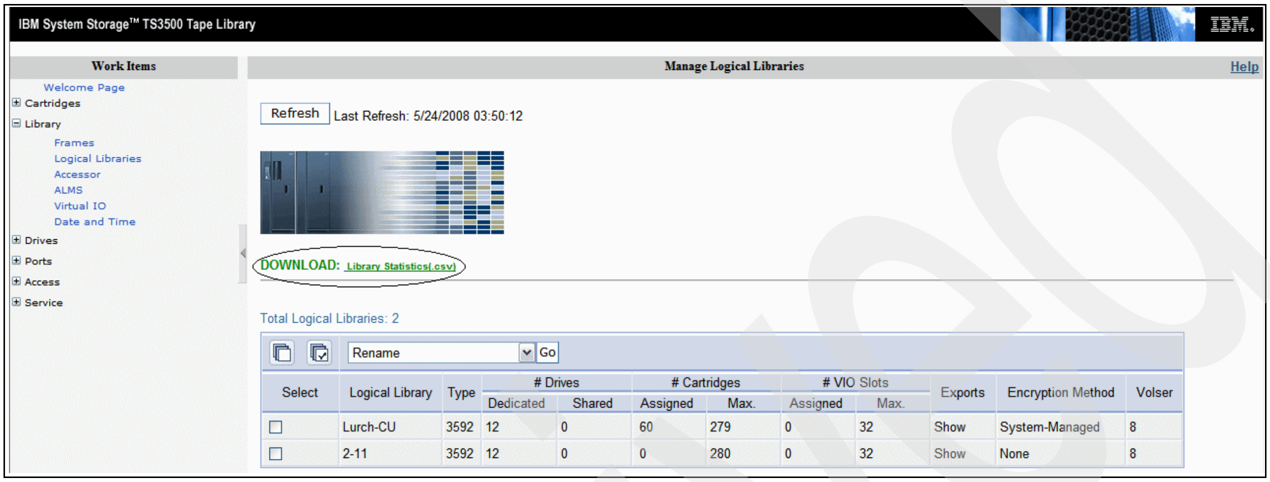


Figure 13-11 TS3500 logical configuration display

A hyperlink DOWNLOAD: Library Statistics(.csv), which is shown in Figure 13-11, allows you to download the Library Statistics report, which is a .csv file that contains data about the TS3500 Tape Library. This information is only available for models L23 and L53. The following information displays:

- **Date and Time**: The date and time that the cartridge was mounted into the drive. The format is *yyyy mm dd hh:nn:ss*, where *yyyy* equals the year, *mm* equals the month, *dd* equals the day, *hh* equals the hour, *nn* equals the minute, and *ss* equals the second.
- **Log Lib**: The name of the logical library for which data has been captured. Ignore the underscore that precedes each name.
- **Residency Max Time**: The amount of time that a cartridge has been mounted in a drive.
- **Residency Avg Time**: The total amount of time that all cartridges have been mounted in drives divided by the number of mounts in the hour.
- **Mounts Total**: The total number of times that a cartridge was mounted to the drive for this logical library.
- **Mounts Max Time**: The time from when a mount command is received until when it is executed.
- **Mounts Avg Time**: The total amount of time that all mount commands have been waiting to be executed divided by the number of mount commands received in the hour.
- **Ejects Total**: The total number of times that a cartridge was moved from the I/O station for this logical library.
- **Ejects Max Time**: The time from when the eject command is received until when it is executed.
- **Ejects Avg Time**: The total amount of time that all eject commands have been waiting to be executed divided by the number of eject commands received in the hour.
- **Total Inputs**: The total number of cartridges moved from the I/O station into the storage slots.

13.3.10 Display information about the Fibre Channel connection

For drives attached to a System z environment, this panel shows the Fibre Channel (FC) connection status between the drive and the switch to the controller or between the drive and the VTS/TS7700. You cannot see the host channel connections.

However, this panel (refer to Figure 13-12) gives you information if your connection from the drive to the switch or the VTS is available and the speed that the connection uses.

Perform the following steps:

1. Type the Ethernet IP address on the Web site line of the browser and press Enter. The Welcome Page appears.
2. Select **Ports** → **Fibre Channel Summary**.

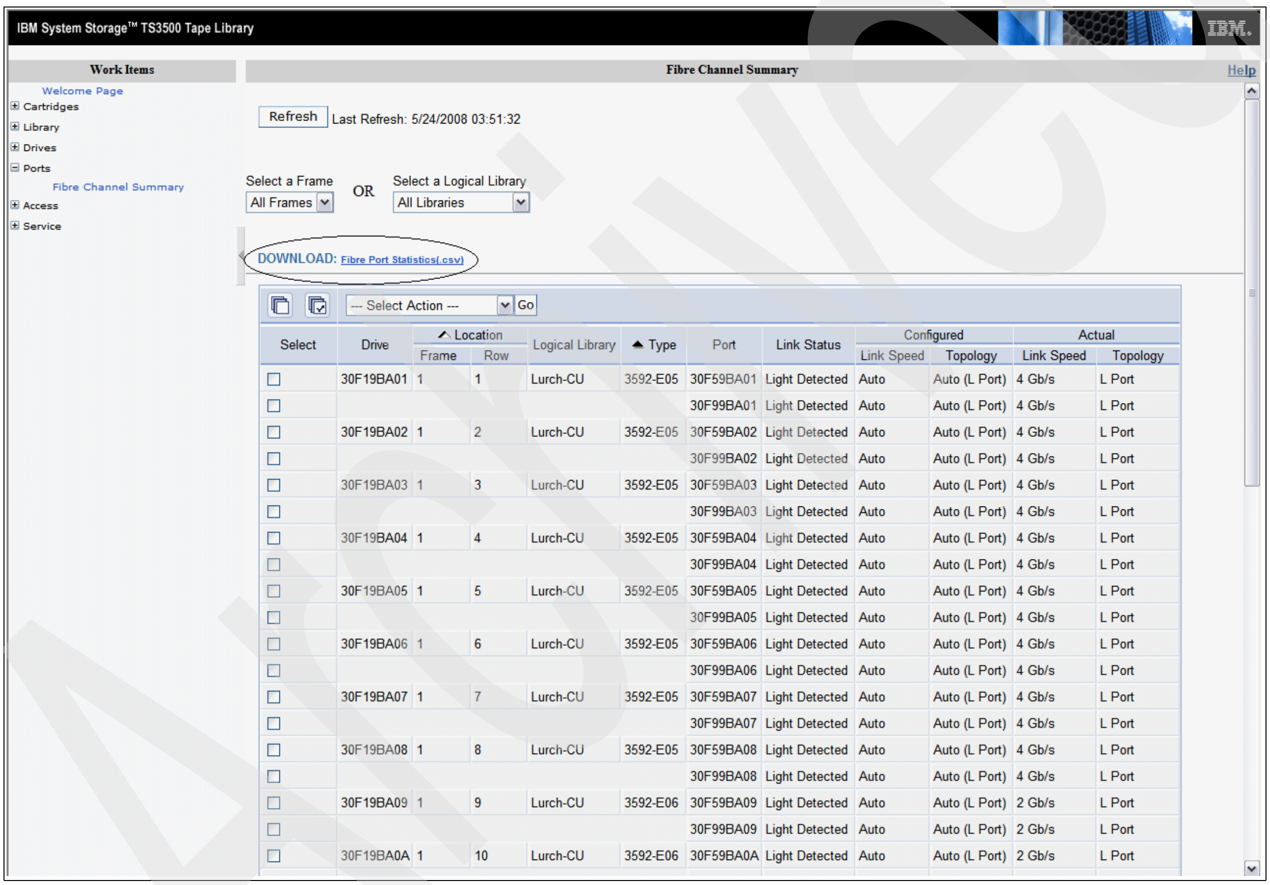


Figure 13-12 TS3500: Fibre Channel Summary

A hyperlink DOWNLOAD: Fibre Port Statistics(.csv), which is shown in Figure 13-12, allows you to download the Fibre Port Statistics report, which is a .csv file that contains data about the ports of the Fibre Channel tape drives in the library. The 3592 tape drives have two Fibre Channel ports; the Ultrium 3 Tape Drive and the Ultrium 4 Tape Drive each have one Fibre Channel port.

The following information displays:

- **WWNN**: The World Wide Node Name of the Fibre Channel drive. Ignore the underscore that precedes each value.
- **Model**: The type of Fibre Channel drive, as reported by the drive's SCSI string. Ignore the underscore that precedes each value.
- **S/N**: The serial number of the Fibre Channel drive. Ignore the underscore that precedes each value.
- **Valid**: A value of 1 in this column (and 0 in all Write or Read columns) means that commands were run, but there were no errors or activity performed by the drive. A value of 0 in this column means that the entries in all columns are invalid.
- **Host Error Since**: The quantity of host Fibre Channel port errors since the date of the time stamp at the top of the report.
- **Host Abort Since**: The quantity of host Fibre Channel port errors that have ended since the date of the time stamp at the top of the report.
- **Host Reset Since**: The quantity of host Fibre Channel port errors that required a reset since the date in the time stamp at the top of the report.
- **Host Recoveries Since**: The quantity of host Fibre Channel port errors recovered during the error-correction process since the date of the time stamp at the top of the report.

13.3.11 Perform an inventory for an IBM TS3500

You can perform an inventory by frame or an inventory for the total TS3500 Tape Library.

Perform the following steps:

1. Type the Ethernet IP address on the Web site line of the browser and press Enter. The Welcome Page appears.
2. Select **Library** → **Frame**. The Physical Library Summary panel displays with options to perform an inventory on a single frame or on all frames.
3. Select **All Frames** and then select **Inventory**.

> **Important:** Performing a library inventory delays all tasks in the work queue until the library inventory is complete. This delay can impact your production depending on whether you request a frame inventory or a library inventory.

13.3.12 Retrieving Vital Product Data

Vital Product Data (VPD) contains the serial numbers of all installed frames and drives. This information is helpful for your operator staff; however, this panel is only accessible with the *superuser* user ID or the *admin* user ID.

Depending on how you implement security, operators might not have superuser user IDs. Therefore, we recommend that you provide this information with printouts of the panels to the operator staff.

Retrieving Vital Product Data for the library

Perform the following steps:

1. Type the Ethernet IP address on the Web site line of the browser and press Enter. The Welcome Page appears.

2. Select **Service** → **Library VPD**. The Vital Product Data panel displays the machine type, model number, and serial numbers of each frame, as well as the type of media that each frame uses.

Figure 13-13 shows the output of this action.

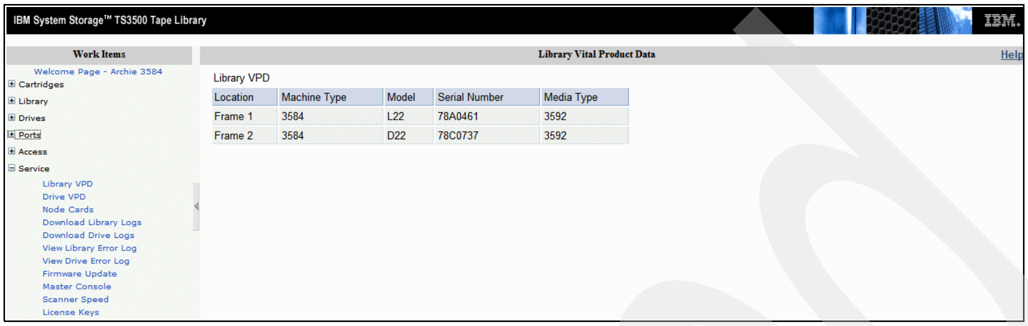


Figure 13-13 TS3500 Specialist: Library VPD

Retrieve Vital Product Data for the drives

Perform the following steps:

1. Type the Ethernet IP address on the Web site line of the browser and press Enter. The Welcome Page appears.
2. Select **Library** → **Drive VPD**. The Vital Product Data panel displays the drive type, serial number, and location of each drive.

Figure 13-14 shows the output of this action.

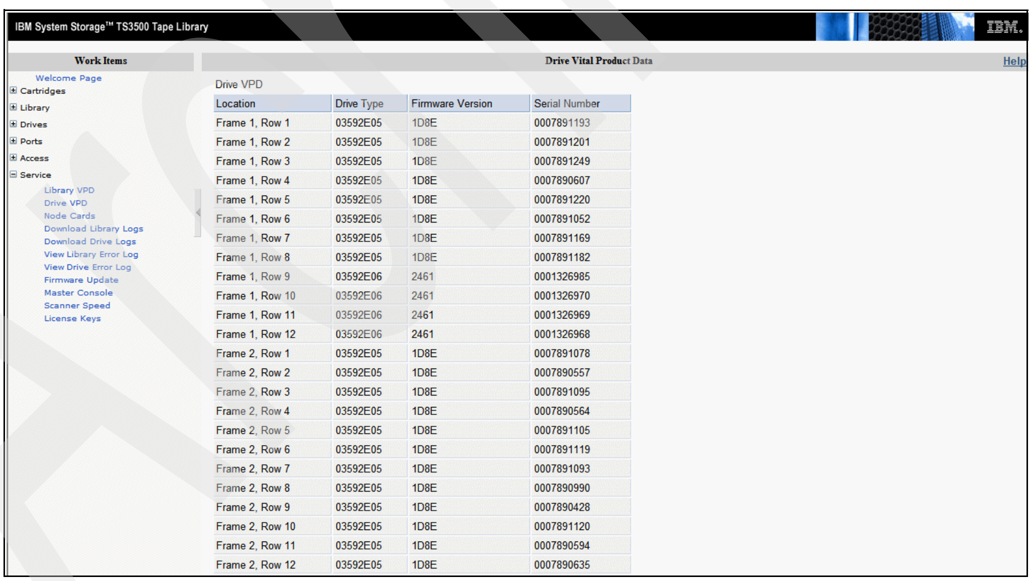


Figure 13-14 TS3500 Specialist: Drive VPD

13.3.13 Cleaning tasks

Each drive in the TS3500 Tape Library needs cleaning. The 3592 drives and TS1120 drives request the cleaning themselves if cleaning is needed. Drive cleaning in the IBM TS3500 does not involve the Library Manager at all. Drive cleaning is the responsibility of the TS3500

Tape Library. However, you must enable the automatic cleaning and provide the necessary cleaning cartridges.

Important: If you install ALMS, cleaning is automatically enabled and cannot be disabled.

Inserting cleaning cartridges

The process to insert cleaning cartridges varies depending on the setup of the IBM TS3500 Tape Library.

With ALMS enabled, you can use the IBM TS3500 Specialist or the library's Operator Panel to insert a cleaning cartridge.

To insert a cleaning cartridge using the IBM TS3500 Specialist, perform the following steps:

1. Open the door of the I/O station and insert the cartridge so that the barcode label faces the interior of the library and the write-protect switch is on the right.
2. Close the door of the I/O station.
3. Type the Ethernet IP address on the Web site line of the browser and press Enter. The Welcome Page appears.
4. Select **Cartridges** → **I/O Station.** The I/O Station panel displays.
5. Follow the instructions on the panel.

Removing cleaning cartridges

In this section, we describe removing cleaning cartridges by using the TS3500 Tape Library Specialist. You can also use the Operator Panel. Refer to the *IBM System Storage TS3500 Tape Library Operator Guide*, GA32-0560, for more information.

Perform the following steps:

1. Type the Ethernet IP address on the Web site line of the browser and press Enter. The Welcome Page appears.
2. Select **Cartridges** → **Cleaning Cartridges**. The Cleaning Cartridges panel appears.
3. Follow the instructions on the panel to specify the cleaning cartridge and remove it to the I/O station.
4. Look at the Activity panel on the Operator Panel to determine whether the I/O station that you want to use is locked or unlocked. If the I/O station is locked, use your application software to unlock it.
5. Open the door of the I/O station and remove the cleaning cartridge.
6. Close the door of the I/O station.

Determine the cleaning cartridge usage in the IBM TS3500

You can determine the usage of the cleaning cartridge in the same panel that you use for the removal of the cleaning cartridges; refer to Figure 13-15 on page 404.

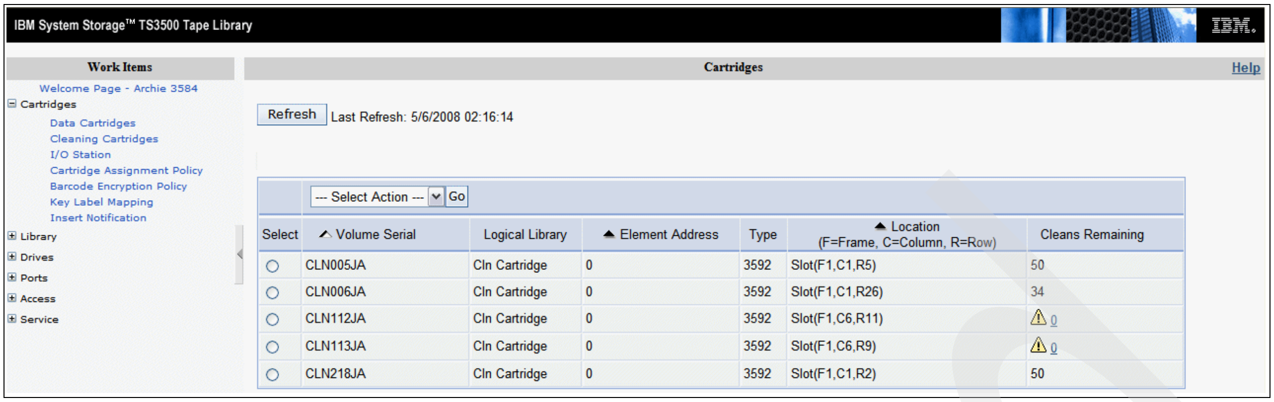


Figure 13-15 TS3500: Cleaning cartridge usage

13.3.14 IPv4 and IPv6 configuration

TS3500 Tape Library supports IPv4, IPv6, or Dual Stack IPv4 + IPv6 transportation. You can choose to show the IP Address for an individual frame or for all frames; however, you can only select one IP Address to modify at a time.

For IPv6, enter your library static IP Address or Router-Assigned IP Address using the following format: http://[*0:0:0:0:0:0:0:0*]. To modify an IP Address:

1. From the main section of the TS3500 Specialist Welcome Page, use the work items on the left side of the panel to navigate to the required panel by selecting **Library** → **Library IP Addresses** as shown in Figure 13-16.

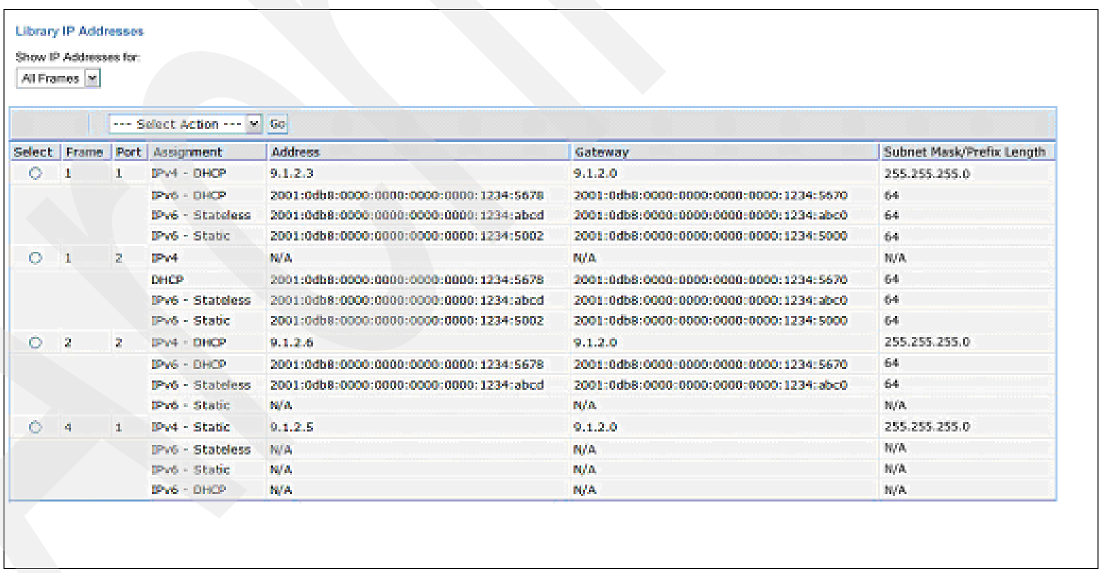


Figure 13-16 Library IP Addresses panel

2. From the Select Action drop-down list box, select **Modify**, and click **Go**. Refer to Figure 13-17 on page 405.

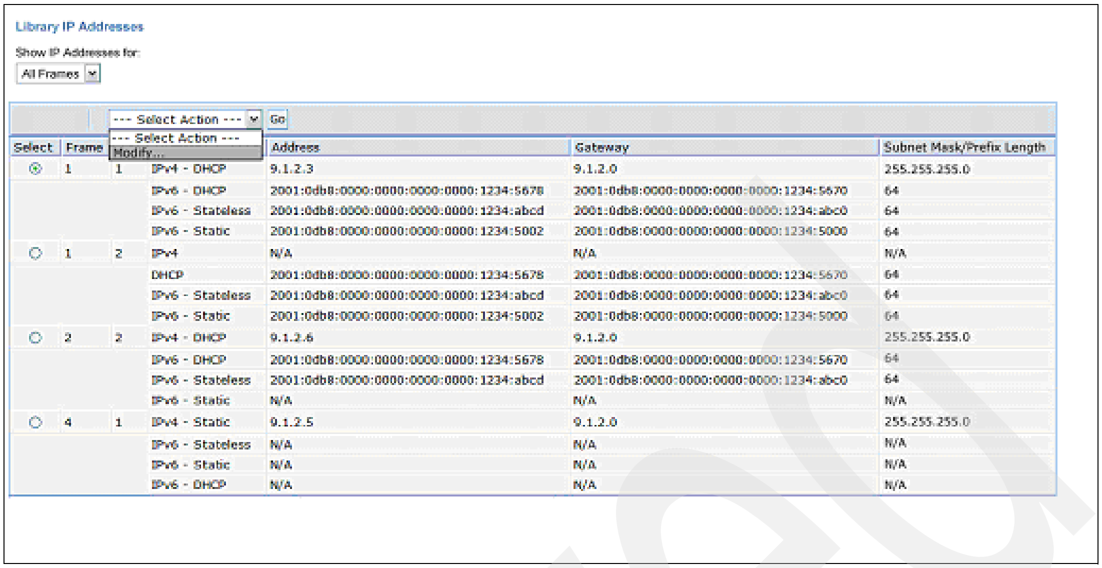


Figure 13-17 Library IP Addresses modify panel

3. Next, the Modify Library IP Addresses panel is displayed (Figure 13-18).

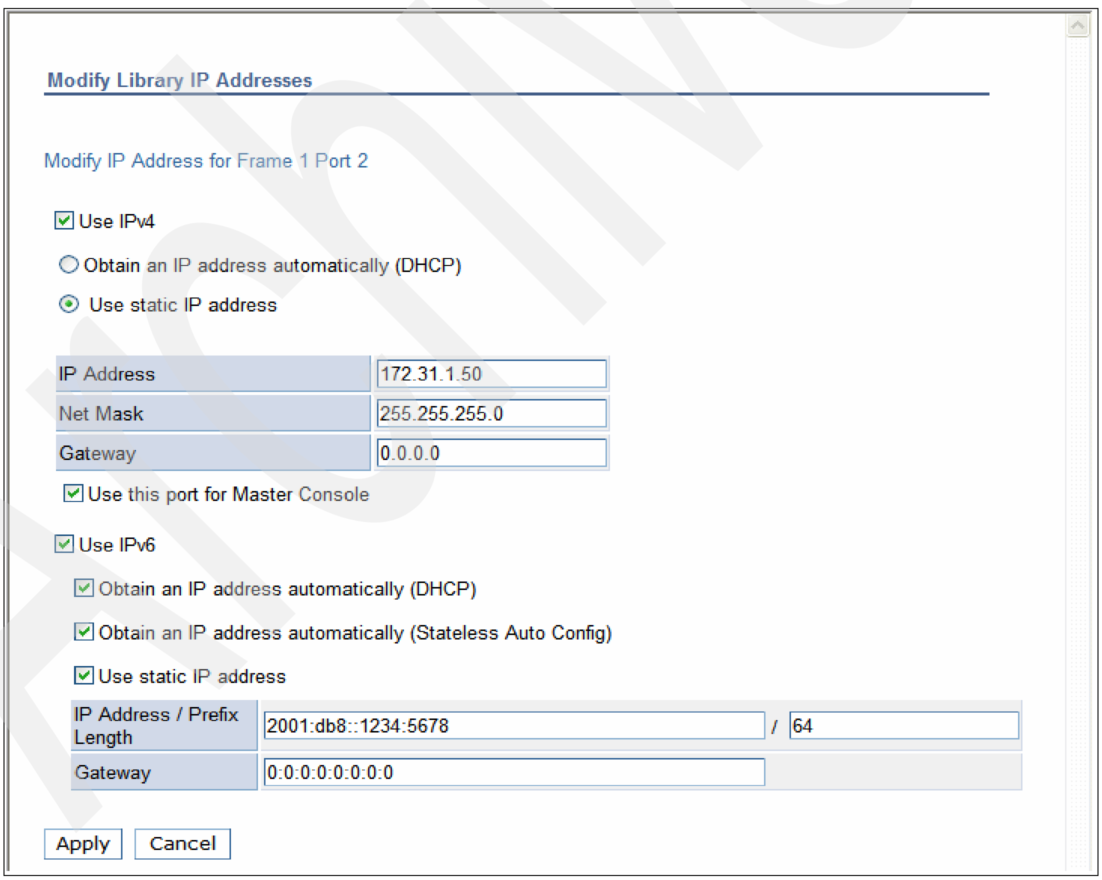


Figure 13-18 Modify Library IP Addresses panel

4. Figure 13-18 on page 405 shows the two ways to configure the Library connection: IPv4 or IPv6. For IPv4, in this case, you can select only one of these options: Use static IP address or Obtain an IP address automatically (DHCP). Or, you can use IPv6 and select all of the options at the same time, but the operating system only considers “Obtain an IP address automatically (Stateless Auto Config)”. Therefore, if you want to have a unique IP address for your Tape Library using IPv6, you need to select Use Static IP address.

13.4 Operating the 3953 Library Manager

The IBM 3953-L05 Library Manager processes all System z host requests and control functions for its associated logical library in the IBM TS3500 Tape Library. The user interface, or operator console, enables you to obtain information about the operation of the Library Manager and its attached components. The user interface also instructs the Library Manager to perform specific tasks through the use of the console (display and keyboard with its pointing device).

The user interface recognizes three types of user or authorization levels: general operator, system administrator, and IBM service support representative (SSR). You can use password protection for the level of authorization. You can optionally password-protect certain functions of Library Manager, for example, service menus, shutdown, request inventory upload, or cancel VTS Export and Import.

13.4.1 IBM 3953 Library Manager base frame operator console

The 3953 Base Frame F05 includes an operator console that allows you to execute all of the necessary operations directly on the hardware. Certain functions are only available on the base frame operator console, for example, backing up and restoring Library Manager Administration data, as well as changing the status of the Library Manager.

13.4.2 ETL Specialist

The ETL Specialist is the Web-based interface of the IBM 3953 Library Manager. Using the ETL Specialist, you can access information, such as current Library Manager status and VTS statistics, from your Web browser by connecting to the Web server on the Library Manager personal computer. You can also perform numerous administrative functions. The Web server serves HTML pages to a remote Web browser over your LAN connection. The ETL Specialist allows multiple active server connections at the same time (service and several user connections).

The ETL Specialist provides display functions and limited control functions. Available on the ETL Specialist are:

- A home page
- A set of Library Manager pages
- A set of Library Partition pages
- A set of VTS partition pages (if TS7700 Virtualization Engine or VTS is installed)
- A set of Security pages
- A link to the TS7700 Management Interface (if TS7700 Virtualization Engine is installed)
- Links to the Peer-to-Peer VTS Specialist (if Peer-to-Peer is installed)
- A link to the IBM TS3500 Tape Library Specialist Web interface (refer to 13.1.2, “IBM TS3500 Tape Library Specialist” on page 381)

You must enable the Specialist at the Commands drop-down menu in the Library Manager.

13.4.3 Library Manager and ETL Specialist security

The Library Manager Operator Panel has a basic set of security. You cannot define user IDs and passwords; however, you can only execute certain functions if you enter the password for the specific mode. The *system administrator mode* has authorization access to all functions of the Library Manager, except for those functions uniquely related to its service and repair. The *service representative mode* has full authorization access to all functions of the Library Manager.

The protection of the system administrator mode is optional. The service representative mode is always protected. To enable Library Manager security, you need to assign a System Administrator password. This system administrator password protects the following functions:

- Access to actions required as part of emergency power off (EPO)
- Inventory new storage
- Re-inventory complete subsystem
- Shut down
- Unlock the keyboard and display when they have been locked
- Delete logical volumes
- Request inventory upload
- Clear all operator interventions

After you enable the ETL Specialist on the Library Manager using the Commands drop-down menu, you can also restrict access to functions in the ETL Specialist in two ways:

- You can also restrict access to functions through user IDs and passwords defined using the ETL Specialist. Panels that allow modification of system settings or initiate a system's action always require a user ID with the proper privilege. This level of security is always enabled. The default user ID is *webadmin* and default password is *webadmin*.
- You can also restrict access to functions through the Library Manager Specialist Settings panel to control which panels display with the ETL Specialist. Monitoring panels are always available without requiring a user ID. However, you can restrict the display of panels that allow administrative tasks, so that even with a valid user ID and password, no one can access the ETL Specialist panels. This setting is valid for all user IDs in the ETL Specialist. There is no capability to allow different levels of panel security.

Only the user ID *webadmin* has the authority to add, change, or delete user IDs. Other users can only change their own password on the security panels. You can specify up to 48 user IDs. User IDs and passwords can be up to eight characters long.

To administer user IDs and passwords, look for the work item Manage Security (as shown in Figure 13-1 on page 382).

13.4.4 Library Manager System Summary window

Figure 13-19 on page 408 shows the Library Manager Status drop-down menu on the operator console in the IBM 3953. The Library Manager Status drop-down menu offers the same options as the IBM 3494 Tape Library menus. From here, you can navigate as usual to the System Summary window, which shows the current Library Manager mode.

The System Summary window shows the Library Manager operational mode (Figure 13-19 on page 408). Note that the mode is simply a reflection of the state of the physical tape library. For example, the Library Manager enters Auto mode when the physical tape library enters its Ready state. Otherwise, the Library Manager remains in Pause mode.

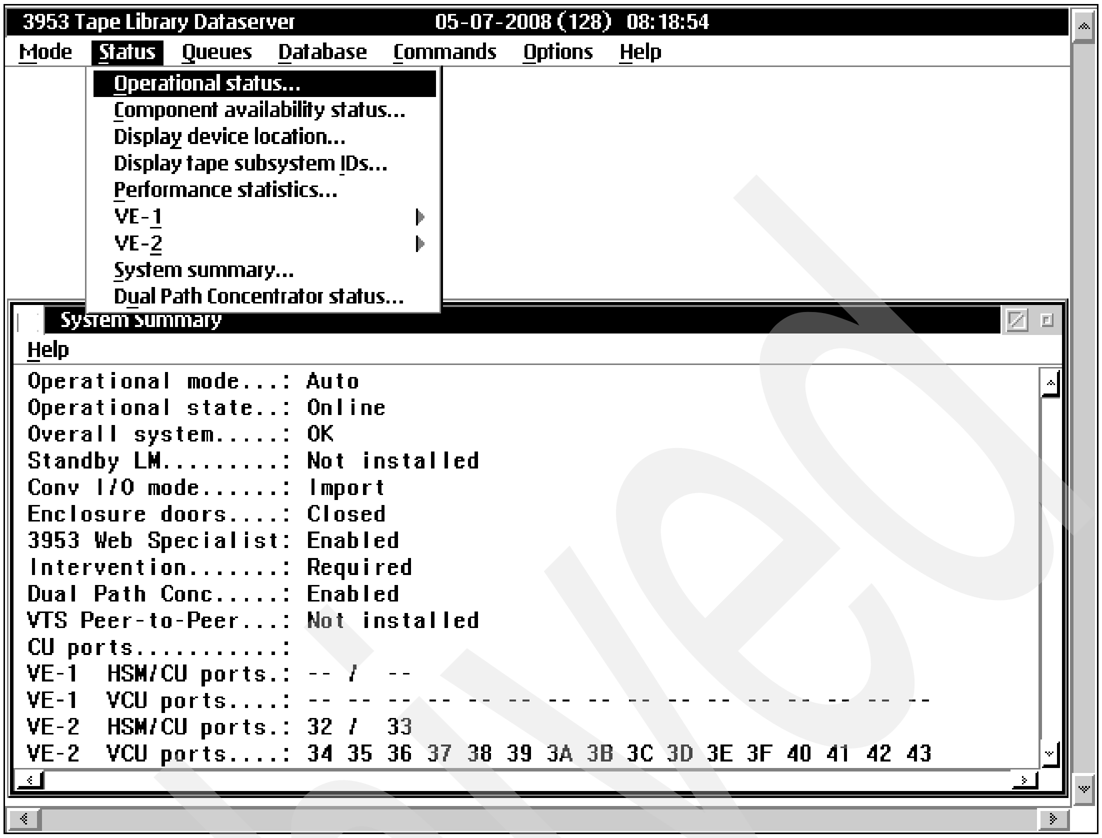


Figure 13-19 Example of IBM 3953 Library Manager Status and summary menu

.The operational mode field shows the actual state of the TS3500 Tape Library. The states are Auto, Auto Pending, Manual, Pause, or Pause Pending:

- Auto is displayed when the IBM TS3500 is ready to perform movement. Auto is indicated in Figure 13-19, showing normal operation. Auto shows if the IBM TS3500 is READY.
- Pause indicates that the tape library has stopped performing automated operations or that the Library Manager can no longer communicate with the tape library. Pause displays when an IBM TS3500 library door is open or if the IBM TS3500 library is not ready for an unknown reason.
- Auto Pending displays when the tape library becomes ready and the Library Manager is uploading the volume inventory.

13.4.5 Library Manager Mode: Operational modes

The following operational modes are valid in the 3953:

- **Online**: The Library Manager and the attached logical libraries are available and accept workload from the attached System z hosts.
- **Offline**: The Library Manager and the attached logical library are not available and do not accept workload from the attached System z hosts.
- **Pending Offline**: The operator switched the library to offline mode. Some active processes still run, and the offline state is not reached yet.

- **Manual**: Manual is only necessary if a problem in the TS3500 Tape Library prevents automatic operations. The Library Manager then displays the pending operations and gives you detailed instructions and the mounts, demounts, or ejects that are requested. When in Manual mode, you follow the instructions on the Library Manager panel and confirm as necessary when you complete the instructions. Mounts and demounts for logical cartridges in a VTS are continued by the Library Manager. Only if a recall needs a physical volume is this task shown as an action for the operator.

> **Important:** If you want to use Manual mode operations on the 3953 Library Manager, you must first put the TS3500 Tape Library in Pause mode.

You can manage Library Manage Mode and State by using the Library Manager operator console or ETL Specialist.

Library Manager (LM) operator console

Figure 13-20 shows the Library Manager Mode drop-down menu on the operator console in the IBM 3953.

Figure 13-20 Example of IBM 3953 Library Manager Mode menu

You can use this Mode menu to change the operating state of the Library Manager between Online and Offline, to enter and exit Manual mode of operation or the Service menu, or to shut down the Library Manager.

> **Note:** You cannot use this menu to change the operational mode between Auto and Pause; these tasks are TS3500 Tape Library functions, which affect the entire physical library and not just the System z logical library. You must use the Operator Panel on the IBM TS3500 to pause the library.

ETL Specialist

The Manage Library Manager Mode and State panel allows you to view and control the general system's condition. Beside the Mode and State and depending on the hardware configuration, this panel includes the view and control of the Active Library Manager, the Active Accessor, and the Dual-Active Accessor conditions.

Use the work items on the left side of the panel to navigate to the required panel by selecting **Administer library manager** → **Manage Mode and State** as shown in Figure 13-21 on page 410.

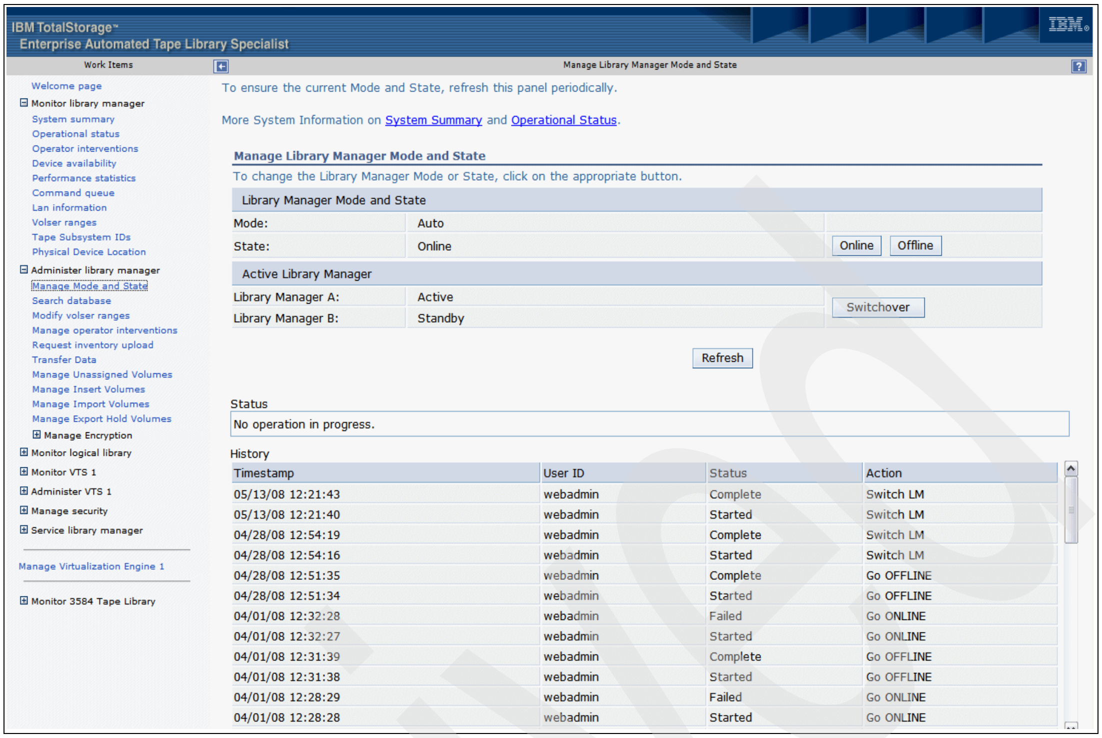


Figure 13-21 Manage Mode and State panel

13.4.6 Using the Database Menu function

Use the Library Manager Database Menu to retrieve information about logical and physical volumes. You can use this panel to identify which constructs are assigned to a specific volume, on which physical tape a logical volume resides, or if a cartridge is misplaced. We briefly describe now the most important functions on this menu:

- **Search database**: Use this criteria to search the database:
  - **VOLSER**: Enter the VOLSER to use in the search. The VOLSER consists of one to six alphanumeric characters that match the cartridge label. You can include a wild card (pattern-matching) character, where the question mark character (?) or underscore (_) indicates one character and an asterisk (*) or a percentage symbol (%) indicates multiple characters.
  - **Category**: Enter the category to use in the search. A *category* is a logical grouping of cartridges for a specific use. The categories are 0000 to FFFF, must contain four hexadecimal characters, and cannot contain wild card characters. Note that there are no categories for cleaning and service cartridges. You perform searches for these cartridges at the tape library Operator Panel.
  - **Device**: Either press Enter or select the device to use in the search. A device is represented by a three-digit tape device identifier. Click the arrow to get a list of valid device identifiers. Single and multiple character wild cards are valid.
  - **Media Type**: Select the media type that you want. All media types supported in the TS3500 Tape Library are valid as search criteria.
  - **Expire Time**: You can include logical volume expiration times in the search criteria.

– **VOLSER Flags**: You can use these flags as search criteria (refer to Figure 13-22):
  - Manual mode
  - Misplaced
  - Mounted
  - Inaccessible
– **Constructs**: You can use all of the System Managed Storage (SMS) constructs (Data Class, Management Class, Storage Class, and Storage Pools) for a database search.
– **Pools**: If you use different physical media pools, you can enter them as search criteria.

- **List database volumes**: You can use list database volumes to output a customized database search to a flat file on a diskette or to the C: drive. The Library Manager must be offline to use this option. Note that this functionality results in an outage for the production environment. Also, you must have physical access to the Library Manager, because you must insert a diskette.
- **Find logical volume's home**: You can use this function to determine the physical volume on which a logical volume resides.
- **Stacked Volume Map**: You can use this function to output a map of the logical volumes that reside on a stacked volume to diskette. Note that this functionality needs physical access to the Library Manager, because you must insert a diskette.

> **Important:** Specify your search criteria as precisely as possible. General searches can result in long search times.

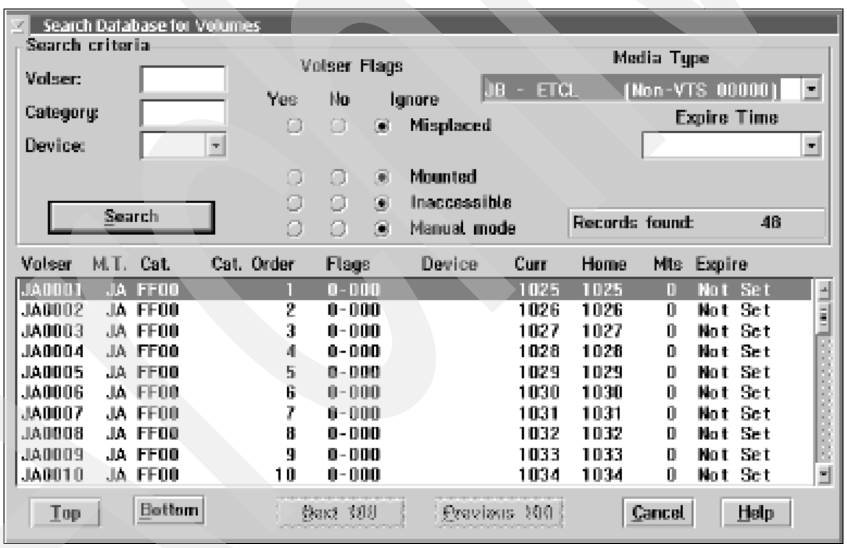


Figure 13-22 Library Manager: Search Database for Volumes

13.4.7 Request Inventory Upload window

The Request Inventory Upload window allows you to manually update the logical volume inventory from the tape library. This procedure is necessary after you insert a volume into the tape library that does not match any of the defined tape library Cartridge Assignment Policies (CAPs). If you do not respond to the Insert Notification at the tape library Operator Panel, the inserted volume is not assigned to a logical library.

> **Important:** Before you use the Request Inventory Update window, you must first specify the correct logical library for the inserted volume using the Web Specialist of the TS3500 Tape Library. Then, select **Request inventory upload** from the Commands menu.

The Library Manager might first prompt you for the system administrator password. To upload the most recent tape library inventory to the Library Manager, click **Request Upload** as shown in Figure 13-23.

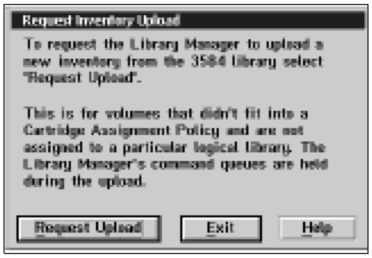


Figure 13-23 Request Inventory Upload

A confirmation window opens. Select Yes to confirm the request and initiate an inventory upload. Select No to close the confirmation window and return to the Request Inventory Upload window without initiating an inventory upload. After selecting **Yes** on the confirmation window, a notification window opens to inform you that the requested action completed successfully. Select **OK** to close the notification window. Note that the Request Inventory Upload window remains open until you click **Exit**. Exit closes the Request Inventory Upload window. The other option on the Request Inventory Upload window is Help, which provides help about the Request Inventory Upload window.

13.4.8 Backup and restore your Library Manager administrative data

The Transfer Library Manager Administrative Data window allows you to back up or restore both Library Manager and VTS partition data. Library Manager data and VTS partition data include the following data:

- Library data:
  - **Construct Names/Actions**: On restore, nonexistent construct names and actions are added, up to the maximum number of construct names allowed. Select Override if the name exists to copy over the existing construct names/actions with the new construct names and actions on the diskette. Select **Do not override** to ignore duplicate construct names/actions on the diskette and to keep the existing construct names/actions.
  - **Specialist User IDs/Passwords**: All existing user IDs and passwords are replaced. Nonexistent user IDs and passwords are added.
  - **Specialist Browser Access**: Replaces existing capabilities. This data sets the Web access for Specialist-related pages.

