

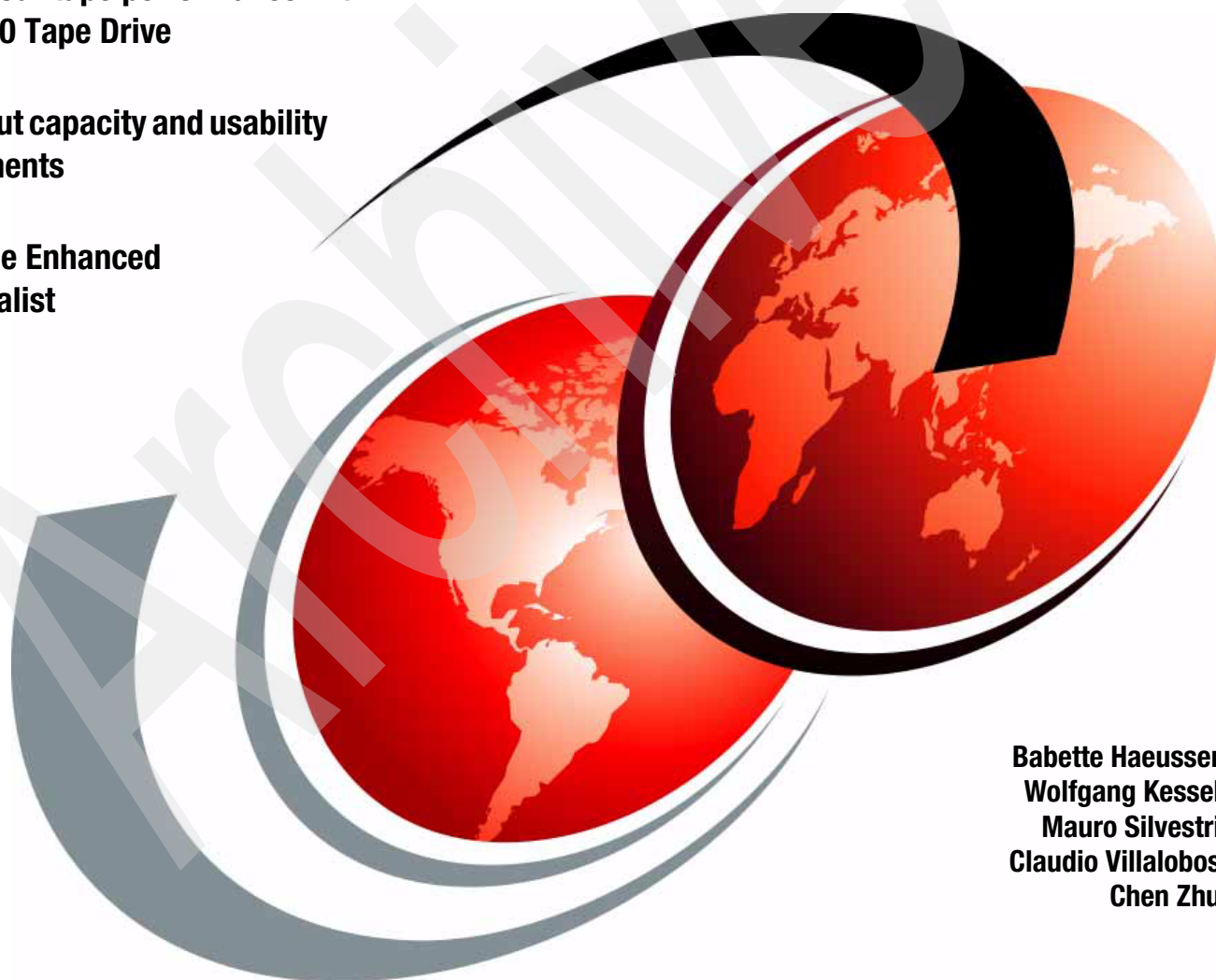
IBM TotalStorage 3494 Tape Library:

A Practical Guide to Tape Drives and Tape Automation

Improve your tape performance with the TS1130 Tape Drive

Learn about capacity and usability enhancements

Explore the Enhanced ETL Specialist



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Redbooks



International Technical Support Organization

**IBM TotalStorage 3494 Tape Library: A Practical Guide
to Tape Drives and Tape Automation**

February 2009

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

Ninth Edition (February 2009)

This edition applies to the IBM 3494 Tape Library, TS1100 tape drives and controllers current at the time of publishing, and the IBM Virtualization Engine TS7700 R1.4a.

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Preface

This IBM® Redbooks® publication is the ninth edition of the best selling *Tape Library Practical Guide*, which was first published in 1996. This book is the indispensable companion for a successful implementation of IBM TotalStorage® Enterprise Tape Drives 3590, IBM System Storage™ 3592 Tape Drives and Controllers including the IBM System Storage TS1120 and TS1130 Tape Drives and Controller, and the IBM TotalStorage Enterprise Tape Library 3494 in your environment.

This book explains how to plan for and how to install the tape products and library in the various enterprise platforms. It considers day-to-day operations and integration with other products and applications. It also provides information about data migration and operational considerations. This document was written for storage systems technical professionals who implement IBM tape drives and libraries. The present version of the book has been updated with the attachment of the IBM TS1130 Tape Drive and usability enhancements of the IBM 3494 Tape Library.

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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Summary of changes

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

Summary of Changes
for SG24-4632-08

for *IBM TotalStorage 3494 Tape Library: A Practical Guide to Tape Drives and Tape Automation* as created or updated on April 14, 2010.

February 2009, Ninth Edition

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

New information

This edition includes:

- ▶ Support for the IBM TS1130 Tape Drive

Updated information

This edition has been updated for:

- ▶ Enhanced ETL Specialist functionality
- ▶ TS1130 attached to Sun StorageTek Silo
- ▶ JES3 example including TS1130
- ▶ Additional functionality of the ETL Specialist

February 2008, Eighth Edition

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

New information

This edition includes:

- ▶ Support for the IBM Virtualization Engine™ TS7700
- ▶ Library-Managed Encryption for Open Systems

April 2007, Seventh Edition

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

New information

This edition included:

- ▶ IBM System Storage TS1120 Tape Drive
- ▶ IBM System Storage TS1120 Tape Controller
- ▶ IBM System Storage 3952 Tape Frame
- ▶ Tape Encryption
- ▶ New tape media

Changed information

Changes included:

- ▶ Added information about products withdrawn from marketing
- ▶ Additional features and enhancements added to existing products



Introduction to IBM tape solutions

For more than fifty years, tape has persisted as the media of choice when clients require inexpensive data storage. Significant advances have been made in nearly every aspect of the recording process: heads, media, channel electronics, and recording platforms. Historically, tape has had to bear the burden of prior products; it had to remain compatible with previous generations. For example, nine-track compatibility restricted density advances solely to linear density. It took an order of magnitude of improvement in density, as well as improvements in reliability, to make the 18-track IBM 3480 drive a success. It took a similar order of magnitude of improvement to introduce the current tape products, which now write at 8 to 16 tracks at a time and are able to store in excess of 2 TB of compressed data per tape cartridge. Tape is an integral part of the storage hierarchy with many clients storing as much as fifteen times more data on tape than on disk. This chapter provides an overview of the IBM System Storage and IBM TotalStorage Enterprise Tape family.

1.1 IBM TotalStorage Enterprise 3494 Tape Library

The IBM TotalStorage Enterprise 3494 Tape Library consists of individual frames that you can configure to help address a variety of client requirements. This flexible design enables organizations to install a solution that helps to address current capacity requirements and to add capacity when required. Configurations include a library base frame, drive frames, storage frames, and up to two IBM TotalStorage Virtual Tape Servers. See Figure 1-1.