- VTS partition data:

  The following options can be applied to either the VTS 1 or the VTS 2 partition (if installed) for backups, and these options can be applied to either the VTS 1 or VTS 2 partition (if installed) or both partitions for restoring data:

  – **Pool Properties**: The pool properties can be applied to any VTS partition in the library. If a VTS is installed in that partition and does not support Advanced Policy Management (APM), the pool properties applied will have no effect. On a TS7700 Virtualization Engine, APM is referred to as Outboard Policy Management (OPM) and is included with the base product.

  – **Inhibit Reclaim Schedule**: The inhibit reclaim schedule is backed up. When restoring data, the schedule is applied based on the number of VTS partitions in the library. The existing schedule is replaced.

  – **Reclaim Threshold Percentages**: The reclaim threshold percentages can be applied to any VTS in the library. If a VTS is installed in that partition and does not support Advanced Policy Management, the reclaim threshold percentage for pool 01 is used. On a TS7700 Virtualization Engine, APM is referred to as Outboard Policy Management and is included with the base product.

  – **Free Storage Threshold**: The free storage threshold can be backed up and restored.

Important: We strongly recommend that you perform this backup on a regular basis or every time that you change the described data. Note that you must back up this data for each 3953 Tape System that you have installed.

To back up the current Library Manager administrative data to diskette, insert a blank, formatted diskette in the A: drive. Select **Backup to diskette**. Select **From VTS 1** or **From VTS 2** and then select **Start Transfer**.

The current Library Manager administrative data can also be backed up to hard disk drive. Refer to Figure 13-24 on page 414.

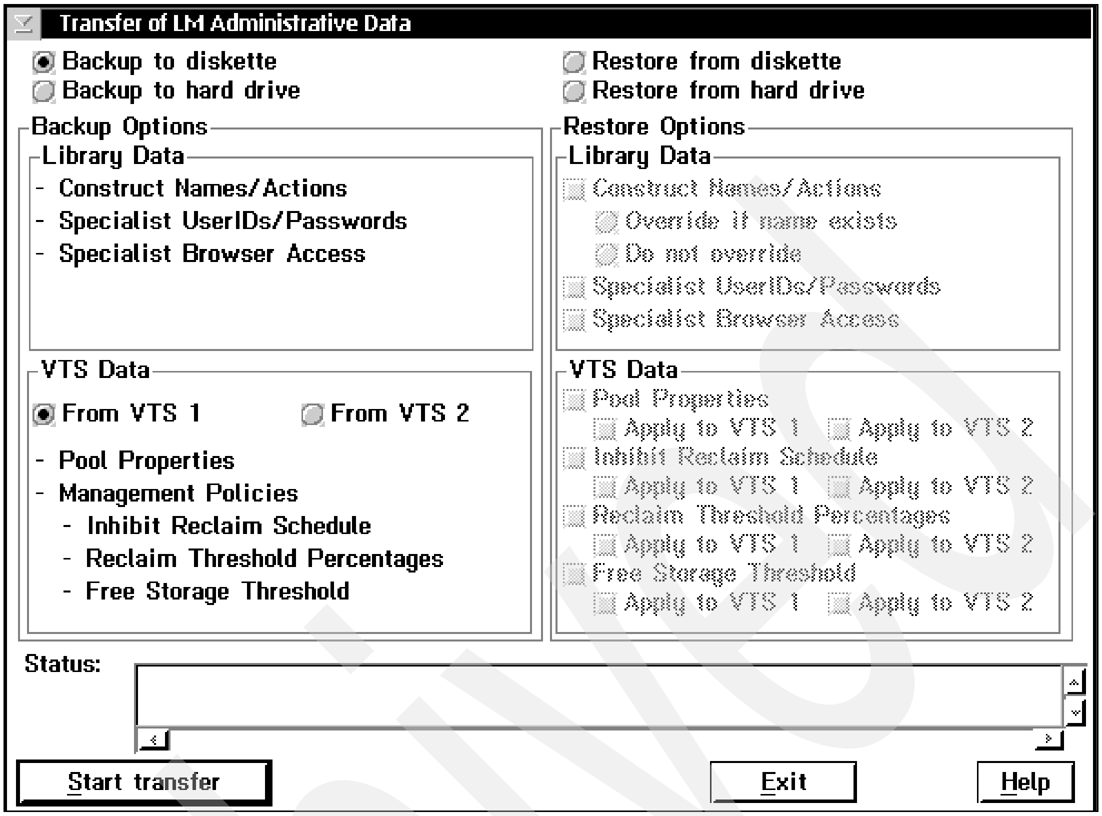


Figure 13-24 Back up Library Manager data to a diskette

To restore Library Manager administrative data from a diskette, insert the diskette containing the data into the A: drive. Select **Restore from diskette**. Select the data that you want to restore, and then select **Start Transfer.**

The current Library Manager administrative data can also be restored from hard disk drive. Refer to Figure 13-25 on page 415.

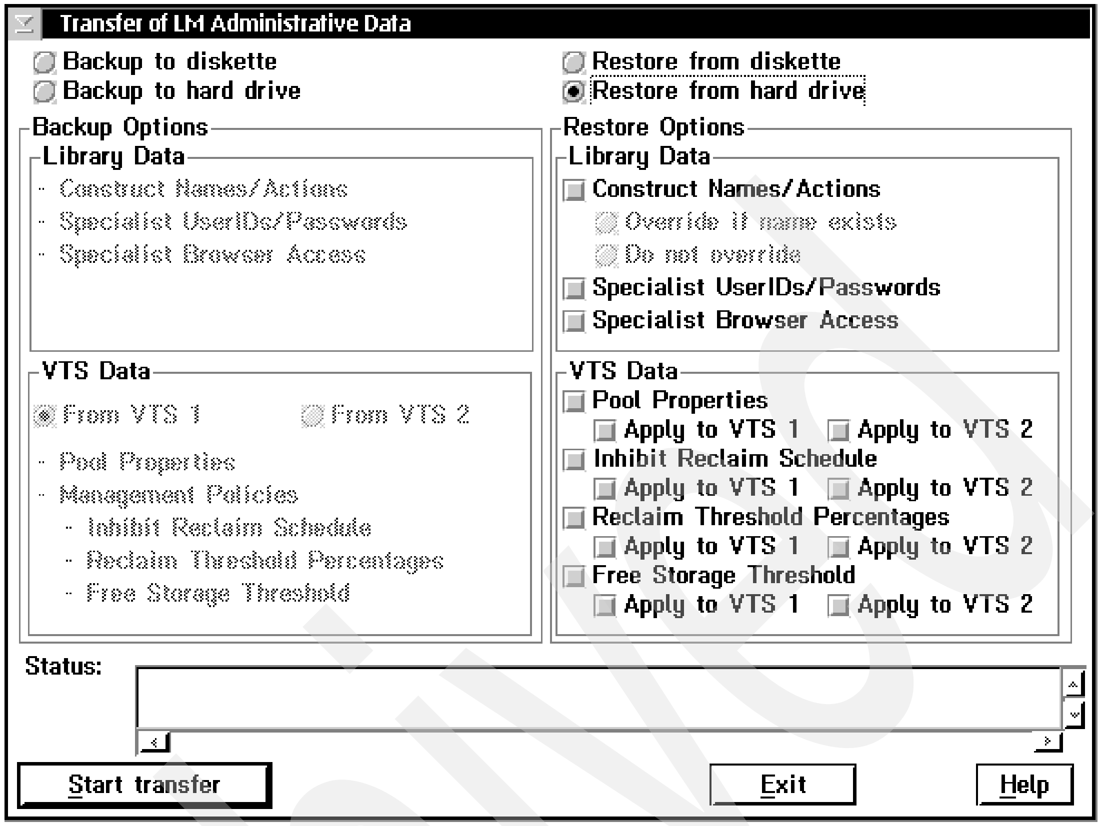


Figure 13-25 Restore Library Manager data from diskette

You can also execute this function from Web Specialist panels, and the functions are only to and from the hard disk drive, not to diskette. Refer to Figure 13-26.

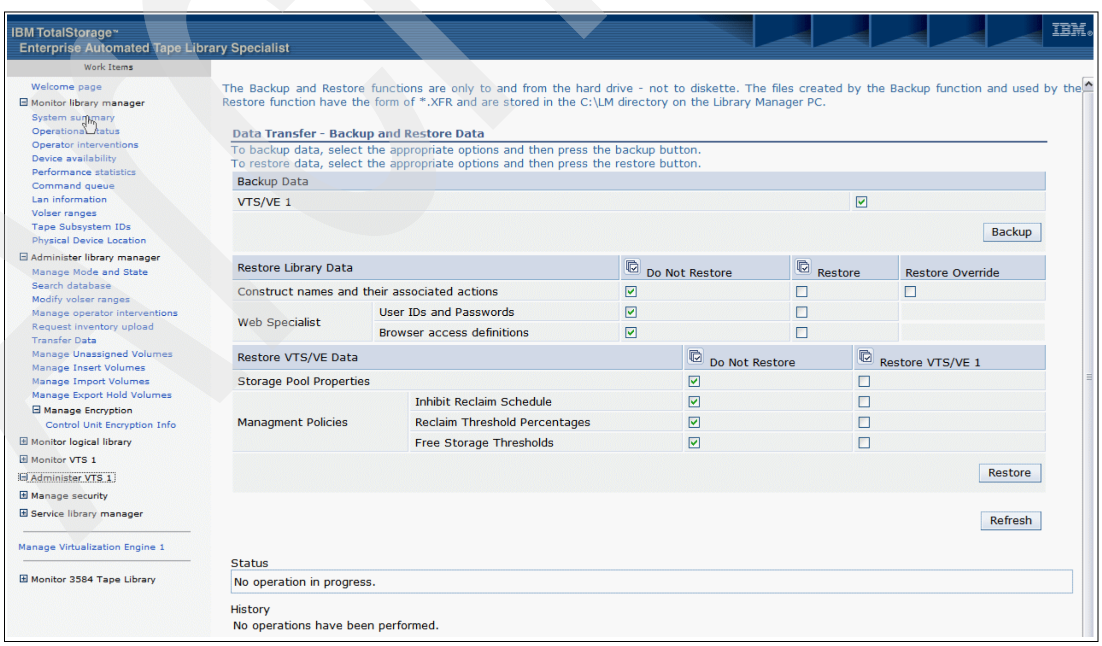


Figure 13-26 Data Transfer - Backup and Restore Data panel

The Data Transfer - Backup and Restore Data panel is used to transfer LM system data from one library to another or from one VTS/VE to another VTS/VE on the same library.

Use the work items on the left side of the panel to navigate to the required panel by selecting **Administer library manager** → **Transfer Data** as shown in Figure 13-26 on page 415.

13.5 Inserting System z data volumes

> **Restriction:** You must execute this function from the Operator Panel.

You can insert two types of volumes into the Library Manager partition: physical volumes and logical volumes. Physical volumes can be used as native cartridges or as back-end drives for the TS7700 Virtualization Engine or a VTS.

Perform these steps to add physical cartridges:

1. Define CAPs at the IBM TS3500 level using ALMS through the Web Specialist. CAPs ensure that all System z VOLSER ranges are recognized by the library hardware and assigned to the correct IBM TS3500 logical library partition. Make sure that the proper CAP definitions are in place before you begin any Library Manager definitions.
2. Assign the physical volumes to the correct Library Manager partition (native or VTS partition). Only VOLSER ranges for TS7700 Virtualization Engine or VTS back-end cartridges can be defined. If a cartridge is inserted, and no definition in the 3953 Library Manager exists, it will be treated as a native cartridge. If a host accepts that cartridge, it will be assigned to the scratch volume category of that host. If no host accepts that cartridge, the cartridge remains in the insert category.
3. Physically insert volumes into the library using the I/O station or by opening the library and placing cartridges in empty storage cells. Cartridges are assigned to the Library Manager partitions according to the definitions.

These procedures ensure that TS7700 Virtualization Engine or VTS back-end cartridges will never be assigned to a host by accident.

The Cartridge Assignment Process during insert processing is illustrated in Figure 13-27 on page 417.

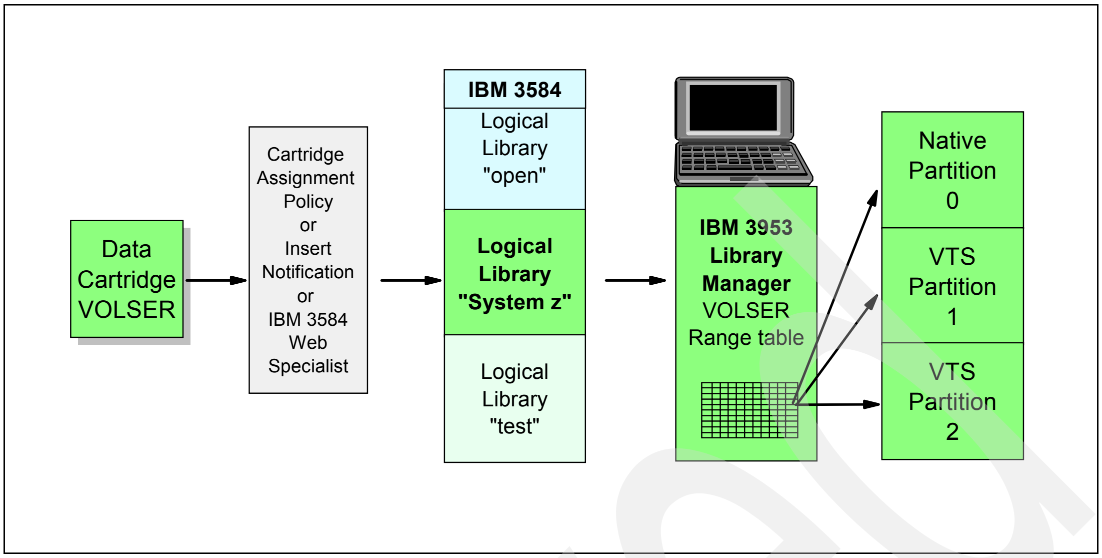


Figure 13-27 Volume assignment to logical libraries

13.5.1 Define Cartridge Assignment Policies in the IBM TS3500 hardware

With the ALMS license installed and using the Web Specialist option, Manage Cartridges, you can add Cartridge Assignment Policies. The policies need to define all of the physical VOLSER ranges that you will use in the System z partition and ensure that they are automatically assigned to the correct IBM TS3500 logical library. Refer to 8.1.2, “Defining Cartridge Assignment Policies” on page 206.

If you do not specify the VOLSER ranges in the cartridge assignment processing and Insert Notification is turned ON, the operator is asked for manual intervention. If the operator does not respond with the manual intervention in 60 seconds, or if Insert Notification is turned OFF, the cartridge remains in an unassigned status. In this case, you have to assign the cartridges manually.

Important: We strongly recommend that you define all used VOLSER ranges *before* the Cartridge Assignment Policy processing and before an insert process is started.

13.5.2 Define VOLSER ranges in the 3953 Library Manager

With the Cartridge Assignment Policy processing, the cartridges are assigned to a TS3500 logical library partition. But inside this logical library partition, they must also be assigned to the VTS 1 or VTS 2 partition. You can use the ETL Specialist panel described in 8.2.1, “Defining VOLSER ranges for physical cartridges” on page 208 to assign them to the VTS 1 or VTS 2 partition.

Important: We strongly recommend that you assign the VOLSER ranges to the Library Manager partitions *in advance* and before an insert process is started.

13.5.3 Inserting physical volumes in the IBM TS3500

There are two methods for inserting physical volumes into the IBM TS3500 Tape Library:

- Opening the library doors and directly inserting them into tape library storage cells

- Using the tape library I/O station

Inserting physical volumes directly into storage cells

The IBM TS3500 CAP defines which volumes are assigned to which logical library partition; if the VOLSER is included in the System z VOLSER range, it will be assigned to the TS3500 logical library partition.

After the doors on the library are closed and the tape library has performed inventory, the upload of the inventory to the 3953 Tape System will be processed before the IBM TS3500 Tape Library reaches the READY state. The Library Manager updates its database accordingly.

> **Note:** The inventory is performed only on the frame where the door is opened and not on the adjacent frames. If you insert cartridges into a frame that is adjacent to the frame that you opened, you must perform a manual inventory of the adjacent frame by using the Operator Panel on the IBM TS3500.

Inserting physical volumes using the I/O station

The TS3500 Tape Library detects volumes in the I/O station and then moves the volumes to empty cells.

The IBM TS3500 Cartridge Assignment Policy defines which volumes are assigned to which logical library; if the VOLSER is included in the System z range, it will be assigned to the IBM TS3500 logical library partition.

Under certain conditions, cartridges will not be assigned to a logical library in the TS3500 or in the 3953 Library Manager.

> **Important:** Unassigned cartridges can exist in the TS3500, as well as in the 3953 Library Manager. But “unassigned” can have different meanings and need different actions from the operator.

Unassigned volumes in the TS3500

If a volume does not match the definitions in the CAP and if no owner was specified during the Insert Notification process, the cartridge remains unassigned in the TS3500 Tape Library. You can then assign the cartridge to the TS3500 logical libraries using the IBM TS3500 Tape Library Specialist Web interface. You must access the 3953 Enterprise Tape Library (ETL) Specialist and request an upload of the inventory to make sure that the now assigned volumes are transferred to the 3953 Library Manager, because the manual assignment of the cartridges will not automatically process an upload of the inventory to the 3953 Library Manager.

Unassigned volumes in the 3953 Library Manager

If a volume did match the CAP and is already assigned to a specific logical library partition, it will be uploaded to the assigned 3953 Library Manager. However, if the following conditions are true, the Library Manager will put the cartridge in the Unassigned category (FF16):

- A VTS is installed and attached to a 3953, which supports Export and Import operations. In this case, the convenience I/O station is the default in IMPORT mode.
- A cartridge is entered through the convenience I/O station and is assigned to that 3953.

The cartridge will be put in the Unassigned category until the operator assigns it manually to the Insert category. If the cartridges were directly assigned to the Insert category, an Import/Export cartridge might be overwritten.

The ETL Specialist Web interface is used to assign unassigned volumes to insert or import when there is a VTS attached to the Library Manager.

The Manage Unassigned Volumes panel allows the operator to move physical volumes in the “Unassigned” category to the “Import” category, which is an essential initial step during a VTS import operation. In addition, the operator can move the physical volumes to the “Insert” category or eject them from the library.

Use the work items on the left side of the panel to navigate to the required panel by selecting **Administer library manager** → **Manage Unassigned Volumes** as shown in Figure 13-28.

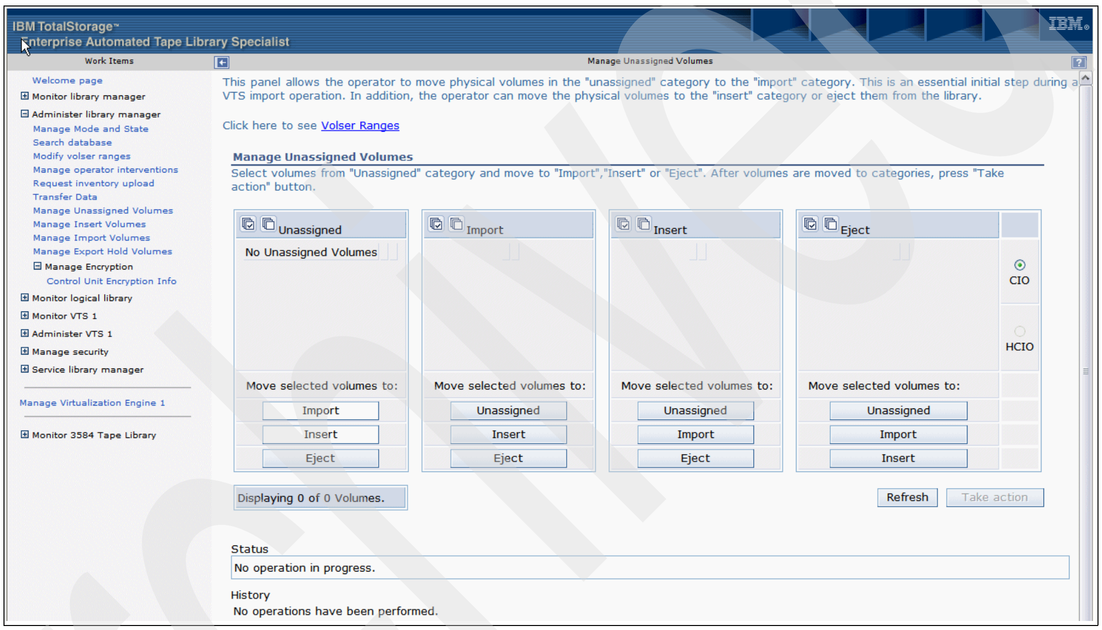


Figure 13-28 Manage Unassigned Volumes panel

The Manage Insert Volumes panel allows the operator to re-evaluate the physical volumes in the “Insert” category for the non-VTS subsystem. By redefining the VOLSER ranges, the physical volumes can be moved to the insert categories for the VTS subsystems. In addition, the operator can eject the physical volumes from the library.

Use the work items on the left side of the panel to navigate to the required panel by selecting **Administer library manager** → **Manage Insert Volumes** as shown in Figure 13-29 on page 420.

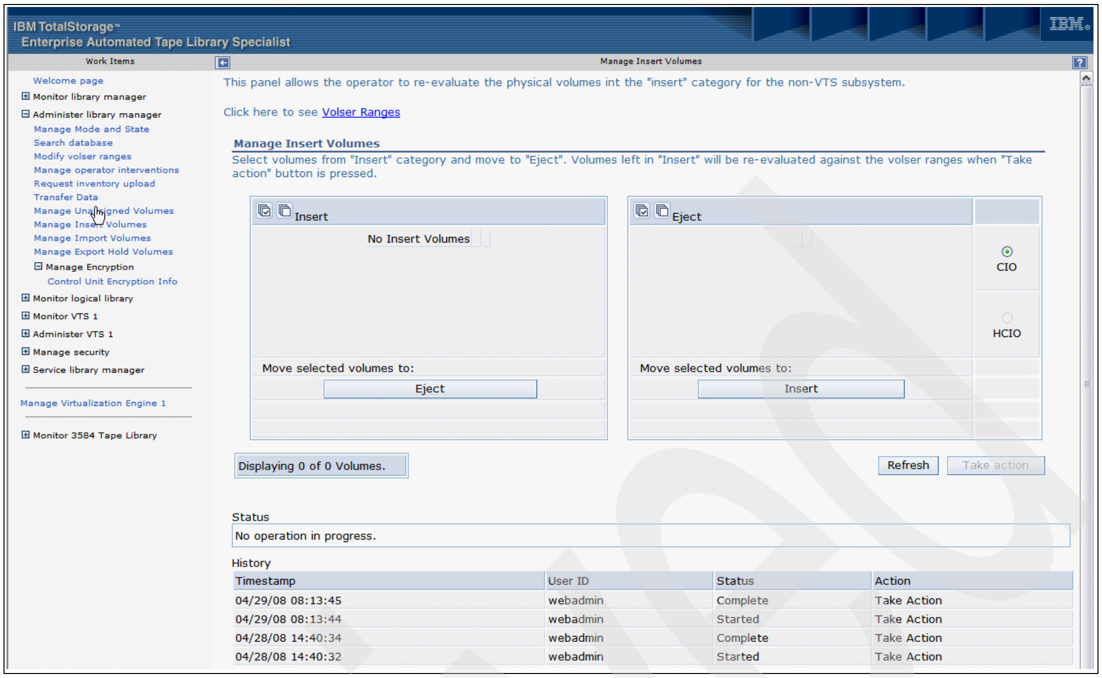


Figure 13-29 Manage Insert Volumes panel

The Manage Import Volumes panel allows the operator to move physical volumes in the “Import” category to the “Insert” category. In addition, the operator can eject the physical volumes from the library.

Use the work items on the left side of the panel to navigate to the required panel by selecting **Administer library manager** → **Manage Import Volumes** as shown in Figure 13-30.

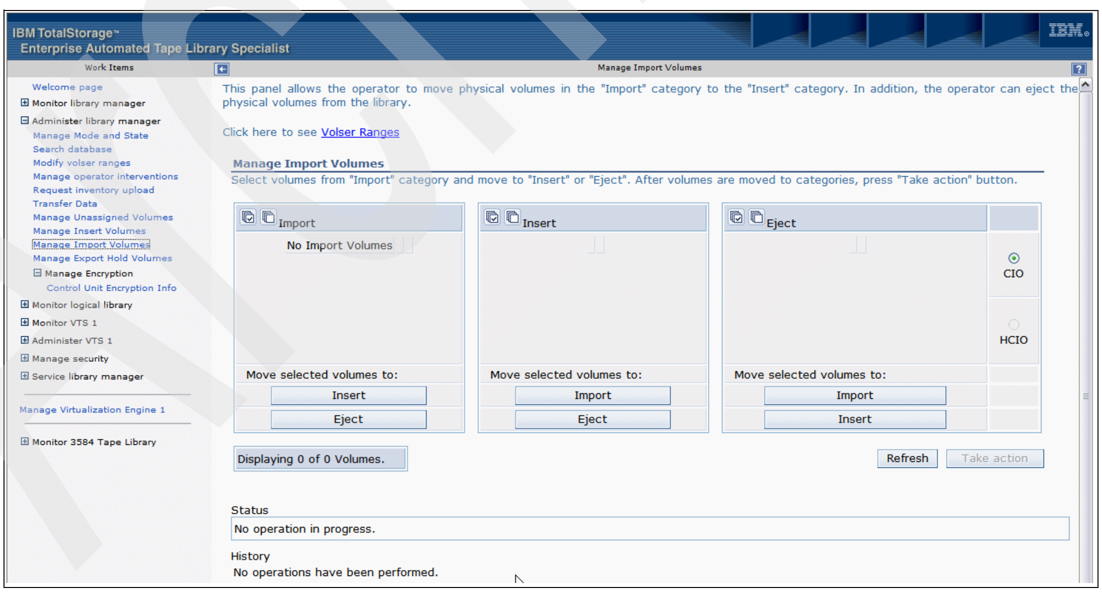


Figure 13-30 Manage Import Volumes panel

Assign cartridges in the IBM TS3500 to a logical library partition

This procedure is only necessary if a cartridge was inserted, but no CAP was provided in advance. Then, you must assign the cartridge manually to a logical library in the TS3500 Tape Library.

This function is only valid and available if ALMS is enabled on the TS3500 Tape Library. You can assign a data cartridge to a logical library by using the Tape Library Specialist Web interface, but not by using the Operator Panel. Also, if ALMS or the cleaning mode is enabled, it is normal for a cleaning cartridge to be unassigned. If cleaning mode is disabled, use the Operator Panel or the Tape Library Specialist Web interface to assign the cleaning cartridge as part of an import operation.

To assign a data cartridge to a logical library in the TS3500 Tape Library, perform the following steps:

1. Type the Ethernet IP address or the library Web site on the Web site line and press Enter. The Welcome Page appears.
2. Select **Cartridges** → **Data Cartridges**. The Data Cartridges panel appears.
3. Select the logical library to which the cartridge is currently assigned and select how you want to sort the cartridge range. (The library can sort the cartridges by volume serial number, SCSI element address, or frame, column, and row location.) Select **Search**. The Cartridges panel displays all ranges for the logical library that you specified.
4. Select the range that contains the data cartridge that you want to assign.
5. Select the data cartridge, and then, select **Assign**.
6. Select the TS3500 logical library to which you want to assign the data cartridge.
7. Select **Finish** to complete the function.

Note: An inventory upload is required, because inventory does not automatically update when cartridges are assigned to logical libraries through the Tape Library Specialist Web interface of the library.

Inserting cartridges without a barcode label

You might receive cartridges from a software vendor, another company, or even from IBM that have standard label (SL) formats but no barcode labels. This special situation needs a particular procedure. The following example describes the insertion of a cartridge with an SL of `YX0100`:

1. First, you must verify that this VOLSER is not defined within a VOLSER range in the TS3500.
2. Insert the cartridge in the entry station. The accessor will not pick the cartridge because of the missing barcode.
3. Use your Web specialist function to select **Manage Cartridges** → **I/O Station**.

   You will see only one cartridge with unknown status.
4. Select the cartridge and select **Fix Unknown Volume Serial**.
5. Enter VOLSER=`YX0100` and the type (JA, JJ, and so forth).

6. Additionally you have to assign the cartridge to the correct logical library, which is z/OS-attached:
   – Now, the accessor picks up the cartridge from the CIO and transports it to a free slot location. The TS3500 library signals the 3953 Library Manager about this new cartridge. Because it does not exist in any defined VOLSER range and in any tape management system, you see the message:

     ```
     CBR3620I Entry of volume YX0100 into library LIBMVS01 failed
     ```

   – The cartridge remains in the “Insert” category of the Library Manager.
7. Because you want to get the cartridge mounted, you have to define a tape configuration database (TCDB) record additionally:

   ```
   //INSERT EXEC PGM=IDCAMS
   //SYSPRINT DD SYSOUT=*
   //SYSIN DD *
   /*
   ```

Now, you can work with the cartridge using VOL=SER=YX0100 in your JCL without any UNIT definition.

13.5.4 Inserting logical volumes into a TS7700 Virtualization Engine

Logical volumes for a TS7700 Virtualization Engine are inserted using the TS7700 Virtualization Engine Management Interface (MI). Inserting a logical volume is a function of the Composite Library operations performed by the hNode and must be serialized across the sites to ensure multiple sites are not performing conflicting operations. In a Multi Cluster Grid, any TS7700 cluster can be used to perform the insertion of logical volumes.

To insert logical volumes into the TS7700 Virtualization Engine, you select **Operations** → **Insert Logical Volume** as shown in Figure 13-31.

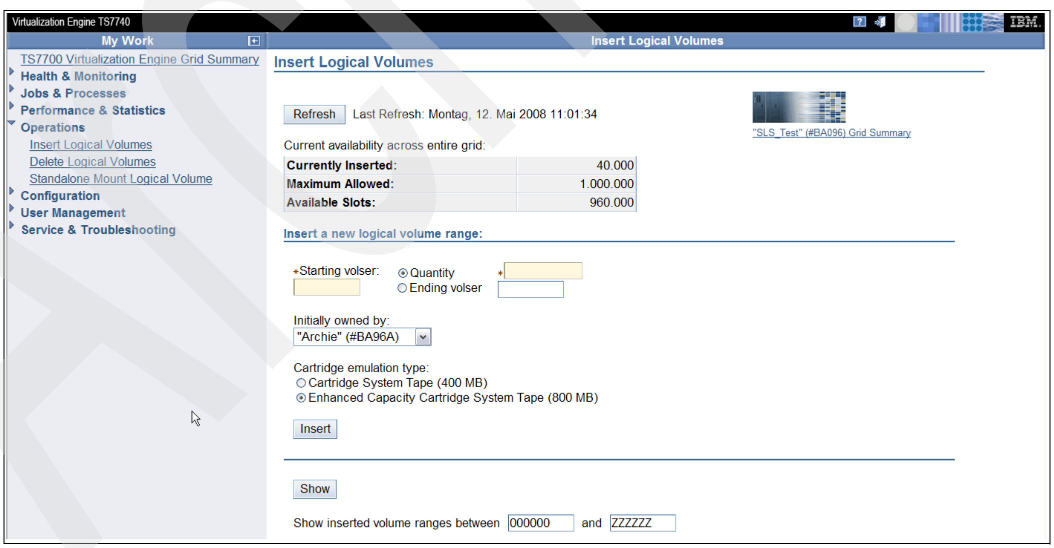


Figure 13-31 Insert Logical Volumes panel from the TS7700 Management Interface

The table shown at the top of Figure 13-31 on page 422 shows current information about the number of logical volumes in the TS7700:

Currently Inserted The total number of logical volumes inserted into the TS7700

Maximum Allowed The maximum number of logical volumes that can be inserted

Available Slots The available slots remaining for logical volumes to be inserted. This number is obtained by subtracting the Currently Inserted logical volumes from the Maximum Allowed logical volumes.

The following information on the panel appears, and this information is used for inserting logical volumes:

- **Starting VOLSER**: The first logical volume to be inserted. The range for inserting logical volumes begins with this VOLSER identifier.
- **Quantity**: Select this option to insert a set number of logical volumes starting with the Starting VOLSER. The adjoining text field is where you enter the quantity of logical volumes to be inserted.
- **Ending VOLSER**: Select this option to insert a range of logical volumes. The adjoining text field is where you enter the ending VOLSER identifier.
- **Cartridge emulation type**: Media type of the logical volume. Possible values are:
  - Cartridge System Tape (400 MB)
  - Enhanced Capacity Cartridge System Tape (800 MB)
- **Select Cluster**: Use this option to select the initial owning cluster of the logical volume.
- **Insert**: Click this button to insert the logical volumes with the selected options.
- **Show**: Click this button to show the inserted ranges that you specified.

> **Restriction:** Up to ten thousand logical volumes can be inserted at one time. This maximum applies to both inserting a range of logical volumes and inserting a quantity of logical volumes. Attempting to insert quantities over ten thousand returns an error.

The TS7700 Management Interface determines the number of volumes to insert from the starting and ending VOLSERs specified. For example, a starting VOLSER of `AAA000` and an ending VOLSER of `AAB999` will insert 2000 logical volumes. The volumes inserted in this example are:

- `AAA000`
- `AAA001` through `AAA999`
- `AAB000`
- `AAB001` through `AAB999`

Note these points about the preceding example:

- The format of the starting VOLSER and the format of the ending VOLSER are the same (that is, the characters at the same position in both the starting and ending VOLSERs are of the same type, either alphabetic or numeric). This condition must be true for the VOLSERs to be valid. If the starting VOLSER were `AAA000` and the ending VOLSER were `AAAB01`, this combination is invalid, because the fourth characters in these VOLSERs are not of the same type.

- VOLSERs are created by incrementing numerical characters numerically and alphabetical characters alphabetically. This system matches how physical cartridge VOLSER labels are ordered. The TS7700 Management Interface checks whether any VOLSERs of a different media type or VTS partition fall within the range entered for the logical volumes to be inserted. If any VOLSERs overlap, the logical volumes are not inserted and the TS7700 Management Interface will cause the task to fail and display the following message on the Task Result Details page:

  "`The local verify failed. VOLSER «`*`volser`*`» is currently in use by another insert operation or is of a conflicting media type.`"

Note that an overlap is allowed if the redundant VOLSERs are in the same VTS partition and are of the same media type. In this case, the existing VOLSERs are not reinserted.

The TS7700 Management Interface performs the overlap check by examining the Library Manager database. However, the database search does not increment alphabetical characters alphabetically and numerical characters numerically as previously described. Instead, the search increments each character numerically from 0 and then alphabetically from A. In the preceding example, the search starts at `AAA000` through `AAA009` and then increments to `AAA00A` through `AAA00Z`. The search then sequences as follows: `AAA010` through `AAA019`, `AAA01A` through `AAA01Z`, `AAA020` through `AAA029`, `AAA02A` through `AAA02Z`, and so on.

In summary, while a set of logical volumes to be inserted might not actually overlap existing VOLSERs, the insertion might fail because the check will indicate an overlap. As an example, assume a set of stacked physical volumes exists in the library partition and has VOLSERs `J1A001` through `J1A500` assigned, which correspond to a set of 500 physical volumes. The operator attempts to insert 20 000 logical volumes starting at VOLSER `J10000` and ending at VOLSER `J29999`. The database overlap search will cause the Library Manager to reject this insertion request because of a sensed overlap as the search sequences past `J19ZZZ` to `J1A000`, `J1A001`, and so on. The operator can avoid this situation by inserting the logical volumes in two ranges: in this example, `J10000 - J19999` and `J20000 - J29999`.

Careful planning of both physical and logical VOLSER assignment can help prevent these situations. Consider one of the following methods to assign VOLSERs:

- Use different characters in the initial position for different media types and VTS partitions; for example, certain characters can designate physical stacked volumes in VTS 1, other characters can designate logical volumes in VTS 1, yet other characters can designate physical stacked volumes in VTS 2, and so on.
- Use the same format for all VOLSERs, both physical and logical, and ensure that all VOLSERs consistently use either all numerical or all alphabetical characters in each character position. For instance, use only alphabetical characters in the first three positions and only numerical characters in the last three positions.

13.5.5 Inserting logical volumes into a VTS

Logical volumes for a stand-alone VTS can be inserted by using the ETL Specialist panel or the IBM 3953 Library Manager Console. Logical volumes for a PtP VTS can be inserted using the ETL Specialist or the IBM 3953 Library Manager Console of the physical library that was specified as the User Interface Library during installation. The panels to insert logical volumes are the same for both a stand-alone VTS and a PtP VTS.

To insert logical volumes, select **Administer VTS*x* → Modify Logical Volumes**. On the following panel, as shown in Figure 13-32 on page 425, you can insert logical volumes.

If the APM feature is installed on the VTS, you can also assign or change management constructs to a range of logical volumes. Note that you must *not* assign or change management constructs to a range of logical volumes in a System z environment under SMS management. For a detailed discussion of APM, refer to *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring*, SG24-2229.

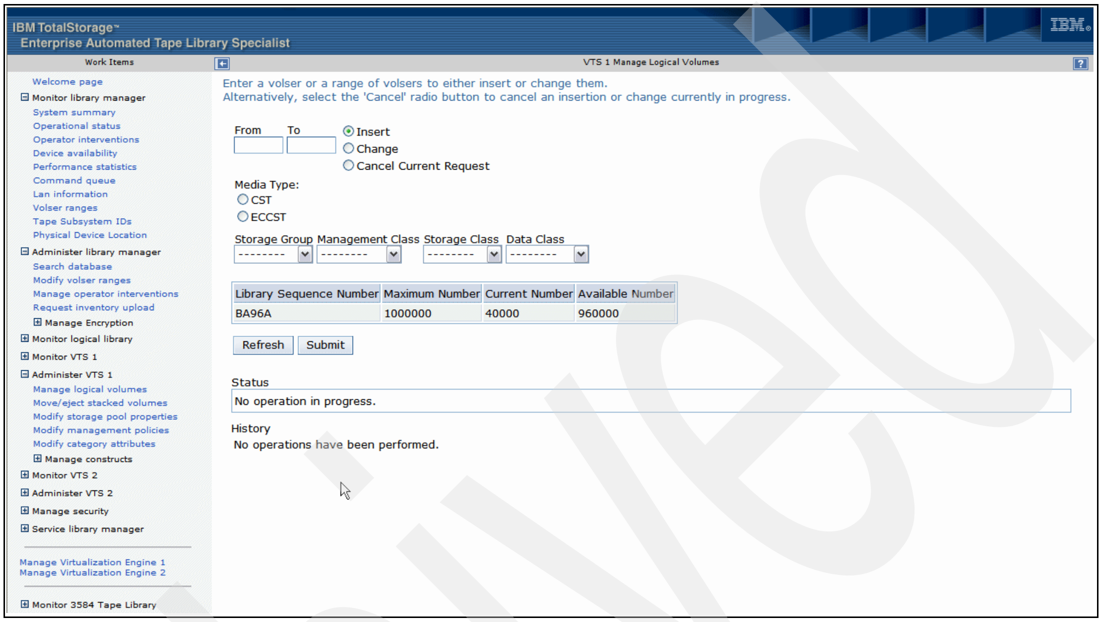


Figure 13-32 Insert Logical Volumes panel

When inserting logical volumes into a logical library, you must specify:

- Starting VOLSER
- Ending VOLSER
- Media type
- Optionally: Management constructs, such as Storage Group, Management Class, Storage Class, or Data Class

The Library Manager determines the number of volumes to insert from the specified starting and ending VOLSERs.

13.5.6 Removing data cartridges

To remove a cartridge from a TS3500 Tape Library, you can use several methods. In the following sections, we describe the use of the TS3500 Specialist. For more information, refer to the *IBM System Storage TS3500 Tape Library Operator Guide*, GA32-0560.

> **Note:** If your library is installed with ALMS, you can use the Tape Library Specialist Web interface to enable virtual I/O slots and make the host application operate as though the library has more I/O slots than actually exist. If a data cartridge is in a virtual I/O slot, you can export and remove it. When virtual I/O slots are enabled, if you remove a cartridge by using the Tape Library Specialist Web interface, the export operation has a higher priority than all server export commands.

To remove data cartridges from the TS3500 library by using the Tape Library Specialist Web interface, perform the following steps:

1. Type the Ethernet IP address on the Web site line of the browser and press Enter. The Welcome Page appears.
2. Select **Cartridges → Data Cartridges.** The Data Cartridges panel appears.
3. Follow the instructions on the panel to specify the data cartridge and remove it to the I/O station.
4. Look at the Activity panel on the Operator Panel to determine whether the I/O station that you want to use is locked or unlocked. If the station is locked, use your application software to unlock it.
5. Open the door of the I/O station and remove the cartridge.
6. Close the door of the I/O station.

Important: *Always* eject a native cartridge from the host using Tape Management or SMS facilities (ISMF) to ensure that your tape configuration database (TCDB) and Tape Management System reflect the update.

Note that removing VTS cartridges out of a library can take some time, depending on the amount of active data on a cartridge. VTS cartridges can only be ejected when they are empty; therefore, all active data must be transferred to a different cartridge before the VTS cartridge can be ejected. There is no function to eject a VTS physical cartridge from the host interface.

13.6 Manual mode of operation

During normal automated operation, no operator attendance is required except to add or to remove cartridges. Operator assistance is required if an error or an exception condition occurs from which the Library Manager cannot recover on its own. Depending on the type of error or exception condition experienced, part or all of the Library Manager's operations are suspended until the problem is corrected. If you cannot resolve the problem, you can start Manual mode operations. When the library is in Manual mode, the Library Manager instructs you to perform manual mount, demount, and eject operations until an IBM SSR resolves the problem. After the problem is resolved, you can return the tape library to Auto mode.

You can use Manual mode during the following conditions:

- A problem in the tape library prevents automated operations.
- An IBM SSR is performing scheduled maintenance activities.

Manual operations are controlled by the IBM 3953 Library Manager and apply only to the System z logical library; you cannot mount cartridges manually using this method on behalf of any Open Systems logical libraries that might be part of the same physical library. Working in Manual mode affects the entire physical library, because the accessor is not active during this mode of operation. However, you will only enter this mode if the accessor is not available for a valid reason.

Note: Before you enter Manual mode, you must first put the library into Pause mode using the IBM TS3500 Operator Panel; you cannot use the Library Manager Console to change the library status to Pause.

The Library Manager allows you to select Manual mode from the Mode menu (refer to 13.4.5, “Library Manager Mode: Operational modes” on page 408). When in Manual mode, you follow the instructions on the Library Manager window and confirm as necessary when you complete the instructions.

The basic process involves the operator mounting and demounting cartridges. The Library Manager Console lists pending requests, which you can use for this procedure. Alternatively and possibly more effectively, you can perform the following steps to use the drive message display:

1. Read the IBM 3592 Tape Drive message display for the VOLSER of the cartridge.
2. Use the IBM TS3500 Operator Panel or Specialist to find the physical location of the cartridge.
3. Mount the cartridge.

Replace used cartridges into any slot in the library. After exiting Manual mode, when the library becomes ready, a library inventory will be performed. Alternatively, you can reserve the cartridges and then reinsert them using the I/O station when the library returns to Auto mode. These procedures are fully documented in the *IBM System Storage 3953 Library Manager Model L05 Operator Guide*, GA32-0558.

The Library Manager continues to automatically process mount and demount requests issued to the virtual drives in a VTS. These requests are not included in the actions that display for operator processing. If a logical volume needs to be recalled from a physical volume in order to satisfy a mount to a virtual drive, the actions that are required under Manual mode include the resulting mount for that physical volume.

13.7 Stand-alone operations

When a host cannot send mount commands to the Library Manager, it can perform stand-alone operations by using stand-alone software. Examples of stand-alone software are:

- **Stand-alone dump**: The host must receive an initial program load (IPL) from tape and then dump the host memory contents to a separate tape. The tape can be mounted later under the control of a host.
- **Stand-alone restore**: The host must receive an IPL with a function to restore the contents of direct access storage device (DASD) volumes from data that is stored on the tape volumes. After the DASD volumes are restored, the host system can receive an IPL with restored DASD volumes.

Important: To execute a stand-alone operation, a unit in the Tape Library must be set as a stand-alone device.

13.7.1 MVS stand-alone restore from a tape library

The Standalone Services program is available with DFDSS V2.5 and DFSMSdss. The Standalone Services RESTORE command is supported by tape devices within the IBM 3953 Tape system. The RESTORE command enables you to restore your dump tapes by using tape devices inside the tape library.

The Standalone Services program runs independently of a system environment either as a true stand-alone system or under a VM system. The program operates in extended control (EC) mode and requires 2 MB of real storage. The Standalone Services program operates on an IBM System/370™ (S/370™) processor in either MVS/ESA™ mode, MVS/XA™ mode, or S/370 mode. It also runs on an IBM System/390® processor in either S/390 mode or S/370 mode. The Standalone Services program can run on a processor that is in BASIC or logical partition (LPAR) mode. Or, you can run the Standalone Services program in a virtual machine under VM. The drives to be used for Standalone Services must remain offline to other systems.

To restore from the dump tapes, the Standalone Services program uses only tapes inside the tape library and the TAPEVOLSER parameter of the RESTORE command to mount specified dump tape volumes by means of the cartridge accessor:

```
RESTORE FRMDV(TAPE) FRMADR(FDD) TOADR(791) -
  NOVERIFY TAPEVOL((BCD101) (BCD102))
```

Device address FDD is a tape drive in the IBM 3953 Tape System. The tape volumes with VOLSERs `BCD101` and `BCD102` contain the dump dataset to be restored. Volume `BCD101` is the first volume in the sequence, and `BCD102` is the second volume in the sequence. Device address `791` is a direct access storage device (DASD). The NOVERIFY parameter of the RESTORE command prompts the operator for permission to write on the device at address 791. Refer to *z/OS DFSMSdss Storage Administration Reference,* SC35-0424, for more information.

13.7.2 Standalone Device option

The Standalone Device option allows the following operations:

- Setup stand-alone device.
- Reset stand-alone device.
- Show stand-alone device status.

Set up stand-alone device

The Setup Standalone Device window allows you to set up a tape drive in stand-alone mode. Use this mode to allow a host to run software that, in general, is in complete control of the tape drive. The software must be attached to a tape drive that is physically or virtually inside a tape library. The software is unaware that the drive is in the tape library, and it cannot issue commands to mount and demount volumes. Stand-alone mode is supported for the virtual tape drives within a VTS but not the physical tape drives associated with a VTS. To assist the host software, the Library Manager uses stand-alone mode to load and unload one or more specific cartridges automatically into a specific tape drive without any host software interaction. The host software allows you to specify the cartridge that is mounted in and demounted from a tape drive by using the Library Manager Console.

Important: The tape drive that is used in stand-alone mode needs to be varied offline from all hosts except the host that is used in this special mode. This action prevents unwanted interaction from all hosts except the host that you want.

The Enter device list box lists all of the tape drives managed by the Library Manager, including virtual tape drives. It excludes physical tape drives that are associated with a VTS.

You can select the following operations:

- **Mount a single volume**: This operation causes a single volume to be mounted in a requested tape drive. When you select this operation, you must enter a VOLSER in the VOLSER field. You must also select either Do not change volume category or Change at mount.
- **Demount a single volume**: This operation causes a single volume to be demounted from the requested tape drive. When you select this operation, you can enter a VOLSER in the VOLSER field, or you can leave the field blank. If you leave the field blank, the volume mounted in the drive currently is demounted. You must select Do not change volume category or Change at demount for this operation.
- **Assign category to a device**: This operation causes a category to be assigned to a drive. When you select this operation, you must enter a Category to assign to device and select one of the three Change volume category options:
  - **Do not change volume category**: This option leaves the volume category alone during the stand-alone device operation.
  - **Change at mount**: This option changes the volume's category when a volume is mounted. If you select this method, you must make a valid entry in the Category to change volser to field.
  - **Change at demount**: This option changes the volume's category when the volume is demounted. If you select this method, you must make a valid entry in the Category to change volser to field.

  Also, you have to specify:
  - **Mount first volume without host interaction**: Selecting this option causes the first mount to a device to be performed without host interaction.
  - **Mount/demount volumes without host interaction**: Selecting this option causes mounts and demounts to be performed automatically without host interaction.
- **Category to assign to device**: This entry field is active when you select Assign category to a device. You must enter a valid category. The list displays the current user categories and their host-assigned aliases.
- **Select volumes in category order**: This option is available if you have selected Assign category to a device. Selecting this option causes volumes to be mounted in their category order. Note that if you select the Select volumes in category order option, you need to also select one of the following (mount) options, or the drive will not be put in stand-alone mode.

13.7.3 Reset Standalone Device

The Reset Standalone Device option allows you to take a device out of stand-alone mode. The Reset Standalone Device window presents a list of tape drives that are currently in stand-alone mode. To reset a tape drive, select it, and then select Reset. If there are no tape drives currently in stand-alone mode, a message displays.

13.7.4 Stand-alone device status

Each tape drive that is set up as a stand-alone device has a separate status window. The following fields are shown in the status window:

- **Device**: The identification of the stand-alone tape drive.
- **Device category**: The category associated with the stand-alone tape drive, if any. The device category is displayed as 0 if the tape drive does not have an associated category.

- **VOLSER**: Displays the VOLSER of the currently mounted volume or the VOLSER of the volume in the process of mounting.
- **ICL mode**: If you selected the Mount/demount volumes without host interaction option when you set up the tape drive as stand-alone, the tape drive is set up to implicitly mount and demount volumes. If you selected this option, the integrated cartridge loader (ICL) mode status displays as Yes. If you did not select this option, the ICL mode status displays as No.
- **Status**: The current status of the tape drive displays here.

13.8 z/OS with system-managed tape

This section contains the necessary commands to operate a tape library in a z/OS and system-managed tape environment. This section is not intended to replace the full description of operational procedures in the product documentation. However, it is a quick reference for the needed DFSMS and MVS commands.

13.8.1 DFSMS operator commands

Several of the commands contain *libname* as a variable. In this case, the SMS-defined library name is required. Depending on whether you refer to a VTS, PtP VTS Distributed Library, PtP VTS Composite Library, or your native drive partition, the output is slightly different for several of these commands. For more information about DFSMS commands, refer to *z/OS DFSMS Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries*, SC35-0427.

Information from the TS3500 Tape Library is contained in some of the outputs. However, you cannot switch the modes of the 3953 Library Manager or the TS3500 Tape Library with z/OS commands.

Important: DFSMS and MVS commands apply only to SMS-defined libraries. The Library name defined during the definition of a library in ISMF is required for *libname* in the DFSMS commands.

The following DFSMS operator commands support the tape library:

- **LIBRARY EJECT,*VOLSER*{,PURGE|KEEP|LOCATION}{,BULK}**

  This command is used to request the ejection of a volume from a tape library. The variations available in this command are:

  – Eject to the convenience I/O station (no additional specification).

  – Eject to the bulk output station (BULK or B).

  – Remove the volume record from the TCDB (PURGE or P).

  – Keep the volume record in the TCDB and update it to indicate that the cartridge has been ejected (KEEP or K). If the record contains information in the SHELF location field, it is not changed. If the SHELF location field is empty, the operator must enter information about the new location as a reply to a “write to operator with reply” (WTOR). The reply can be up to 32 characters long.

  – Keep the volume record in the TCDB and update it, including updating the SHELF location even if there is some information in this field (LOCATION or L). The operator has to enter the new information as a reply to WTOR.

If none of the variations (PURGE, KEEP, or LOCATION) is indicated in the command, a default decides whether the record is kept or purged. This default can be set separately for each library through the ISMF Library Definition panel.

This command is available for the operator to eject single cartridges. Mass ejection of cartridges is usually performed through program interfaces, such as ISMF, a tape management system, or a batch job.

- **LIBRARY SETCL, *device-number*, *media-type***

  This command allows you to set the media type of the scratch volume that is to be loaded into the ICL of the specified tape drive. You must issue the command on the system on which the drive is online. The other hosts are notified when the drive is varied online on the system.

  If the media assignment by this command is different from the current assignment, the ICL is emptied, and the proper cartridges are loaded.

- **VARY SMS,LIBRARY(*libname*),OFFLINE**

  This command acts on the SMS-library, which is referred by *libname*. That is, this command stops tape library actions and gradually makes all of the tape units within this logical library unavailable. The units are varied offline “for library reasons”, which means that they are inaccessible, because the whole SMS-defined library is offline.

  This simple form is a single-system form. The status of the library remains unaffected in other MVS systems.

  > **Note:** This command does not change the status of the Library Manager or the TS3500 Tape Library. It only applies to the SMS-defined logical libraries.

- **VARY SMS,LIBRARY(*libname*),ONLINE**

  This command is required to bring the SMS-defined library back to operation after it has been offline.

  The logical library does not necessarily go offline as a result of an error in some component of the physical library. Therefore, several message explanations for error situations request that the operator first vary the library offline and then back online. This action usually clears all error indications and returns the library to operation. Of course, this action is only the MVS part of error recovery. You must clear the hardware, software, or operational error within the physical library and the 3953 Library Manager before you bring the library back to work with MVS.

- **VARY SMS,LIBRARY(*libname,sysname*,...),ON|OFF** and
  VARY SMS,LIBRARY(*libname*,ALL),ON|OFF

  These extended forms of the VARY command can affect more than one system. The first form affects one or more named MVS systems. The second form performs the VARY action on all systems within the SMSplex.

  The VARY SMS command allows the short forms ON and OFF as abbreviations for ONLINE and OFFLINE.

- **DISPLAY SMS,OAM**

  This command gives a single line of information about all tape libraries (if present), their tape units, storage cells, and scratch cartridges.

  This is the view of the single system where the command was executed. The number of unallocated, online drives is given under the heading AVL DRV (available drives).

If both optical libraries and tape libraries are defined in the SMS configuration, two multiline “write to operators” (WTOs) are displayed. The first multiline display produced by the library control system (LCS) is the display of optical library information. The second multiline display contains tape library information.

- **DISPLAY SMS,LIBRARY(*libname*|ALL),STATUS**

  The library status display shows the SMS view of either one SMS-defined library or all SMS-defined libraries. The result contains one line of information for each library. This is a multihost view, which basically indicates whether the SMS-defined library is online, offline, or pending offline.

  STATUS is the default parameter.

- **DISPLAY SMS,LIBRARY(ALL),DETAIL**

  The DETAIL display, although a single-system view, gives slightly more information. The display is similar to the result of DISPLAY SMS,OAM, but each library gets its own line of information.

- **DISPLAY SMS,LIBRARY(*libname*),DETAIL**

  This command provides details about the status of a single library. It is the only command that displays the library state (auto, pause, or manual mode). Reasons for the mode and indications of inoperative parts of the library are given on additional status lines. Examples of special situations are:

  – Safety enclosure interlock open
  – Vision system not operational
  – Convenience output station full
  – Out of cleaner volumes

- **DISPLAY SMS,STORGRP(*grpname*|ALL)**

  There are no new parameters in the Storage Group display command, because the optical library request formats are adequate here.

  This display command is a general form of a request and gives the total SMS multihost view of the situation. The result is a display of the status of either all Storage Groups (DASD, optical, and tape) or a single Storage Group. There is no format to display one category only.

- **DISPLAY SMS,STORGRP(*grpname*|ALL),DETAIL**

  The DETAIL display is not much more detailed than the general display. Only the library names of this Storage Group are indicated. This display is, in fact, more restricted than the general display. It gives the view of only one system, the view of its object access method (OAM), as the header line indicates.

  The LISTVOL parameter of DISPLAY SMS,STORGRP is not used for tape Storage Groups. Although you can view a volume list through ISMF, a similar listing on the console is too long to be meaningful.

- **DISPLAY SMS,VOLUME(*VOLSER*)**

  This command displays all information that is stored about the volume in the TCDB (the VOLCAT) and some nonpermanent state information, such as “volume mounted on library-resident drive”.

MVS commands

The following commands are described in detail in the *z/OS MVS System Commands*, SA22-7627:

- **DS QT,*devnum*,1,RDC**

  This command displays identification, status, and diagnostic information about tape devices. You can use the command to display the LIBRARY-ID and the LIBPORT-ID that are stored for a device in a TS3500.

- **DS QT,*devnum*,MED,*nnn***

  This command displays information about the device type, media type, and the cartridge volume serial number. It is particularly useful when more than one 3592 Model type tape volume exist together. The *devnum* is the device address in hexadecimal. The *nnn* is the number of devices to query.

- **DS QL,LIST(,*filter*)**

  This command displays a list of active Library-IDs (ACTIVE is the default). You can optionally generate a list of INACTIVE Library-IDs or QUEUE'd library orders using the subparameters ACTIVE, INACTIVE, QUEUE.

- **DS QL,LISTALL(,*filter*)**

  This command produces a detailed list of all libraries, including the devices and port IDs within each library. Valid subparameters are ACTIVE (default) and INACTIVE.

- **DS QL,*libid*(,*filter*)**

  Use this command to list information for the library with the serial number "libid". The "libid" parameter uses sub-parameters ACTIVE (default), INACTIVE, VALIDATE, QUEUE, and DELETE.

- **VARY *unit*,ONLINE|OFFLINE**

  The VARY unit command has not changed. However, new situations can occur when the affected unit is attached to a library.

  When the library is offline, the tape units cannot be used. This situation is internally indicated in a new status, *offline for library reasons*, which is separate from the normal *unit offline* status. A unit can be offline for both library and single-unit reasons.

  A unit that is offline for library reasons only cannot be taken online with VARY *unit*,ONLINE. Only VARY SMS,LIBRARY(...),ONLINE helps.

  You can bring a unit online that was individually varied offline and was offline for library reasons by varying it online individually and varying its library online. The order of these activities is not important, but both activities are necessary.

  Currently, no display directly gives the reason that the unit is offline, nor is there a display that gives the name of the library to which this unit belongs.

- **DISPLAY U**

  The DISPLAY U command displays the status of the requested unit. If the unit is part of a tape library (either manual or automated), device type 348X is replaced by 348L. An IBM 3490E is shown as 349L, and a 3590 as 359L.

  For a manual tape library, this command can create a situation where it is no longer possible to see from the console response whether a particular tape unit supports improved data-recording capability (IDRC), because this information is overlaid by the L indicating that the unit belongs to a library.

  The output of DEVSERV is not changed in this way.

- **MOUNT *devnum*, VOL=(NL|SL|AL,*serial*)**

  The processing of MOUNT has been modified to accommodate automated tape libraries and the requirement to verify that the correct volume has been mounted.

- **UNLOAD *devnum***

  The UNLOAD command allows you to unload a drive, if the rewind/unload process was unsuccessful initially.

Device SWAP

Dynamic Device Reconfiguration (DDR) swap handles swaps involving the enhanced 3592 Model E06 and media written in EFMT1, EFMT2/EEFMT2, and the new EFMT3/EEFMT3 recording formats. The 3592 Model E06 reads and writes in EFMT3 and EEFMT3. It is *n*-2 downward-read compatible with the 3592 Model J1A format (EFMT1) and *n*-1 downward-write compatible with the 3592 Model E05 formats (EFMT2 and EEFMT2). DDR swap is modified to handle swaps involving the 3592 Model E06 and the new recording formats (EFMT3 and EEFMT3), as well as lower technology formats (EFMT1, EFMT2, and EEFMT2). The rules in Table 13-1 apply.

Table 13-1 Rules for device swaps

Format	From device	Swap to device
EFMT1	3592-3E and Write attempt	3592-J 3592-2 3592-2E
EFMT1	3592-3E	3592-J 3592-2 3592-2E 3592-3E
EFMT1	3592-J 3592-2 3592-2E	3592-J 3592-2 3592-2E
EFMT2	3592-J 3592-2E 3592-3E	3592-2 3592-2E 3592-3E
EEFMT2	3592-2E 3592-3E	3592-2E 3592-3E
EFMT3	3592-3E	3592-3E
EEFMT3	3592-3E	3592-3E

A

Monitoring and reporting

This appendix briefly describes the available sources, products, and tools for monitoring and reporting, as well as general considerations about these topics. It describes the monitoring aspects of TS3500 Tape Library and 3953 Tape System. This appendix provides details about a subset of the tape tools:

- MOUNTMON
- TAPEWISE
- VTSSTATS
- VEHSTATS

This appendix does not provide detailed information about all tools and reports. For detailed information, refer to the appropriate sources listed throughout this appendix.

Where to find information

With TS3500 Tape Library and System z-attached environments, monitoring involves multiple levels of monitoring using different tools with each level using various information sources for monitoring (refer to Figure A-1). You can monitor the physical resources at the TS3500 Tape Library level using the TS3500 Specialist. Additional information specific to the 3953 logical library can be obtained using the 3953 Tape Library Specialist. If you have a Virtual Tape Server (VTS) attached to the 3953, the 3953 Tape Library Specialist also offers additional information specific to the VTS. With the introduction of the TS7700 Virtualization Engine, a new management interface provides monitoring information specific to the TS7700 Virtualization Engine. In addition to those Web-based interfaces, we also have batch tools that provide more detailed information for performance diagnostics and analysis.

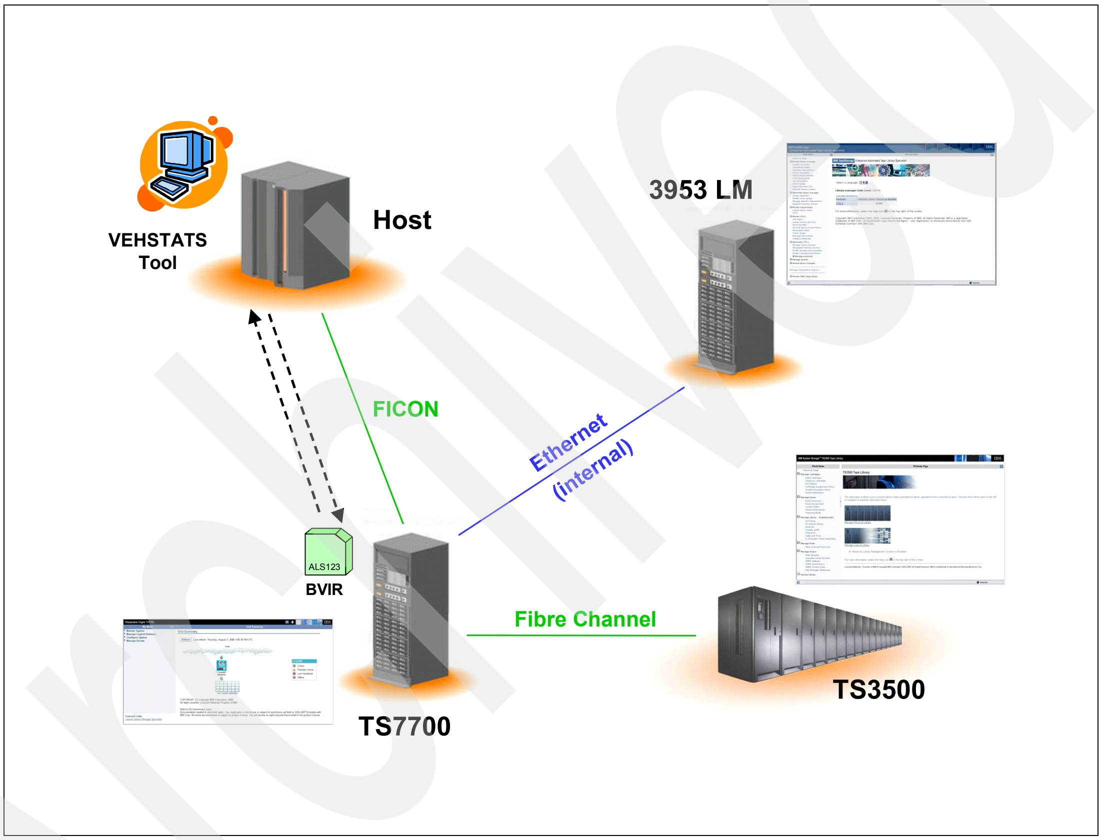


Figure A-1 Monitoring in a TS3500 Tape Library environment

We now describe which information can be gained in which tool:

- TS3500 Tape Library: Operator Panel or Web interface
- 3953 Library Manager: Operator Panel or Web interface
- TS7700 Management Interface (MI)
- Bulk Volume Information Retrieval function (BVIR)
- z/OS: VMA, based on SMF information using SMF type 14, 15, 21, and 30 records
- z/OS: Tape tools, based on various SMF information, including SMF94

You can access the TS3500 Tape Library and the 3953 Library Manager information using the Operator Panels or the Web interfaces. You can only access the TS7700 Management Interface through the Web interface. In this section, we describe the usage of these Web interfaces. The information that you can retrieve is snapshot information from the last hour, the last day, or the last 30 days, depending on the source of the information. The Web interface or the Operator Panel contains no historical data. However, you can download part of the data. For forecasts, you might want to store the data so that historical data is available for capacity planning and trend analysis. Also, VMA and other tape tool reports are a good source of information for this purpose.

Monitoring with the TS3500 Specialist

The IBM System Storage Tape Library Specialist (IBM TS3500 Specialist) provides management and monitoring of TS3500 Tape Library activities. It provides information about physical activities of the entire library. Part of the information in the TS3500 Specialist is only in a display format. There is no capability to download the display only information in a CSV format. Other information is only provided in a download format. This information can be downloaded directly to your PC and then used as input for a snapshot analysis, or if historical data is stored, for a forecast.

For further information regarding how to request this data, refer to 13.3, “Operating the TS3500 Tape Library” on page 386:

- Accessor usage - display only:
  - Activity of each accessor and gripper
  - Travel meters of accessors
- Drive status and activity - display only
- Drive statistics - download only:
  - Last VOLSER on this drive
  - Write and read MB per drive
  - Write and read errors corrected per drive
  - Write and read errors uncorrected per drive
- Mount history for cartridges - download only:
  - Last tape alert
  - Number of mounts of a specific cartridge
  - Number of write and read retries of a specific cartridge in the life cycle
  - Number of write and read permanent errors of a specific cartridge in the life cycle
- Fibre port statistics - download only:
  - Report errors, cancels, resets, and recoveries between the TS7700 or VTS and the drives, or for native attached drives between the controller and the drive

  Restriction: This statistic does not provide information from the host to the TS7700, VTS, or controller.

- Library statistics (subset of SMF94 not for TS7700), on a hourly basis - download only:
  - Total mounts
  - Total ejects
  - Total inserts
  - Average and maximum amount of time a cartridge was mounted on a drive (residency)
  - Average and maximum amount of time needed to perform a single mount
  - Average and maximum amount of time needed to perform an eject

  Restriction: These statistics can be downloaded using the TS3500 data gathering facility; however, they are not included in the SMF records processed by the Library Manager.

TS3500 tape library data gathering

The IBM System Storage Tape Library Specialist Web interface enables you to manage storage devices of the IBM TS3500 Tape Library using the LAN of your enterprise. The Tape Library Specialist allows you to communicate directly with your library and perform a full range of user, operator, and administrator tasks without being at the Operator Panel. The Web interface is included with models L22, L23, L52, and L53. It is also available as feature code (FC) 1662 for Model L32. The Tape Library Specialist requires a Category 5 Ethernet cable (not supplied with the tape library). Either you or your IBM Service Support Representative (SSR) can install it.

You can use the Tape Library Specialist Web interface to download the files in comma-separated value (CSV) format that contain information for analyzing the library, drives, Fibre Channel ports, and the health of the cartridges:

- Library Statistics.csv

  This file contains information about the maximum and average cartridge residency, mount, and eject times, and total cartridge inserts, mounts, and ejects. The information is provided for each hour of a 24-hour period and for each logical library. (These statistics are only available for L23 and L53 libraries with firmware level 6110.)

- Drive Statistics.csv

  This file contains information about each drive since the last library reset.

- Port Statistics.csv

  This file contains Fibre Channel port information since the last library reset.

- Mount History.csv

  This file includes statistics about the last 100 cartridges that were demounted in the library and information about the IBM System Storage TS1120 and TS1130 tape drives (check the required firmware level of the drives), as well as the TS1040 tape drives. The statistics are derived from the customer-centric Statistical Analysis and Reporting System (ccSARS).

You can use the data to identify storage area network (SAN), drive, or media performance trends. The CSV file format can easily be imported into most spreadsheet and database programs.

For more information about the meaning of the statistics, refer to the *IBM System Storage TS3500 Tape Library with ALMS Tape System Reporter User's Guide,* GA32-0589, or ask your SSR or IBM Business Partner for the Introduction in the IBM System Storage white paper, *TS3500 Tape Library Data Gathering*, which is only on the IBM intranet or Partner World:

http://w3-03.ibm.com/sales/support/ShowDoc.wss?docid=H966731Y59713R82&infotype=SK&infosubtype=M0&node=brands,B5000&ftext=TS3500wp&sort=date&showDetails=true&hitsize=50&offset=0&campaign=

Tape System Reporter (TSR) feature

The IBM Tape System Reporter application is a Windows-based GUI software application that allows you to monitor and generate reports for multiple TS3500 tape libraries and associated tape cartridges and tape drives.

The TSR application enables operators and administrators of the TS3500 Tape Library to monitor and report on storage devices from any location in an enterprise environment. This application communicates directly with your library to collect and store pertinent data enabling you to generate and view performance trends.

The IBM TSR application is bundled with your Advanced Library Management System (ALMS) purchase. It reports mount history for the cartridges and drives in all TS3500 Tape Library frame models and provides additional information about the library performance of models L23 and L53. The TSR does not provide any mount history data for the Ultrium 1 Tape Drive.

The IBM TSR application operates by collecting information from a TS3500 Tape Library, aggregating the data in a database, and providing you with the ability to generate a general SQL query or custom report on the utilization and performance of tape cartridges, tape drives, and the tape library. Either you or IBM Lab Services can install TSR.

> **Note:** Use of the TSR application requires that you establish database connectivity through firewalls and to any tape libraries that it will monitor.

For more information about the prerequisites for using IBM TSR, installing and setting up the application, working with the Derby database, and generating reports, refer to the *IBM System Storage TS3500 Tape Library with ALMS Tape System Reporter User's Guide,* GA32-0589.

Monitoring with the 3953 ETL Specialist

The 3953 Library Manager provides performance statistics regarding the 3953 logical library for the Native, VTS 1, and VTS 2 partitions.

From the Enterprise Tape Library (ETL) Specialist, select **Monitor Library Manager → Performance Statistics** (refer to Figure A-2 on page 440). You can obtain the following information regarding the logical library within the TS3500 Tape Library that is associated with the 3953 Library Manager. These statistics reflect activity involving physical volumes in the library:

- The number of physical mounts for the previous seven days
- The number of physical mounts for the previous 24 hours
- The number of physical mounts per hour for the previous 24 hours
- The average physical mount time for the previous 24 hours
- The number of physical ejects for the previous 24 hours
- The number of physical inserts for the previous 24 hours
- The number of physical audits for the previous 24 hours
- The peak number of physical mounts per hour for the previous 24 hours
- The time when peak physical mounts per hour occurred
- The number of physical mounts during the last hour
- The number of physical demounts during the last hour
- The number of physical ejects during the last hour
- The number of physical inserts during the last hour
- A graph showing the number of physical mounts per hour during the previous 24 hours

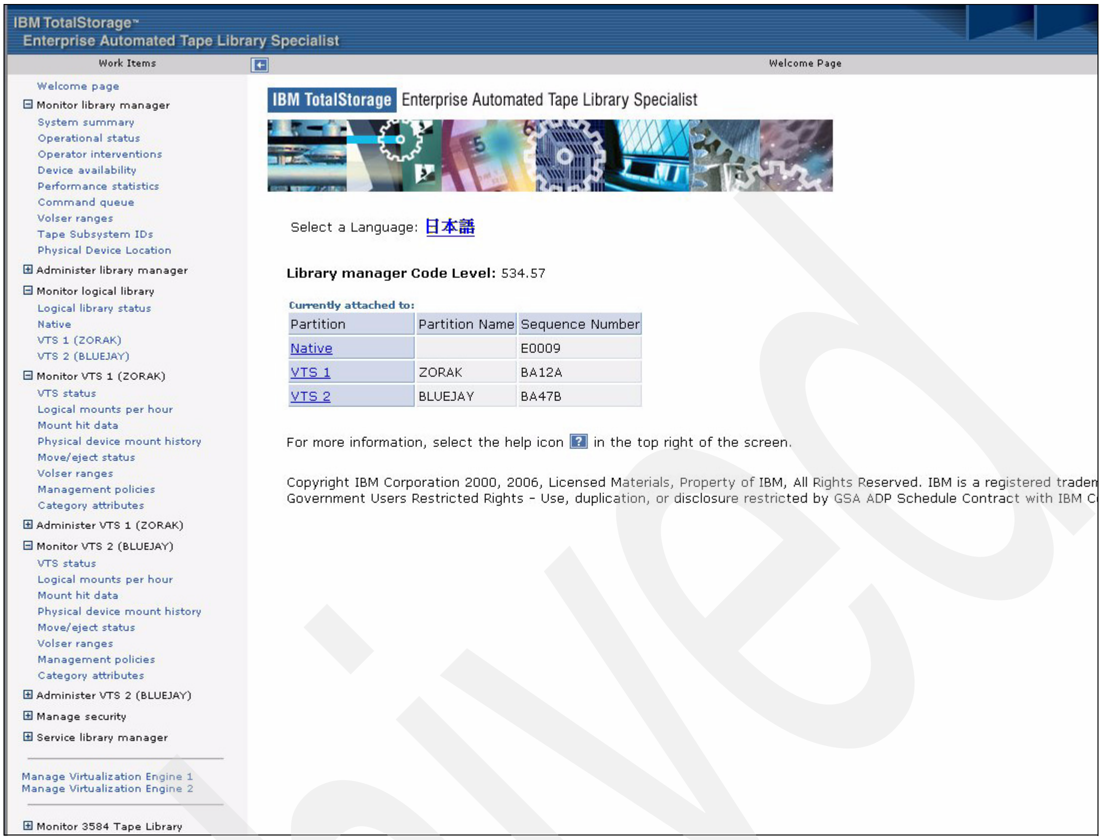


Figure A-2 ETL Specialist for monitoring library, TS7700, and VTS

Note: Activities involving TS7700 Virtualization Engine or VTS logical volumes are not part of these statistics. Refer to “Monitoring the TS7700 or VTS with the 3953 ETL Specialist”.

For further information, refer to *IBM System Storage 3953 Library Manager Model L05 Operator Guide*, GA32-0558.

Monitoring the TS7700 or VTS with the 3953 ETL Specialist

For a TS7700 Virtualization Engine or a VTS attached to a 3953 Library Manager, performance data is also available. From the Enterprise Tape Library (ETL) Specialist, select **Monitor VTS *x***. On the left side of the panel shown in Figure A-2, you can see the items that you can select to monitor a VTS partition:

VTS status
Displays general information about the VTS partition, such as the model of virtualization subsystem attached to this VTS partition, as well as configuration information.

Logical mounts per hour
Displays the number of logical mounts per hour, which includes the sum of Fast Ready mounts, cache hit mounts, and physical mounts (recalls). Data is displayed for the previous 24 hours.

Mount hit data Displays the distribution as a percentage of three types of logical mounts: Fast Ready hits, cache hits, and physical mounts required. Data is displayed for the previous 24 hours.

Physical device mount history Displays the maximum, average, and minimum numbers of physical tape drives used at one time to mount stacked volumes. Data is displayed for the previous 24 hours.

Move/eject status Displays two tables: the status of in progress eject and move stacked volume requests.

VOLSER ranges Summarize the current defined VOLSER ranges for the TS7700 stacked volumes.

Management policies Display the current TS7700 management policy settings for inhibit reclaim and the free storage threshold. These values can be changed at the Library Manager Console, but not from the Specialist panel.

Category attributes Display the Library Manager categories that have the Fast Ready attribute set. The Fast Ready attribute can only be changed from the Library Manager Console.

For further information, refer to *IBM System Storage 3953 Library Manager Model L05 Operator Guide*, GA32-0558.

Monitoring the TS7700 with the TS7700 Management Interface

The TS7700 Management Interface (MI) belongs to the family of tools used for reporting and monitoring IBM storage products. The MI can be used for online queries about the status of the TS7700 Virtualization Engine, its components, and the Distributed Libraries. It also provides information about the copies that have not been completed yet and the amount of data to be copied in a Multi Cluster TS7700 Grid.

The TS7700 Management Interface is based on a Web server that is installed in each TS7700 Virtualization Engine. You can access the TS7700 Management Interface pages from the 3953 ETL Specialist and the opposite is also true, because there is a link between the products that enables you to switch between them seamlessly and hence easily find the required information. From the ETL Specialist, you can navigate further to the attached physical TS3500 Tape Library Specialist.

You can access the following selections if you navigate within the TS7700 Management Interface and click **Performance & Statistics**. On the left side of the panel shown in Figure A-3 on page 442, you can see the items that you can select:

- Logical Mounts
- Physical Mounts
- Host Throughput
- Cache Throttling
- Cache Utilization
- Grid Network Throughput

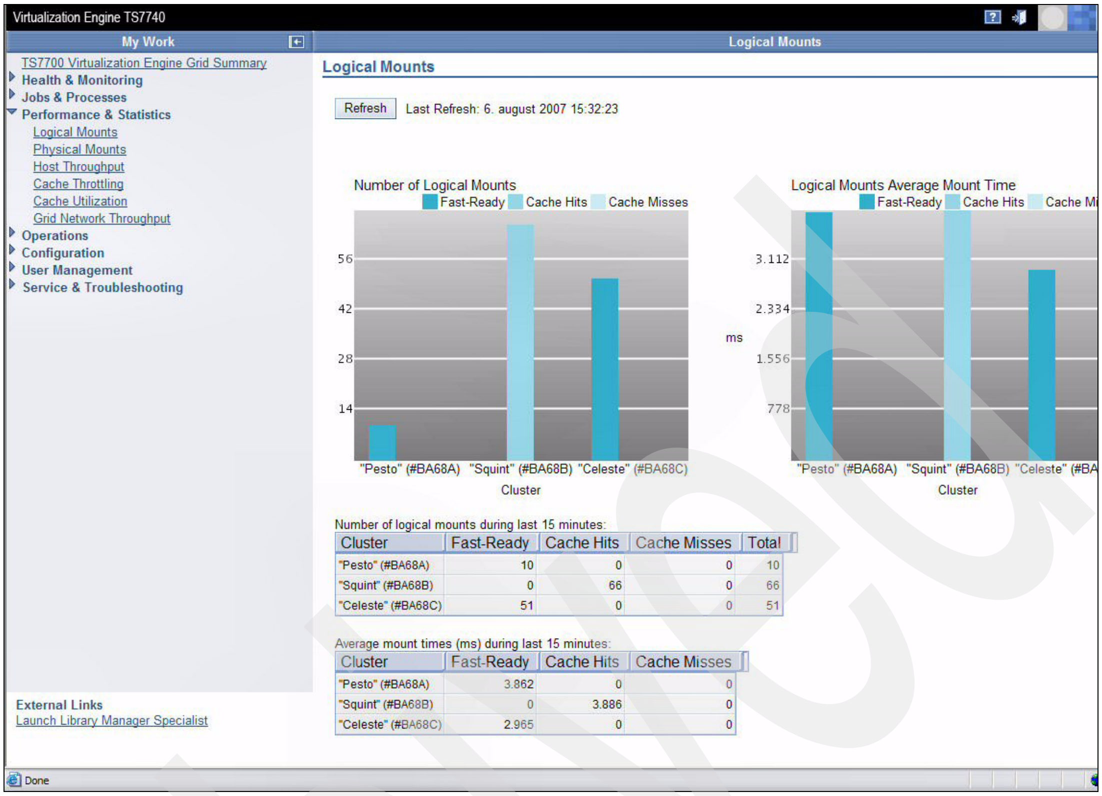


Figure A-3 TS7700 Management Interface showing logical mounts on a Three Cluster Grid

For more information about monitoring a TS7700 Virtualization Engine using the TS7700 Management Interface, refer to *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312.

Bulk Volume Information Retrieval (BVIR)

The IBM TotalStorage 3494 Virtual Tape Server (VTS) revolutionized the way System z clients utilized their tape resources. To help the client monitor the performance of the VTS, various statistics were developed. These statistics appeared in two forms: hourly records sent to the hosts known as SMF94 records and periodic real-time statistics available through the library's Web Specialist.

For the next generation of VTS, the TS7700 Virtualization Engine, the statistics design has been revised. The TS7700 does not send SMF type 94 records to be stored at the host, but rather writes statistical records to a TS7700 database. Various statistics from the VTS have been retained, and new statistics relevant for the TS7700 have been added.

The TS7700 Virtualization Engine provides different types of statistics:

- Point-in-time statistics: These statistics report operations over the last 15 second interval to help answer, "What is going on now?"
- Historical statistics: These statistics report operations in 15 minute intervals. Intervals are accumulated on a daily basis (96 intervals/day) and 90 days of historical statistics are retained in the TS7700 subsystem. The question that these statistics are intended to help answer is, "How are you using the resources?"

- An audit function is available with TS7700 R1.4A to evaluate the copy status on one or more TS7700 clusters in a grid:
  - You will get a list of volumes that do not have a valid copy according to the copy policy of the audited cluster.
  - This function provides information to use in determining the recovery point after a disaster.
  - This function also can be useful if you want to determine if all needed copies have been made before removing a cluster from a grid.

With the potential to support hundreds of thousands of logical volumes in a TS7700 Virtualization Engine, providing a set of information for each of those volumes through normal channel control type commands is impractical. Luckily, the functions of a TS7700 subsystem that allow it to virtualize a tape volume also allow for a simple and effective method to transfer the information to a requesting application. The TS7700 converts the format and storage conventions of a tape volume into a standard file managed by a file system within the subsystem. These statistical records are available to a host through the Bulk Volume Information Retrieval (BVIR) facility.

The BVIR facility uses an IBM standard-labeled tape volume to both initiate a request for information and to return the results. By using a standard tape volume, no special interfaces or access methods are needed for an application to use this facility. In practice, no specific applications are required, because standard IBM utilities, such as IEBGENER, provide the function needed to request and obtain the information.

> **Note:** The BVIR function was first introduced on the prior generation of Virtual Tape Servers. It can also be used to get statistical data from a 3494 Model B10 or B20. Its use has been expanded with the introduction of the TS7700 Virtualization Engine. For the monitoring and adjustment of the grid links and for the control of copies within a grid, there are two new functions available with TS7700 R1.4A:
>
> - Dynamic link load balancing
>
>   Today, the copy-workload, which has to go to the other clusters within a grid, is balanced equally on the grid links. The *dynamic link load balancing* function compensates for unbalanced network performance by different network equipment or path length. A host console request provides information about the performance of the grid links from the perspective of a specific TS7700.
>
> - Host console copy control
>
>   A host console request is available to suspend/resume logical volume copies on a cluster basis. For example, you can suspend the copy for a specific logical volume in a three site grid (local-local-remote) on the remote cluster only.

There are two steps to obtain information using this facility (refer to Figure A-4 on page 444):

1. A single dataset with the information request is written to a logical volume. During Close processing, the TS7700 Virtualization Engine server will recognize it as a request volume and “prime” the subsystem for the next step.
2. The request volume is again mounted, this time as a specific mount. Seeing that the volume was “primed” for a data request, the TS7700 appends the requested information to the dataset. When the TS7700 has completed appending to the dataset, the host is notified that the mount has completed.

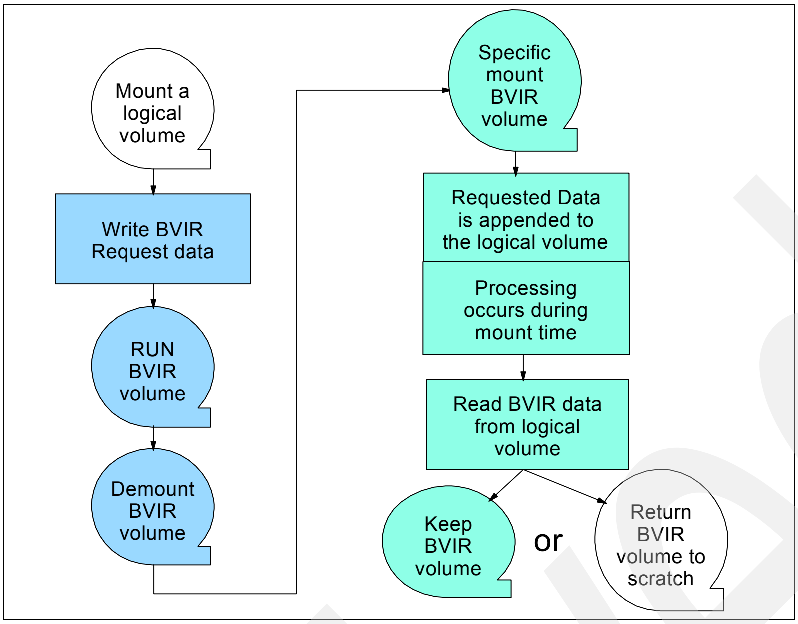


Figure A-4 BVIR process flow

The requested data can then be accessed like any other tape dataset. To convert the binary response records from BVIR, you can use the tool that is provided by IBM, which is called VEHSTATS. IBM provides, as well, a white paper with the record layout of the binary BVIR response data, which you can use to decode the binary file or which you can use to program your own tool. The white paper is *IBM TotalStorage Virtual Tape Server 3494 Bulk Volume Information Retrieval Function User's Guide*. It is available for IBM Business Partners and IBM employees on the Web at:

http://w3-03.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP100430

For clients:

http://www-1.ibm.com/support/docview.wss?rs=0&q1=BVIR&uid=tss1wp100430&loc=en_US&cs=utf-8&cc=us&lang=en

For more information about BVIR and VEHSTATS prerequisites, how to get the tools, and how to use them, refer to *IBM Virtualization Engine TS7700: Tape Virtualization for System z Servers*, SG24-7312.

Library Request command

The Library Request host console command provides a way for an administrator or an operator to determine the status of the TS7700 and obtain information about the resources of the TS7700, as well as prioritizing part of the active work. The Library Request host console command also enables the client to perform problem determination and act proactively, for instance, about the delays of single important jobs waiting for recalls from back-end drives.

The command was introduced with the TS7700 Virtualization Engine code level 8.3.*x.x*. z/OS support is also required. Refer to object access method (OAM) APAR OA20065 and device services APARs OA20066, OA20067, and OA20313.

A detailed description of Library Request commands and responses is available from *IBM Virtualization Engine TS7700: Tape Virtualization For System z Servers*, SG24-7312.

Volume mount analyzer (VMA) reporting for tape utilization

The *volume mount analyzer* is a program that helps you analyze your current tape environment. You use VMA to study tape mount activity and monitor tape media use. This program was originally introduced to gather information for preparing Tape Mount Management (TMM).

VMA is a good source to provide information about your tape environment. It uses SMF records for input. Therefore, this information is available for every I/O device installed, regardless of the vendor.

This program is useful for determining maintenance windows for hardware and microcode. It also helps determine whether new applications or users will find enough available drives in a specific tape library at the time that they need them. In an environment with multiple z/OS users using the same Library Manager partitions, you can create a focal point to get exact information about the total workload transferred to these host logical libraries. You cannot get information about the total workload of a TS3500 Tape Library, because you cannot get the information about the number of real mounts, as well as workload, from attached Open Systems environments.

Another good option is to use the information from VMA if you want to migrate to a new tape library or to new drives and media. VMA allows continuous tracking and monitoring of your workload and allows you to see a trend of your data growth. It enables you to recognize bottlenecks and to perform the appropriate sizing of upgrades.

Note that there is a restriction regarding TS7700 Virtualization Engine and VTS.

> **Restriction**: VMA reports do not provide information about the exchanges (demount and mount) of the physical TS3500 Tape Library. The mount information and the demount information are only for the TS3500 logical library that is managed by the Library Manager.

Installation and customization

VMA is a no charge feature from DFSMS. It is delivered with the base code. No additional installation is required. The SMF type records 14, 15, 21, and 30 are the input for VMA. If the SMF record is not already enabled, add it to SMFPRM*xx* in SYS1.PARMLIB.

Creating an extractor file

In the SMF type records (especially 14 and 15), all I/O devices are reported, not only tapes. If VMA reports directly access this data, the jobs are impacted by many records that are never used.

As a result, VMA creates an extractor file. This file contains only the records written by tape devices and stores them in a compacted format.

Creating VMA reports

VMA introduces many types of selection criteria. This criteria can include device types, device ranges, system ID in the SMF record, dataset name-patterns, hierarchical storage management (HSM) or NONHSM, and more. The selection criteria helps you create a report exactly as you need it. You can concatenate extractor files if necessary.

The following examples show how to control VMA reports:

- To report all datasets smaller than 200 MB and sort by size:

  `REPORT(DATASET) MAXSIZE(200) DSORT(SIZE)`

- To report the hierarchical storage management (HSM) usage:

  `REPORT(TOP,USAGE) USAGE(HSM)`

- To get the GB distribution per hour:

  `REPORT(TOP)`

- To get device usage per hour only for a specific device range:

  `REPORT(USAGE) UADR(INCLUDE(400*,401*))`

- To report a specific dataset pattern:

  `DATASET(INCLUDE(HSM.**,SAVE.DAY.**))`

Remember that you can combine the filter techniques of VMA, which can make VMA quite a powerful tool.

Restrictions with TS7700 and VTS

A workload that is directed to a TS7700 Virtualization Engine or VTS shows you 3490E traffic and the virtual drive view. There is no way to obtain information about:

- The usage of the physical installed drives and models
- The back-end traffic regarding reclaim
- Recall times
- The physical mounts and demounts in the library

This information is only provided in SMF94 for the 3494 library and through VEHSTATS for the TS3500 library.

> **Note:** For information about the total exchanges (mounts and demounts) from an TS3500 Tape Library, you must use the TS3500 Specialist.

Implementation considerations for multiple z/OS users

This section provides hints and tips to create an environment for monitoring and troubleshooting in multiple z/OS and Library Manager partitions. If you monitor your environment or look for bottlenecks, you might have two views regarding the installed tape environment:

- The platform view:
  - How many workloads are necessary to create the system/sysplex?
  - How many drives are needed in a time frame from the system/sysplex?
  - Which workload is done (HSM, DFDSS, and so forth)?
  - What is the trend of this workload (increasing?)
- The installed I/O devices and logical tape library view:
  - How many workloads are directed in a logical library:
    - One day?
    - One hour?
    - In the batch window?
  - How many drives are used in which time frame?

To answer these questions, regular VMA reports are needed. Sometimes, you also need to compare data for detailed troubleshooting. The following implementation is an example of getting this information on a daily basis:

1. Run the extractor on each system/sysplex and store it in a generation dataset (GD) limit for 30 days.
2. Run the necessary VMA reports on a daily basis, scheduled through your scheduling system:
   - Total workload from this system/sysplex (all tape devices, all libraries)
   - Workload to a specific library from this system/sysplex
3. Store the output (either in an output management system or on a direct access storage device (DASD)).
4. Create a focal point on one system. Then, transfer SMF type 14, 15, 21, and 30 records (not extracted through VMA) to this system.
5. Merge SMF type 14, 15, 21, and 30 records from all the systems in your environment.
6. Run an extractor of the SMF record file created in step 5, and store it in a Generation Data Group dataset (GDGD) limit for 30 days.
7. Run the necessary VMA reports on a daily basis scheduled through your scheduling system. They need to be based on the total workload from all systems/sysplexes to each specific library.
8. Store the output (in an output management system or on DASD).

The advantages of this implementation are that you:

- Have detailed information from a host view (on the logical environment of a virtualization system only)
- Have comparison data
- Have data from three weekends and month-end processing
- Have the necessary SMF data available for IBM sizing tools
- Can always run additional VMA reports, without reading SMF raw data again

> **Note:** The size of a VMA extractor file depends on the amount of SMF data and the percentage of tape workload that you have. Allow approximately 10 tracks of the VMA extractor file per 1 million SMF records in an environment with high tape usage.

Tape tools

Tape tools are highly sophisticated tools. This section gives you an overview of the tools, the benefits that they offer, the input sources that they need, and the output that they deliver. Tape tools are available on the following client Web site:

ftp://ftp.software.ibm.com/storage/tapetool

Additional tools (refer to “Additional tools” on page 456) are available only for IBM Business Partners or IBM employees.

For questions or suggestions regarding tape tools, send an e-mail to TAPETOOLS@us.ibm.com.

Tape tools for multiplatform systems

VTSLOGRP is the only monitoring tool for a shared VTS among multisystem platforms. It uses the input of the Library Manager and SMF records to show the virtual drive activity, the physical drive activities, and information about the total volume cache (TVC) (cache hits and misses).

VTSLOGRP does not support Peer-to-Peer (PtP) VTS.

Table A-1 lists the personal computer-based tape tools.

Table A-1 Personal computer-based tape tools

Tool	Major use
VTSLOGRP	Multiplatform VTS monitoring tool run on the 3494 Library Manager (personal computer-based)
VTSGRAPH	Tool that creates Freelance presentations, which is based on VTSLOGRP and VTSSTATS

Tape tools for z/OS

There are many tape tools on the FTP server that are usable in a z/OS environment. Table A-2 and Table A-3 on page 452 provide information about their major uses, benefits, necessary input, and the output that they create.

Certain tape tools have an expiration mechanism. There are several updates for these tools to provide new hardware, such as VTS B10 and B20, or new functions, such as Advanced Policy Management (APM). Therefore, these tools expire to give you the opportunity to obtain the latest version. We recommend that you pick up the newest version every six months to prevent a sudden expiration.

The file OVERVIEW.PDF gives a brief description of all the tools.

You need to review the UPDATES.TXT file more frequently just to evaluate if something has been changed in the tool that you use on your system.

> **Restriction:** The tools relying on SMF data can only show the data for 3953 logical libraries. They are not aware of the TS3500 Tape Library. All information about mount and demount is related only to the logical libraries or (if determined with SMF type 14, 15, 21, and 30 records) to the z/OS system. For information regarding the TS3500 Tape Library, you must use the TS3500 Specialist.

Table A-2 z/OS tape tools: Major use and benefits

Tools for TS3500 and TS7700/VTS		
Tool	**Major use**	**Benefit**
VEPSCAN	Shows the TS7700 and 3953 Library Manager serial numbers for Point-in-time statistics.	Shows the LIBRARY-IDs of the TS7700 and 3953 Library Manager.
VEHSCAN	Shows the TS7700 and 3953 Library Manager serial numbers for historical data.	Shows the LIBRARY-IDs of the TS7700 and 3953 Library Manager.

VTSCAN94	Shows the VTS and 3494 serial numbers.	Shows the LIBRARY-IDs of the VTS and 3494.
MOUNTMON	Monitors mount pending and volume allocations.	Determines accurate mount times and concurrent drive allocations.
LIBMANGR	Library content management.	Allows user to identify and eject non-mounted volumes.
ST@S3953	Reports 3953 library statistics.	Monitor your environment.
ST@S3494	Reports 3494 library statistics.	Monitor your environment.
Tools for TS7700/VTS only		
Tool	**Major use**	**Benefit**
BADBLKSZ	Identifies small TS7700/VTS block sizes.	Improves performance and make jobs run fast.
EXPORT	Quantifies VTS export/import processing times.	Determines the times of export/import in advance. Checks if export/import is viable.
VEPSTATS	TS7700 performance for Point-in-time reporting.	Shows how TS7700 performs at a specific time.
VEHSTATS	TS7700 performance for historical reporting.	Shows how TS7700 performs over a period of time.
VTSSTATS	VTS performance reporting.	Shows how VTS performs.
VOLREUSE	Shows volume reuse activity.	Identifies the dataset for TS7700/VTS cache management.
TAPECOMP	Shows the actual derived tape compression ratios.	Gets information about the reached compression ratio.
BVIRVTS	Bulk Volume Information Retrieval request for further data processing.	The only tool to get data from the TS7700 - input for BVIRRPT.
BVPITRPT	Point-in-time statistics.	Reports the current load figures.
BVIRPLNN	Statistics of media pool.	Reports the used percentage of the back-end volumes.
BVIRMES	Reports virtual volumes that have to be copied to get a TS7700 grid in sync.	Helps to accelerate the synchronization process after a move from VTS to TS7700.
BVIRPOOL	Creates a report of all defined pools.	Used for housekeeping purposes.
BVIRHSTV	Historical data is written to DASD in RECFM=VB.	Input for VEHSTATS.
BVIRHSTU	Historical data is written to DASD in RECFM=U.	Input for VEHSTATS.

BVIRHSTS	Historical data is written to SMF.	To further exploit SMF-based reporting.
BVIRPRPT	Report of volumes that have to be synchronized.	Used to synchronize a PtP VTS.
BVIRPIT	Creates the input for the Point-in-time reports.	The only tool for TS7700
COPYVTS	Creates recall jobs for a VTS synchronization.	Helps to synchronize a PtP VTS.
VESYNC	Audits the TS7700 for volumes that do not have a copy.	Helps to synchronize a TS7700 grid.
TVCBYDSN	Creates a list of dataset names that currently are in cache.	Can be used to improve your critical batch job chain.
TVC2VOL	Check volumes in TVC to see if they have a tape copy.	TS7700/VTS management.
Tools for migration or decisions where to go next		
Tool	**Major use**	**Benefit**
CHGDATE	Changes dates in SMF type 14, 15, 21, 30, and 40 records.	Allows analyst to simulate combining workloads from two periods.
DCOLLRPT	Reports the number of Tape Mount Management (TMM) migrated datasets.	Identifies the size of TMM data if considering VTS.
FINDLRG	Identifies multivolume tape datasets.	Creates a filter list to separate 3590 workload for Batchmagic.
FSRTMM	Quantifies TMM usage.	Identifies TMM activity. Redirecting to TS7700/VTS saves CPU cycles.
CLEANDIL	If you plan to move ‘DILIGENT’ to a VTS.	Simulates the move.
Tools for the tape management system		
Tool	**Major use**	**Benefit**
BVIRRPT	Identifies TS7700/VTS virtual volumes by owner.	Determines which applications or user have virtual volumes.
CHKDUPS	Identifies duplicate VOLSERs.	Finds duplicate VOLSERs.
ORPHANS	Identifies orphan datasets in Tape Management Catalog.	Cleans up the tool.
CRTDIST	Shows the volume created over time.	Shows client use patterns of volumes.
EXPDIST	Quantifies the number of volumes expiring in *n* days from now.	Determines the rate of return to scratch.
OFFSITE	Identifies the datasets sent off-site.	Creates a filter list to separate off-site workload.

BIRTHDST	Finds old cartridges.	Improves data reliability.
DIFFEXP	Identifies multifile volumes with different expiration dates.	Prevents a single file from not allowing the volume to return to scratch.
LASTLIST	Reports VOLSERs last referenced between SDATE/EDATE.	Determines how many VOLSERs were last referenced during a period.
VOLLIST	Shows all active VOLSERs from the tape management catalog. Also, gets volume counts by group, size, and media.	Takes a picture of the user data naming convention. Sees how many volumes are allocated to different applications.
EXPORT	Quantifies VTS export/import processing times.	Determines if Eject/Insert is viable.
GETVOLS	Gets VOLSERs from a list of dsnames.	Automates input for prestage.
PTPSYNC	Synchronizes VTSs after PtP creation.	Determines volumes that need sync to orderly recall.
PRESTAGE	Recalls volumes to TS7700/VTS.	Is ordered and efficient.
TMCREUSE	Identifies datasets with create date equal to last referenced date.	Gets candidate list for TS7700/VTS PG0.
COPYCNT	Reads TMS catalog and lists active dsnames.	Helps housekeeping.
FORMCATS	Builds a common record format of different TMS systems.	Used for tape analysis.
RMMVLT2	Unloads VRS report to tape.	Used for tape analysis.
RMMEXTR2	Creates extract file of Removable Media Manager (RMM).	Used for tape analysis.
RMMVLT1	Creates a vault list.	Used for tape analysis.
Job environment and job improvement tools		
Tool	**Major use**	**Benefit**
IOSTATS	Reports job elapsed times.	Shows run-time improvements.
TAPEWISE	Identifies tape usage improvement opportunities.	Helps to improve the tape usage. Shows the wrong allocation types.
QSAMDRVR	Monitor and report Write/Read throughputs on tape drives.	Possible unequal loads.
Helping hands		
FILETIME	Measures file positioning times.	Determines positioning differences between drive types.

FSRMATCH	Replaces *.HMIGTAPE.DATASET in SMF14 with actual recalled name.	Allows TapeWise and other Tools using SMF type 14 and 15 record data to report the actual recalled dataset name.
SMFILTER	IFASMFDP exit or E15 exit.	Filters SMF records to keep tape activity only.
GRPDSN	Generic dsname lists.	Speeds up the process of making dsname lists generic, which makes tape study more accurate.
CHGSMFID	Change the SMF-ID in cases where multiple SMF files are to be processed.	Improves the quality of a tape analysis.

Table A-3 Tape tools: Necessary input, given output, and prerequisites

Tools for TS3500 and TS7700/VTS			
Tool name	**Input**	**Output**	**Prerequisites**
VEPSCAN	Data from BVIRPIT data file	The LIBRARY-IDs from the 3953 (Distributed and Composite)	None
VEHSCAN	Data from BVIR facility obtained using BVIRHIST	The LIBRARY-IDs from the 3953 (Distributed and Composite)	None
VTSCAN94	SMF94	The LIBRARY-IDs from the 3494 and PtP VTS (Distributed and Composite)	None
MOUNTMON	Is an active task, samples tape UCB	The number of mounts, mount times, tape allocation, and so forth	None
LIBMANGR	TCDB, TMS: CA1, TLMS, RMM, ZARA, CTLT	List of volumes not referenced in *n* days, eject list, detail content report	None
Tools for TS7700/VTS only			
Tool name	**Input**	**Output**	**Prerequisites**
BADBLKSZ	Logrec MDR TMS: CA1, TLMS, RMM, ZARA	VOLSER, *jobname*, and *dsname* for VTS volumes with small block sizes	None
BVIRRPT	BVIR data and CA1, TLSM, RMM, ZARA,CTLT	Logical volumes by *jobname* or *dsname*, logical to physical report	VTS 7.4 for size
EXPORT	CA1, TLSM, RMM, ZARA	Number of off-site volumes, MBs, amount of time for export/import process	None
VEPSTATS	Data from BVIR facility obtained using BVIRPIT	TS7700 Point-in-time reports on vNode, cache, physical drive usage, and Distributed Library statistics	None

VEHSTATS	Data from BVIR facility obtained using BVIRHIST	TS7700 Historical reports on vNode, cache, physical drive usage, and Distributed Library statistics	None
VTSSTATS	SMF94	VTS Physical drive usage, virtual drive usage, and TVC (cache) statistics; reclaim statistics	None
VOLREUSE	SMF type 14, 15, 21, and 30 records	Reuse distribution	None
TAPECOMP	Logrec MDR or EREP history file	Shift and hourly reports showing current read and write compression ratios	None
EXPORT	CA1, TLSM, RMM, ZARA, CTLT	Projected off-site volumes, MBs, amount of time for Eject/Insert process	None
GETVOLS	Tape management catalogs	VOLSER of requested dsn	None
PTPSYNC	BVIR map, tapecatalog	List of all VOLSERs to recall by application	None
PRESTAGE	BVIR maps	Job to prestage list of VOLSERs	VTS 7.2
TCMREUSE	CA1, TLSM, RMM, ZARA, CTLT	Filter list of potential PG0 candidates	None
Tools for migration or decisions where to go			
Tool name	**Input**	**Output**	**Prerequisites**
CHGDATE	SMF type 14, 15, 21, 30, and 40 records	Modified SMF records	None
DCOLLRP*x*	DFHSM MCDS file	Number of files and GBs	None
FINDLRG	CA1, TLSM, RMM, ZARA, CTLT	Dataset length distribution, used as input for Batchmagic	None
FSRTMM	HSM FRS records	Report showing ML0-ML2 and ML2-ML0 activity	SAS
Tools for tape management system			
Tool name	**Input**	**Output**	**Prerequisites**
CHKDUPS	CA1, TLSM, RMM, ZARA, CTLT	List of duplicate VOLSERs	None
ORPHANS	CA1, TLSM, RMM, ZARA, CTLT	List file shows all multi-occurrence GDG datasets that have not been created in the last *nn* days	None
CRTDIST	CA1, TLSM, RMM, ZARA, CTLT	Distribution of create dates	None
EXPDIST	CA1, TLSM, RMM, ZARA, CTLT	Volume count distribution by media	None

OFFSITE	CA1, TLSM, RMM, ZARA, CTLT	Report and a disk file filter list of off-site dataset names	None
BIRTHDST	CA1, TLSM, RMM, ZARA, CTLT	List of active data on old cartridges and cartridge birth date distribution	None
DIFFEXP	CA1, TLSM, RMM, ZARA, CTLT	List of files not matching file one expiration date	None
LASTLIST	CA1, TLSM, RMM, ZARA, CTLT	List of VOLSERs and dsnames	None
VOLLIST	CA1, TLSM, RMM, ZARA, CTLT	Dsname, VOLSER, create date, volume sequence; group names and counts by media type	None
Job environment and job improvement tools			
Tool name	**Input**	**Output**	**Prerequisites**
IOSTATS	SMF type 30 records	Job step detail reporting	None
TAPEWISE	SMF type 14, 15, 21, 30, and 40 records	UNIT_AFF, early close, Unit=(TAPE,2) multimounts, users of allocations, and so forth	None
Helping hands			
Tool name	**Input**	**Output**	**Prerequisites**
FILETIME	Runtime parameters	Positioning time reports	None
FSRMATCH	FSR records, plus SMF type 14, 15, 21, 30, 40, and so forth records	Updated SMF14, plus all other SMF records as they were	None
SMFILTER	SMF data	Records for tape activity, plus optional TMM activity	None
GRPDSN	Dsname list	Generic dsname list	None

The following sections describe four of these products in detail:

- MOUNTMON
- TAPEWISE
- VEHSTATS
- VTSSTATS

MOUNTMON

Use MOUNTMON to answer the following questions:

- How many tape mounts occur in general or per device type?
- How many scratch mounts and how many specific mounts?
- How long does it take to mount a tape?
- How long are tapes allocated?
- How many drives are used at any time?
- Which jobs are allocating to many drives?

MOUNTMON is the most accurate source of concurrent drive usage reports. For details of MOUNTMON, refer to the presentation that is available on the FTP server at:

`ftp://ftp.software.ibm.com/storage/tapetool/mountmon.pdf`

TAPEWISE

Tape Usage Analyzer (TAPEWISE) is based on SMF type 14, 15, 21, 30, and (40) records. It gives you information about how many drives are used and how many mounts are done. It also gives you an idea about the following items:

- Who is using too many drives?
- Do media errors occur?
- How many allocation delays occur?
- Does remounting of the same VOLSERs occur?
- Are there allocations without open?
- Which is used: UNIT=AFFF or UNIT=(TAPE,2)?
- Why do we experience a long allocation of tapes, but only a small amount of data is transferred?
- What datasets are recalled in a VTS?

For details about TAPEWISE, refer to the presentation available on the FTP server at:

ftp://ftp.software.ibm.com/storage/tapetool/tapeWise.pdf

VEHSTATS

The IBM TS7700 Virtualization Engine's activity is recorded within the subsystem. There are two types of statistics:

- **Point-in-time statistics**: Snapshot™ about activity of the last 15 seconds
- **Historical statistics**: Up to 90 days in 15 minute increments

Because both types of statistical data are delivered in binary format from the BVIR functions, you need to translate the content into a readable format. You can perform this translation manually by using the information provided in the *Virtualization Engine TS7700 Series Statistical Data Format* white paper, which is available from:

http://www-1.ibm.com/support/docview.wss?rs=0&q1=BVIR&uid=tss1wp100829&loc=en_US&cs=utf-8&cc=us&lang=en

Or, you can use an existing, automated tool.

IBM provides a tool called *VEHSTATS*. Like the other IBM tape tools, the VEHSTATS program is provided as-is without official support for the single purpose of showing how the data might be reported. There is no guarantee of its accuracy, and there is no additional documentation available for this tool.

You can use VEHSTATS to monitor TS7700 Drive and Tape Volume Cache (TVC) activity and to analyze trends to see where the bottlenecks are and whether an upgrade, such as adding additional physical tape drives, might improve the overall performance of the TS7700 Virtualization Engine. VEHSTATS is not a projection tool, but it provides the basis for an overall health check of the TS7700 and reports the following information:

- Virtual drive activity:
  - Number of drives allocated
  - Number of mounts (Fast Ready, read hits, read misses)
- Physical drive activity:
  - Number of drives allocated
  - Mounts for recall, pre-migration, reclaim

- Tape Volume Cache activity:
  - MBs read and written to Tape Volume Cache
  - MBs read and written to physical tape
  - Virtual volume size
  - Logical volumes managed
- Recall and write overrun statistics
- Percentage of throttling and average throttle value
- Number of scratch stacked volumes (available cartridge storage)
- Number of stacked private volumes (cartridges containing active data)
- Active cartridge data distribution:
  - Twenty values with number of volumes with 0 - 5%, 5 - 10%, and so forth of active data
  - Reclaim threshold
- Min/Max/Avg mount times for Fast Ready, read hits, and read misses
- Compression ratio achieved in the host adapter cards
- Compression ratio achieved between the TVC and drive
- Block sizes of data written to TS7700:
  - Average channel block size
  - Number of blocks written
  - Distribution of block sizes:
    - 0 to 2K, 2K to 4K, 4K to 8K, 8K to 16K
    - 16K to 32K, 32K to 64K, greater than 64K
- Reports by physical volume pool
- Reports by cache preference level

We provide guidance for interpretation of the reports in *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312.

VTSSTATS

VTSSTATS is based on SMF94 records. It summarizes the VTS activity on an hourly and daily basis. It gives you a complete and detailed view of the workload of your VTS for all attached users. It is used for:

- Monitoring VTS drive and Tape Volume Cache (TVC) activities
- Determining whether content management (cache management) is necessary
- Analyzing performance trends to see when an upgrade is needed (TVC sizes, physical drive attachment, and so forth)
- Monitoring the stacked volume environment
- Watching out for bottlenecks (throttling and small block sizes)
- For more information about how to use VTSSTATS, refer to *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring,* SG24-2229.

Additional tools

Certain tools are not available through the client Web site. Table A-4 on page 457 provides an overview of the tools that IBM uses.

Table A-4 Additional tools

Tool	Major use
Batchmagic	Analysis and projection of tape environments. Analyzes the tape usage today and creates simulations, for example, by introducing new technology. To produce a valid simulation, at least 30 days of SMF data input and TMC backups are necessary.
Tapemagic	Personal computer-based tool for VTS sizing.
EXIMCALC	VTS Import/Time Estimator (Lotus® 1-2-3®).
3584SLOT	Calculates available slots based on configuration (Lotus 1-2-3).

For more information, refer to the following Web site:

ftp://vtstools@service2.boulder.ibm.com

Monitoring and reporting scenarios

The following sections describe scenarios where various tools can be of assistance.

General considerations about monitoring and reporting

As long as you install your environment with generous resources, monitoring and reporting are not a priority. However, today the environments of most clients are based on the terms of "rightsizing and downsizing".

Tape libraries are not a DASD environment. The extension of a library is much more difficult than installing a new DASD string. Therefore, having a good knowledge of your environment or your client's environment is the key to establishing a right-sized, smoothly running, and no problem environment. This is the point at which monitoring and reporting become important.

If your installation is right-sized, monitoring and reporting are a number one priority. In this environment, the following problems might arise that do not occur in a generous environment:

- Huge workload growths
- Changing of production time lines
- Hardware failures

Most monitoring tools provide good information for troubleshooting and problem determination.

Reporting in different environments

There are two views for reporting:

- The view from your operating system platform (which workload and what amount of data is processed in this platform)

  In a z/OS platform, you can report the workload from a single system or sysplex with SMF type 14, 15, 21, and 30 records and review it with VMA (refer to "Volume mount analyzer (VMA) reporting for tape utilization" on page 445). Other platforms do not provide this information.

- The view of the logical library or VTS partition (what is processed in a logical library system or VTS)

  An SMF94 record contains all of this information for one 3953 Library Manager. SMF94 records are written in the Library Manager and are transferred automatically to an attached z/OS system. This record contains the workload for all attached users. If you process a report with tape tools, such as VTSSTATS, on the z/OS system, you receive information about the workloads that the library or VTS handled, in addition to the z/OS system where the job is running.

  TS7700 Virtualization Engine does not produce SMF94 records. You must use BVIR instead of VTSSTATS to get information about the workload processed by a TS7700 Virtualization Engine.

If you share your library or VTS among multiple users or platforms, you must consider that VMA reports are not enough to get a complete picture of the workload in a library.

Problem determination scenarios

This section provides example problem determination scenarios. It is not intended as a complete list but serves as a pointer to probable causes for common problems.

Native mounts are not handled in an adequate amount of time

Possible reasons for this are:

- Library degraded
- Too much physical movement in the library
- Scratch cartridges are relabeled because of an intermix of device types

You might want to look at the following areas to resolve the problem:

- Library Manager Main Menu, Intervention required

  z/OS: D SMS,LIB(*xxxx*),DETAIL command

- Library Manager statistics (TS3500 Specialist)
- Check with your IBM service support representative (SSR). The IBM SSR can see the actual “reached load point” time of the cartridge. Check the TAPE ON message in the syslog. If there is a big difference, relabeling is the possible reason.

Some possible solutions are:

- Repair the hardware.
- Reduce physical movement:
  - Check the home cell mode and positioning of cartridges.
  - Check movements for TS7700 or VTS reclaims (Threshold setting).
  - Reduce your APM pools.
  - There are too many users accessing the library.
  - Introduce a second gripper.
  - Introduce a second accessor.
- This solution only applies to scratch cartridges. If it happens, check with your IBM SSR. They can see the actual time of load point reached on the cartridge. Compare this time to the moment that you receive the TAPE ON message in your system. If there is a big difference, this difference is an indicator that a relabeling has occurred.

TS7700 or VTS logical scratch mounts not handled in adequate amount of time

A possible reason is that the Fast Ready scratch attribute is not set for this logical volume category. You might want to look at the Library Manager to resolve this problem. Select **Commands** → **System Management** → **Set VTS Category Attributes**. The solution is to set Fast Ready for the specific volume range.

Write jobs do not process adequately

Possible reasons for this are:

- No units (native or VTS partition) are available.
- Bottlenecks are in the channels.
- Control unit is busy.
- Bad traffic.
- Too much recall back-end processing.

You might want to look at the following areas to resolve the problem:

- z/OS library command DD LIBRARY
- RMF™ reports for channel
- RMF reports for control units
- Small block size processing (BDBLKSZ tape tool and VMA)
- VTSSTATS and BVIR

You cannot monitor Fibre Connection (FICON) using FICON directors in the intersection between the Director and the unit with z/OS tools.

Possible solutions are:

- Add more units, spread your jobs to different time slices, and look for allocation without open.
- Add more channels and introduce FICON.
- Add or upgrade to a C06 controller.
- For bad traffic, try to migrate to TS7700 or a VTS. Even if the traffic is not perfect, it performs better than in native drives. Try to increase the block size.
- Manage your cache with Initial Access Response Time (IART) or APM.

TS7700 or VTS recalls are not fast enough

Possible reasons for this are:

- Hardware is degraded.
- An insufficient number of physical drives are installed.
- Too high a migration threshold for stacked volumes.
- Too many physical pools are introduced with APM.
- Bad or no cache management.

You might want to look at the following areas to resolve the problem:

- z/OS display commands
- Issue Library Request commands to evaluate
- Issue Library Request Command to give higher recall priority to a specific logical volume
- ETL Specialist
- VTSSTATS, VEHSTATS, or BVIR
- APM and physical movement of cartridges in the ETL Specialist and the TS3500 Specialist

Several possible solutions are:

- Repair the hardware.
- Install more physical drives.
- Reduce a migration threshold. You might need more cartridges.
- Reduce pooling.
- Manage your cache with IART or APM.

Ejecting cartridges takes too long

Possible reasons for this are:

- Hardware is degraded.
- Too much physical traffic is in the library.

You might want to look at the TS3500 Specialist to resolve the problem.

Several possible solutions are:

- Repair the hardware.
- Look for a better time frame for ejecting (less movement in the TS3500 Tape Library).

Improvement in monitoring

Because the IBM TS3500, the Peer-to-Peer VTS, and the IBM 3953 Library Manager each has its own Web interface, you have to connect on each Web Specialist to get an overview of the current situation. You can navigate among the various Specialists, but you can also merge windows.

To have a complete picture of the system status both from a TS3500 Tape Library and from a Library Manager view, you can merge the two Specialists' panels onto one panel through an HTML script. This newly created Web page can be automatically refreshed with a time that you can choose.

To create this Web page:

1. Allocate an empty text document on your computer.
2. Use the text in Figure A-5 on page 461 as an example for your HTML script.

```
      <HTML>
  <HEAD>
 </HEAD>
<META HTTP-EQUIV="refresh" CONTENT="600">
<FRAMESET ROWS="22%,78%">
<frameset cols="50%,50%">
  <frame src="http://x.xxx.xx.xx/srvrroot/en/en-us/wsmast.htm">
<frame
src="http://y.yyy.yy.yyy/US/En_US-En_US-01286374939/Images/wgif_leftside.gif">
</frameset>
 <frameset cols="50%,50%">
        <frame src="http://x.xxx.xx.xx/srvrroot/en/en-us/wslll1.htm" name="sommaire">
        <frame
src="http://y.yyy.yy.yyy/US/En_US-En_US-01286374939/whtm_status_drive.htm"
name="principal">
</frameset>
</HTML>
```

Figure A-5   HTML script for Web Specialist

3. In Figure A-5, enter the time that you want in seconds for the automatic refresh. We recommend that you use a time between 3 minutes and 10 minutes to get a useful picture and allow the refresh to complete.
4. Replace the *x.xxx.xx.xx* and the *y.yyy.yy.yyy* with your IP addresses of the Specialist pages that you want to monitor.
5. Save and rename the extension "*txt*" by "*html*".
6. Double-click the document HTML to execute the script.

> **Note:** With Internet Explorer, you can always access and modify your source code. To activate your modifications, you need to refresh your Web page.

This script is only an example that you can customize with the address of the Web pages that you want to monitor. Just replace the Web addresses with those that are most important to your continuous monitoring. Note that the two first Web addresses are just a link to a .gif file showing the name of the machine and providing the heading of the Web page. They are not dynamic; you can also refer to them as simple text.

The two last addresses are dynamic and are the links to the Web Specialist page that you want to monitor. For the two last addresses, do not insert the address of a GIF, because they are not dynamic, they are just pictures called by the page.

To obtain the address of the Web Specialist, right-click the Web page that you want to display and select **Properties**. You will find the address in this box. For example, Figure A-6 on page 462 shows you the address of the IBM logo.

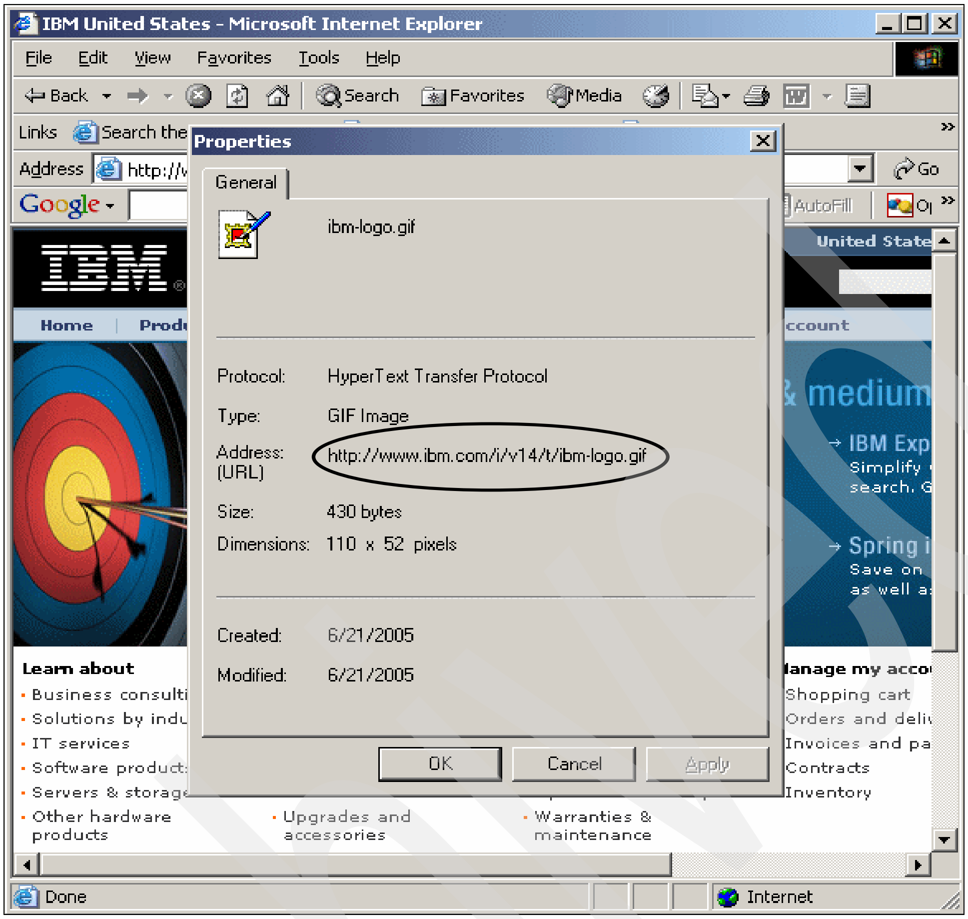


Figure A-6 Address of the IBM logo

Figure A-7 on page 463 shows the merger of two Web Specialists. On the left side, we monitor the status of the logical libraries, and on the right side, we monitor the drives of a TS3500 Tape Library.

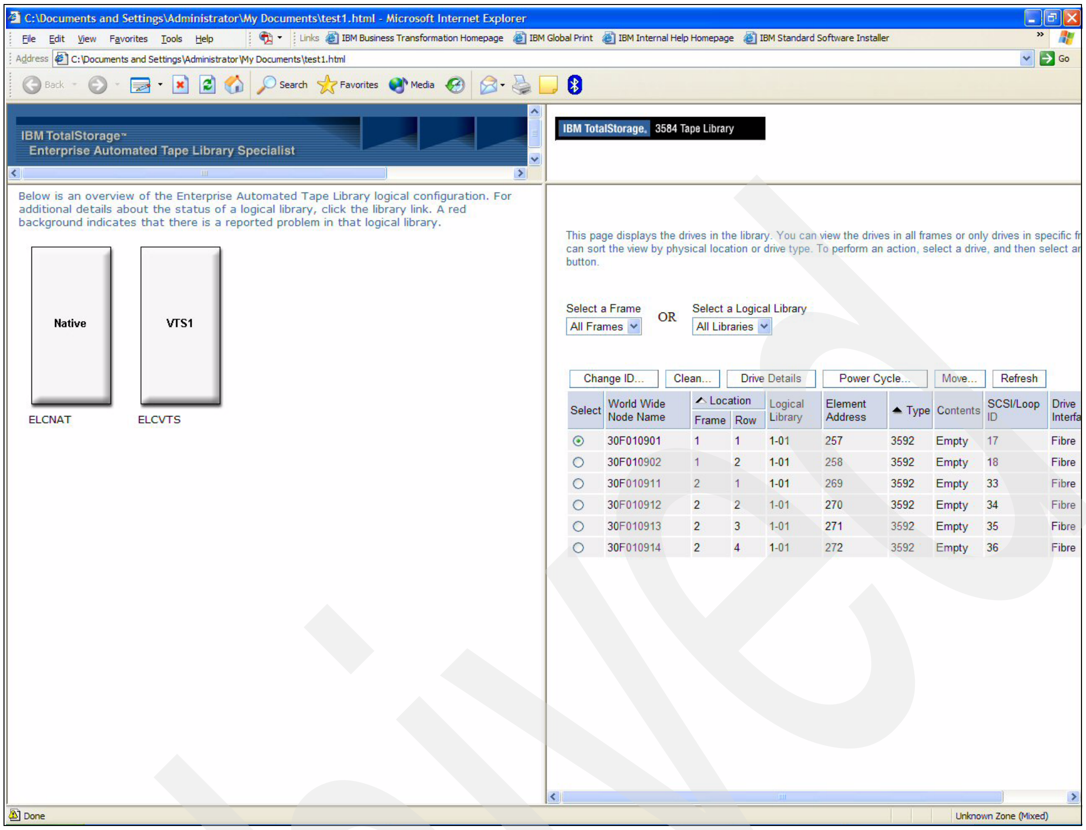


Figure A-7 Merging two Web interfaces

B

IPv6 overview

TS3500 Tape Library supports both IPv4 and IPv6. In this appendix, we introduce:

- IPv6 concept and address format compared with IPv4
- IPv6 supported list of Tape Library products

IPv6 introduction

Internet Protocol version 6 (IPv6) is a network layer for packet-switched Internetworks. It is designated as the successor of IPv4, the current version of the Internet Protocol, for general use on the Internet.

By the early 1990s, it was clear that the change to a classless network introduced a decade earlier was not enough to prevent IPv4 address exhaustion and that further changes to IPv4 were needed. By the beginning of 1992, several proposed systems were being circulated and by the end of 1992, the Internet Engineering Task Force (IETF) announced a call for white papers (Request for Comments (RFC) 1650) and the creation of the “IP, the Next Generation” (IPng Area) of working groups.

IPng was adopted by the Internet Engineering Task Force on 25 July 1994 with the formation of several “IP Next Generation” (IPng) working groups. By 1996, a series of RFCs were released defining IPv6, starting with RFC 2460.

IPv4 and IPv6 address formats

The primary change from IPv4 to IPv6 is the length of network addresses. IPv6 addresses are 128 bits long (as defined by RFC 4291), whereas IPv4 addresses are 32 bits; where the IPv4 address space contains roughly 4 billion addresses, IPv6 has enough room for 340 undecillion unique addresses.

An IPv4 address has the following format: *x.x.x.x* where *x* is called an *octet* and must be a decimal value between 0 and 255. Octets are separated by periods. An IPv4 address must contain three periods and four octets.

Examples of valid IPv4 addresses include:

- 1.2.3.4
- 01.102.103.104

An IPv6 address can have two formats:

- Normal - Pure IPv6 format
- Dual - IPv6 plus IPv4 formats (not used in this release)

Normal IPv6 address

An IPv6 (Normal) address has the following format: *y:y:y:y:y:y:y:y* where *y* is called a *segment* and can be any hexadecimal value between 0 and FFFF. The segments are separated by colons - not periods. An IPv6 normal address must have eight segments; however, a short form notation can be used the Tape Library Specialist Web interface for segments that are zero, or those that have leading zeros. The short form notation cannot be used from the Operator Panel.

Examples of valid IPv6 (Normal) addresses are:

- 2001:db8:3333:4444:5555:6666:7777:8888
- 2001:db8:3333:4444:CCCC:DDDD:EEEE:FFFF
- :: (implies all eight segments are zero)
- 2001:db8:: (implies that the last six segments are zero)
- ::1234:5678 (implies that the first six segments are zero)

- 2001:db8::1234:5678 (implies that the middle four segments are zero)
- 2001:0db8:0001:0000:0000:0ab9:C0A8:0102 (This address can be compressed to eliminate leading zeros, as follows: 2001:db8:1::ab9:C0A8:102)

Dual IPv6 address

An IPv6 (Dual) address combines an IPv6 and an IPv4 address and has the following format: *y:y:y:y:y:y:x.x.x.x*. The IPv6 portion of the address (indicated with *y*'s) is always at the beginning, followed by the IPv4 portion (indicated with *x*'s):

- In the IPv6 portion of the address, *y* is called a segment and can be any hexadecimal value between 0 and FFFF. The segments are separated by colons - not periods. The IPv6 portion of the address must have six segments, but there is a short form notation for segments that are zero.
- In the IPv4 portion of the address, *x* is called an octet and must be a decimal value between 0 and 255. The octets are separated by periods. The IPv4 portion of the address must contain three periods and four octets.

Examples of valid IPv6 (Dual) addresses are:

- 2001:db8:3333:4444:5555:6666:1.2.3.4
- ::11.22.33.44 (implies all six IPv6 segments are zero)
- 2001:db8::123.123.123.123 (implies that the last four IPv6 segments are zero)
- ::1234:5678:91.123.4.56 (implies that the first four IPv6 segments are zero)
- ::1234:5678:1.2.3.4 (implies that the first four IPv6 segments are zero)
- 2001:db8::1234:5678:5.6.7.8 (implies that the middle two IPv6 segments are zero)

Subnet masks (IPv4) and prefix lengths (IPv6)

All IP addresses are divided into portions. One part identifies the network (the network number) and the other part identifies the specific machine or host within the network (the host number). Subnet masks (IPv4) and prefixes (IPv6) identify the range of IP addresses that make up a *subnet*, or group of IP addresses on the same network. For example, a subnet can be used to identify all the machines in a building, department, geographic location, or on the same local area network (LAN).

Dividing an organization's network into subnets allows it to be connected to the Internet with a single shared network address. Subnet masks and prefixes are used when a host is attempting to communicate with another system. If the system is on the same network or subnet, it will attempt to find that address on the local link. If the system is on a different network, the packet is sent to a gateway, which will then route the packet to the correct IP address. This is called *Classless-InterDomain Routing* (CIDR).

In IPv4, the subnet mask 255.255.255.0 is 24 bits and consists of four 8 bit octets. The address: 10.10.10.0 subnet mask 255.255.255.0 means that the subnet is a range of IP addresses from 10.10.10.0 - 10.10.10.255.

The prefix length in IPv6 is the equivalent of the subnet mask in IPv4. However, rather than being expressed in four octets like it is in IPv4, it is expressed as an integer between 1 - 128. For example: 2001:db8:abcd:0012::0/64 specifies a subnet with a range of IP addresses from: **2001:db8:abcd:0012**:0000:0000:0000:0000 - **2001:db8:abcd:0012**:ffff:ffff:ffff:ffff. The portion in bold is called the network portion of the IP address, or the prefix. The non-bold portion is called the host portion of the IP address, because it identifies an individual host on the network.

IPv6 functionality

To support this functionality, changes have been made to the following components:

- Ethernet driver

  The Ethernet driver is modified to support either an IPv4 or IPv6 link layer configuration.

- Network Manager

  IP Stack configuration can be either IPv4 or IPv6. This configuration includes IP addresses, subnet masks, and gateway addresses.

- Operator Panel

  Operator Panel allows the Ethernet connection to be configured as either IPv4 or IPv6.

- Call Home

  Call Home determines the IP version used and presents the correct IP address and parameters to the IP Stack.

- Key Proxy

  The Key Proxy determines the IP version used and presents the correct IP address and parameters to the IP Stack.

- Nonvolatile random access memory (NVRAM)

  NVRAM stores the IPv4 and IPv6 IP and gateway addresses, as well as network masks for both IP and gateway addresses. Functions have been provided to set and get the parameters.

- Vital product data (VPD) cache

  VPD cache contains the IPv4 and IPv6 IP and gateway addresses, as well as network masks for both IP and gateway addresses. Functions have been provided to set and get the parameters.

- Web User interface

  Those pages that contain IP addresses now provide provisions for both IPv4 and IPv6 formats. For example, the page that contains the IP address for the External Key Manager provides both IPv4 and IPv6 formats.

Interoperability of applications for IPv4 and IPv6

Most of the mechanisms of IPv6 transition have been developed to connect IPv4 networks with IPv6 networks and base their operations in entities that are located at an intermediate point of the network to perform some kind of processing, for example, tunnels or translation of protocols.

IBM tape product support

The following IBM System Storage tape libraries and controllers support IPv4, IPv6, or Dual Stack IPv4 and IPv6:

- TS3500
- TS3400
- TS3310
- TS3200
- TS3100
- TS2900
- TS1120 Model C06

For more IPv6 information, refer to these additional resources from the Internet:

- Basic IPv6 Information:

  http://en.wikipedia.org/wiki/Ipv6

- IBM IPv6 certification page:

  http://www-306.ibm.com/software/info/ipv6/index.jsp

- Converting IPv4 programs to IPv6 (C/C++):

  http://www-128.ibm.com/developerworks/web/library/wa-ipv6.html

- Java (JRE™ 1.4 and later need to have IPv6 compliance):

  http://java.sun.com/j2se/1.4.2/docs/guide/net/ipv6_guide/

C

Library Manager volume categories

Table C-1 lists all default Library Manager volume categories, the platforms on which they are used, and their definitions.

Note: z/OS users can define any category up to X‘FEFF’ with the DEVSUP*xx* member SYS1.PARMLIB. The appropriate member must be pointed to by IEASYS*xx*. See the DEVSUP discussion in 9.2.1, “Updating SYS1.PARMLIB” on page 235.

Table C-1 Library Manager volume categories

Category (in hex)	Used by	Definition
0000	Null category	This pseudo category is used in certain library commands to specify that the category, which is already associated with the volume, is to be used by default or that no category is specified. Use of the null category does not affect the volume’s order within the category to which it is assigned. No volumes are associated with this category.
0001	DFSMS/MVS	Indicates scratch MEDIA1. MEDIA1 is a standard-capacity cartridge system tape.
0002	DFSMS/MVS	Indicates scratch MEDIA2. MEDIA2 is an enhanced-capacity cartridge system tape.
0003	DFSMS/MVS	Indicates scratch MEDIA3. MEDIA3 is the IBM TotalStorage Enterprise 3590 High Performance Tape Cartridge.
0004	DFSMS/MVS	Indicates scratch MEDIA4. MEDIA4 is the IBM TotalStorage Enterprise 3590 Extended High Performance Tape Cartridge.
0005	DFSMS/MVS	Indicates scratch MEDIA5. MEDIA5 is the IBM TotalStorage Enterprise Tape Cartridge 3592 DATA.

Category (in hex)	Used by	Definition
0006	DFSMS/MVS	Indicates scratch MEDIA6. MEDIA6 is the IBM TotalStorage Enterprise Tape Cartridge 3592 WORM.
0007	DFSMS/MVS	Indicates scratch MEDIA7. MEDIA7 is the IBM TotalStorage Enterprise Tape Cartridge 3592 ECONOMY.
0008	DFSMS/MVS	Indicates scratch MEDIA8. MEDIA8 is the IBM TotalStorage Enterprise Tape Cartridge 3592 ECONOMY WORM.
0009	DFSMS/MVS	Indicates scratch MEDIA9. MEDIA9 is the IBM System Storage 3592 Extended Tape Cartridge.
000A	DFSMS/MVS	Indicates scratch MEDIA10. MEDIA10 is the IBM 3592 Extended WORM Tape Cartridge.
000B to 000D	DFSMS/MVS	Reserved.
000E	DFSMS/MVS	Indicates an error volume. Volumes in this category are scratch volumes for which the software detected an error during processing.
000F	DFSMS/MVS	Indicates a private volume. Volumes in this category contain user data or are assigned to a user.
0010 to 007F	DFSMS/MVS	Reserved. These volume categories can be used for library partitioning.
0080	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH0.
0081	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH1.
0082	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH2.
0083	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH3.
0084	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH4.
0085	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH5.
0086	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH6.
0087	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH7.

Category (in hex)	Used by	Definition
0088	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH8.
0089	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCH9.
008A	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCHA.
008B	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCHB.
008C	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCHC.
008D	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCHD.
008E	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCHE.
008F	DFSMS/VM including VSE Guest	Indicates that the volume belongs to the VM category SCRATCHF.
0090 to 009F	N/A	Currently not assigned.
00A0	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH00.
00A1	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH01.
00A2	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH02.
00A3	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH03.
00A4	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH04.
00A5	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH05.
00A6	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH06.
00A7	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH07.
00A8	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH08.

Category (in hex)	Used by	Definition
00A9	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH09.
00AA	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH10.
00AB	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH11.
00AC	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH12.
00AD	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH13.
00AE	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH14.
00AF	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH15.
00B0	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH16.
00B1	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH17.
00B2	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH18.
00B3	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH19.
00B4	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH20.
00B5	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH21.
00B6	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH22.
00B7	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH23.
00B8	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH24.
00B9	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH25.
00BA	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH26.
00BB	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH27.
00BC	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH28.
00BD	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH29.

Category (in hex)	Used by	Definition
00BE	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH30.
00BF	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH31.
00C0 to 00FF	N/A	Currently not used.
0100	OS/400® and i5/OS (MLDD)	Indicates that the volume has been assigned to category *SHARE400. Volumes in this category can be shared with all attached System i, iSeries, and AS/400 systems.
0101	OS/400 and i5/OS (MLDD)	Indicates that the volume has been assigned to category *NOSHARE. Volumes in this category can be accessed only by the OS/400 or i5/OS system that assigned it to the category.
0102 to 012B	N/A	No assignment to a specific host system. These categories can be dynamically assigned by the Library Manager on the request of a host.
012C	TSM for AIX	Indicates a private volume. Volumes in this category are managed by Tivoli Storage Manager (TSM).
012D	TSM for AIX	Indicates an IBM 3490 scratch volume. Volumes in this category are managed by TSM.
012E	TSM for AIX	Indicates an IBM 3590 scratch volume. Volumes in this category are managed by TSM.
012F to 0FF1	N/A	No assignment to a specific host system. These categories can be dynamically assigned by the Library Manager on the request of a host.
0FF2	Basic Tape Library Support (BTLS)	Indicates a scratch volume. Volumes in this category belong to the optional scratch pool SCRTCH2.
0FF3	BTLS	Indicates a scratch volume. Volumes in this category belong to the optional scratch pool SCRTCH3.
0FF4	BTLS	Indicates a scratch volume. Volumes in this category belong to the optional scratch pool SCRTCH4.
0FF5	BTLS	Indicates a scratch volume. Volumes in this category belong to the optional scratch pool SCRTCH5.
0FF6	BTLS	Indicates a scratch volume. Volumes in this category belong to the optional scratch pool SCRTCH6.
0FF7	BTLS	Indicates a scratch volume. Volumes in this category belong to the optional scratch pool SCRTCH7.
0FF8	BTLS	Indicates a scratch volume. Volumes in this category belong to the optional scratch pool SCRTCH8.
0FF9 to 0FFE	N/A	No assignment to a specific host system. These categories can be dynamically assigned by the Library Manager on the request of a host.

Category (in hex)	Used by	Definition
0FFF	BTLS	Indicates a scratch volume. Volumes in this category belong to the default scratch pool used by Basic Tape Library Support (BTLS). **Note**: If you are planning to migrate to DFSMS/MVS, use this default scratch category only.
1000 to F00D	N/A	No assignment to a specific host system. These categories can be dynamically assigned by the Library Manager on the request of a host.
F00E	BTLS	Indicates a volume in error. Volumes are assigned to the error category during demount if the volume serial specified for demount does not match the external label of the volume demounting.
F00F to FEFF	N/A	No assignment to a specific host system. These categories can be dynamically assigned by the Library Manager on the request of a host.
FF00	All	Insert category When a tape volume is added to an automated tape library, the library reads the external label on the volume, creates an inventory entry for the volume, and assigns the volume to the insert category. This category can be updated by operator interaction through Librarian Workstation Support.
FF01	Virtual Tape Server and TS7700 Virtualization Engine	Stacked Volume Insert category for a Virtual Tape Server (VTS) and TS7700 Virtualization Engine A volume is set to this category when its volume serial number is in the range specified for stacked volumes for any VTS library partition.
FF02	Virtual Tape Server	Stacked Volume Scratch category 0 for a Virtual Tape Server and TS7700 Virtualization Engine This category is reserved for future use for scratch stacked volumes.
FF03	Virtual Tape Server	Stacked Volume Scratch category 1 for a Virtual Tape Server and TS7700 Virtualization Engine This category is used by the VTS for its scratch stacked volumes. This category is not used if licensed internal code (LIC) is 527 or higher.
FF04	Virtual Tape Server and TS7700 Virtualization Engine	Stacked Volume Private category for a Virtual Tape Server and TS7700 Virtualization Engine This category is used by the VTS and TS7700 Virtualization Engine for its private stacked volumes. If LIC level is 527 or higher, this category includes both scratch and private volumes.
FF05	Virtual Tape Serve and TS7700 Virtualization Engine	Stacked Volume Disaster Recovery category for a Virtual Tape Serve and TS7700 Virtualization Engine A volume is set to this category when its volume serial number is in the range specified for stacked volumes for any VTS library partition *and* the Library Manager is in disaster recovery mode.

Category (in hex)	Used by	Definition
FF06	Virtual Tape Server and TS7700 Virtualization Engine	This category is used by the VTS and TS7700 Virtualization Engine as a temporary category for disaster recovery. After a stacked volume in category FF05 is processed, it is put into this category.
FF07	Virtual Tape Serve and TS7700 Virtualization Engine	This category is reserved for future hardware functions.
FF08	Virtual Tape Server	This category is used by the VTS to indicate a Read-Only-Recovery Stacked Volume with active data that cannot be recovered.
FF09 to FF0F	N/A	Reserved for future hardware functions.
FF10	Library Manager	Convenience-Eject category When a tape volume is assigned to the convenience-eject category, it becomes eject pending and the Library Manager queues the tape volume to be moved to a convenience output station. When the volume is delivered to an output station, it is deleted from the Library Manager’s inventory. **Note:** Logical volumes cannot be ejected from the library. They can be deleted or exported.
FF11	Library Manager	Bulk-Eject category Set when the Library Manager accepts an eject request. The volume becomes eject pending and is queued to be moved to the high capacity output station. When the cartridge accessor delivers the volume to the output rack, it is deleted from the Library Manager’s inventory. **Note:** Logical volumes cannot be ejected from the library. They can be deleted or exported.
FF12	Virtual Tape Server	Export-Pending category A logical volume to be exported is assigned to this category at the beginning of a Virtual Tape Server export operation. Logical volumes in this category are considered in use. Any attempt by a host to mount, audit, or change the category of a volume fails. **Engineering note:** If the library export operation is cancelled or fails, any volumes assigned to this category are reassigned to the category they were in prior to the export operation.
FF13	Virtual Tape Server	Exported category Set when the Virtual Tape Server has exported the logical volume. The attached hosts are notified when volumes are assigned to this category. Any attempt by a host to mount, audit, or change the category of a volume fails, except a Library Set Volume Category order assigning the volume to the purge-volume category.

Category (in hex)	Used by	Definition
FF14	Virtual Tape Server	Import category Stacked volumes that contain logical volumes to import into the Virtual Tape Server are assigned to this category by an operator at the Library Manager, after they are entered into the library through the convenience I/O station and placed in the Unassigned category.
FF15	Virtual Tape Server	Import-Pending category Logical volumes to be imported from a stacked volume are added to the Library Manager inventory and assigned to this category when the Virtual Tape Server starts importing them. At completion, successfully imported volumes are assigned to the insert category (FF00). The attached hosts are then notified of volumes assigned to the insert category. Any host attempt to use a volume assigned to this category fails. **Engineering note:** If the library import operation is cancelled or fails, any volumes assigned to this category are deleted from the library inventory.
FF16	Virtual Tape Server and TS7700 Virtualization Engine	Unassigned category Volumes are assigned to this category by the Library Manager whenever volumes are added to the library through the convenience I/O station, and the library contains one or more VTS subsystems that have the Import/Export functions installed and enabled. Manual intervention is required to assign the cartridges to the proper category. For exported stacked volumes, this is the import category (FF14).
FF17	Virtual Tape Server	Export-Hold category Physical volumes are assigned to this category on completion of processing for an export stacked volume.
FF18 and FF19	N/A	Reserved for library These categories are reserved for future hardware functions.
FF20	Peer-to-Peer (PtP) Virtual Tape Server and TS7700 Virtualization Engine	Corrupted-Token Volume category In a Peer-to-Peer VTS and TS7700 Virtualization Engine, volumes are assigned to this category when it has been determined that the tokens associated with the volume have been corrupted. This is to prevent the volume from being selected by a category mount request.
FF21 to FFF5	N/A	Reserved for library These categories are reserved for future hardware functions.
FFF4	Library Manager	3592 Cleaner Volume Cleaner volumes for 3592 type devices in the library are assigned to this category automatically.
FFF5	Library Manager	3592 Service Volume Volumes are assigned to this category by the Library Manager when it detects that a volume has a unique service cartridge VOLSER and a media type compatible with a 3592 device.

Category (in hex)	Used by	Definition
FFF6	Library Manager	3590-Service-Volume category Volumes are assigned to this category by the Library Manager when it detects that a volume has a unique service cartridge VOLSER and a media type compatible with a 3590 device.
FFF7 and FFF8	N/A	Reserved for library These categories are reserved for internal library functions.
FFF9	Library Manager	3490-Service-Volume category Volumes are assigned to this category by the Library Manager when it detects that a volume has a unique service cartridge VOLSER and a media type compatible with a 3490 device.
FFFA	Library Manager	Manually-Ejected category Volumes are assigned to this category when they are removed from the library under the control of an operator, not the control program. Volumes in this category are no longer available for any other operations except purge-volume category assignment.
FFFB	Library Manager	Purge-Volume category When this category is specified in a Perform Library Function command with the Library Set Volume Category order and the volume is either in the misplaced state, is assigned to the exported category, or is assigned to the manually ejected category, the specified VOLSER's record is deleted from the inventory. No volumes are associated with this category.
FFFC	Library Manager	Unexpected-Volume category This category is reserved for future use.
FFFD	Library Manager	3590-Cleaner-Volume category Cleaner volumes for 3590 type devices in the library are assigned to this category automatically.
FFFE	Library Manager	3490-Cleaner-Volume category Cleaner volumes for 3490 type devices in the library are assigned to this category automatically.
FFFF	Library Manager	VOLSER-Specific category This category is for general use by programming except that any Library Mount request to this category must be for a specific VOLSER and not based on the category only.

D

JES3 examples and information

This appendix presents configuration examples and other JES3 considerations. It describes the necessary parameters and the considerations if more than one device type is installed in a library in a JES3 environment.

We provide two examples:

- Two libraries with an intermix of native drives of 3592-J1A and 3592-E05 installed
- Three libraries with an intermix of 3592-J1A, 3592-E05, 3592-E06/EU6, Single Cluster TS7700 Grid, and Multi Cluster TS7700 Grid installed

These examples provide all of the necessary information to install any possible configuration in a TS3500 Tape Library. For more basic information about the products in these scenarios, refer to the following publications:

- *z/OS JES3 Initialization and Tuning Guide*, SA22-7549
- *z/OS JES3 Initialization and Tuning Reference*, SA22-7550
- *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312

JES3 support for system-managed tape

This section describes JES3 IBM TS3500 Tape Library support with DFSMS. The primary purpose of this support is to maintain JES3 resource allocation and share tape allocations. For detailed information, refer to the *z/OS JES3 Initialization and Tuning Reference*, SA22-7550.

DFSMS has support that provides JES3 allocation with the appropriate information to select an IBM TS3500 Tape Library device by referencing device strings with a common name among systems within a JES3 complex.

The following steps are necessary to set up an IBM TS3500 Tape Library in a JES3 environment:

1. Define library device groups (LDGs). Prepare the naming conventions in advance. Clarify all the names for the library device groups that you need.
2. Include the esoteric names from step 1 in the Hardware Configuration Definition (HCD) and activate the new EDT.
3. Update the JES3 INISH deck:
   a. Define all devices in the IBM TS3500 Tape Library through DEVICE statements.
   b. Set JES3 device names through the SETNAME statement.
   c. Define which device names are subsets of other device names through the high water mark setup name (HWSNAME) statement.

All IBM TS3500 Tape Library units can be shared between processors in a JES3 complex. They must also be shared among systems within the same SMSplex.

> **Note:** Tape drives in the IBM TS3500 Tape Library cannot be used by JES3 dynamic support programs (DSPs).

Define all devices in the libraries through DEVICE statements. All IBM TS3500 Tape Library tape drives within a complex must be either JES3-managed or non-JES3-managed. Do not mix managed and non-managed devices. Mixing might prevent non-managed devices from use for new dataset allocations and reduce device eligibility for existing datasets. Allocation failures or delays in job setup result.

Neither JES3 or DFSMS verifies that a complete and accurate set of initialization statements is defined to the system. Incomplete or inaccurate IBM TS3500 Tape Library definitions can result in jobs failing to be allocated.

Library device groups

Library device groups (LDGs) isolate the IBM TS3500 Tape Library drives from other tape drives in the complex. They allow JES3 main device scheduler (MDS) allocation to select an appropriate set of library-resident tape drives.

The DFSMS JES3 support requires LDGs to be defined to JES3 for SETNAME groups and HWSNAME names in the JES3 initialization statements. During converter/interpreter (C/I) processing for a job, the LDG names are passed to JES3 by DFSMS for use by MDS in selecting library tape drives for the job. Unlike a JES2 environment, a JES3 operating environment requires the specification of esoteric unit names for the devices within a library. These unit names are used in the required JES3 initialization statements.

Important: Even if the LDG definitions are defined as esoterics in the HCD, they are not used in the JCL. There is no need for any UNIT Parameter in JES3 JCL for libraries. The allocation goes through the automatic class selection (ACS) routines. Coding a UNIT Parameter might cause problems.

The only need for coding the LDG definition in HCD as an esoteric name is the HWSNAME definitions in the JES3 INISH deck.

Each device within a library must have exactly four special esoteric names associated with it. These names are:

- The *complex-wide name* is always `LDGW3495`. It allows you to address every device and device type in every library.
- The *library-specific name* is an 8-character string composed of `LDG` prefixing the 5-digit library identification number. It allows you to address every device and device type in that specific library.
- The *complex-wide device type*, shown in Table D-1, defines the various device types that are used. It contains a prefix of `LDG` and a device type identifier. It allows you to address a specific device type in every tape library.

Table D-1 Library device groups: Complex-wide device type specifications

Device type	Complex-wide device type definition
3490E	LDG3490E
3592-J1A	LDG359J
3592-E05	LDG359K
3592-E05 encryption-enabled	LDG359L
3592-E06 encryption-enabled	LDG359M

- A *library-specific device type name*, which is an 8-character string, starts with a different prefix for each device type followed by the 5-digit library device number. Refer to Table D-2.

Table D-2 Library device groups: Library-specific device types

Device type	Library-specific device type	Content
3490E	LDE + library number	All 3490E in lib *xx*
3592-J1A	LDJ + library number	All 3592 Model J1A in lib *xx*
3592-E05	LDK + library number	All 3592 Model E05 in lib *xx*
3592-E05	LDL + library number	3592 Model E05 encryption-enabled in lib *xx*
3592-E06	LDM + library number	3592 Model E06 encryption-enabled in lib *xx*

It also allows you to address a specific device type in a specific tape library. In a Single Cluster Grid and a Multi Cluster TS7700 Grid or Peer-to-Peer (PtP) Virtual Tape Server (VTS) environment installed in two physical libraries, there is still only one library-specific device name. The LIBRARY-ID of the Composite Library is used.

Updating the JES3 INISH deck

To allow JES3 to allocate the appropriate device, you must code several definitions:

- DEVICE statements
- SETNAME statements
- HWSNAME (High water mark setup) statements

These statements are described in detail in the following sections.

DEVICE statement: Defining I/O devices for IBM TS3500 tape libraries

Use the DEVICE format to define a device so that JES3 can use it. A device statement (refer to Figure D-1) must be defined for each string of IBM TS3500 Tape Library drives in the complex. XTYPE specifies a one to eight character name, which is given by the user. There is no default or specific naming convention for this statement. This name is used in other JES3 init statements to group the devices together for certain JES3 processes (for example, allocation). Therefore, it is necessary that all the devices with the same XTYPE belong to:

- The same library
- The same device type

The letters CA in the XTYPE definition tell us that this is a CARTRIDGE device.

```
*/  Devices 3592-J1A, 3592-E05, and 3592-E06 in Library 1 ......................./*

DEVICE,XTYPE=(LB13592J,CA),XUNIT=(1100,*ALL,,OFF),numdev=4
DEVICE,XTYPE=(LB13592K,CA),XUNIT=(1104,*ALL,,OFF),numdev=4
DEVICE,XTYPE=(LB13592M,CA),XUNIT=(0200,*ALL,,OFF),numdev=4
```

Figure D-1 DEVICE statement sample

> **Note:** TS3500 Tape Library tape drives cannot be used as support units by JES3 dynamic support programs (DSPs). Therefore, do not specify DTYPE, JUNIT, and JNAME parameters on the DEVICE statements. No check is made during initialization to prevent TS3500 Tape Library drives from definition as support units, and no check is made to prevent the drives from allocation to a DSP if they are defined. Any attempt to call a tape DSP by requesting a TS3500 Tape Library fails, because the DSP is unable to allocate a TS3500 Tape Library drive.

SETNAME statement

The SETNAME statement is used for proper allocation in a JES3 environment. For tape devices, it tells JES3 which tape device belongs to which library. The SETNAME statement specifies the relationships between the XTYPE values (coded in the DEVICE Statement) and the LDG names (refer to Figure D-2 on page 485). A SETNAME statement must be defined for each unique XTYPE in the device statements.

The rules for the SETNAME statement are:

- Each SETNAME statement has one entry from each LDG category.
- The complex-wide library name must be included in all statements.
- A library-specific name must be included for XTYPEs within the referenced library.
- The complex-wide device type name must be included for all XTYPEs of the corresponding device type in the complex.
- A library-specific device type name must be included for the XTYPE associated with the devices within the library.

```
SETNAME,XTYPE=LB1359K,
        NAMES=(LDGW3495,LDGF4001,LDG359K,LDKF4001)
              Complex   Library   Complex   Library
               Wide      Specific  Wide      Specific
               Library   Library   Device    Device
               Name      Name      Name      Name
```

Figure D-2 SETNAME rules

Note: Do not specify esoteric and generic unit names, such as 3492, SYS3480R, and SYS348XR. Also, never use esoteric names, such as TAPE and CART.

High watermark setup names (HWSNAME)

Use the HWSNAME statement to define which device names are subsets of other device names. You must specify all applicable varieties. Therefore, HWSNAME coding is not easily understood. To clarify the subject, we introduce only the rules and coding and discuss the details in the configuration examples. The statement is:

```
HWSNAME, TYPE=(groupname,{altname})
```

Note the following explanations:

- *groupname*: Specifies a device type valid for a high watermark setup.
- *altname*: Specifies a list of valid user-supplied or IBM-supplied device names. These are alternate units to be used in device selection.

Consider the following example:

```
HWSNAME,TYPE=(LDGW3495,LDGF4001,LDGF4006,LDG359J,LDG359K,LDG359M,
      LDJF4001,LDKF4001,LDKF4006)
```

The rules for LDG HWSNAME statements are:

- The complex-wide library name, LDGW3495, must include all other LDG names as alternates.
- The library-specific name must include all LDG names for the corresponding library as alternates. When all tape devices of a type within the complex are within a single IBM 3494 Tape Library, the complex-device type name must also be included as an alternate name.
- The complex-wide device type name must include all library-specific device type names. When all devices of one type in the complex are within a single IBM TS3500 Tape Library, the complex-wide device type name is equivalent to that library name. In this case, you need to also specify the library name as an alternate.
- The library-specific device type name must be included. Alternate names can be specified as follows:
  - When all drives within the IBM TS3500 Tape Library have the same device type, the library-specific device type name is equivalent to the library name. In this case, you need to specify the library-specific name as an alternate.
  - When these drives are the only drives of this type in the complex, the complex-wide device type name is equivalent to the library-specific device type name.

Make sure that all valid alternate names are specified.

First configuration example

The first example includes different native tape drives in two separate IBM tape libraries. Figure D-3 shows a JES3 complex with two TS3500 tape libraries attached to it. Library 1 has a LIBRARY-ID of F4001 and a mix of 3592-J1A and 3592-E05 drives installed. Library 2 has a LIBRARY-ID of F4006 and only 3592-E05 models installed. The 3592-E05 drives are not encryption-enabled.

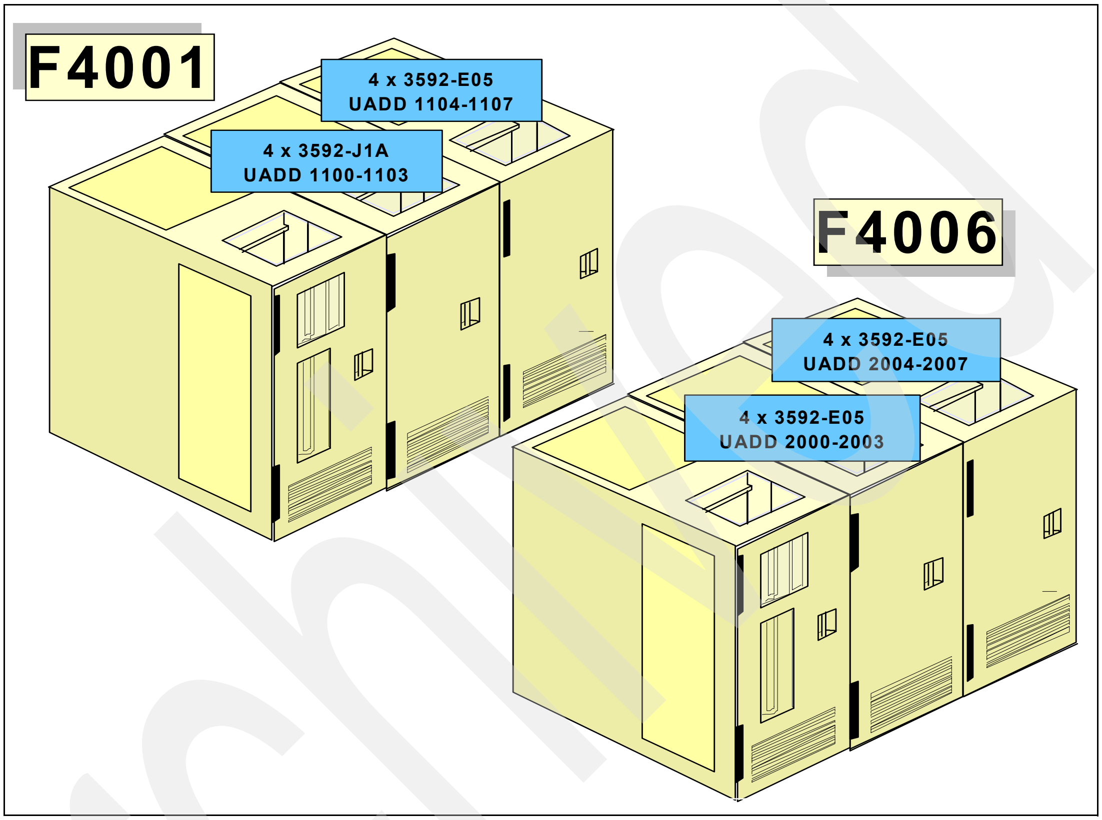


Figure D-3 First JES3 configuration example

LDG definitions necessary for the first example

Table D-3 on page 487 shows all the LDG definitions needed in HCD. There is a total of eight esoterics to define.

Table D-3 LDG definitions for the first configuration example

LDG definition	Value of LDG	Explanation
Complex-wide name	LDGW3495	Standard name, appears once
Library-specific name	LDGF4001 LDGF4006	One definition for each library
Complex-wide device type	 LDG359J LDG359K	One definition for each installed device type: Represents the 3592-J1A devices Represents the 3592-E05 devices
Library-specific device type	 LDJF4001 LDKF4001 LDKF4006	One definition for each device type in each library: Represents the 3592-J1A in library F4001 Represents the 3592-E05 in library F4001 Represents the 3592-E05 in library F4006

Device statements needed for this configuration

In our examples, we use a naming convention for XTYPE that contains the library (LB1, LB2) in the first three digits and then the device type (refer to Figure D-4). A naming convention for XTYPE is not mandatory, but it makes it easier to use the JES3 INISH deck.

```
*/  Devices 3592-J1A and 3592-E05 in Library 1 ............................/*

DEVICE,XTYPE=(LB13592J,CA),XUNIT=(1000,*ALL,,OFF),numdev=4
DEVICE,XTYPE=(LB13592K,CA),XUNIT=(1104,*ALL,,OFF),numdev=4

*/  Devices 3592-E05 Encryption-Enabled in Library 2 ...................../*

 DEVICE,XTYPE=(LB23592L,CA),XUNIT=(2000,*ALL,,OFF),numdev=8
```

Figure D-4 First configuration example: Device type definition sample

SETNAME statements needed for this configuration

Figure D-5 includes all the SETNAME statements for the first configuration example.

```
SETNAME,XTYPE=(LB13592J,CA),NAMES=(LDGW3495,LDGF4001,LDG359J,LDJF4001)

SETNAME,XTYPE=(LB13592K,CA),NAMES=(LDGW3495,LDGF4001,LDG359K,LDKF4001)

SETNAME,XTYPE=(LB23592L,CA),NAMES=(LDGW3495,LDGF4006,LDG359K,LDKF4006)
```

Figure D-5 First configuration example: SETNAME definition sample

You need three SETNAME statements, because you have:

- One library with two different device types = Two SETNAME statements
- One library with one device type = One SETNAME statement

Note: For definition purposes, encryption-enabled and non-encryption-enabled drives are considered two different device types. In the first example, all 3592 tape drives are not encryption-enabled.

HWSNAME statement needed for this configuration

The HWSNAME definition is tricky and needs your attention, which is why we explain every statement shown in Figure D-6. If you are not experienced in JES3, read carefully through the explanation.

```
HWSNAME,TYPE=(LDGW3495,LDGF4001,LDGF4006,LDG359J,LDG359K,LDJF4001,LDKF4001,LDKF4006)[1]
HWSNAME,TYPE=(LDGF4001,LDJF4001,LDKF4001,LDG359J)[2]
HSWNAME,TYPE=(LDGF4006,LDKF4006)[3]
HWSNAME,TYPE=(LDJF4001,LDG359J)[4]
HWSNAME,TYPE=(LDG359J,LDJF4001)[5]
HWSNAME,TYPE=(LDG359K,LDKF4001,LDGF4006,LDKF4006)[6]
```

Figure D-6 HWSNAME definition sample

The following numbers, which correspond to the numbers in Figure D-6, explain the statements in the sample:

1. All LDG definitions are a subset of the complex-wide name.
2. LDG359J is a subset of library F4001 (LDGF4001), because the other library only has 3592-E05 installed.
3. All 3592-E05s in library F4006 (LDKF4006) are a subset of library F4006. LDG359K will not be specified, because there are also 3592-E05s installed in the other library.
4. All 3592-J1As (LDG359J) are a subset of the 3592-J1A in library F4001, because no other 3592-J1As are installed.
5. All 3592-J1As in library `F4001` (`LDJF4001`) are a subset of 3592-J1A, because no other 3592-J1As are installed.
6. All 3592-E05s in library `F4001` (`LDKF4001`) are a subset of 3592-E05. `LDGF4006` (the entire library with the ID `F4006`) is a subset of 3592-E05, because only 3592-E05s are installed in this library.

Second configuration example

Figure D-7 on page 489 shows a JES3 configuration with three IBM TS3500 tape libraries attached to it. Library 1 has a LIBRARY-ID of *F4001*, a mix of 3592-J1A and 3592-E05 drives that are not encryption-enabled, and one TS7700 Virtualization Engine of a Multi Cluster TS7700 Grid (Distributed Library) installed. The Multi Cluster TS7700 Grid has a Composite Library LIBRARY-ID of *47110*.

Library 2 has a LIBRARY-ID of *F4006* and a mix of encryption-enabled and and non-encryption-enabled 3592-E05 drives installed, which is also the reason why you might need to split a string of 3592-E05 drives. Library 2 is also the second Distributed Library for the Multi Cluster Grid with Composite Library LIBRARY-ID *47110*.

Library 3 has a LIBRARY-ID of *22051* and only a TS7700 Virtualization Engine installed with a Composite Library LIBRARY-ID of *13001*.

Figure D-7 on page 489 does not show the actual needed configuration for the TS7700 Virtualization Engine configurations regarding the numbers of frames, controllers, and the back-end drives. We have limited the drives and frames displayed to those drives and frames actually needed for the host definitions.

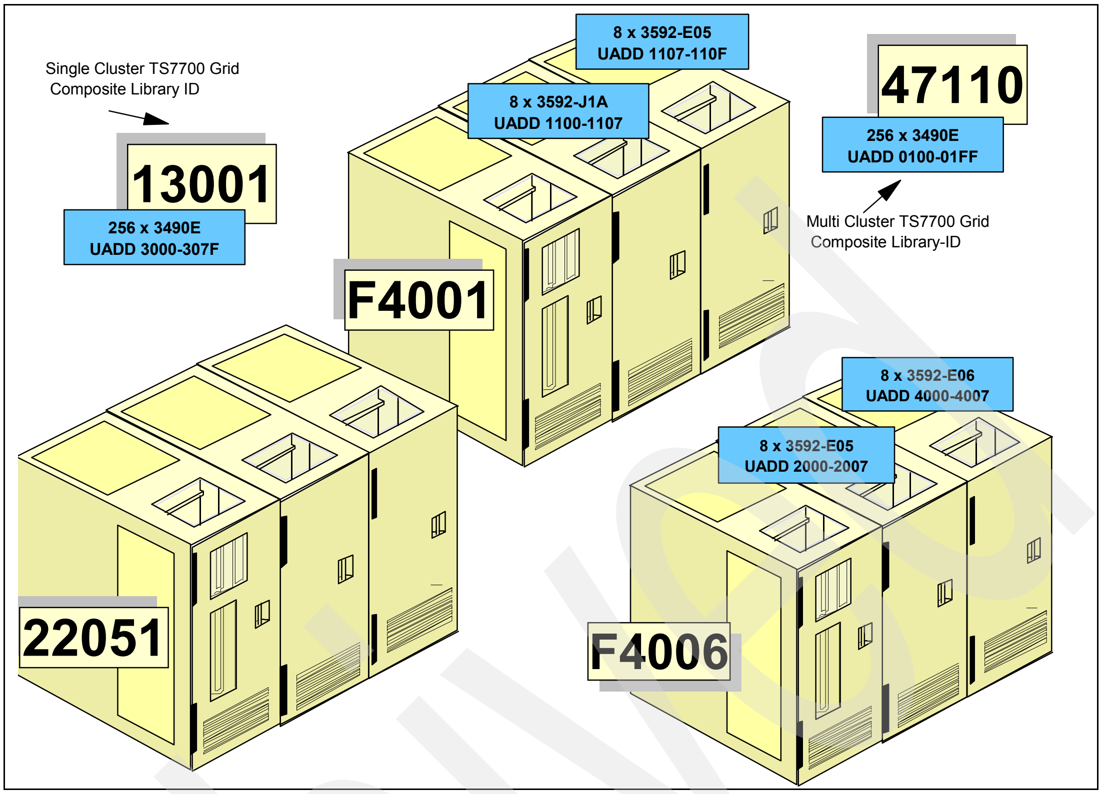


Figure D-7 Second JES3 configuration example

LDG definitions needed for the second configuration example

Table D-4 on page 490 shows all the LDG definitions needed in the HCD. Here are the esoterics to define.

Table D-4 LDG definitions for the second configuration example

LDG Definition	Value for LDG	Explanations
Complex-wide name	LDGW3495	Standard name, which appears once
Library-specific name	LDGF4001 LDGF4006 LDG13001 LDG47110	One definition for each library and for each Single Cluster TS7700 Grid. For a Single or Multi Cluster TS7700 Grid, only the Composite Library LIBRARY-ID is specified.
Complex-wide device type	 LDG3490E LDG359J LDG359K LDG359L LDG359M	One definition for each installed device type: Represents the devices in Multi Cluster TS7700 Grid Represents the 3592-J1A Represents the 3592-E05 Represents the 3592-E05 with Encryption Represents the 3592-E06
Library-specific device type	 LDE13001 LDE47110 LDJF4001 LDKF4001 LDLF4006 LDMF4006	One definition for each device type in each library, except for the Multi Cluster TS7700 Grid: Represents the virtual drives in the Single Cluster TS7700 Grid in library 22051 Represents the virtual drives in the Multi Cluster TS7700 Grid in libraries F4001 and F4006 Represents the 3592-J1A in library F4001 Represents the 3592-E05 in library F4001 Represents the encryption-enabled 3592-E05 in library F4006 Represents the 3592-E06 in library F4006

Device statement needed for the second configuration example

Figure D-8 on page 491 shows all of the device statements for the given example.

```
*/  Devices 3592-J1A and 3592-E05 in Library F4001 .............................../*

DEVICE,XTYPE=(LB13592J,CA),XUNIT=(1100,*ALL,,OFF),numdev=8
DEVICE,XTYPE=(LB13592K,CA),XUNIT=(1107,*ALL,,OFF),numdev=8,

*/  Devices 3592-E06 and 3592-E05 in Library F4006................................/*

DEVICE,XTYPE=(LB2359M,CA),XUNIT=(4000,*ALL,,OFF),numdev=8
DEVICE,XTYPE=(LB2359L,CA),XUNIT=(2000,*ALL,,OFF),numdev=8

*/  Devices Single Cluster TS7700 Grid in library 22051 ........................../*

DEVICE,XTYPE=(LB3GRD1,CA),XUNIT=(3000,*ALL,,OFF),numdev=256

*/  Devices Multi Cluster TS7700 grid in libraries F4001 and F4006................/*
ADDRSORT=NO

DEVICE,XTYPE=(LB12GRD,CA),XUNIT=(0110,*ALL,S3,OFF)
DEVICE,XTYPE=(LB12GRD,CA),XUNIT=(0120,*ALL,S3,OFF)
DEVICE,XTYPE=(LB12GRD,CA),XUNIT=(0130,*ALL,S3,OFF)
DEVICE,XTYPE=(LB12GRD,CA),XUNIT=(0140,*ALL,S3,OFF)
DEVICE,XTYPE=(LB12GRD,CA),XUNIT=(0111,*ALL,S3,OFF)
DEVICE,XTYPE=(LB12GRD,CA),XUNIT=(0121,*ALL,S3,OFF)
DEVICE,XTYPE=(LB12GRD,CA),XUNIT=(0131,*ALL,S3,OFF)
DEVICE,XTYPE=(LB12GRD,CA),XUNIT=(0141,*ALL,S3,OFF)
;;;;;;;
DEVICE,XTYPE=(LB12GRD,CA),XUNIT=(01FF,*ALL,S3,OFF)
```

Figure D-8 DEVICE statements for the second configuration example

Restriction: If you code NUMDEV in a PtP VTS environment, the workload balancing from the CX1 controllers does not work. Therefore, you must specify each device as a single statement and specify ADDRSORT=NO to prevent JES3 from sorting them. For more information, refer to the *IBM TotalStorage Peer-to-Peer Virtual Tape Server Planning and Implementation Guide*, SG24-6115.

The same restriction applies to the virtual devices of the clusters of a Multi Cluster Grid configuration; if you want to balance the workload across the virtual devices of all clusters, we recommend that you do not code the NUMDEV parameter.

SETNAME statements needed for the second configuration example

Figure D-9 includes the necessary SETNAME statements.

```
SETNAME,XTYPE=LB1359J,NAMES=(LDGW3495,LDGF4001,LDG359J,LDJF4001)
SETNAME,XTYPE=LB1359K,NAMES=(LDGW3495,LDGF4001,LDG359K,LDKF4001)
SETNAME,XTYPE=LB2359L,NAMES=(LDGW3495,LDGF4006,LDG359L,LDKF4006)
SETNAME,XTYPE=LB2359M,NAMES=(LDGW3495,LDGF4006,LDG359M,LDMF4006)
SETNAME,XTYPE=LB3GRD1,NAMES=(LDGW3495,LDG13001,LDG22051,LDG3490E,LDE22051,LDE13001)
SETNAME,XTYPE=LB12GRD,NAMES=(LDGW3495,LDG47110,LDG3490E,LDE47110)
```

Figure D-9 SETNAME statement values for the second example

High watermark setup name statements for the second example

Figure D-10 shows the high watermark setup name statements.

```
HWSNAME,TYPE=(LDGW3495,LDGF4001,LDGF4006,LDG13001,LDG47110,LDG3490E,
              LDG359J,LDG359K,LDG359L,LDG359M,LDE13001,LDE47110,LDJF4001,
              LDKF4001,LDLF4006,LDMF4006)
HWSNAME,TYPE=(LDGF4001,LDJF4001,LDKF4001)
HWSNAME,TYPE=(LDGF4006,LDLF4006,LDMF4006)
HWSNAME,TYPE=(LDG47110,LDE47110)
HWSNAME,TYPE=(LDG13001,LDE13001)
HWSNAME,TYPE=(LDG3490E,LDE47110,LDE13001)
HWSNAME,TYPE=(LDG359J,LDJF4001)
HWSNAME,TYPE=(LDG359K,LDKF4001)
HWSNAME,TYPE=(LDG359L,LDLF4006)
HWSNAME,TYPE=(LDG359M,LDMF4006)
```

Figure D-10 High watermark setup statements for the second example

Processing changes

Although no JCL changes are required, a few processing restrictions and limitations are associated with using the IBM TS3500 Tape Library in a JES3 environment:

- JES3 spool access facility (SPAF) calls are not used.
- Two calls, one from the prescan phase and the other call from the locate processing phase, are made to the new DFSMS/MVS support module, as shown in Figure D-11 on page 493.
- The main device scheduler (MDS) processing phases, system select and system verify, are not made for tape datasets.
- The MDS verify phase is bypassed for IBM TS3500 Tape Library mounts, and mount processing is deferred until job execution.

Figure D-11 on page 493 shows the JES3 processing phases for C/I and MDS. The processing phases shown include the support for system-managed direct access storage device (DASD) datasets.

The major differences between IBM TS3500 Tape Library deferred mounting and tape mounts for non-library drives are:

- Mounts for non-library drives by JES3 are only for the first use of a drive. Mounts for the same unit are issued by z/OS for the job. All mounts for IBM TS3500 Tape Library drives are issued by z/OS.
- If all mounts within a job are deferred, because there are no non-library tape mounts, that job is not included in the setup depth parameter (SDEPTH).
- MDS mount messages are suppressed for the IBM TS3500 Tape Library.

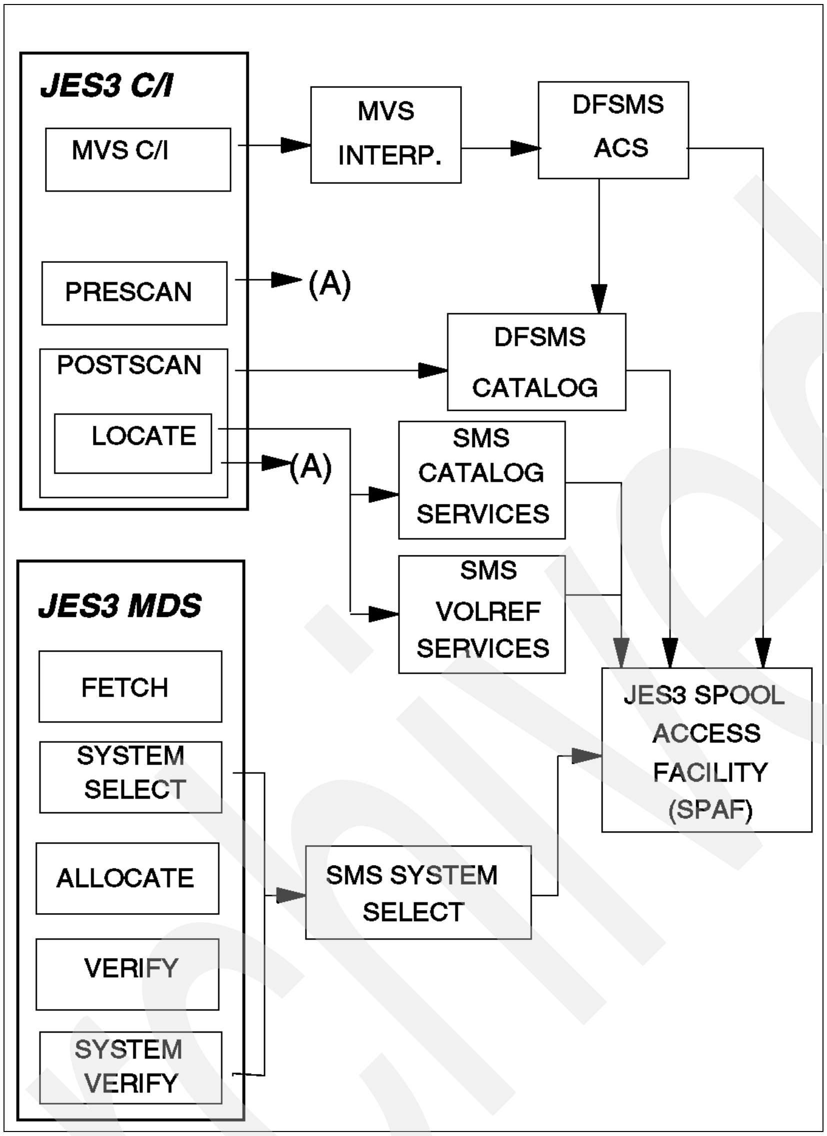


Figure D-11 JES3 C/I and MDS processing phases

JES3/DFSMS processing

DFSMS is called by the z/OS interpreter to:

- Update the scheduler work area (SWA) for DFSMS tape requests
- Call automatic class selection (ACS) exits for construct defaults

DFSMS/MVS system-managed tape devices are not selected by using the UNIT parameter in the JCL. For each DD request requiring an IBM TS3500 Tape Library unit, a list of device pool names is passed, and from that list, an LDG name is assigned to the DD request, which results in an LDG name passed to JES3 MDS for that request. Device pool names are never known externally.

Selecting UNITNAMEs

For a DD request, the LDG selection is based on the following conditions:

- When all devices in the complex are eligible to satisfy the request, the complex-wide LDGW3495 name is used.
- When the list of names contains names of all devices of one device type in the complex, the corresponding complex-device type name (for example, LDG3490E) must be used.
- When the list of names contains all subsystems in one IBM TS3500 Tape Library, the library-specific LDG name (in our examples, LDGF4001, LDGF4006, and so forth) is used.
- When the list contains only subsystems for a specific device type, within one IBM TS3500 Tape Library, the LDG device type library name (in our example, LDKF4001, and so forth) is used.

New or modified datasets

For new datasets, ACS directs the allocation by providing Storage Group, Storage Class, and Data Class. When the Storage Group specified by ACS is defined in the active DFSMS configuration as a tape Storage Group, the request is allocated to an IBM TS3500 Tape Library tape drive.

DFSMS-managed DISP=MOD datasets are assumed to be new update locate processing. If a catalog locate determines that the dataset is *old* by the VOLSER specified, a new LDG name is determined based on the rules for old datasets.

Old datasets

Old dataset allocations are directed to a specific IBM TS3500 Tape Library when the volumes containing the dataset are located within that IBM TS3500 Tape Library. For old datasets, the list is restricted to the IBM TS3500 Tape Library that contains the volumes.

DFSMS catalog processing

JES3 catalog processing determines all of the catalogs required by a job and divides them into two categories:

- DFSMS-managed user catalogs
- JES3-managed user catalogs

DFSMS catalog services, a subsystem interface call to catalog locate processing, is used for normal locate requests. DFSMS catalog services is invoked during locate processing. It invokes SVC 26 for all existing datasets when DFSMS is active. Locates are required for all existing datasets to determine whether they are DFSMS-managed, even if VOL=SER= is present on the DD statement. If the request is for an old dataset, catalog services determine whether it is for a library volume. For multivolume requests that are system-managed, a check is made to determine whether all volumes are in the same library.

DFSMS VOLREF processing

DFSMS VOLREF services are invoked during locate processing if VOL=REF= is present on a DD statement for each dataset that contains a volume reference to a cataloged dataset. DFSMS VOLREF services determine whether the dataset referenced by a VOL=REF= parameter is DFSMS-managed. Note that VOL=REF= now maps to the same Storage Group for a DFSMS-managed dataset, but not necessarily to the same volume. DFSMS VOLREF services also collect information about the job’s resource requirements.

The IBM TS3500 Tape Library supports the following features:

- Identifies the DDs that are IBM TS3500 Tape Library-managed mountable entries
- Obtains the associated device pool names list
- Selects the LDG that best matches the names list
- Provides the LDG name to JES3 for setup
- Indicates to JES3 that the mount is deferred until execution

Fetch messages

While IBM TS3500 Tape Library cartridges are mounted and demounted by the library, fetch messages to an operator are unnecessary and can be confusing. With this support, all fetch messages (`IAT5110`) for IBM TS3500 Tape Library requests are changed to be the non-action informational USES form of the message. These messages are routed to the same console destination as other USES fetch messages. The routing of the message is based on the UNITNAME.

JES3 allocation and mounting

JES3 MDS controls the fetching, allocation, and mounting of the tape volumes requested in the JCL for each job to be executed on a processor. The scope of MDS tape device support is complex-wide, unlike z/OS job resource allocation, whose scope is limited to one processor. Another difference between JES3 MDS allocation and z/OS allocation is that MDS considers the resource requirements for all the steps in a job for all processors in a loosely coupled complex. z/OS allocation considers job resource requirements one step at a time in the executing processor.

MDS processing also determines which processors are eligible to execute a job based on resource availability and connectivity in the complex.

z/OS allocation interfaces with JES3 MDS during step allocation and dynamic allocation to get the JES3 device allocation information and to inform MDS of resource deallocations. z/OS allocation is enhanced by reducing the allocation path for mountable volumes. JES3 supplies the device address for the IBM TS3500 Tape Library allocation request through an SSI request to JES3 during step initiation when the job is executing under the initiator. This support is not changed from previous releases.

DFSMS/MVS and z/OS provide all of the IBM TS3500 Tape Library support except the interfaces to JES3 for MDS allocation and processor selection.

JES3 MDS continues to select tape units for the IBM TS3500 Tape Library. MDS no longer uses the UNIT parameter for allocation of tape requests for IBM TS3500 Tape Library requests. DFSMS/MVS determines the appropriate LDG name for JES3 setup, from the Storage Group and Data Class assigned to the dataset, and replaces the UNITNAME from the JCL with that LDG name. Because this action is done after the ACS routine, the JCL-specified UNITNAME is available to the ACS routine. This capability is used to disallow JCL-specified LDG names. If LDG names are permitted in the JCL, the associated datasets must be in a DFSMS tape environment. Otherwise, the allocation fails, because an LDG name restricts allocation to IBM TS3500 Tape Library drives that can be used only for system-managed volumes.

Note: An LDG name specified as a UNITNAME in JCL can be used only to filter requests within the ACS routine. Because DFSMS/MVS replaces the externally specified UNITNAME, it cannot be used to direct allocation to a specific library or library device type.

All components within z/OS and DFSMS/MVS request tape mounting and demounting inside an IBM TS3500 Tape Library. They call a DFP service, library automation communication services (LACS), instead of issuing a write to operator (WTO), which is done by z/OS allocation, so all mounts are deferred until job execution. The Library Manager LACS support is called at that time.

MDS allocates an available drive from the available unit addresses for LDGW3495. It passes that device address to z/OS allocation through the JES3 allocation SSI. At dataset OPEN time, LACS are used to mount and verify a scratch tape. When the job finishes with the tape, either CLOSE or deallocation issues a demount request through LACS, which removes the tape from the drive. MDS does normal breakdown processing and does not need to communicate with the Library Manager.

E

Installation worksheets

The IBM installation team requires information that only the client can supply. The client needs to complete the following worksheets with the local IBM account team and give the worksheets to the installation team:

- IBM 3953 Web Specialist worksheet: Refer to Table E-1 on page 498.
- IBM TS3500 library information: Refer to Table E-2 on page 499.
- Master Console information: Refer to Table E-3 on page 500.
- IBM 3953 Tape Frame information: Refer to Table E-4 on page 500.
- TS1130, TS1120, or IBM 3592-J70 information: Refer to Table E-5 on page 501.
- Virtual Tape Server information: Refer to Table E-6 on page 501.

Table E-1 IBM 3953 Web Specialist worksheet

IBM 3953 Web Specialist worksheet		
Library Manager A	**Information**	**Comment**
TCP/IP Host Name		
TCP/IP Address		
SubnetMask (or Network Mask)		
Router Address (or Gateway Address)		(optional)
Domain Name		(optional)
Nameserver Address		(optional)
Library Sequence Number for 3953 Native Partition		Must match z/OS host LIBRARY-ID
Library Sequence Number for 3953 VTS 1 Partition		Must match z/OS host LIBRARY-ID
Library Sequence Number for 3953 VTS 2 Partition		Must match z/OS host LIBRARY-ID
Library Manager B	**Information**	**Comment**
TCP/IP Host Name		
TCP/IP Address		
Subnet Mask (or Network Mask)		
Router Address (or Gateway Address)		(optional)
Domain Name		(optional)
Nameserver Address		(optional)
Library Sequence Number for 3953 Native Partition		Must match z/OS host LIBRARY-ID
Library Sequence Number for 3953 VTS 1 Partition		Must match z/OS host LIBRARY-ID
Library Sequence Number for 3953 VTS 2 Partition		Must match z/OS host LIBRARY-ID

Table E-2 IBM TS3500 library information worksheet

TS3500 library information		
Item	**Information**	**Comment**
FC1643 Intermediate Capacity on Demand		Need key
FC1644 Full Capacity on Demand		Need key
FC1690 Advanced Library Management System		Need key
FC1692 Entry Advanced Library Management System		Need Key
FC1693 Intermediate Advanced Library Management System		Need Key
FC 1694 Full Advanced Library Management System		Need Key
Host Name		
IP Address on Client Network		IPv4
Subnet Mask		IPv4
Gateway		IPv4
IP Address on Client Network		IPv6
Prefix		IPv6
Gateway		IPv6
IBM 3953 Logical Library Number		Default: 1
Logical Library Starting Storage Element Address		Default: 1025
IBM TS3500 Serial Number		
Logical Library Cartridge VOLSER Range for Cartridge Assignment Policy (CAP)		
Device ID per control unit (from TS3500)		
Analog Phone Connection Location		For Call Home function
Analog Phone Number		

Table E-3 Master Console information worksheet

Master Console information		
Item	**Information**	**Comment**
Phone Connection Location		
Phone Number for Connection		
Client’s Name		
Phone Number for Off-Shift Contact		
Analog Phone Connection Location		For Call Home function
Analog Phone Number		

Table E-4 IBM 3953 Tape Frame information worksheet

IBM 3953 Tape Frame information		
Item	**Information**	**Comment**
Host name for LMA		
Host name for LMB		
IP Address for LMA		
IP Address for LMB		
Ethernet cable location for LMA		
Ethernet cable location for LMB		
Library sequence number Port 0		For J70 or C06
Library sequence number Port 1		For VTS 1
Library sequence number Port 2		For VTS 2
Physical VOLSER assignment		
- VTS 1		From the VOLSER information in the TS350: native as compared to VTS VOLSER ranges
- VTS 2		
- J70 or C06 in the base frame		
Client’s name		

Table E-5 IBM 3592 Model J70 or TS1120 Model C06 information

IBM 3592-J70 or TS1120 Model C06 information		
Item	**Information**	**Comment**
Physical Device beginning Device ID		
Number of drives		
Physical drive location in the TS3500		Frame and row
Physical drive location in the TS3500		
Physical drive location in the TS3500		
Physical drive location in the TS3500		
Physical drive location in the TS3500		
Physical drive location in the TS3500		
Physical drive location in the TS3500		
Physical drive location in the TS3500		
Physical drive location in the TS3500		
Physical drive location in the TS3500		
Physical drive location in the TS3500		
Physical drive location in the TS3500		

Table E-6 Virtual Tape Server information

Virtual Tape Server (VTS) or TS7700 Virtualization Engine information		
Item	**Information**	**Comment**
VTS 1		
VTS or TS7700 physical serial number		
Fast Ready categories		
VOLSER ranges for physical volumes		
VOLSER ranges for logical volumes		
Address ranges for physical drives		
Address ranges for logical drives		

Virtual Tape Server (VTS) or TS7700 Virtualization Engine information		
VTS LIBRARY-ID defined at the host		
Physical drive location in the TS3500 1/12		Frame and row
Physical drive location in the TS3500 2/12		
Physical drive location in the TS3500 3/12		
Physical drive location in the TS3500 4/12		
Physical drive location in the TS3500 5/12		
Physical drive location in the TS3500 6/12		
Physical drive location in the TS3500 7/12		
Physical drive location in the TS3500 8/12		
Physical drive location in the TS3500 9/12		
Physical drive location in the TS3500 10/12		
Physical drive location in the TS3500 11/12		
Physical drive location in the TS3500 12/12		
VTS 2		
VTS or TS7700 physical serial number		
Fast Ready categories		
VOLSER ranges for physical volumes		
VOLSER ranges for logical volumes		
Address ranges for physical drives		
Address ranges for logical drives		
VTS LIBRARY-ID defined at the host		
Physical drive location in the TS3500 1/12		Frame and row
Physical drive location in the TS3500 2/12		
Physical drive location in the TS3500 3/12		
Physical drive location in the TS3500 4/12		
Physical drive location in the TS3500 5/12		
Physical drive location in the TS3500 6/12		
Physical drive location in the TS3500 7/12		
Physical drive location in the TS3500 8/12		Frame and Row
Physical drive location in the TS3500 9/12		
Physical drive location in the TS3500 10/12		
Physical drive location in the TS3500 11/12		
Physical drive location in the TS3500 12/12		

Virtual Tape Server (VTS) or TS7700 Virtualization Engine information	
Peer-to-Peer VTS definitions	
Composite Library Name	
Composite Library LIBRARY-ID	
Distributed Library Names	
Distributed Library LIBRARY-IDs	
User Interface Distributed Library	
Copy Mode Selection	
VTC Switch Address	
Preferred I/O VTS Selection	
Option to force scratch mounts to preferred VTS	
Master VTS Selection	
Distance between Distributed Libraries	

Table E-7 TS3500 Tape Library Configuration information for TS7700 Cluster 0, Cluster 1, and Cluster 2

Field	Cluster 0	Cluster 1	Cluster 2	Notes
Tape Drive Physical Positions (F*n*,R*nn*) for the drives assigned to this V06.	F=Frame, R=Row 1. F____,R____ 2. F____,R____ 3. F____,R____ 4. F____,R____ 5. F____,R____ 6. F____,R____ 7. F____,R____ 8. F____,R____ 9. F____,R____ 10. F____,R____ 11. F____,R____ 12. F____,R____ 13. F____,R____ 14. F____,R____ 15. F____,R____ 16. F____,R____	F=Frame, R=Row 1. F____,R____ 2. F____,R____ 3. F____,R____ 4. F____,R____ 5. F____,R____ 6. F____,R____ 7. F____,R____ 8. F____,R____ 9. F____,R____ 10. F____,R____ 11. F____,R____ 12. F____,R____ 13. F____,R____ 14. F____,R____ 15. F____,R____ 16. F____,R____	F=Frame, R=Row 1. F____,R____ 2. F____,R____ 3. F____,R____ 4. F____,R____ 5. F____,R____ 6. F____,R____ 7. F____,R____ 8. F____,R____ 9. F____,R____ 10. F____,R____ 11. F____,R____ 12. F____,R____ 13. F____,R____ 14. F____,R____ 15. F____,R____ 16. F____,R____	A logical library can be connected to one or two clusters. The first is known as Cluster 0, the second (if installed) is known as Cluster 1, and the third (if installed) is known as Cluster 2. Each cluster will have a separate set of tape drives. A minimum of four and a maximum of 16 drives can be connected to each cluster.

Field	Cluster 0	Cluster 1	Cluster 2	Notes
Tape Drive Worldwide Node Names (WWNNs)	1. ______ 2. ______ 3. ______ 4. ______ 5. ______ 6. ______ 7. ______ 8. ______ 9. ______ 10. ______ 11. ______ 12. ______ 13. ______ 14. ______ 15. ______ 16. ______	1. ______ 2. ______ 3. ______ 4. ______ 5. ______ 6. ______ 7. ______ 8. ______ 9. ______ 10. ______ 11. ______ 12. ______ 13. ______ 14. ______ 15. ______ 16. ______	1. ______ 2. ______ 3. ______ 4. ______ 5. ______ 6. ______ 7. ______ 8. ______ 9. ______ 10. ______ 11. ______ 12. ______ 13. ______ 14. ______ 15. ______ 16. ______	Record the Worldwide Node Name (WWNN) of each tape drive.
Media Type				JA, JJ, and JB tape cartridges are supported and can be intermixed in the TS7700. However, no other tape types can be intermixed. The type is indicated by the last two characters of the eight character barcode label VOLSER on the cartridges.
Media Volume Serial (VOLSER) Range	From:______ To:______	From:______ To:______	From:______ To:______	This is a range containing the barcode label VOLSERs of all the cartridges assigned to a single TS7700.

Table E-8 3953-L05 Library Manager Configuration information for TS7700

Field	Cluster 0	Cluster 1	Cluster 2	Notes
Library Sequence Number (also called Library Sequence ID)				The Library Sequence ID is assigned by the client's administrator. This is a five character name that is used as an identifier for a specific partition (logical library) within the tape library. This identifier is specified in the configuration and must match in all machines that reference the partition. Note: If the client did not supply a library sequence number, use the last five digits of the 3953 serial number.
Home Pool				The Home Pool specifies a storage pool to which the stacked volumes will be assigned. The default value is 00.
Logical Device IDs				Each tape drive is assigned a Logical Device ID by the client's administrator. This number is used in mainframe messages and error log entries to identify the affected tape drive.
Native				This is the address.

The information contained in Table E-9 is required for a single site TS7700 configuration.

Table E-9 TS7700 Configuration information

Field	Value	Notes
Domain Name		The Domain Name is assigned by the client's MVS or z/OS (mainframe) administrator. The administrator might know this as the System Managed Storage (SMS) Composite Library name.
Node Name		The node name is assigned by the client's MVS or z/OS (mainframe) administrator. MVS or z/OS will access the machine using a combination of Domain Name and Node Name. In many cases, the Node Name is also used to identify the machine on the client's Ethernet network. As an example, if the Node Name is A, the machine might be accessed on the client's Ethernet network as A.customer.com.
Cluster Index		0 to 2. If the cluster you are installing will not be in a grid configuration, set this to 0. In a grid (Peer-to-Peer) environment, each peer (site) must have a different index, and the index must use consecutive numbers.
Node Index		0 for the first in the frame; 1 for the second in the frame.
Library Sequence Number/Library Sequence ID		The Library Sequence Number (ID) is assigned by the client's administrator. This is a five character name that is used as an identifier for a specific V06 Partition. This identifier is specified in the configuration and must match in all machines that reference the partition.
Library Type Indicator		For IBM System Storage TS3500 Tape Library, use library type = 1.
Library V06 Partition (for this node)		1 or 2. Each 3953 Library Manager (or pair of Library Managers if they are in a dual Library Manager configuration for redundancy) can be attached to one or two V06s or subsystems.

Field	Value	Notes
Dual Library Manager Library Indicator		y or n. If the TS7700 is connected to dual (redundant) Library Managers, this must be set to y. If the TS7700 is connected to a single Library Manager, this must be set to n.
Primary Client IP		Client's network administrator.
Primary Router Client IP		Client's network administrator.
Alternate Router IP		Client's network administrator.
Client Gateway		Client's network administrator.
Client Subnet Mask		Client's network administrator.

The information in Table E-10 is used if a TS7700 grid will be installed. If this TS7700 will not be part of the global grid, enter 0.0.0.0 for the following values.

Table E-10 TS7700 grid configuration information

Field	Value	Notes
Primary cross cluster subnet mask		
Primary Local Interface Network Mask Address		The Primary Local Interface is the Host Adapter Card located in slot C4 of the 9131-52A system unit.
Primary Gateway Address for Local Interface		
Secondary Local Interface Network Mask Address		The Secondary Local Interface is the Host Adapter Card located in slot C5 of the 9131-52A system unit.
Secondary Gateway Address for the Local Interface		The Secondary Local Interface is the Host Adapter Card located in slot C5 of the 9131-52A system unit.
Node Number for the local TS7740		Each node is assigned a number. The grid number is 0 or 1.

F

REXX utility to recover TCDB

The following code shows the REXX program to create IDCAMS Volume Entry commands:

```
/***************************** REXX ********************************/
/*                      IBM INTERNAL USE ONLY                       */
/*                                                                  */
/* TCDB RECOVERY TOOL V1.0                                          */
/*                                                                  */
/* DESCRIPTION: REXX program for making the IDCAMS CREATE VOLUME   */
/*              ENTRY COMMAND FROM 3494 LIBRARY MANAGER DB LIST.   */
/*              In the case of crashing the volcat(TCDB),          */
/*              you can recreate VOLUME ENTRY by this program and  */
/*              IDCAMS.                                             */
/*                                                                  */
/*              Before executing this exec, you are required to    */
/*              prepare the input FILE WHICH CONTAINS LM DB FILE.  */
/*              (FILE NAME IS TCDBRECV INFILE A)                   */
/*              The output is written to TCDBRECV OUTFILE A.       */
/*                                                                  */
/* NOTE1      : This program assumes that;                          */
/*                Recording technique of Media type 1 is  36TRACK. */
/*                Recording technique of Media type E is  36TRACK. */
/*                Recording technique of Media type J is 128TRACK. */
/*                Recording technique of Media type K is 128TRACK. */
/*                                                                  */
/* NOTE2      : ENTER YOUR SCRATCH/PRIVATE CATEGORY CODE.          */
/*              ENTER YOUR LIBRARY NAME.                            */
/*                                                                  */
/* Creation Date: 1999/07/14  By K.Uchiyama (IBM Japan)            */
/* Last Update  : 2003/03/11  by K. Denefleh                       */
/* Last Update  : yyyy/mm/dd                                        */
/*******************************************************************/

/* Enter your scratch category code */
scratch1 = 0001
scratch2 = 0002
scratch3 = 0003
scratch4 = 0004
```



```
/* Enter your private category code */
private1 = 000F
private2 = PPPP

/* Enter your error   category code */
error1   = 000E

/* Enter your LIBRARY name */
atllib1 = LIBATL1     /* for 3494ATL */
vtslib1 = LIBVTS1     /* for 3494VTS */
vtslib2 = LIBVTS2     /* for 3494VTS */

/*****************************************************************/
/*                                                               */
/* Open the file and queue all the records.                      */
/*                                                               */
/*****************************************************************/

"execio * diskr tcdbRECV INFILE A (FINIS"

  if rc  < > 0  then do
     say '***Error: Could not read the input file ***'
     exit 16
  end

/*****************************************************************/
/*                                                               */
/* Delete the header information in the queue.                   */
/* If 'VOLSER' is found, call the subroutine and stop the process. */
/*                                                               */
/*****************************************************************/

i = 0   /* for debugging */
j = 0   /* for debugging */

done1 = 'no'
do while done1 = 'no'

  pull stackitem
  i = i + 1   /* for debugging */

    if index(stackitem,'VOLSER') <> 0 then do
         call sub1
         done1 = 'yes'
      end
    else nop
end /* end do while */

/*****************************************************************/
/*                                                               */
/* Delete the useless information and then make the CREATE command.*/
/*                                                               */
/*****************************************************************/

done2 = 'no'
do while done2 = 'no'
   parse pull stackitem
   i = i + 1    /* for debugging */
   select
      when substr(stackitem,1,6)  = '------' then nop
```

```
      when substr(stackitem,1,6)  = '      ' then nop
      when substr(stackitem,n2,2) = 'FF'     then nop
      when substr(stackitem,1,5)  = 'Total'  then done2 = 'yes'

      otherwise

      volume    =  substr(stackitem,n1,6)
      category  =  substr(stackitem,n2,4)
      mediatype =  substr(stackitem,n3,10)
      mediatype =  space(mediatype,0)         /* omit space */

   call sub2

    if   uattr = '??????'   then  do
     say 'warning: Error or unexpected Category code was detected.'
     say '         VOLSER= 'volume
     say '         Category code = 'category
     say '         Volume Entry was not created.'
     say ' '
     end

     else     do
       entry1 = " CREATE VOLENTRY (NAME(V"volume")  - "
       entry2 = "        LIBNAME("libname") -"
       entry3 = "        MEDIATYPE("media") -"
       entry4 = "        UATTR("uattr") -"
       entry5 = "        RECORDING("recording") LOCATION(LIBRARY))"

       queue entry1
       queue entry2
       queue entry3
       queue entry4
       queue entry5

       j = j + 1  /* for debugging */

end  /* end else   */
   end   /* end select */
end    /* end do while */

/*******************************************************************/
/*                                                                 */
/* Write the queued entries to file.                               */
/*                                                                 */
/*******************************************************************/
say 'message: The number of input records       = 'i /* for debugging */
say 'message: The number of created vol entries = 'j /* for debugging */

 "execio * diskw tcdbRECV OUTFILE A (FINIS"

  if rc  < > 0  then do
     say '***Error: Could not write to the output file ***'
     exit 16
  end

exit 0


/* SUBROUTINE 1****************************************************/
/* Find the word position.                                         */
```

```
/*******************************************************************/

sub1:
 n1 = index(stackitem,'VOLSER')
 n2 = index(stackitem,'CATEGORY')
 n3 = index(stackitem,'MEDIA TYPE')
 n4 = index(stackitem,'MOUNT DATE')
return

/* SUBROUTINE 2*****************************************************/
/* Set the mediatype,libname,RECORDING TECHNIQUE AND USER ATTRIBUTE.*/
/* Attention:                                                      */
/* Mediatype and recording technology have NO 1:1 dependency.      */
/* LM cannot provide the correct recording technology              .*/
/* Setting the recording to 128TRACK can only cause problems, if   */
/* you have a mixed environment installed, and a VOLSER which is   .*/
/* written in recording technology > 128 is mounted on 3590B model .*/
/* However, setting a higher recording technology will cause       */
/* problems as long as drive models with the lower technology      */
/* are installed. In a mixed environment, use the lowest          .*/
/* value of the recording technology. In non-mixed environments,   */
/* use the correct recording technology for your drives:           */
/* 3590B = 128                                                     */
/* 3590E = 256                                                     */
/* 3590H = 384                                                     */
//* Please adjust the REXX to fit your environment.                */
/*******************************************************************/
sub2:
 select
       when substr(mediatype,1,1) = 1  then media = 'MEDIA1'
       when substr(mediatype,1,1) = E  then media = 'MEDIA2'
       when substr(mediatype,1,1) = J  then media = 'MEDIA3'
       when substr(mediatype,1,1) = K  then media = 'MEDIA4'
       otherwise                            media = '??????'
 end
select
       when substr(mediatype,1,1) = 1  then recording = '36TRACK'
       when substr(mediatype,1,1) = E  then recording = '36TRACK'
       when substr(mediatype,1,1) = J  then recording = '128TRACK'
       when substr(mediatype,1,1) = K  then recording = '128TRACK'
       otherwise                            recording = 'xxxTRACK'
 end
select
       when substr(mediatype,1,1) = '1'  then libname = atllib1
       when substr(mediatype,3,1) = '1'  then libname = vtslib1
       when substr(mediatype,3,1) = '2'  then libname = vtslib2
       otherwise                              libname = '???????'
 end
select
       when category  = scratch1  then uattr = 'SCRATCH'
       when category  = scratch2  then uattr = 'SCRATCH'
       when category  = scratch3  then uattr = 'SCRATCH'
       when category  = scratch4  then uattr = 'SCRATCH'
       when category  = private1  then uattr = 'PRIVATE'
       when category  = private2  then uattr = 'PRIVATE'
       when category  = error1    then uattr = '??????'
       otherwise                       uattr = '??????'
 end

return
```

G

Feature codes

In this appendix, we provide the descriptions of the feature codes (FC) available to install IBM 3592 tape drives and controllers with an TS3500 Tape Library and attach them to System z host systems.

Note that four-digit feature codes are specific to model types. The same feature might deliver different hardware based on its specified model type.

The process of either upgrading your existing system or moving parts from an existing system to a new system is called a *miscellaneous equipment specification* (MES).

IBM 3953 Model F05 Frame

The IBM 3953 Model F05 is an independent frame that is used to house the IBM 3953 Library Manager Model L05 and other components. There are two types of frames, but they have the same model number. They are differentiated by the addition of feature codes: FC5505 for the base frame and FC5506 for the expansion frame.

FC0500: Library function enhance field

This feature provides an update to the microcode of an installed Library Manager to provide the latest level of functional microcode firmware support. Newer microcode levels might be required with additional new functions.

FC1903: Dual AC power

This feature provides one additional Power Distribution Unit (PDU) to allow connection to independent branch power circuits. This feature is optional and can be installed either at the manufacturing plant or as an MES upgrade.

FC1904: Redundant AC power

This feature provides two power switching units to allow true power redundancy. This feature is orderable only on a base frame (FC5505), not an expansion frame. Components in the expansion frames already have integrated dual power attachments for optional connection to separate power supplies. The prerequisites for the feature are FC1903 (dual AC power) and FC5505 (base frame feature). This feature is optional and can be installed either at the manufacturing plant or as an MES upgrade.

FC2714: Console expansion

This feature provides an attachment cable and mounting hardware for connection of an existing IBM System Storage TS3000 System Console (TSSC) mounted externally to the base frame. This feature also supplies a rack-mountable 16-port TSSC Ethernet switch. This feature is only available for a base frame and can be ordered in place of FC2718, Master Console for Service.

FC2719: Console upgrade

This feature provides a memory upgrade to 2 GB total RAM and a second Ethernet card for the Service Console to allow redundant connections into the service network. This feature only applies to consoles shipped with features FC2718 and FC2720. It is required on any console used by TS7700 features FC2714, FC2715, or FC2720. This feature can be ordered from the plant or as an MES.

FC3487: 2 Gb Fibre Channel switch

(Withdrawn from marketing effective 29 September 2006)

IBM 3592 drives have Fibre Channel connections and connect to the IBM 3592 Controllers and VTSs through Fibre Channel switches. This feature provides an integrated 2 Gb Fibre Channel switch with 20 LC shortwave ports for attachment to IBM 3592 tape drives in the TS3500 Tape Library. The 2 Gb Fibre Channel switch has dual power connection for optional attachment to separate power supplies.

For each IBM 3592-J70 Controller, you can attach drives through one or optionally two of these switches; there is a maximum of two. Each VTS, however, requires two switches. The maximum number of these switches in a frame is six. The corequisite feature is FC4888 (switch mounting kit), where one feature is required for each pair of FC3487 switches.

FC3488: 4 Gb Fibre Channel switch

This feature provides a 4 Gb Fibre Channel switch with 20 LC Shortwave ports for attachment to 3592 tape drives in the TS3500 Tape Library. The 4 Gb Fibre Channel switch has dual power connection for optional attachment to separate power supplies. For each 3592-J70 or TS1120 Model C06 Controller, there is a maximum of two. For each VTS or TS7700, this feature must be ordered in pairs. The maximum number of these switches in a frame is six. The corequisite feature is FC4888 (switch mounting kit), where one feature is required for each pair of FC3488 switches.

FC3491: External fabric support field

Clients, who already own supported external Fibre Channel switches, can use them as part of the IBM 3953 subsystem. This feature on the frame indicates that IBM 3592 drives will connect to an IBM 3592 Controller through a supported external client-supplied Fibre Channel switch, or directly to the controller. The client is then responsible for providing the cables from the controller to the switch. (Cables from the switch or controller to the 3592 tape drives can be ordered with the drives or supplied by the client.) One feature is required for each attachment up to a maximum of six per frame.

FC4865: Control unit removal

This feature allows the field removal of a (redundant) Library Manager or tape control unit from an installed IBM 3953 frame. This feature is for currently installed units only, so it is not necessary on a frame that is new from the plant.

In addition, you must also remove the frame installation feature for the Library Manager, or the control unit; one of FC5065, FC5066, FC5067, FC5875, FC5876, or FC5877 must be removed. The maximum number of removal features on a frame is three.

FC4870: Replace controller with C06

This feature provides the changes to the mounting hardware that are required in order to replace a 3592-J70 Controller with a TS1120 Tape Controller in an installed 3953-F05 frame.

FC4888: Fibre Channel switch mount kit

This feature provides the mounting hardware for up to two Fibre Channel switches on a 3953-F05 Frame that contains a tape controller or is attached to a VTS/TS7700. It includes the required mounting hardware, bifurcated power cables, and instructions for installing up to two Fibre Channel switches in the 3953-F05 frame. One feature is required for each pair of FC3488 switches, or FC4889 or FC4890, up to a maximum of three per frame.

FC4889: Reinstall 2 Gb Fibre Channel switch

Clients who already own IBM 3494-integrated switches can reuse them as part of the IBM 3953 subsystem. This feature installs a client-supplied 2 Gb Emulex Fibre Channel switch to attach tape controllers to drives, instead of ordering FC3487 switches. The 2 Gb Emulex Fibre Channel switch has dual power connection for optional attachment to separate power supplies. One FC4889 is required for each Emulex switch installed, up to a maximum of six per frame.

FC4890: Reinstall 2109 F16 switch

Clients who already own IBM 2109 F16 Fibre Channel switches can use them as part of the IBM 3953 subsystem. This feature installs a client-supplied 2 Gb IBM 2109 Model F16 Fibre Channel switch to attach tape controllers to drives, instead of ordering FC3487 switches. The IBM 2109 Model F16 Fibre Channel switch has dual power connection for optional attachment to separate power supplies. Only one IBM 2109 F16 switch is supported per controller (not two); one FC4890 is required for each switch, up to a maximum of three per frame.

Note that the IBM 2109 F16 switch is not supported in an IBM 3953 configuration.

FC4897: Reinstall 4 Gb Fibre Channel switch

This feature is the same as FC3488 but allows the client to provide a 4 Gb Fibre Channel switch FC3488 that was removed from a 3592 Controller or a 3952-F05 Frame or 3953-F05 Frame and reinstall it for attachment to this TS1120 Model C06 Controller. Plant-installed or field-installed. Maximum: two. Prerequisites: FC3478. This feature is mutually exclusive of FC3492, FC3493, FC4887, FC9492, and FC9493.

FC5065: Plant install second IBM 3953-L05

Each of feature codes FC5065, FC5066, and FC5067 supplies mounting hardware to install an optional second Library Manager in the base frame for availability. The first Library Manager mounting hardware is installed as standard at the plant. The second Library Manager must be ordered separately as Model type 3953-L05 in addition to the correct mounting feature. There can be no more than one of these features on a base frame.

FC5065 is used on a new Model F05 base frame when the second Library Manager is installed at the manufacturing plant as part of a new order for the frame with two Library Managers. FC9065 must appear on the new IBM 3953-L05 Model, indicating that it will be integrated at the plant. This feature is plant-installed only and is not available as an upgrade.

There are three prerequisite features for a second Library Manager:

- FC5505 because the second Library Manager must be installed in a base frame
- FC1903 to allow connection through different power circuits for availability
- Either FC5511 or FC5510 to enable the operator station in the frame to be shared

FC5066: Field merge second IBM 3953-L05

Refer to “FC5065: Plant install second IBM 3953-L05” on page 514 for description and prerequisites.

FC5066 is used on a new Model F05 base frame when the second Library Manager will be installed in the field at the client site. FC9066 must appear on the IBM 3953-L05 Model. This feature is plant-installed only and is not available as an upgrade.

FC5067: Field install second IBM 3953-L05

Refer to “FC5065: Plant install second IBM 3953-L05” on page 514 for description and prerequisites.

FC5067 is used on an installed Model F05 base frame when you add a second Library Manager to an installed frame at the client site. FC5067 must appear on the new IBM 3953-L05 Model. This feature is field-installed only and is not available on a new frame from the plant.

FC5505: Base user interface

This is an important feature, which designates a frame as the base frame, containing the Library Managers, the Master Console, up to one tape control unit, and associated Fibre Channel switches. It provides the mounting hardware for one IBM 3953 Model L05 Library Manager. Also included with this feature are two 24-port Ethernet switches, a keyboard and mouse, and the video monitor.

Note that, in addition, you must order the IBM 3953-L05 (with FC9065), because FC5505 provides only the mounting hardware. Each frame must have either FC5505 or FC5506 installed. There must be one base frame in the IBM 3953 subsystem. FC5505 is plant-installed only and is not available as an upgrade.

FC5506: Expansion connectivity

This is an important feature that designates a frame as an expansion frame, which contains tape controllers and associated Fibre Channel switches. It provides two 8-port Ethernet routers and the capability of installing up to three IBM 3592 controllers.

Each frame must have either FC5505 or FC5506 installed. There can be up to five expansion frames in the IBM 3953 subsystem. The expansion frame must have at least one and a maximum of three of FC5875, FC5876, and FC5877, which are controller installation features. This feature is plant-installed only and is not available as an upgrade.

FC5510: Plant install and 5511: Field install KVM switch

Each of these features provides the keyboard, video monitor, and mouse switch, as well as the mounting hardware for installation in the base frame. This feature allows the operator station interface to be shared by the Library Managers and the Master Console. It is a requirement if either a Master Console or a second Library Manager is installed in the base frame (any of feature codes: FC2718, FC5065, FC5066, or FC5067).

These features can be ordered only on the base frame, so FC5505 (base frame feature) is a prerequisite. Only one or the other of these features can be installed, but not both.

FC5510 is installed on new frames where the KVM switch is integrated at the manufacturing plant; FC5511 is ordered as an upgrade to an installed base frame if it is required, for example, to support a field upgrade to add a second Library Manager to a subsystem.

FC5593: Router for Encryption Key Manager (EKM) attach

Provides two routers for redundant connections between the Encryption Key Manager and the tape control unit. Ethernet cables from the routers to the control unit are also provided.

FC5875: Field merge 3592-J70

This feature code provides mounting hardware and notifies the plant that a client-supplied IBM 3592 Model J70 Controller will be field-merged into a new IBM 3953 frame coming from the plant as part of the final client installation. This feature must appear on the new-order IBM 3953-F05, and FC9875 must be ordered on the IBM 3592-J70.

FC5876: Plant install 3592-J70

This feature provides mounting hardware and plant installs a new IBM 3592 Model J70 Controller into a new IBM 3953 frame. This feature must appear on the new-order IBM 3953-F05, and FC9876 must appear on the new-order IBM 3592 Model J70.

FC5877: Field install 3592-J70

This feature provides mounting hardware to field install any IBM 3592 Model J70 Controller into a currently installed IBM 3953 Model F05 Frame. This feature must be added as an upgrade MES to the installed IBM 3953-F05, and FC9875 must appear on the IBM 3592 Model J70, either as a new order from the plant or as a field MES to a client-owned unit.

FC5878: Field merge 3592 Model C06 Controller in a 3953-F05 Frame

This feature provides mounting hardware and notifies the plant that a client-supplied TS1120 Tape Controller will be field-merged into a 3953-F05 Frame from the plant as part of the final client installation. This feature must appear on the 3953-F05 Frame order, and FC9887 must appear on the TS1120 Tape Controller order.

FC5879: Plant install 3592 Model C06 Controller in a 3953-F05 Frame

This feature provides mounting hardware and plant installs a TS1120 Tape Controller into a new 3953-F05 frame. This feature must appear on the 3953- F05 Frame order, and FC9876 must appear on the TS1120 Tape Controller order.

FC5880: Field install 3592 Model C06 Controller in a 3953-F05 Frame

This feature provides mounting hardware for the field installation of a client-supplied TS1120 Tape Controller into a currently installed 3953-F05 frame. This feature must appear on the 3953-F05 Frame order, and FC9887 must appear on the TS1120 Tape Controller order.

FC9013: TS7700 attach

This Specify Code specifies the attachment to the TS7700. There can be only two VTSs/TS7700s in an IBM 3953 subsystem, so a minimum of zero and a maximum of two of these features in combination with FC9020 are allowed on one base frame.

These are the prerequisites for TS7700 attach FC9013:

- Requires a minimum of two FC3488 (4 Gb switches) for each TS7700 attachment.
- Dual AC Power (FC9013) is required.
- Maximum quantity of FC9020 and FC9013 is two.

FC9020: VTS attach

This feature specifies the attachment of an IBM 3953 base frame to each VTS Model B10 or B20. There can be only two VTSs/TS7700s in an IBM 3953 subsystem, so a minimum of zero and a maximum of two of these features in combination with FC9013 are allowed on one base frame.

There are three prerequisite features for VTS attach FC9020:

- FC5505 because this feature can be ordered only on the base frame.
- FC1903 to allow connection through different power circuits for availability.
- Each VTS must be attached to the tape drives using two Fibre Channel switches, so two Fibre Channel switch features (FC3487 or FC4889) per FC9020 are corequisites in the base frame.

FC9491: External fabric support plant

Clients, who already own supported external Fibre Channel switches, can use them as part of the IBM 3953 subsystem. This feature on the frame indicates that IBM 3592 drives will connect to an IBM 3592 Controller through a supported external client-supplied Fibre Channel switch, or directly to the controller.

The client is then responsible for providing the cables from the controller to the switch. (Cables from the switch or controller to the 3592 tape drives can be ordered with the drives or supplied by the client.) One feature is required for each attachment up to a maximum of six features per frame.

You use this feature on a new frame installed at the plant only. If you want to order the facility for an installed IBM 3953 frame to add this facility as an upgrade MES, you use FC3491 (refer to “FC3491: External fabric support field” on page 513).

Power cords

One power cord feature is required: one of FC9953, FC9954, FC9955, FC9956, FC9957, FC9958, FC9959, or FC9966. The power cord features are chosen according to country of installation.

IBM 3953 Model L05 Library Manager

The IBM 3953 Model L05 is the Library Manager housed in the Model F05 independent tape frame.

FC0500: Library function enhance field

This feature provides an ability to order any required update to the microcode of an installed Library Manager to provide the latest level of functional microcode firmware support. Newer microcode levels might be required with additional new functions. This is not a mandatory feature and has no prerequisites; it can be ordered only as an MES on installed equipment.

FC5048 Library Manager performance enhancement - field

This feature provides the field installation of a performance improvement card in the Library Manager (LM). If this feature is added to a High Availability configuration (3953 Frame with dual Library Managers or a 3494 Library with an HA1 frame), the other LM must have FC5048 or FC9048.

FC5226: Remote Console (DCAF)

The Remote Console feature provides software that you load on a suitable client-supplied personal computer to enable remote access to the Library Manager interface. The view of the interface is the same as the view at the Library Manager operator station. In most cases, any required remote access for monitoring and controlling is more appropriately provided using the user-friendly IBM 3953 Web Specialist GUI.

You can put the Remote Console terminal anywhere on the client-supplied Local Area Network (LAN), and it will operate at the LAN communication rate. However, the client must be able to provide a LAN connection to a dedicated personal computer, running *one* of:

- Communication Manager 2 (CM/2) for APPC operation
- Communication Server for OS/2® WARP® (CS/2) for APPC operation
- TCP/IP Version 2.0 or higher (included in WARP) on the operating system OS/2 WARP Version 3 or higher with Multi-Protocol Transport Services (MPTS)

A separate feature is required for each IBM 3953 Model L05 Library Manager that is to be connected to the LAN. If there are two Library Managers in a single base frame, you can load the software in both Library Managers.

FC9048 Library Manager performance enhancement - plant

This feature provides the plant installation of a performance improvement card in the Library Manager (LM). If this feature is added to a High Availability configuration (3953 Frame with dual Library Managers or a 3494 Library with an HA1 frame), the other LM must have FC5048 or FC9048.

FC9065: Plant install in IBM 3953 Model F05 Frame

This feature tells the manufacturing plant to build the Library Manager into a base frame at the plant. It applies to new orders only.

FC9066: Field merge in IBM 3953 Model F05 Frame

This feature tells the manufacturing plant to deliver the Library Manager for installation into a frame at the client site (FC9066). It applies to new orders only.

TS3500 Model L23, D23, and S24 frames

The features included here are not an exhaustive list for the TS3500; we include new features related to the IBM 3953 subsystem and those relevant to IBM 3592 Tape Drive installation. Note the key FC9217 signifying System z attachment to the TS3500 Model L*xx* frame.

FC0500: Library function enhance field

This feature provides an ability to order any required update to the microcode of an installed TS3500 library and the tape drives to provide the latest level of functional microcode firmware support. Newer microcode levels might be required with additional new functions. This is not a mandatory feature and has no prerequisites; it can be ordered only as an MES on installed equipment.

FC1440: Service Bay B config and second accessor

This feature provides a second accessor and hardware to support a tape library that includes the 3584 High Availability Frame Model HA1. The Model HA1 frame installed adjacent to the Model L*xx* in the TS3500 Tape Library functions as a Service Bay A and the TS3500 Model D22 or D23 Expansion Frame at the opposite end of the library functions as a Service Bay B. Any tape drives and cartridges in the frame, which functions as the Service Bay B, are not addressable by the client. As additional frames are added to the library, the Service Bay B function will be assumed by the frame on the end without the need to move this feature.

FC1451: Enhanced frame control assembly

This feature provides the hardware and firmware required to support the installation of IBM tape drives within this frame. This feature provides an enhanced power architecture and frame control assembly for the Model L23 accessor that includes two power supplies and also provides a redundant AC line feed for the Model L23 accessor. It comes standard on the L23 Model and can be ordered as an optional feature on the D23 Model.

FC1461: Additional LC/LC patch panel cable

This feature provides one additional 2.0 meter (6 ft. 6.7 in.) LC/LC Fibre Channel cable to attach the second interface port on a 3592 tape drive to the Fibre Channel patch panel. It is required when the drive is attached to an IBM 3592 Controller through two Fibre Channel switches.

FC1513: 3592 Fibre drive mounting kit

This feature includes a Fibre-capable fixed sled, power supply, and one LC/LC drive-to-patch panel cable and coupler for installing a 3592 Tape Drive canister feature (FC1674, FC9677, or FC9680). This feature can be preinstalled to simplify future tape drive installation. (This feature applies to J1A and E05 drives only.)

FC1515: 3592 Fibre drive mounting kit

This feature includes a Fibre-capable fixed sled, power supply, and one LC/LC drive-to-patch panel cable and coupler for installing a 3592 Tape Drive canister feature (FC1674 or FC9683). This FC supports all 3592 drive models.

FC1610: Add Model D22, D23, D52, D53, S24, and S54 to Model *x*32

This feature is required when a short depth frame (Model D22, D23, D52, D53, S24, or S54) is added to an installed long depth frame (Model D32 or L32) in a TS3500 library. This feature includes a short rear side cover for the Model D32/L32 frame and the Model D22/D23/D52/D53/S24/S54 front and rear side covers.

FC1643: Intermediate capacity on demand

This feature provides on demand activation of additional storage elements within the tape library to increase the available cartridge slot capacity from 58 to 117 3592 cartridges for a Model L22/L23.

FC1644: Full capacity on demand

This feature provides on demand activation of additional storage elements within the tape library to increase the available cartridges to the maximum capacity of 199 - 260 3592 cartridges (depending on features ordered) for the Model L22/L23. The maximum 3592 cartridge capacity of 260 is reduced by 12 cartridges when five to eight 3592 Fibre Drive Mounting Kits (FC1513 or FC1515) are installed, and by 11 cartridges when nine to twelve Drive Mounting Kits are installed. The installation of a 16 additional I/O slots feature (FC1658 or FC1659) reduces the maximum cartridge capacity by 38 cartridges.

FC1645: Capacity on demand - S24 Frame

This feature provides on demand activation of additional 400 slots of capacity (Tier 3 and 4) for Model S24.

FC1646: Capacity on demand - S54 Frame

This feature provides on demand activation of additional 660 slots of capacity (Tier 3, 4, and 5) for Model S54.

FC1656: 64 additional I/O slots - 3592

This feature provides an additional 64 I/O slots for 3592 data cartridges in a D23 frame. It is supported in 3592 media library environments only. There is no mixed media support with Linear Tape-Open (LTO) media. The additional I/O slots provide the capability to simultaneously insert or remove 3592 data cartridges in addition to the insertion or removal of data cartridges with the standard I/O station. One FC1656 can be ordered for a D23 frame and requires FC1451. A maximum of three of these features can be ordered per TS3500 Tape Library configuration. FC1656 is plant only.

FC1659: 16 additional 3592 I/O slots

This feature provides an additional 16 I/O slots for 3592 data cartridges. It is for a TS3500 Model L22 or L23 without 3592 mixed media requirements in the library, or for a TS3500 Model L52 or L53 with 3592 mixed media requirements in the library. The additional I/O slots provide the capability to simultaneously insert or remove 3592 data cartridges in addition to the insertion or removal of data cartridges with the standard I/O station.

If you are adding frames to an installed Linear Tape-Open (LTO) library for System z attachment, this feature is required on the Model L52/L53 frame to provide the I/O station capability for the IBM 3592 cartridges.

It cannot be installed with FC1658, which supplies 16 additional LTO I/O slots. It is a prerequisite for this feature that the L frame is configured to full slot capacity, with either FC1642 or FC1644.

FC1663: Drive removal

This feature provides for the removal of one of the 3592 Tape Drive canister features (FC9677, FC9680, FC9683, or FC1674) from an installed TS3500 frame. This feature is intended for those clients who might need to remove drives from one frame and install them in another frame.

FC1674: 3592 drive field install

This feature provides install instructions to install or reinstall all 3592 drives (J1A, E05, and E06) from 3494 Silo, or 3584 with the 3592 Maintenance Plan terms. There are no parts included in this feature code, but it has an unenforceable prerequisite of Fibre drive mounting kits except for reinstall from a 3584. This FC covers both field install and field merge and allows for recovery of IBM service support representative (SSR) time.

FC1690: Advanced library management system

This feature is required on the L frame when a TS3500 Tape Library is attached to System z servers.

The Advanced Library Management System (ALMS) provides a license key to enable dynamic management of cartridges, storage slots, tape drives, and logical libraries. Tape drives can be assigned to any logical library using a Web user interface. ALMS is designed to allow logical libraries to be added, deleted, or changed while avoiding disruption to the host application. The assignment of inserted cartridges to a logical library can be set manually, by the software application, or by user-defined policies. Storage capacity can be changed while avoiding disruption to host applications.

FC1692: Entry advanced library management system

This feature provides entry level ALMS. If you purchase an entry-capacity L*xx* frame, you can purchase the Entry ALMS .

FC1693: Intermediate advanced library management system

This feature provides intermediate level ALMS. FC1693 has a prerequisite of FC1692. If you purchase an intermediate-capacity L*xx* frame, you can purchase the Intermediate ALMS.

FC1694: Full advanced library management system

This feature provides full ALMS. FC1694 has a prerequisite of FC1693.

FC1695: LTO test hardware for HD

This feature needs to be ordered on the attached HA1 when an S54 frame is installed in a HA library.

FC1696: 3592 test hardware for HD

This feature needs to be ordered on the attached HA1 when an S24 frame is installed in a HA library.

FC1802: 1-2 frame X-Track cable

This feature must be added to any TS3500 Tape Library (that does not contain a Model HA1) when frames are removed from a library that has three or more frames, so that there are only one or two frames remaining (one Model D22, D23, D32, D42, D52, or D53 frame attached).

FC1806: 3-6 frame X-Track cable

This feature must be added to any TS3500 Tape Library (that does not contain a Model HA1) when frames are added to a library that has one or two frames, so that there will only be three to six frames in the TS3500 library configuration (two to five Model D22, D23, D32, D42, D52, or D53 frames attached). This feature must also be added to any TS3500 Tape Library (that does not contain a Model HA1) when frames are removed from a library that has seven or more frames, so that there will only be three to six frames remaining (two to five Model D22, D23, D32, D42, D52, or D53 frames attached).

FC1814: 7-14 frame X-Track cable

This feature must be added to any TS3500 Tape Library (that does not contain a Model HA1) when one frame is added to a library that has one to six frames, so that there will only be seven frames in the TS3500 library configuration (six Model D22, D23, D32, D52, or D53 frames attached). If this feature is on the Model L32, seven to 14 total frames can be supported without changing this feature. This feature must also be added to any TS3500 Tape Library (that does not contain a Model HA1) when frames are removed from a library that has eight or more frames and the 8-16 frame X-Track cable feature (FC1816 or FC9316) installed, so that there will only be seven frames remaining (six Model D22, D23, D32, D52, or D53 frames attached).

FC1816: 8-16 frame X-Track cable

This feature can be added to any TS3500 Tape Library (that does not contain a Model HA1) when frames are added to a library that has one to seven frames, so that there will be eight to 16 frames in the TS3500 library configuration (seven to 15 Model D22, D23, D32, D52, or D53 frames attached). This feature must be added to any TS3500 Tape Library (that does not contain a Model HA1) when frames are added to a library, so that there will be 15 to 16 frames in the TS3500 library configuration (14 or 15 Model D22, D23, D32, D52, or D53 frames attached), unless FC9316 is installed.

FC1840: Change HA X-Track cable

This feature provides a different set of X-Track cables when the number of frames is changed in a TS3500 Tape Library that has a 3584 High Availability Frame Model HA1. Each TS3500 Four Tape Library configuration containing a Model HA1 requires a different set of X-Track cables for the dual accessors in the library depending on the total number of frames in that TS3500 Tape Library. This feature must be ordered every time that the number of attached frames is changed (either added or removed), and the proper X-Track cables will be shipped based on the number of FC9003s on the Model L*xx* frame.

FC1909: Single power source bifurcated cable

This feature provides attachment of an *xx*3 frame to a single power outlet while maintaining drive redundant power.

FC2205: Enhanced grippers/pivot for models L22, L23, L32, L52, or L53

This feature is required for field install high density gripper assembly to support frame Model S*xx* if FC9205 is not installed. The gripper must be installed on frame Model L*x*3.

FC2206: Enhanced grippers/pivot for HA for models D22, D52, D23, or D53

This feature is required for the field install high density gripper assembly to support frame Model S*xx* if FC9206 is not installed. The gripper must be installed on fame Model D*x*3 with Service Bay B (FC1440) for High Availability configuration (FC9040).

FC2304: Enhanced accessor for models L22, L23, L52, or L53

This feature provides completed accessor assembly with HD grippers to L*xx* models.

FC2305: Enhanced accessor for HA for models D22, D52, D23, D53, S24, or S54

This feature provides completed accessor assembly with HD grippers to D22/D52/D*x*3 models with FC1440.

FC2710: Remote support facility

This feature supplies a cable and connectors for connection to an IBM-supplied modem to enable remote diagnostic support. This feature must be specified on the first unit in an installation.

FC2712: Remote support attachment

This feature provides an additional cable and connector. It must be ordered on the third through the fourteenth library attached to the Remote Support Switch in an installation site.

FC2714: Console expansion

This feature provides an attachment cable for connection to the TS3000 System Console (FC2720) or a Master Console For Service. It also includes an Ethernet hub for expanding the number of units that can be attached. Up to 14 additional connections are provided by this feature for connection of FC2715 or another FC2714.

FC2715: Console attachment

This feature provides a cable to attach to the Ethernet hub provided by the TS3000 System Console (FC2720), a Master Console for Service, or the console expansion (FC2714). A maximum of 40 of the FC2715s can be included in a single console facility.

FC2720: TS3000 System Console

This feature provides the enhanced TS3000 System Console, an Ethernet hub, and a cable and connectors for connection of one machine to an IBM-supplied modem to enable remote enhanced service. This feature must be specified on the first machine in an installation connected to a TS3000 System Console facility. The Ethernet hub provides 14 additional connections for cables supplied with features FC2714 and FC2715.

FC2730: Customer rack mountable TS3000 System Console

This feature provides a rack-mountable version of the TS3000 Service Console for a client-provided rack. This feature provides a 1U server, keyboard, display, mouse, and Ethernet switch. This feature replaces Request for Price Quotation (RPQ) 8B3406. FC2730 is field orderable for models L22, L32, and L52. FC2730 is plant and field orderable for models L23 and L53.

FC5096: Interposer SC-LC Fibre

This feature provides a Fibre Channel cable assembly kit used to convert a 50 micron Fibre Channel cable from SC type to LC type connectors. It includes a 50 micron fibre cable 2 meters (6.6 ft.) in length with an SC duplex female adapter on one end (that can connect to a 50 micron Fibre Channel cable with an SC duplex male connector, such as features FC5913, FC5922, or FC5961) and an LC duplex male connector on the other end (for connection to an LC duplex adapter).

Fibre Channel cables (FC5922, FC6005, FC6013, FC6025, and FC6061)

A Fibre Channel cable is required to attach a Fibre Channel tape drive to host Fibre Channel adapters, the IBM 2109 SAN Fibre Channel switch, or other storage area Fibre Channel components. The cable can be client-supplied or ordered with the tape library in the lengths shown. The attaching Fibre Channel cable must be a 50.0/125 micrometer short wavelength fiber-optic cable. The TS1120 Tape Drive is a dual-ported tape drive and the canister comes with two LC duplex connectors.

FC5922: 22 meter SC-LC Fibre Cable

This feature provides a 22 meter (72.2 ft.) cable with a male LC duplex connector on one end (for connection to the tape drive) and an SC connector (for connection to a server adapter) at the opposite end.

FC6005: 5 meter LC-LC Fibre Channel Cable

This feature provides a 5 meter (16.5 ft.) cable with male LC duplex connectors on each end.

FC6013: 13 meter LC-LC Fibre Channel Cable

This feature provides a 13 meter (43 ft.) cable with male LC duplex connectors on each end.

FC6025: 25 meter LC-LC Fibre Channel Cable

This feature provides a 25 meter (82.5 ft.) cable with male LC duplex connectors on each end.

FC6061: 61 meter LC-LC Fibre Channel Cable

This feature provides a 61 meter (201 ft.) cable with male LC duplex connectors on each end.

FC8802: 3592 cleaning cartridge

This feature provides a 3592 cleaning cartridge.

FC9900: Encryption assurance and readiness

This feature drives System Assurance and ensures client-initiated procedures for enabling and configuring the TS3500 Tape Library to support Encryption with the TS1120 Model E05 or TS1130 Model E*x*6 encryption-capable tape drive.

FC9001: Driveless frame

A TS3500 frame can be ordered without any drives by specifying FC9001. This feature directs the plant to ship the TS3500 Frame without any tape drives installed. This feature is required if there is no tape drive feature ordered (FC9677, FC9680, FC9683, or FC1674) on a Model L22/L23.

Expansion frame attachments (FC9002, FC9003)

These features notify the plant of control that expansion frames are attached to the Model L*xx* base frame. FC9002 must be applied to the L*xx* frame for the first Model D22, D23, D32, D52, D53, S24, or S54 attached. FC9003 must be applied to the L*xx* frame for each additional expansion frame attached to assure that proper cables are shipped and configuration records are correct.

FC9002: First Expansion Frame Attachment

One FC9002 is required for the first Model D22, D23, D32, D52, D53, S24, or S54 attached to the Model L*xx* (as the second frame). The Full Capacity Storage feature (FC1642 or FC1644) is required to attach the optional Expansion Frame models D22, D23, D32, D52, D53, S24, or S54.

FC9003: Additional expansion frame attachment

One FC9003 is required for each additional Model D22, D23, D32, D52, D53, S24, or S54 attached to the Model L*xx* after the first expansion frame.

FC9040: High Availability library

This feature must be specified on the TS3500 Model L*xx* of a TS3500 Tape Library that contains a 3584 High Availability Frame Model HA1. This feature notifies the plant that a Model HA1 is attached so that the proper associated hardware and interface cables are provided for the TS3500 Tape Library. This feature is required for all new Model HA1 orders, including when adding a Model HA1 to an installed TS3500 Tape Library.

The Advanced Library Management System feature (FC1690) must be installed. A minimum of one Model D22, D23, D52, or D53 frame must be ordered when this feature is ordered to serve as a Service Bay B for the second accessor (at least one FC9003 must be added).

FC9050: Expansion Frame Model S*xx* frame attachment

This feature is required for expansion frame Model S*xx* frame attached to the Model L*x*3 or D*x*3. It has a prerequisite of FC2205, FC2305, or FC9205. If FC9040 (HA library) is installed, it has an additional prerequisite of FC2206, FC2305, or FC9206 for that library string. FC1700 is needed only on L*x*2 models, and only if total capacity is greater than 6887 slots.

FC9205: Enhanced grippers/pivot for models L23 or L53

This feature is required for the plant install high density gripper assembly to support frame Model S*xx*. The gripper must be installed on frame Model L*x*3.

FC9206: Enhanced grippers/pivot for HA for models D23, D53, S24, or S54

This feature is required for the plant install high density gripper assembly to support frame Model S*xx*. The gripper must be installed on frame Model D*x*3 with FC1440 ordered.

FC9217: Attached to 3953 Library Manager

FC9217 is the key designator on a TS3500 L frame (for example, the L23) to indicate attachment to the IBM 3953 Library Manager. Note that this is a *mandatory* feature for System z attachment (unlike other system attachment features) and ships hardware for the subsystem.

Prerequisites are one of FC1690, FC1692, FC1693, or FC1694 (ALMS), which must be installed and enabled, and FC1659 (16 Additional 3592 I/O Slots), applicable to an L52 or L53 frame only, and not required but optional on an L23 model. Also, an Ethernet connection from the TS3500 Model D*xx* frame to a TS3000 System Console or Master Console for Service facility on the 3953 is recommended to improve first-time-data-capture for exception events.

FC9316: 8-16 frame X-Track cable - plant

This feature must be added to any TS3500 Tape Library coming from the plant that will have 15 to 16 frames (14 or 15 Expansion Frames attached to the Model L22, L23, L52, or L53). For ease of future expansion to 15 or 16 frame configurations, this feature can be added to any TS3500 Tape Library coming from the plant that will have eight or more frames (seven or more Expansion Frames attached to the Model L22, L23, L52, or L53).

FC9677: Plant install 3592 Model J1A in TS3500

(This feature was withdrawn from marketing effective 29 September 2006). Refer to FC1674 for 3592 drive field install.

Up to 12 FC9677s, plus FC1674, can be installed per frame.

Note that if a second switch is installed so that the drives are connected to the controller through two switches, an LC/LC patch panel cable, FC1461, is required to attach the second port of each IBM 3592 Tape Drive.

FC9680: Plant install 3592 Model E05 in TS3500

This feature tells the plant to install one 3592 Tape Drive Model E05 into a TS3500 Model D23 or L23 coming from the plant. Installation of a 3592 Model E05 Tape Drive canister requires that a 3592 Fibre Drive Mounting Kit feature (FC1513 or FC1515) is installed to contain the canister.

FC9683: Plant install 3592 Model E06 in TS3500

This feature tells the plant to install one 3592 Tape Drive Model E06 into a TS3500 Model D23 or L23 coming from the plant. Installation of a 3592 Model E06 Tape Drive canister requires that a 3592 Fibre Drive Mounting Kit feature (FC1515) is installed to contain the canister.

FC9700: No host cables from plant

This feature must be placed on any TS3500 frame shipping from the plant with no host attachment cables specified when a tape drive is ordered on the frame. This feature is not required if the Driveless Frame feature (FC9001) is specified. When this feature is on the order, the plant will not include any Fibre Channel tape drive host attachment cables with the shipment of this TS3500 frame. Any required cables must be supplied by the client.

Power cords

The appropriate power cord will be shipped based on country code unless otherwise specified. If any power cord other than the default is required, it must be specified from one of the following specify codes.

FC9970: Dual 4.3 meter power cord

This feature provides dual 4.3 m (14 ft.) 250 volt (V) AC 16 Amp power cords with IEC 309 Type 2P+GND 16A connectors, Hubbell type HBL316P6W for connection to Hubbell type HBL316R6W receptacles. This is the default power cord if no other feature is specified in all countries, except Argentina, Australia, Brazil, Canada, China, Japan, Korea, New Zealand, the Philippines, South Africa, Taiwan, and the United States.

FC9972: Dual 4.3 meter power cord non-watertight

This feature provides dual 4.3 m (14 ft.) 250 volt (V) AC 15 Amp power cords with a non-watertight connector NEMA L6-15P for connection to NEMA L6-15R receptacles. This is the default power cord if no other feature is specified in the United States, Canada, and the Philippines.

FC9976: Dual 4.3 meter power cord Argentina

This feature provides dual (2x) 4.3 m (14 ft.) 10 Amp 250 Vac power cords with an IRAM 2073 plug for Argentina. This is the default power cord for Argentina if no other feature is specified.

FC9977: Dual 4.3 meter power cord Brazil

This feature provides dual (2x) 4.3 m (14 ft.) 15 Amp 250 Vac power cords with an Earth Pin InMetro NBR 14136 plug for Brazil. This is the default power cord for Brazil if no other feature is specified.

FC9978: Dual 4.3 meter power cord Australia/New Zealand

This feature provides dual (2x) 4.3 m (14 ft.) 10 Amp 250 Vac power cords with an AS/NZS 3112/2000 plug for Australia and New Zealand. This is the default power cord for Australia and New Zealand if no other feature is specified.

FC9979: Dual 4.3 meter power cord Japan

This feature provides dual (2x) 4.3 m (14 ft.) 15 Amp 250 Vac power cords with a JIS C8303, C8306 plug for Japan. This is the default power cord for Japan if no other feature is specified.

FC9980: Dual 4.3 meter power cord China

This feature provides dual (2x) 4.3 m (14 ft.) 10 Amp 250 Vac power cords with a GB 2099.1, 1002 plug for China. This is the default power cord for China if no other feature is specified.

FC9981: Dual 4.3 meter power cord Korea

This feature provides dual (2x) 4.3 m (14 ft.) 12 Amp 250 Vac power cords with an earth pin KS C8305, K60884-1 plug for Korea. This is the default power cord for Korea if no other feature is specified.

FC9982: Dual 4.3 meter power cord Taiwan

This feature provides dual (2x) 4.3 m (14 ft.) 10 Amp 250 Vac power cords with a CNS 10917-3 plug for Taiwan. This is the default power cord for Taiwan if no other feature is specified.

FC9983: Dual 4.3 meter power cord South Africa

This feature provides dual (2x) 4.3 m (14 ft.) 16 Amp 250 Vac power cords with a SANS 164-1 plug for South Africa. This is the default power cord for South Africa if no other feature is specified.

FC9984: Dual 4.3 meter single phase line cord NEMA L6-20P

This feature provides dual (2x) 4.3 m (14 ft.) 250V, 15A single phase line cord assemblies with NEMA L6-20P non-watertight twistlock 20A plugs. UL/CSA certified for use in US and Canada. Mates with client-supplied NEMA L6-20R receptacles.

FC9985: Dual 4.3 meter single phase line cord watertight Russellstoll plugs

This feature provides dual 4.3 m (14 ft.) 250V, 15A single phase line cord assemblies with watertight 15A Russellstoll plugs (RS p/n 3720DPU2). UL/CSA certified for use in US and Canada. Mates with client-supplied Russellstoll 3743U2 or 9R23U2W receptacles.

IBM 3592 Model J70 Tape Controller

The features included here are not an exhaustive list for the IBM 3592 Controller; we include new features related to the IBM 3953 subsystem and those features that are relevant to IBM 3592 Tape Drive attachment.

FC0520: Functional enhancement field

This feature provides an ability to order any required update to the microcode of an installed IBM 3592 Model J70 Controller and the attached tape drives, to provide the latest level of functional microcode firmware support. Newer microcode levels might be required with additional new functions. This is not a mandatory feature and has no prerequisites; it can be ordered only as an MES on installed equipment.

FC2713: Master Console for service

(Withdrawn from marketing effective 1 December 2006)

This feature provides the IBM TotalStorage Master Console, an Ethernet hub, a cable, and connectors for connection of one of the above units to an IBM-supplied modem to enable remote enhanced service. This feature must be specified on the first unit in an installation connected to a master console facility. The Ethernet hub provides 14 additional connections for cables supplied with FC2714 or FC2715. This is an optional feature on the Model J70.

FC2714: Console expansion

This feature provides an attachment cable for connection of one of the above units, and an Ethernet switch for expanding the number of units that can be attached to the TS3000 System Console (FC2720) or Master Console for Service (FC2713). Up to 14 additional connections are provided by this feature for connection of FC2715 or another FC2714.

FC2715: Console attachment

This feature provides a cable to attach a unit to the Ethernet switch provided by the TS3000 System Console (FC2720), Master Console for Service (FC2713), or the Console Expansion (FC2714). A maximum of 40 FC2715s can be included in a single master console facility.

FC2719: Console upgrade

This feature provides a memory upgrade to 2 GB total RAM and a second Ethernet card for the Service Console to allow redundant connections into the service network. This feature only applies to consoles shipped with features FC2718 and FC2720. It is required on any console used by TS7700 features FC2714, FC2715, or FC2720.

FC2720: TS3000 System Console

This feature provides the enhanced TS3000 System Console, an Ethernet switch, a cable, and connectors for connection of one of the above units to an IBM-supplied modem to enable remote enhanced service. This feature must be specified on the first unit in an installation connected to a master console facility. The Ethernet switch provides 14 additional connections for cables supplied with FC2714 or FC2715.

FC3059: Drive-to-switch cables

These features are not required on the IBM 3592-J70 when it is installed in the IBM 3953 frame. They are relevant only for controllers installed in the IBM 3494 Tape Library or a stand-alone rack.

In the IBM 3953 tape subsystem, drive-to-switch cables can be ordered with the tape drives. The cables need to have LC/LC connections at both ends; the length can be specified according to how far the IBM 3953 frames and switches are located from the IBM TS3500 library and the drives.

FC3413, FC3434, and FC3435: Host attachment features

These features provide FICON or ESCON channel adapters for the IBM 3592 Controller to attach to the System z hosts. At least one of these features is required on each IBM 3592 Controller, up to a maximum of four. Feature conversions are available if you want to change from, for example, ESCON to FICON.

FC3413, Dual ESCON Attachment for J70, provides a dual-ported ESCON adapter for attachment to two ESCON host system channels. Each port on the ESCON adapter can support up to 64 logical channels, and, using ESCON Directors, can be up to 43 km (26.7 miles) from the host system.

FC3434, 2 Gbps Attach, Long Wave, provides one long-wavelength 2 Gbps FICON adapter, with an LC Duplex connector, for the attachment to a FICON host system long wave channel utilizing a 9-micron single-mode Fibre cable. The total cable length cannot exceed 10 km (6.2 miles). Each 2 Gbps FICON attachment can support up to 128 logical channels.

FC3435, 2 Gbps Attach, Short Wave, provides one short-wavelength 2 Gbps FICON adapter, with an LC Duplex connector, for the attachment to a FICON host system short wave channel utilizing a 50-micron multimode Fibre cable. The total cable length cannot exceed 300 m (984 ft.). Each 2 Gbps FICON attachment can support up to 128 logical channels.

Permitted maximum combinations of FC3413, FC3434, and FC3435 are shown in Table G-1. Note that a single FICON feature provides one FICON connection while a single ESCON feature provides two ESCON connections.

Table G-1 Permitted maximum combinations of channel adapter features

Number of FICON FC3434 or FC3435	Number of ESCON FC3413	Number of FICON attachments	Number of ESCON attachments
0	4	0	8
1	3	1	6
2	2	2	4
3	1	3	2
4	0	4	0

FC3476: LC Fibre drive adapters

This feature installs two short-wavelength 2 Gbps Fibre Channel adapters with LC connectors in a 3592 Model J70 Controller for attaching up to twelve 3592 tape drives when attached through a 2109 SAN Fibre Channel switch, or sixteen 3592 tape drives when attached through a 2 Gb/4 Gb Fibre Channel switch. Total cable length from the adapters to the switch cannot exceed 500 m (1640 ft.).

Note that FC3477, Dual SCSI Drive Adapters, is not supported in an IBM 3953 environment.

FC3478: Two dual-ported LC Fibre Channel drive adapters

This feature installs two short-wavelength 4 Gbps dual-ported Fibre Channel adapters with LC connectors in a 3592 Model J70 Controller for attaching up to twelve 3592 tape drives through a 2109 SAN Fibre Channel or the 2 Gb/4 Gb Fibre Channel switch. Total cable length from the adapters to the switch cannot exceed 500 m (1640 ft.). Mutually exclusive of FC3477 (Dual-Ported SCSI Drive Adapters) or FC3476 (Two LC Fibre Channel Drive Adapters). Plant or field installation.

FC3483 and FC3484: Fibre drive attached switch

These features are not required, even if you are reinstalling an IBM 2109-F16 or a 2 Gb Emulex Fibre Channel switch as part of the configuration. These features are designed to indicate whether any supplied interconnection cables need to have SC or LC type connectors; however, in the IBM 3953 configurations, these cables have LC type connectors.

FC3491: External fabric support field

(This feature was withdrawn from marketing effective 29 September 2006)

This feature on the controller indicates that the IBM 3592 tape drives are connected to the IBM 3592 Controller through an external client-supplied Fibre Channel switch or directly to the controller. The client is responsible for providing the cables from the IBM 3592 Controller to the client-supplied Fibre Channel switch. (Cables from the switch or controller to the 3592 tape drives can be ordered with the IBM 3592 tape drives or supplied by the client.)

This feature is the field install MES version of the feature. If external fabric support is required for a new controller from the manufacturing plant, use FC9491.

If you are attaching one or two drives directly to the controller, or if you are attaching up to 16 drives through one external switch, order one of FC3491 or FC9491 per controller. If you are attaching the drives through two external switches, order two features.

This feature is mutually exclusive of the other internal switch feature codes: FC3483, FC3484, FC3487, FC3488, and FC4887. FC3476, Two LC Fibre Channel Drive Adapters, on the controller is a prerequisite.

FC5245: Dual path attachment

This feature provides the necessary cables and adapters for attachment of the IBM 3592 Controller in an IBM 3953 Model F05 Frame to attach to an IBM 3953 Model L05 Library Manager. It is required on any IBM 3592-J70 installed in an IBM 3953 frame.

FC9000: Attach to S/390 and System z

The following “specify” codes indicate the attached system types. They are used to determine how microcode updates are distributed and might change at any time.

FC9476: J1A tape drive attached to controller

This feature is required on all IBM 3592-J70 controllers that have IBM 3592-J1A tape drives attached to that controller. Only one feature is required per controller.

FC9491: External fabric support plant

This feature on the controller indicates that the IBM 3592 tape drives are connected to the IBM 3592 Controller through an external client-supplied Fibre Channel switch or directly to the controller. The client is responsible for providing the cables from the IBM 3592 Controller to the client-supplied Fibre Channel switch. (Cables from the switch or controller to the 3592 tape drives can be ordered with the IBM 3592 tape drives or supplied by the client.)

This feature is the plant install version of the feature. If external fabric support is required for an installed or client-supplied controller, FC3491 is used to supply the MES.

If you are attaching one or two drives directly to the controller, or if you are attaching up to 16 drives through one external switch, order one of FC3491 or FC9491 per controller. If you are attaching the drives through two external switches, order two features.

This feature is mutually exclusive of the other internal switch feature codes FC3483, FC3484, FC3487, FC3488, and FC4887. FC3476, Two LC Fibre Channel Drive Adapters, on the controller is a prerequisite.

FC9700: No plant cables

This feature must be specified if you do not want the plant to ship any ESCON or FICON cables with the new shipment of an IBM 3592-J70 Controller. Specify this feature if none of the following features is desired: FC9752, FC9753, FC9762, FC9763, FC9770, FC9771, FC9775, FC9789, or FC9790.

Cables

Table G-2 describes the cables available to order as feature codes on the IBM 3592 Controller.

Table G-2 Feature codes for cables supplied optionally with the IBM 3592-J70

Cable feature code for IBM 3592-J70	Length in meters (feet)	Description	Maximum
9752	31 (100)	9-Micron LC/LC Fibre	One per FC3434
9753	2 (6)	9-Micron LC/SC 2 m Fibre Cable	One per FC3434
9762	31 (100)	50-Micron LC/LC 31 m Fibre Cable	One per FC3435
9763	2 (6)	50-Micron LC/SC 2 m Fibre Cable	One per FC3435
9770	31 (100)	62.5-Micron MT-RJ/ESCON R-Cable	Two per FC3413
9771	31 (100)	62.5-Micron MT-RJ/ESCON P-Cable	Two per FC3413
9775	2 (6)	62.5-Micron MT-RJ/ESCON Jumper	Two per FC3413
9789	31 (100)	62.5-Micron MT-RJ/MT-RJ P-Cable	Two per FC3413
9790	31 (100)	62.5-Micron MT-RJ/MT-RJ R-Cable	Two per FC3413
9793	31 (100)	9-Micron LC/SC 31 m Fibre Cable	One per FC3434
9794	31 (100)	50-Micron LC/SC 31 m Fibre Cable	One per FC3435

FC9875: Field install J70 in 3953-F05

This specify feature indicates that an IBM 3592 Model J70 Controller will be field-merged, or field-installed, into an IBM 3953 Model F05 Frame. It must be ordered on the IBM 3592 Controller either as a new order from the plant or as a field MES to a client-owned unit.

Prerequisite features on the controller are: FC3476 (Two LC Fibre Channel Drive Adapters), FC5245 (Dual Path Attachment), or FC3478 (Two Dual-Ported LC Fibre Channel Drive Adapters), and one IBM Master Console FC2713, FC2714, or FC2715. Corequisite installation features on the IBM 3953-F05 Frame are one FC5875 (field merge) or FC5877 (field install).

FC9876: Plant install J70 in 3953-F05

(This feature was withdrawn from marketing effective 29 September 2006)

This specify feature notifies the plant that an IBM 3592 Model J70 Controller will be plant-installed into an IBM 3953-F05 Frame. It must be ordered on the IBM 3592 Controller as a new order from the plant.

Prerequisite features on the controller are: FC3476 (Two LC Fibre Channel Drive Adapters), FC5245 (Dual Path Attachment), and one IBM Master Console FC2713, FC2714, or FC2715. The corequisite installation feature on the IBM 3953-F05 Frame is one FC5876 (plant install).

Power cords

You do not need to specify power cords for the IBM 3592 Model J70. It comes with a short cord that plugs into the frame or rack and takes advantage of the external power cord of the box in which it is installed.

IBM TS1120 Model C06 Tape Controller

FC0520: Functional enhancement field

This feature provides an update to the microcode of an installed IBM TS1120 (3592-C06) Controller and the attached tape drives to provide the latest level of functional microcode firmware support. Newer microcode levels might be required when adding new functions.

FC2714: Console expansion

This feature provides an attachment cable for connection to a TS3000 System Console or Master Console for Service, and an Ethernet switch for expanding the number of units that can be attached. Up to 14 additional connections are provided by this feature for connection of FC2715 or another FC2714.

FC2715: Console attachment

This feature provides a cable to attach a unit to the Ethernet switch provided by the TS3000 System Console, Master Console for Service, or the Console Expansion (FC2714). A maximum of 40 of FC2715s can be included in a single master console facility.

FC2719: Console upgrade

This feature provides a memory upgrade to 2 GB total RAM and a second Ethernet card for the Service Console to allow redundant connections into the service network. This feature only applies to consoles shipped with features FC2718 and FC2720. It is required on any console used by TS7700 features FC2714, FC2715, or FC2720.

FC2720: TS3000 System Console

This feature provides the enhanced TS3000 System Console, an Ethernet switch, a cable, and connectors for connection of one of the above units to an IBM-supplied modem to enable remote enhanced service. This feature must be specified on the first unit in an installation connected to a master console facility. The Ethernet switch provides 14 additional connections for cables supplied with FC2714 or FC2715.

FC3440, FC3441, FC3442, and FC3443: Host attachment features

These features provide FICON or ESCON channel adapters for the IBM 3592 Controller to attach to the System z hosts. At least one of these features is required on each IBM 3592 Controller, up to a maximum of four. Feature conversions are available if you want to change from, for example, ESCON to FICON.

FC3440: Dual ESCON host adapter

This feature provides an ESCON adapter for attachment of 3592 tape drives through the TS1120 (3592 Model C06) Controller to two ESCON host system channels. Each port on the ESCON adapter can support up to 64 logical channels and, using ESCON Directors, can be up to 43 km (26.7 miles) from the host system.

FC3441: FICON short wave attachment

This feature provides one short-wavelength FICON adapter, with an LC Duplex connector, for the attachment of 3592 tape drives through the TS1120 Model C06 Controller to a FICON host system long wave channel utilizing a 50-micron multimode fibre cable. The total cable length cannot exceed 150 m (492 ft.). Each FICON attachment can support up to 128 logical channels. A feature conversion is available to convert FC3441 to FC3442 or FC3443.

FC3442: FICON long wave attachment

This feature provides one long-wavelength FICON adapter, with an LC Duplex connector, for the attachment of 3592 tape drives through the TS1120 Model C06 Controller to a FICON host system long wave channel utilizing a 9-micron single-mode fibre cable. The total cable length cannot exceed 4 km (2.5 miles). Each FICON attachment can support up to 128 logical channels. A feature conversion is available to convert FC3442 to FC3441 or FC344.

FC3443: FICON long wave 10 km attachment

This feature provides one long-wavelength FICON adapter, with an LC Duplex connector, for the attachment of 3592 tape drives through the TS1120 Model C06 Controller to a FICON host system long wave channel utilizing a 9-micron single-mode fibre cable. The total cable length cannot exceed 10 km (6.2 miles). Each FICON attachment can support up to 128 logical channels. A feature conversion is available to convert FC3443 to FC3441 or FC3442.

Permitted combinations of FICON/ESCON attachments using FC3440, FC3441, FC3442, and FC3443 are shown in Table G-3.

Note that a single FICON feature provides one FICON connection while a single ESCON feature provides two ESCON connections.

Table G-3 Permitted combinations of FICON/ESCON attachments

Number of FC3434 + FC3435 or FC3441 + FC3442 + FC3443	Allowed number of FC3413 or FC3440	Number of FICON attachments	Number of ESCON attachments
0	4	0	8
1	3	1	6
2	2	2	4
3	1	3	2
4	0	4	0

FC3478: Dual-ported Fibre adapters

This feature installs two short-wavelength 4 Gbps dual-ported Fibre Channel adapters with LC connectors in a 3592 Tape Controller for attaching up to sixteen 3592 tape drives when attached through a 2 Gb/4 Gb Fibre Channel switch. Total cable length from the adapters to the switch cannot exceed 150 m (492 ft.).

FC3488: 4 Gb Fibre Channel switch

This feature provides a 4 Gb Fibre Channel switch with 20 LC short-wave ports for attachment of up to sixteen 3592 tape drives to a 3592 tape controller. The 4 Gb Fibre Channel switch has dual power connection for attachment to separate power supplies. Intermix of the 2 Gb and 4 Gb Fibre Channel switches is not supported within the 3592 Tape Controller.

FC3492: External fabric support/field

This feature on the controller indicates that 3592 tape drives will be connected to 3592 Model C06 Controller through an external client-supplied Fibre Channel switch.

External Fabric: The client is responsible for providing the cables from the 3592 Model C06 installed in a 3952 or 3953 Model F05 Frame to a client-supplied Fibre Channel switch. (Cables from the switch to the 3592 tape drives can be ordered with the 3592 tape drives or supplied by the client.)

FC3493: Direct connect drive field

This feature indicates that 3592 tape drives will be directly connected to a 3592 Tape Controller.

Direct connect drives:

- You must specify FC3493 (Direct Connect™ Drives/Field) or FC9493 (Direct Connect Drives/Plant) on the 3592 Model C06.
- A minimum of one FC3062 (3592 drive cables) up to a maximum of four FC3062s for rack-installed 3592 tape drives.
- If you are directly connecting drives to the 3494 Model D22 or D24, or 3592 Model C20 Silo Frame, cables can be ordered with the 3592 tape drives or supplied by the client.

FC5274: Enhanced router

This feature provides one 8-port router with enhanced capabilities. This feature does not support IPv6. Order a second feature for out-of-band encryption connection to Encryption Key Manager (EKM). Maximum: two. Prerequisites: FC4641 and FC9014. This feature is mutually exclusive of FC5593 and FC5248.

FC5248: Network 16-port switch

This feature provides a 16-port switch for use in attaching to a client network. This feature also supports IPv4 and IPv6 environments. This feature also provides a single Ethernet cable. Prerequisites: FC4641. This feature is mutually exclusive of FC5593 and FC5274.

FC5593: Router for Encryption Key Manager (EKM) attach

This feature provides two routers for redundant connections between the Encryption Key Manager and the Tape Control unit. Ethernet cables from the routers to the control unit are also provided. This feature is mutually exclusive of FC5248.

FC5595: CU Encryption configuration/field

This feature provides configuration and reconfiguration support of the control unit for Encryption. The first time that FC5595 is ordered, it will ship the minimum level control unit microcode required. The minimum level Library Manager microcode will also be supplied if the control unit is not in a client rack solution (FC4641). For in-band encryption, no other control unit features are required. For out-of-band encryption, FC5593 on the 3592 Tape Controller (Model C06 or J70), the Tape Frame (3952 Model F05 or 3953 Model F05), the Library-Managed Frame (3494 Model L*xx*), or the 3590 Model C10 Frame is required to provide a path through the router to the EKM.

> **Note:** Only supported with encryption-capable TS1120 and TS1130 (3592 Model E05 and Model E*x*6) (not valid with 3592-J1A or 3590 tape drives).

FC9000: Attach to S/390 and System z

The following “specify” codes indicate the attached system types. They are used to determine how microcode updates are distributed and can change at any time.

FC9478: 3592 Tape Drive attached to C06

This feature is required on all 3592 Model C06 controllers that will have a 3592 Tape Drive attached to the 3592 Model C06.

FC9492: External fabric support plant

This feature on the controller indicates that 3592 tape drives will be connected to the 3592 Model C06 Controller through an external client-supplied Fibre Channel switch.

External Fabric: The client is responsible for providing the cables from the 3592 Model C06 installed in a 3952 or 3953 Model F05 Frame to a client-supplied Fibre Channel switch. (Cables from the switch to the 3592 tape drives can be ordered with the 3592 tape drives or supplied by the client.)

FC9493: Direct connect drives plant

This feature indicates that 3592 tape drives will be directly connected to a 3592 Tape Controller.

Direct connect drives:

- You must specify FC3493 (Direct Connect Drives/Field) or FC9493 (Direct Connect Drives/Plant) on the 3592 Model C06.
- A minimum of one FC3062 (3592 Drive Cables) up to a maximum of four FC3062s for rack-installed 3592 tape drives.
- If you are directly connecting drives to the 3494 Model D22 or D24, or 3592 Model C20 Silo Frame, cables can be ordered with the 3592 tape drives or supplied by the client.

FC9595: CU Encryption configuration/plant

Provides Encryption configuration support of the control unit and attached tape drives. This feature will ship the minimum level Library Manager microcode required if the control unit is not in a client rack solution (FC4641). For in-band Encryption, no other control unit features are required. For out-of-band Encryption, FC5593 is required on the 3592 Tape Controller (Model C06 or J70), or the Tape Frame (3952 Model F05 or 3953 Model F05), the Library Manager Frame (3494 Model L*xx*), or the 3590 Model C10 frame to provide a path through the router to the EKM.

> **Note:** Only supported with encryption-capable TS1120 and TS1130 (3592 Model E05 and Model E*x*6) tape drives (not valid with 3592-J1A or 3590 tape drives).

FC9700: No factory cables

This feature must be specified if you do not want the factory to ship any ESCON or FICON cables with the new shipment of an IBM 3592-J70 Controller. Specify this feature if none of the following is desired: FC9752, FC9753, FC9762, FC9763, FC9770, FC9771, FC9775, FC9789, or FC9790.

FC9887: Field-Merge C06 in 3953-F05

This specify feature notifies the plant that a 3592 Model C06 Controller will be field-merged, or field-installed, into a 3953 Model F05 Frame.

FC9888: Plant install C06 in 3953-F05

This specify feature notifies the plant that a 3592 Model C06 Controller will be plant-installed into a 3953 Model F05 Frame. This feature must appear on the Model C06, and FC5879 must appear on the 3953 Model F05 order.

Cables

Table G-4 describes the cables available to order as feature codes on the IBM 3592 Controller.

Table G-4 Feature codes for cables supplied optionally with the IBM 3592-C06

Cable feature code for IBM 3592-J70	Length in meters (feet)	Description	Maximum
9752	31 (100)	9-Micron LC/LC Fibre	One per FC3442 or FC3443
9753	2 (6)	9-Micron LC/SC 2 m Fibre Cable	One per FC3442 or FC3443
9762	31 (100)	50-Micron LC/LC 31 m Fibre Cable	One per FC3441
9763	2 (6)	50-Micron LC/SC 2 m Fibre Cable	One per FC3441
9771	31 (100)	62.5-Micron MT-RJ/ESCON P-Cable	Two per FC3440
9775	2 (6)	62.5-Micron MT-RJ/ESCON Jumper	Two per FC3440
9789	31 (100)	62.5-Micron MT-RJ/MT-RJ P-Cable	Two per FC3440
9793	31 (100)	9-Micron LC/SC 31 m Fibre Cable	One per FC3442 or FC3443
9794	31 (100)	50-Micron LC/SC 31 m Fibre Cable	One per FC3441

FC9887: Field merge 3592-C06 in 3953-F05

This feature specifies that a TS1120 Model C06 Controller will be field-merged, or field-installed, into a 3953-F05 Frame.

Corequisites: One Field Install/Field Merge TS1120 Model C06 Controller feature (FC5878 or FC5880) must be ordered on the 3953-F05 Frame.

FC9888: Plant install 3592-06 in 3953-F05

This feature specifies the plant attachment of a new TS1120 Model C06 Controller to a 3953-F05 Frame.

Corequisites: One Plant Install TS1120 Model C06 Controller (FC5879) must be ordered on the 3953-F05 Frame.

IBM TS1120 Tape Drive

There are no features on the tape drives specific to the IBM 3953 subsystem attachment.

FC0500: Drive microcode update

This feature provides an update to the TS1120 or 3592 tape drive microcode on an installed tape drive. Newer microcode levels might be required when attaching the TS1120 or 3592 in selected Fibre Channel or storage area network (SAN) environments.

FC1674: Field install 3592 tape drive in TS3500

This feature indicates field installation of a TS1120 Tape Drive in a currently installed TS3500 Model D2*x* or L2*x* frame. This feature must appear on the 3592 Tape Drive order.

FC5592: Encryption-capable refurb - field

This feature provides new or refurbished hardware, as well as microcode, for a TS1120 Model E05 or TS1130 Model E*x*6 to be encryption-capable. This upgrade might contain new or used parts.

FC9000: System z ESCON/FICON attach

This specify code indicates the attached system types as System z. These features are used to determine how microcode updates will be distributed.

FC9592: Encryption-capable - plant

This specify feature provides an encryption-capable IBM TS1120 Model E05 or TS1130 Model E*x*6 Tape Drive from the plant.

FC9677: Plant install 3592 in a TS3500 Frame

This specify code notifies the plant to plant-install a new TS1120 or 3592 tape drive into a new TS3500 Tape Library Frame coming from the plant. This code must appear on the tape drive order and also the plant-install 3592-E05 in a 3584 feature (FC9680) must appear on the 3584 frame order.

IBM TS1130 Tape Drive

There are no features on the tape drives specific to the IBM 3953 subsystem attachment.

FC0500: Drive microcode update

This feature provides an update to the TS1120 or 3592 tape drive microcode on an installed tape drive. Newer microcode levels might be required when attaching the TS1120 or 3592 in selected Fibre Channel or storage area network (SAN) environments.

FC1674: Field install 3592 Tape Drive in TS3500

This feature indicates field installation of a TS1130 Tape Drive in a currently installed TS3500 Model D2*x* or L2*x* frame. This feature must appear on the 3592 Tape Drive order.

FC9000: System z ESCON/FICON attach

This specify code indicates the attached system types as System z. These features are used to determine how microcode updates will be distributed.

FC4772: Remove a 3592 Tape Drive from a rack

This feature removes a 3592 Tape Drive canister that is installed in a cradle in a rack. Any cradle features associated with this removed tape drive are also removed from the tape drive, but the physical cradle or shelf can remain installed in that rack.

FC4802: Left drive cradle in rack

This feature adds a left-side drive cradle for accepting up to two 3592 Tape Drive canisters in a rack. The feature also provides a shelf capable of supporting a left-side and a right-side drive cradle, as well as rack panels for covering either cradle. It includes two redundant power supplies, drive identification logic for up to two TS1120 or 3592 tape drives, and a pluggable large display and control panel for the drives.

FC4812: Right drive cradle in rack

This feature adds one right-side drive cradle on the same shelf as a tape drive with the cradle FC4802, for accepting up to two 3592 Tape Drive canisters in a rack. It includes two redundant power supplies and drive identification logic for up to two 3592 tape drives.

FC9677: Plant install 3592 in a 3584 Frame

This specify code notifies the plant to factory-install a new TS1130 Tape Drive into a new 3584 Tape Library Frame coming from the plant. This code must appear on the tape drive order and also the Plant Install 3592-E06 in a 3584 FC9683 must appear on the 3584 Frame order.

This feature does not apply to 3592-EU6.

FC9689: Field merge 3592 in a 3584 Frame

This specify feature notifies the plant that a 3592 Model E06 Tape Drive will be field-merged, or field-installed, into a 3584 Tape Library Frame.

This feature does not apply to 3592-EU6.

IBM 3592-J1A Tape Drive

There are no features on the tape drives specific to the IBM 3953 subsystem attachment.

FC0500: Library function enhance field

This feature provides an ability to order any required update to the microcode of an installed IBM 3592 Tape Drive, to provide the latest level of functional microcode firmware support. Newer microcode levels might be required with additional new functions. This is not a mandatory feature and has no prerequisites; it can be ordered only as an MES on installed equipment.

FC1674: Field install 3592 Tape Drive in TS3500

This feature indicates field installation of a 3592 Tape Drive Model J1A in a currently installed TS3500 Model D2*x* or L2*x* frame. This feature must appear on the 3592 Tape Drive order.

FC4772: Remove a 3592 Model J1A from a rack

This feature removes an IBM 3592 Tape Drive canister that is installed in a cradle in a rack. Any cradle features associated with this removed tape drive are also removed from the tape drive, but the physical cradle or shelf can remain installed in that rack.

FC9000: System z ESCON/FICON attach

This specify code indicates the attached system types as System z. These features are used to determine how microcode updates will be distributed.

FC9677: Plant install 3592 Model J1A in TS3500

(This feature was withdrawn from marketing effective 29 September 2006)

This feature notifies the plant to install a new 3592 Model J1A tape drive into a new TS3500 Model D22 or L22 frame coming from the plant. This feature must appear on the 3592 Model J1A Tape Drive order, and it must also appear on the order for the TS3500 Model D22 or L22 frame, which will contain the 3592 Model J1A Tape Drive.

IBM 3494 Tape Library

IBM 3592 controllers and tape drives might be redeployed from the IBM 3494 library and used as part of an IBM 3953 subsystem.

FC4772: Remove 3592 Model J1A Tape Drive from a 3494 Frame

This feature provides the instructions to remove an IBM 3592 Model J1A Tape Drive from a currently installed D frame.

FC4865: Remove 3592 Model J70 from a 3494 Frame

This feature is required to remove an IBM J70 from an IBM 3494 Model D24 or D14 rack and replace it with storage slots. Any associated drives must also be removed from the frame.

> **Note:** There are no new feature codes required for attaching a VTS or part of a Peer-to-Peer VTS to a TS3500/3953 configuration. A new feature code, FC4036, is, however, available for support of large logical volumes. For details, refer to the *IBM TotalStorage 3494 Tape Library Introduction and Planning Guide*, GA32-0279.

H

IBM 3592 media and LTO Ultrium media

When an IBM Tape Library is ordered, it is supplied with one Ultrium data cartridge or one 3592 data cartridge and one cleaning cartridge at no charge. Each member of the IBM 35*xx* and TS3*xxx* tape library family has different media features and rules that apply when placing the order. The following information will assist you in ordering additional media.

If you want to order media for your Ultrium or 3592 tape drives, go to this Web site:

`http://www-03.ibm.com/servers/storage/media/distributors/index.html`

Select your geographic location and your country, and a list of authorized distributors is presented.

Refer to “Features available with IBM Ultrium hardware initial order” on page 545 for a list of additional features for IBM LTO Ultrium and 3592 data cartridges with barcode labels that are separately delivered from the data cartridges. The actual value of barcode labels cannot be predetermined. For cartridges with predefined barcode labels and predetermined barcode values, order cartridges from an authorized dealer. Refer to Table H-9 on page 551.

The media suppliers can supply tape cartridges from different manufacturers or offer a choice of brands. The tape cartridges that you use must be manufactured by a qualified Linear Tape-Open (LTO) media company to meet the LTO standards.

IBM 3599 tape cartridges

This section provides information about ways of ordering media supplies, including feature codes and part numbers for ordering media supplies for 3592 tape drives. Selected media supplies can be ordered using feature codes when purchasing a 3592 drive. This is the pack-in method of ordering, and the media will be shipped with the hardware order. Not all media types are available with this method.

The 3599 Tape Media method is available for ordering all types of data and cleaning cartridges. This method is typically used for ordering larger quantities and for ordering initialized and pre-labeled cartridges. Media supplies can also be ordered using part numbers through IBM-authorized distributors.

Model description

For clients who order media using the 3599 Tape Media method, IBM TotalStorage Enterprise Tape Media 3599 provides the ability to order unlabeled, pre-labeled, initialized, and bulk-packaged tape data cartridges in a wide variety of combinations, and cleaning cartridges for the 3592-J1A, TS1130, and TS1120 tape drives.

Cartridge capacity is dependent on the recording format of the tape drive writing the cartridges. The 3592-J1A writes in FMT1 mode, the 3592-E05 can write in either EFMT1 or EFMT2 format. 3592 models E06 and EU6 can write in EFMT3 and in EFMT2 format. Models E05 and E*x*6 can also write in an encrypted format, which does not change the capacity of the cartridge compared to the non-encrypted format. TS1120 writes in EEFMT2 encrypted format, and TS1130 writes in EEFMT2 and EEFMT3.

The IBM 3592 Enterprise Tape Cartridge has a native capacity of 700 GB when formatted for EFMT3, 500 GB when formatted for EFMT2, and 300 GB when formatted for EFMT1.

The IBM 3592 Extended Tape Cartridge has a native capacity of 1000 GB in EFMT3 format or 700 GB in EFMT2 format. This cartridge is not supported with 3592-J1A drives.

The IBM 3592 Economy Tape Cartridge has a native capacity of 128 GB in EFMT3 format, 100 GB in EFMT2 format, and 60 GB in EFMT1 format. Capacities of data cartridges can be increased through data compression, with the actual compression and capacity depending upon the specific data. Write Once Read Many (WORM) cartridges are also available in all three capacities.

With the 3599 Tape Media method of ordering, model numbers are used to identify the cartridge types, and feature code combinations are used to specify the quantities, labeling, and initialization options. IBM 3599 supports VOLSER labels with embedded radio-frequency identification (RFID)-enabled barcode labels, which store and allow remote retrieval of VOLSER information. RFID labels contain a 216-bit unique preprogrammed field and a 256-bit user-defined field. These RFID labels work with most standard asset tracking and management software.

You have to order cartridges either labeled, or labeled and initialized in order to obtain cartridges with the RFID labels. Refer to Table H-1 on page 541 for additional details.

Table H-1 3599 media feature description

Media type	3599 Model	Format L=Labeled I= Initialized	External media ID		RFID label	Quantity 20-pack feature code	Description
			Yes[a]	No[b]			
JA	011	L + I[c,d]	FC 9030	FC 9031	Yes	FC1020	3592 Enterprise Tape Cartridge with Labeling and Initialization
	012	L			Yes	FC2020	3592 Enterprise Tape Cartridge with external volume labels only
	013	Not L + I	N/A	N/A	N/A	FC3020	3592 Enterprise Tape Cartridge without Labels or Initialization
JB	014	L + I[c,d]	FC 9032	FC 9034	Yes	FC4020	3592 Extended Tape Cartridge with labeling and initialization
	015	L			Yes	FC5020	3592 Extended Tape Cartridge with external Volume labels only
	016	Not L + I	N/A	N/A	No	FC6020	3592 Extended Tape Cartridge without labeling or initialization
JJ	E11	L + I[c]	FC 9050	FC 9051	Yes	FC1120	3592 Economy Tape Cartridge with labeling and initialization
	E12	L			Yes	FC1220	3592 Economy Tape Cartridge with external volume label only
	E13	Not L + I	N/A	N/A	No	FC1320	3592 Economy Tape Cartridge without labels or initialization

Media type	3599 Model	Format L=Labeled I= Initialized	External media ID		RFID label	Quantity 20-pack feature code	Description
			Yes[a]	No[b]			
JR	E21	L + I[c]	FC 9042	FC 9043	Yes	FC3120	3592 Economy Tape Cartridge (WORM) with labeling and initialization
	E22	L			Yes	FC3220	3592 Economy Tape Cartridge (WORM) with external volume labels only
	E23	Not L + I	N/A	N/A	No	FC3320	3592 Economy Tape Cartridge (WORM) without labels or initialization
JW	021	L + I[c]	FC 9040	FC 9041	Yes	FC2120	3592 Enterprise Tape Cartridge (WORM) with labeling and initialization
	022	L			Yes	FC2220	3592 Enterprise Tape Cartridge (WORM) with external volume labels only
	023	Not L + I	N/A	N/A	No	FC2320	3592 Enterprise Tape Cartridge (WORM) without labels or initialization
JX	024	L + I[e]	FC 9044	FC 9045	Yes	FC2420	3592 Extended Tape Cartridge (WORM) with labeling and initialization
	025	L			Yes	FC2520	3592 Extended Tape Cartridge (WORM) with external volume labels Only
	026	Not L + I	N/A	N/A	No	FC2620	3592 Extended Tape Cartridge (WORM) without labels or initialization

Media type	3599 Model	Format L=Labeled I= Initialized	External media ID		RFID label	Quantity 20-pack feature code	Description
			Yes[a]	No[b]			
JA	017	L + I	FC 7005	FC 7006	No	N/A	5-pack 3592 Cleaning Cartridges, 50 uses

a. The Media Identifier feature is required for cartridges in order to have an RFID label.
b. If the cartridges are to be used on a Silo Compatible Tape Drive Frame 3592 Model C20, order the feature code described to provide the cartridge without Media ID letters.
c. FC9080 is related to EFMT1 format (3592-J1A), FC9081 is for EFMT2 format (3592-E05), and FC9082 is for EFMT3 format (3592-E*x*6).
d. FC9060 ships cartridges pre-initialized to 20% of total capacity of the cartridge. FC9062 provides for a single partition of approximately 80% of total capacity with the first 20% of capacity having fast record access characteristics.
e. Only FC9081 (E2 Format) and FC9082 (E3 Format) are supported.

Table H-2 lists the data cartridges and media supplies that you can order for the 3592 tape drives. You can use one of the following methods to order the cartridges:

- Order by part number through an IBM-authorized distributor. For the closest distributor, visit the Web at:

  http://www.ibm.com/storage/media

- If you do not have Internet access, order the cartridges from any authorized IBM Business Partner or your IBM Marketing Representative.
- Call 1-888-IBM-MEDIA.

Table H-2 Media supplies for the 3592 drive

Supply item	Media ID	Part number
IBM 3592 Enterprise Tape Cartridge	JB	25R9830
IBM 3592 Enterprise Tape Cartridge	JA	18P7534
IBM 3592 Economy Tape Cartridge	JJ	24R0316
IBM 3592 Enterprise Cartridge WORM	JX	23R9831
IBM 3592 Enterprise Cartridge WORM	JW	18P7538
IBM 3592 Economy Cartridge WORM	JR	24R0317
IBM TotalStorage Enterprise Data Cartridge 3592 cleaning, 50 uses	JA	18P7535

Labeling service

This service applies to IBM 3589 and IBM 3599 media types that have labels as described in the previous two sections.

There are six characters in the VOLSER, and IBM provides specific codes to allow you the flexibility to choose where to begin the volume range that you require. The sixth character is always a zero character (0), because your Volume serial range must always begin at a 0 boundary for labeling, and the labels supplied are sequential. So, for example, if you order 20 cartridges, the first cartridge will be labeled with a sixth digit of 0, and the twentieth cartridge will be labelled with a sixth digit of 9.

The character identifier features are four-digit feature numbers of the form 9*nnn*, composed as:

- The first digit, 9, means the feature carries no charge.
- A second digit of 1, 2, 3, 4, or 5 indicates which character in the VOLSER this feature is specifying (1st, 2nd, 3rd, 4th, or 5th).
- The third and fourth digits range from 00 through 35, where 00 through 09 represent the characters 1 through 9, and 10 through 35 represent the characters A through Z.

Choose the first 1, 2, 3, 4, or 5 digits by using the feature numbers as follows:

- First alphanumeric digit (0 to 9 or A to Z): use FC9100 (0) to FC9135 (Z).
- Second alphanumeric digit (0 to 9 or A to Z): use FC9200 (0) to FC9235 (Z).
- Third alphanumeric digit (0 to 9 or A to Z): use FC9300 (0) to FC9335 (Z).
- Fourth numeric digit (0 to 9): use FC9400 (0) to FC9409 (9).
- Fifth numeric digit (0 to 9): use FC9500 (0) to FC9509 (9).
- Sixth numeric digit is set to 0 as standard.
- Seventh and eighth characters of the VOLSER are set based on media type. Refer to the Media Identifier column in Table H-7 on page 548 and "Labeling service" on page 544.

If you do not specify a feature code, the supplied starting character will be a zero. Therefore, if you specify features for the first thee characters as `ABC` but no more, the sequence of labels will begin `ABC000`.

Two specific features indicate requirements for colored labels:

- FC9077 specifies a white background.
- FC9022 specifies a colored background for the alpha characters.

If you specify FC9022, you can choose from 10 available colors as shown in Table H-3.

Table H-3 Color specify feature codes for the IBM 3599

Alpha prefix background	Feature code	Alpha prefix background	Feature code
Red	9003	Orange	9008
Yellow	9004	Pink	9009
Light green	9005	Dark green	9010
Light blue	9006	Light orange	9011
Gray	9007	Purple	9012

Features available with IBM Ultrium hardware initial order

The following media features are available for inclusion with the initial hardware order. Note that all media and cleaning cartridges are warranted separately from the IBM Ultrium hardware.

IBM TotalStorage 3581 2U Tape Autoloader (Models L38 and F38) - Ultrium 3

These chargeable features provide media with the IBM 3581 Ultrium 2 Tape Drive and are available only with the initial order:

- FC8301 provides a single 400 GB Ultrium data cartridge. A maximum of 20 is allowed.
- FC8002 provides a single Ultrium cleaning cartridge. A maximum of five is allowed.

IBM System Storage TS2230 Tape Drive

Because the TS2230 Tape Drive is an Express model, a part number is used instead of a feature code: Part number 95P2020 provides a pack of five Ultrium 3 data cartridges.

IBM System Storage TS2240 Tape Drive

Because the TS2240 Tape Drive is an Express model, a part number is used instead of a feature code: Part number 95P2020 provides a pack of five Ultrium 4 data cartridges.

IBM System Storage TS2340 Tape Drive

Because the TS2340 Tape Drive is an Express model, a part number is used instead of a feature code: Part number 95P4278 provides a pack of five Ultrium 4 data cartridges.

IBM System Storage TS2900 Tape Drive

Because the TS2900 Tape Drive is an Express model, a part number is used instead of a feature code:

- Part number 95P4278 provides a pack of five Ultrium 4 data cartridges.
- FC8002 provides a single Ultrium cleaning cartridge. For the high volume sellers, the cleaning cartridge must be ordered using part number 23R7008.

IBM System Storage TS3100 Tape Library

The TS3100 Tape Library can be an Express model so a part number can be used or a feature code can be used when ordering data cartridges:

- Part number 95P2020 provides a pack of five Ultrium 3 data cartridges.
- Feature code 8405 provides a pack of five Ultrium 4 data cartridges.

IBM System Storage TS3200 Tape Library

These chargeable features provide media with the TS3200 Tape Library and are available with the initial order:

- Feature code 8305 provides a pack of five 400 GB Ultrium 3 data cartridges.
- Feature code 8405 provides a pack of five Ultrium 4 data cartridges.

IBM System Storage TS3310 Tape Library

Refer to “IBM 3589 LTO Ultrium tape cartridges” on page 546 for more information about ordering tape cartridges.

IBM System Storage TS3400 Tape Library

No feature code is available for ordering data cartridges at the initial order.

IBM System Storage TS3500 Tape Library

For ordering media supplies for the TS3500 Tape Library, go to “IBM 3589 LTO Ultrium tape cartridges” on page 546 and “Ordering barcode labels” on page 550.

IBM 3589 LTO Ultrium tape cartridges

To ensure that the IBM Ultrium Tape Drive conforms to the IBM specification for reliability, IBM recommends that you use only IBM LTO Ultrium tape cartridges. IBM TotalStorage LTO Ultrium Data Cartridges cannot be interchanged with the media used in other IBM non-LTO Ultrium tape products.

Table H-4 shows the various generations of IBM TotalStorage Ultrium data cartridges identified by color.

Table H-4 LTO Ultrium data cartridges identified by color

Data cartridge	Case color
Ultrium 4 WORM	Green top; platinum (silvery gray bottom)
Ultrium 4	Green
Ultrium 3 WORM	Blue top; platinum (silvery gray bottom)
Ultrium 3	Blue
Ultrium 2	Purple
Ultrium 1	Black

All four generations contain 1/2-inch, dual-coat, metal-particle tape. Table H-5 shows the native capacity of Ultrium data cartridges.

Table H-5 Native capacity of the Ultrium data cartridges

Data cartridge	Native data capacity
Ultrium 4 WORM	800 GB (1600 GB at 2:1 compression)
Ultrium 4	800 GB (1600 GB at 2:1 compression)
Ultrium 3 WORM	400 GB (800 GB at 2:1 compression)
Ultrium 3	400 GB (800 GB at 2:1 compression)
Ultrium 2	200 GB (400 GB at 2:1 compression)
Ultrium 1	100 GB (200 GB at 2:1 compression)

Cartridge compatibility

Table H-6 shows the compatibility of all four generation Ultrium cartridges in an Ultrium 4 tape drive.

Table H-6 Ultrium data cartridge compatibility with an Ultrium 4 tape drive

IBM Ultrium Tape Drive	**IBM TotalStorage LTO Ultrium Data Cartridge**			
	800 GB (Ultrium 4)	400 GB (Ultrium 3)	200 GB (Ultrium 2)	100 GB (Ultrium 1)
Ultrium 4	Read/Write	Read/Write	Read only	N/A
Ultrium 3	N/A	Read/Write	Read/Write	Read only
Ultrium 2	N/A	N/A	Read/Write	Read/Write
Ultrium 1	N/A	N/A	N/A	Read/Write

Model description and ordering media supplies

We have put together two tables where you can easily find the media description and several ways to order the media.

Table H-7 on page 548 lists the twelve models of the IBM TotalStorage Tape Media 3589 for use with IBM Ultrium tape drives. IBM 3589 now support VOLSER labels with embedded radio-frequency identification (RFID)-enabled barcode labels, which store and allow remote retrieval of VOLSER information. RFID labels contain a 216-bit unique preprogrammed field and a 256-bit user-defined field. These RFID labels are designed to work with most standard asset tracking and management software.

The following selection of 3589 models include a 20-pack of labeled LTO Ultrium data cartridges and Write Once Read Many (WORM) data cartridges. These cartridges support RFID labels and are used in LTO Ultrium Tape Drive products:

Model 002	100 GB labeled Ultrium tape cartridges
Model 006	200 GB labeled Ultrium tape cartridges
Model 008	400 GB labeled Ultrium tape cartridges
Model 010	800 GB labeled Ultrium tape cartridges
Model 028	400 GB labeled Ultrium WORM tape cartridges
Model 032	800 GB labeled Ultrium WORM tape cartridges

With the media identifier, the following type of cartridge is identified:

- Media identifier L1 is an Ultrium 1 cartridge.
- Media identifier L2 is an Ultrium 2 cartridge.
- Media identifier L3 is an Ultrium 3 cartridge.
- Media identifier L4 is an Ultrium 4 cartridge.
- Media identifier LT is a WORM cartridge.

Table H-7 3589 media

Model	Description	Media identifier	Feature code
3589-02	IBM Ultrium 1 cartridge (100 GB) with Labels (20-pack)	L1	FC2020
3589-03	IBM Ultrium 1 cartridge (100 GB) without Labels (20-pack)	L1	FC3020
3589-06	IBM Ultrium 2 cartridge (200 GB) with Labels (20-pack)	L2	FC6020
3589-07	IBM Ultrium 2 cartridge (200 GB) without Labels (20-pack)	N/A	FC7020
3589-08	IBM Ultrium 3 cartridge (400 GB) with Labels (20-pack)	L3	FC0820
3589-09	IBM Ultrium 3 cartridge (400 GB) without Labels (20-pack)	N/A	FC0920
3589-10	IBM Ultrium 4 cartridge (800 GB) with Labels (20-pack)	L4	FC1020
3589-11	IBM Ultrium 4 cartridges without Labels (20-pack)	N/A	FC1120
3589-28	IBM Ultrium 3 WORM cartridge (400 GB) with Labels (20-pack)	LT	FC2820
3589-29	IBM Ultrium 3 WORM cartridge (400 GB) without Labels (20-pack)	N/A	FC3920
3589-32	IBM Ultrium 4 WORM cartridge (800 GB) with Labels	LT	FC3220
3589-33	IBM Ultrium 4 WORM cartridge (800 GB) without Labels	N/A	FC3320

Table H-8 shows another way of presenting the 3589 media and links to the Internet, as well as telephone numbers for ordering the 3589 media.

Table H-8 Media supplies

Supply item	Methods of ordering
IBM TotalStorage LTO Ultrium 800 GB Data Cartridge	Order the cartridge from your IBM Marketing Representative or any authorized IBM Business Partner by specifying Machine Type 3589 Model 010. Specify the VOLSER characters that you want.
Barcode labels are pre-applied to cartridges.	Order as part number 96P1470 (color label) or 96P1471 (black and white label) through an IBM-authorized distributor. Specify the VOLSER characters that you want.
IBM TotalStorage LTO Ultrium 800 GB Data Cartridge	Order the cartridge from your IBM Marketing Representative or any authorized IBM Business Partner by specifying Machine Type 3589 Model 011. Specify the VOLSER characters that you want.
Order VOLSER labels separately.	Order as part number 24R1922 through an IBM-authorized distributor. Specify the VOLSER characters that you want.
5-PACK IBM TotalStorage LTO Ultrium Data Cartridge	Order as part number 95P2020 through an authorized IBM Business Partner. Specify the VOLSER characters that you want.

Supply item	Methods of ordering
IBM TotalStorage LTO Ultrium 400 GB Data Cartridge Barcode labels are pre-applied to cartridges. This media can be used with Ultrium 3 drives (Read/Write).	Order the cartridge from your IBM Marketing Representative or any authorized IBM Business Partner by specifying Machine Type 3589 Model 009. Specify the VOLSER characters that you want. Order as part number 96P1470 (color label) or 96P1471 (black and white label) through an IBM-authorized distributor. For the closest distributor, visit the Web at: `http://www.ibm.com/storage/media` Or, call 1-888-IBM-MEDIA. Specify the VOLSER characters that you want.
IBM TotalStorage LTO Ultrium 400 GB Data Cartridge Order VOLSER labels separately. This media can be used with Ultrium 3 drives.	Order the cartridge from your IBM Marketing Representative or any authorized IBM Business Partner by specifying Machine Type 3589 Model 008. Order as part number 24R1922 through an IBM-authorized distributor. For the closest distributor, visit the Web at: `http://www.ibm.com/storage/media` Or, call 1-888-IBM-MEDIA. Specify the VOLSER characters that you want.
IBM Ultrium 3 400 GB WORM Tape Cartridge (with attached labels) IBM TotalStorage 3589 Model 028 FC2820 is a 20-pack of WORM cartridges labeled with starting Volume serial information and, optionally, packed in individual jewel cases. Attached labels have been preprinted with a barcode that ends with LT, where L stands for LTO, and T identifies the cartridge as a WORM cartridge. This media can be used with Ultrium 3 drives.	Order by Machine Type/Model and Feature Code through an IBM-authorized distributor. For the closest distributor, visit the Web at: `http://www.ibm.com/storage/media` If you do not have Internet access, order the cartridge from any authorized IBM Business Partner or your IBM Marketing Representative. Call 1-888-IBM-MEDIA.
IBM Ultrium 3 400 GB WORM Tape Cartridge (without attached labels) IBM TotalStorage 3589 Model 029 FC2920 is a 20-pack of WORM cartridges packed in individual jewel cases with unattached blank labels. This media can be used with Ultrium 3 drives (Read/Write).	Order by Machine Type/Model and Feature Code through an IBM-authorized distributor. For the closest distributor, visit the Web at: `http://www.ibm.com/storage/media` If you do not have Internet access, order the cartridge from any authorized IBM Business Partner or your IBM Marketing Representative. Call 1-888-IBM-MEDIA.

Supply item	Methods of ordering
IBM TotalStorage LTO Ultrium 200 GB Data Cartridge Barcode labels are pre-applied to cartridges. This media can be used with LTO2 drives (Read/Write) and LTO3 drives (Read/Write).	Order the cartridge from your IBM Marketing Representative or any authorized IBM Business Partner by specifying Machine Type 3589 Model 006. Specify the VOLSER characters that you want. Call 1-888-IBM-MEDIA.
IBM TotalStorage LTO Ultrium 200 GB Data Cartridge Order VOLSER labels separately (refer to “Ordering barcode labels” on page 550). This media can be used with LTO2 drives (Read/Write) and LTO3 drives (Read/Write).	Order the cartridge from your IBM Marketing Representative or any authorized IBM Business Partner by specifying Machine Type 3589 Model 007. call 1-888-IBM-MEDIA.
IBM LTO Ultrium 100 GB Data Cartridge Order VOLSER labels separately (refer to “Ordering barcode labels” on page 550). This media can be used with LTO1 drives (Read/Write), LTO2 drives (Read/Write), and LTO3 drives (Read only).	Order as part number 08L9120 through an IBM-authorized distributor. For the closest distributor, visit the Web at: http://www.ibm.com/storage/media if you do not have Internet access, order the cartridge from any authorized IBM Business Partner or your IBM Marketing Representative. Call 1-888-IBM-MEDIA.
IBM TotalStorage LTO Ultrium Cleaning Cartridge Universal cleaning cartridge for use with Ultrium 1, Ultrium 2, and Ultrium 3 drives. VOLSER labels are included.	Order as part number 08L9120 through an IBM-authorized distributor. For the closest distributor, visit the Web at: http://www.ibm.com/storage/media if you do not have Internet access, order the cartridge from any authorized IBM Business Partner or your IBM Marketing Representative. Call 1-888-IBM-MEDIA.

Ordering barcode labels

You can order barcode labels from one of the following authorized suppliers. Refer to Table H-9 on page 551.

Table H-9 Authorized suppliers of custom barcode labels

In the Americas	In Europe and Asia
EDP/Colorflex 2550 West Midway Boulevard Broomfield, CO 80020-1633 U. S. A. Telephone: 800-432-1337 or 303–666-2160 `http://www.colorflex.com/Ai/Home.asp`	EDP Europe, Ltd. 43 Redhills Road South Woodham Ferrers Chelmsford, Essex CM3 5UL U. K. Telephone: 44 (0) 1245-322380 `http://www.edpeurope.com/media_labelling.htm`
Dataware 7570 Renwick Houston TX 77081 U. S. A. Telephone: 800-426-4844 `http://www.datawarelabels.com/`	Dataware Labels Europe Heubergstrasse 9 D-83052 Bruckmuhl-Gotting Germany Telephone: 49 806-29455 `http://www.datawarelabels.com/`
NetC P. O. Box 320784 Fairfield, CT 06432 U. S. A. Telephone: 203-372-6382 `http://www.netcllc.com/`	NetC Europe Ltd Town Farm Bungalow North Curry Taunton Somerset U. K. TA3 6LX Telephone: 44 (0) 1823 491439 `http://www.netclabels.co.uk`
	NetC Asia Pacific Pty Ltd PO Box 609 Windsor NSW 2756 Australia Telephone: 61 (0) 2 4577 3793 `http://www.netclabels.com.au`

I

IEHINITT usage

In this appendix, we describe the initialization process of cartridges within a tape library and the enhancements for IEHINITT.

Initializing tapes in a library

If you need to initialize a tape, for example, to change the volume serial number, you can use the process described in this section. The following process initializes volumes that are inside a tape library that has native drives attached to MVS:

1. Ensure that all cartridges have unique external labels that will meet the criteria of the destination system.
2. Ensure that *NO* system has a volume serial range defined that includes those volume serials of the cartridges to be initialized.
3. The MVS tape management system and the cartridge entry exit must exclude the range of volume serials within which the subject volumes fall.
4. Any other system attached to the library must not be able to process the subject cartridges on insertion into the library.
5. Insert the subject cartridges into the library. The display of entries for the inserted volumes on the Search Database for Volumes pop-up window shows that the volumes are in the INSERT (x'FF00') category. If they are not in the INSERT category, a system might have processed them, so go back to step 2. If the volumes are ejected or set in error category, then go back to step 1. If they are in the Unassigned Category, you will have an opportunity to move them into INSERT category at the Library Manager console.
6. At the MVS system, you then execute an IDCAMS job to create volume entries in the tape configuration database (TCDB) (create them as PRIVATE). Refer to the topic CREATE VOLUMEENTRY in the publication *DFSMS/MVS Access Method Services for the Integrated Catalog Facility,* SC26-7394. There will not be a corresponding entry in the tape management system database. After all of the volume entries are made, you can display that list of volumes in Interactive Storage Management Facility (ISMF). This step does NOT change the entries in the Library Manager database. At this point, the entries still show INSERT category.
7. Display the created entries in the TCDB at the Mountable Volume List panel in ISMF. Refer to the topic Monitoring and Maintaining Tape Volumes in the appendix of *z/OS DFSMS Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries*, SC35-0427, for information about displaying and altering volumes in the list.
8. Use ISMF to ALTER the Use Attribute (category) from PRIVATE to PRIVATE to cause OAM to communicate to the Library Manager that those volumes are to be set to PRIVATE category. The Library Manager will do this even though the current category is INSERT. You can display the volumes at the Library Manager console and see the category is now the private category associated with the system from which you did the ALTER.
9. Run IEHINITT utility program to re-initialize the cartridges to the new labels. Refer to the topic IEHINITT (Initialize Tape) Program in the publication *DFSMS/MVS Utilities*, SC26-4926.
10. If the volumes have to be used outside the library, use ISMF to eject the volumes. Use PURGE on the EJECT command, this will insure that the TCDB entry for that volume is deleted. Refer to the reference in step 6. The result will be that all entries in both the TCDB and the Library Manager data base will be deleted when the cartridge is ejected.

Enhancements to IEHINITT

The tape encryption rekeying support in z/OS is provided as an extension of the existing IEHINITT (tape initialization) utility. The new rekey (REKEY) support takes as input a volume serial number and its new key labels and encoding mechanism. Two key labels can be specified; however, it requires that at least one key label is specified. The same value can be specified for both key labels. If only one key label is specified, the same value will be used for the other key label. The new key labels can be the same key labels that were used to generate the existing Externally Encrypted Data Key (EEDK) structures on the tape. There will be no checking whether the new key labels are the same key labels that were originally used.

When NUMBTAPE is specified, the volume serial number of the first volume is specified and is increased by one for each additional volume (maximum serial number is 999999). The serial number specified must be all numeric.

As with the existing INITT function, the new REKEY function uses as input a control dataset that contains the utility control statements and produces on output a dataset that contains:

- Utility program identification
- New key label information for each tape volume that is successfully rekeyed
- Message codes and error messages

Figure I-1 shows the sample output of an IEHINITT REKEY operation.

Figure I-1 Sample IEHINITT output

```
SYSTEM SUPPORT UTILITIES                 IEHINITT
LABEL   REKEY SER=001000,KEYLABL1=First_Key_Label,KEYENCD1=L,
             KEYLABL2=Second_Key_Label,KEYENCD2=H,NUMBTAPE=2

001000 KEYLABL1=First_Key_Label           KEYENCD1=L
       KEYLABL2=Second_Key_Label          KEYENCD2=H

001001 KEYLABL1=First_Key_Label           KEYENCD1=L
       KEYLABL2=Second_Key_Label          KEYENCD2=H
```

The new REKEY control statement syntax is:

```
ddname    REKEY   SER=VOLSER
                [,DISP=[rewind|unload}]
                [,NUMBTAPE={n|1}}]
                [,KEYLABL1=keylabel1 (64-char)]
                [,KEYENCD1={L|H}]  (L=Label;H=Hash)
                [,KEYLABL2=keylabel2 (64-char)]
                [,KEYENCD2={L|H}]  (L=Label;H=Hash)
```

Note that all other INITT-related keywords are invalid. The new fields are in bold type.

The parameters are:

- **SER=*VOLSER***

  The SER keyword can be specified in two forms:

  SER=*VOLSER* Specify the volume serial number of one volume

SER=*VOLSER*,NUMBTAPE=*n*

When NUMBTAPE is specified, SER is the volume serial number of the first volume and is increased by one for each additional volume (maximum serial number is 999999). The serial number specified must be all numeric.

- **KEYLABL1=*keylabel1_name***

  KEYLABEL1 specifies the first key label for the key encryption key used by the EKM. A key label is 1-to-64 characters with blanks padding the field on the right. A key label contains alphanumeric, national (special symbols used in specific languages), or special characters with certain additional characters also allowed. Enclose it in single quotation marks if it contains any blanks or special characters. IEHINITT does not validate the character set specified for the key label keyword.

  At least one key label and its encoding mechanism are required for REKEY. When you specify this operand, you must also specify a value for the key encoding mechanism using the KEYENCD1.

  Note that if only one key label and its associated encoding mechanism are specified, the same key label and mechanism values will be used for both key labels and mechanisms.

- **KEYENCD1={L|H}**

  Specifies the encoding mechanism of the first key label KEYLABL1. The encoding mechanism indicates how the label for the key encrypting key specified by the key label is to be encoded by the EKM and stored on the tape:

  L Label – encoded as the specified label

  H Hash – encoded as a Hash of the public key referenced by the specified key label

- **KEYLABL2=*keylabel2_name***

  Specifies the second key label for the key encryption key used by the EKM. A key label is 1-to-64 characters with blanks padding the field on the right. A key label contains alphanumeric, national, or special characters with some additional characters also allowed. Enclose the key label in single quotation marks if it contains any blanks or special characters. IEHINITT does not validate the character set specified for the key label keyword.

  At least one key label and its associated encoding mechanism are required for REKEY. When you specify this operand, you must also specify a value for the key encoding mechanism using the KEYENCD2. Note that if only one key label and its associated encoding mechanism are specified, the same key label and mechanism values will be used for both key labels and mechanisms.

- **KEYENCD2={L|H}**

  Specifies the encoding mechanism of the second key label KEYLABL2. The encoding mechanism indicates how the label for the key encrypting key specified by the key label is to be encoded by the EKM and stored on the tape:

  L Label – encoded as the specified label

  H Hash – encoded as a Hash of the public key referenced by the specified key label

- **NUMBTAPE={*n*|1}**

  Specifies the number of tapes to be rekeyed. The value *n* represents a number from 1 to 255. If more than one tape is specified, the volume serial number of the first tape must be all numeric.

As an enhancement to the initial release of IEHINIT's re-keying support (OA20076), support has been added with APAR OA22119 for z/OS V1R7 to allow an alphanumeric VOLSER to be specified with the SER= keyword when NUMBTAPE is specified. Today, if more than one tape is specified (using the NUMBTAPE= keyword), the volume serial number of the first tape must be *all* numeric. This enhancement will allow the volume serial number to be specified as an alphanumeric string such that at least one or more (up to six) rightmost characters must be numeric. The numeric suffix of the volume serial number will be increased by one for each additional tape. This support will be provided for both the INITT and REKEY functions. As an example:

- VOL100 is incremented to VOL101
- V19999 is incremented to V20000
- 123456 is incremented to 123457

The following rules apply when the value specified for NUMBTAPE is greater than 1:

- When the numeric suffix exceeds its incremental limit, IEHINITT will process up to the largest number allowed for the numeric suffix and issue a warning message.

  For example: `SER=TOM991, NUMBTAPE=10`

  In this example, the maximum value of the numeric suffix 991 is 999, therefore, up to nine tapes are processed. The 10th tape will be ignored and the following new message will be issued:

  ```
  IEH641I THE NUMERIC SUFFIX OF THE SERIAL NUMBER EXCEEDED POSSIBLE MAXIMUM VALUE
  - THE LAST VOLUME PROCESSED WAS 'volser'
  ```

  In this example, the "*volser*" indicated is `TOM999`.

  An exception to this rule is when the serial number is all numeric and an overflow occurs, we allow the serial number to wrap around as we do today (Serial number 999999 is incremented to 000000).

- When the last character is alphabetic, the following updated message will be issued:

  Existing message:

  ```
  IEH623E INVALID SERIAL NUMBER. SERIAL NUMBER MUST BE ALL NUMERIC WHEN VALUE
  SPECIFIED FOR NUMBTAPE IS GREATER THAN 1
  ```

  Modified message:

  ```
  IEH623E SERIAL MUST BE ALL NUMERIC OR AT LEAST ONE OR MORE RIGHTMOST CHARACTERS
  MUST BE NUMERIC WHEN NUMBTAPE IS GREATER THAN 1
  ```

  The following parameter keywords will be updated:

  SER=*serial number*

  specifies the volume serial number of the first or only tape to be labeled. Specify up to six characters. For IBM standard labeled (SL) tapes, the serial number cannot contain blanks, commas, apostrophes, equal signs, or special characters other than periods, hyphens, dollar signs, pound signs, and at signs ('@'). ISO/ANSI labeled tapes (AL) can contain any valid ISO/ANSI 'a' type character as described under the OWNER keyword. However, if any non-alphanumeric character (including a period or a hyphen) is present, delimiting apostrophes must be included. You cannot use a blank as the first character in a volume serial number. When the NUMBTAPE keyword is specified with a value greater than 1, the volume serial number must be all numeric or at least one or more rightmost characters of the volume serial number must be numeric.

  When a volume serial number is all numeric, it is increased by one for each additional tape (Note: Serial number 999999 is increased to 000000).

When a volume serial number is alphanumeric, only the numeric suffix is increased by one for each additional tape, for example:

– VOL100 is increased to VOL101
– T19999 is increased to T20000
– 100A01 is increased to 100A02

In the case where the numeric suffix exceeds its incremental maximum value, IEHINITT processes up to the largest serial number allowed for the numeric suffix and the warning message IEH641I is issued, for example:

`VOLSER=AAA991 and the parameter NUMBTAPE=10, then up to nine volumes are processed and the last volume is AAA999.`

The parameter `NUMBTAPE={`*n*`|1}` specifies the number of tapes to be processed according to the specifications made in this control statement. The value *n* represents a number from 1 to 255. If more than one tape is specified, the volume serial number of the first tape must be all numeric or the last one to six characters must be numeric.

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, refer to “How to get IBM Redbooks publications” on page 562. Note that some of the documents referenced here might be available in softcopy only:

- *The IBM System Storage Tape Libraries Guide for Open Systems*, SG24-5946
- *IBM Fiber Saver (2029) Implementation Guide*, SG24-5608
- *IBM System Storage TS7700 Virtualization Engine: Tape Virtualization for System z Servers*, SG24-7312
- *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring,* SG24-2229
- *IBM TotalStorage Peer-to-Peer Virtual Tape Server: Planning and Implementation Guide,* SG24-6115
- *IBM Virtualization Engine TS7520: Planning, Implementation, and Usage Guide,* SG24-7520
- *IBM Virtualization Engine TS7510: Tape Virtualization for Open Systems Servers,* SG24-7189
- *IBM TotalStorage 3494 Tape Library: A Practical Guide to Tape Drives and Tape Automation*, SG24-4632
- *TS7700 R1.4a and lower: IBM Virtualization Engine TS7700: Tape Virtualization for System z Servers*, SG24-7312
- *TS7500 R1.5 and higher: IBM Virtualization Engine TS7740 R1.5 and TS7720: New Virtualization Options for Mainframe Servers*, SG24-7712

Other publications

These publications are also relevant as further information sources:

- *IBM System Storage TS3500 Tape Library Introduction and Planning Guide,* GA32-0559
- *IBM System Storage TS3500 Tape Library Operator Guide*, GA32-0560
- *IBM System Storage 3953 Library Manager Model L05 Operator Guide*, GA32-0558
- *IBM System Storage 3953 Tape System Introduction and Planning Guide*, GA32-0557
- *IBM System Storage Tape System 3592 Introduction and Planning Guide,* GA32-0464
- *IBM Virtualization Engine TS7700 Series, Introduction and Planning Guide,* GA32-0567
- *IBM Fiber-Optic Channel Link Planning and Installation*, GA23-0367
- *IBM Token-Ring Network Introduction and Planning Guide*, GA27-3677

- *IBM General Information Manual: Installation Manual-Physical Planning*, GC22-7072
- *Resource Access Control Facility General Information*, GC28-0722
- *z/OS DFSMS Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries*, SC35-0427
- *DFSMS/MVS DFSMSdss Storage Administration Guide*, SC26-4930
- *z/OS DFSMS Access Method Services for Catalogs*, SC26-7394
- *z/OS MVS System Commands*, SA22-7627
- *z/OS DFSMS Software Support for IBM System Storage TS1130 and TS1120 Tape Drives (3592)*, SC26-7514
- *IBM Encryption Key Manager component for the Java platform Introduction, Planning, and User's Guide,* GA76-0418
- *IBM Tivoli Automated Tape Allocation Manager for z/OS*, SC32-9122
- *z/VSE System Administration Guide*, SC33-8224
- *z/VSE System Macros Reference*, SC33-8230
- *IBM TotalStorage 3494 Tape Library Introduction and Planning Guide*, GA32-0279
- *IBM TotalStorage 3494 Tape Library Operator's Guide*, GA32-0280
- *VM/ESA DFSMS/VM FL221 Removable Media Services User's Guide and Reference,* SC35-0141
- *IBM TotalStorage Virtual Tape Server 3494 Bulk Volume Information Retrieval Function User's Guide* white paper, which is available on the Web from:

  http://w3-03.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP100430

  For clients:

  http://www-1.ibm.com/support/docview.wss?rs=0&q1=BVIR&uid=tss1wp100430&loc=en_US&cs=utf-8&cc=us&lang=en
- *Virtualization Engine TS7700 Series Statistical Data Format* white paper, which is available from:

  http://www-1.ibm.com/support/docview.wss?rs=0&q1=BVIR&uid=tss1wp100829&loc=en_US&cs=utf-8&cc=us&lang=en

Online resources

These Web sites are also relevant as further information sources:

IBM Storage Media Support

This Web site provides access to current regional and country-specific IBM addresses and telephone numbers.

http://www-1.ibm.com/servers/storage/media/index.html

IBM 3592 Tape System Support

The following Web site provides access to current information related to 3592 tape systems.

Device driver support:

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

IBM Network Integration and Deployment Services

Provides information about connectivity and the integration of cabling systems.

http://www-1.ibm.com/services/us/index.wss/it/gn/a1000412

IBM Tape Storage Publications

Provides IBM Hardware product documents in a PDF format for viewing and printing.

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

SAN Fabric

Provides information about high-performance switches and gateways.

http://www-1.ibm.com/servers/storage/san//

I/O Connectivity

Lists updated information regarding FICON and Fibre Channel connectivity.

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

IBM Tivoli products

http://www.ibm.com/software/tivoli/products/tape-optimizer-zos

Vendor Support

Provides compatibility information in PDF format for implementing software, servers, and operating systems with IBM tape drives and libraries.

http://www-1.ibm.com/servers/storage/tape/compatibility/index.html

Non-IBM Support

Cisco

Provides access to Cisco products and support.

http://www.cisco.com/

McData

Provides access to McData products and support.

http://www.mcdata.com/

CNT

Provides access to CNT products and support.

http://www.cnt.com/

Brocade

Provides access to Brocade products and support.

http://www.brocade.com/

Like IBM, the following companies have tape copy tool products:

Beta Systems Software AG

http://www.betasystems.com

Computer Associates International, Inc.

http://www.cai.com

Rocket Software, Inc.

http://www.rocketsoftware.com/portfolio/tapemedia/

OpenTech Systems, Inc.

http://www.opentechsystems.com/tape-copy.php

Cartagena Software Ltd.

http://www.cartagena.com

Software Engineering of America

http://www.seasoft.com/zela.asp

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IBM TS3500 Tape Library with System z Attachment A Practical Guide to Enterprise Tape Drives and TS3500 Tape Automation

(1.0” spine)
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460 <-> 788 pages

IBM TS3500 Tape Library with System z Attachment

A Practical Guide to Enterprise Tape Drives and TS3500 Tape Automation

Improve your tape workload performance with TS1130 Tape Drive

Increase your TS3500 capacity with the High Density Frame

Discover new cartridge storage options

The IBM System Storage TS3500 Tape Library, also known as the IBM System Storage 3584 Tape Library, is designed for medium to large automated tape storage and backup solutions and is part of a whole family of tape libraries for small to large tape automation solutions. Originally designed for IBM Linear Tape-Open (LTO) Ultrium Technology drives, the library was enhanced to also support the IBM System Storage Enterprise Tape Drive 3592 in preparation of System z server attachment. Together with the IBM System Storage 3953 Tape System, the TS3500 Tape Library attaches to System z servers as well as to Open Systems hosts.

This book is intended for Hardware and Software Planners, System Programmers, Storage Administrators, and anyone involved in planning, implementing, and operating the TS3500 Tape Library in a System z environment. It is also suitable for everyone seeking detailed technical information about the TS3500 Tape Library and the IBM Tape System 3953 that allow attachment to System z hosts.

In this IBM Redbooks publication, we discuss the enhancements that allow attachment of the IBM System Storage TS3500 Tape Library to System z host systems through the IBM System Storage 3953 Tape System, which consists of the IBM System Storage 3953 Model L05 Library Manager and the Model F05 Frame. The IBM 3953 Tape System significantly broadens the attachment options of the TS3500 Tape Library, which is well established in Open Systems environments, and they allow nearly all platforms to share a single tape library. The latest version of the IBM Redbooks publication has been updated with the TS1130 Tape Drive (IBM 3592 Model E06/EU6) and Controller and enhancements to the TS3500 Tape Library, such as the High Density Frame that allows storage of up to 1320 cartridges in a single library.

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SG24-6789-03 ISBN 0738431567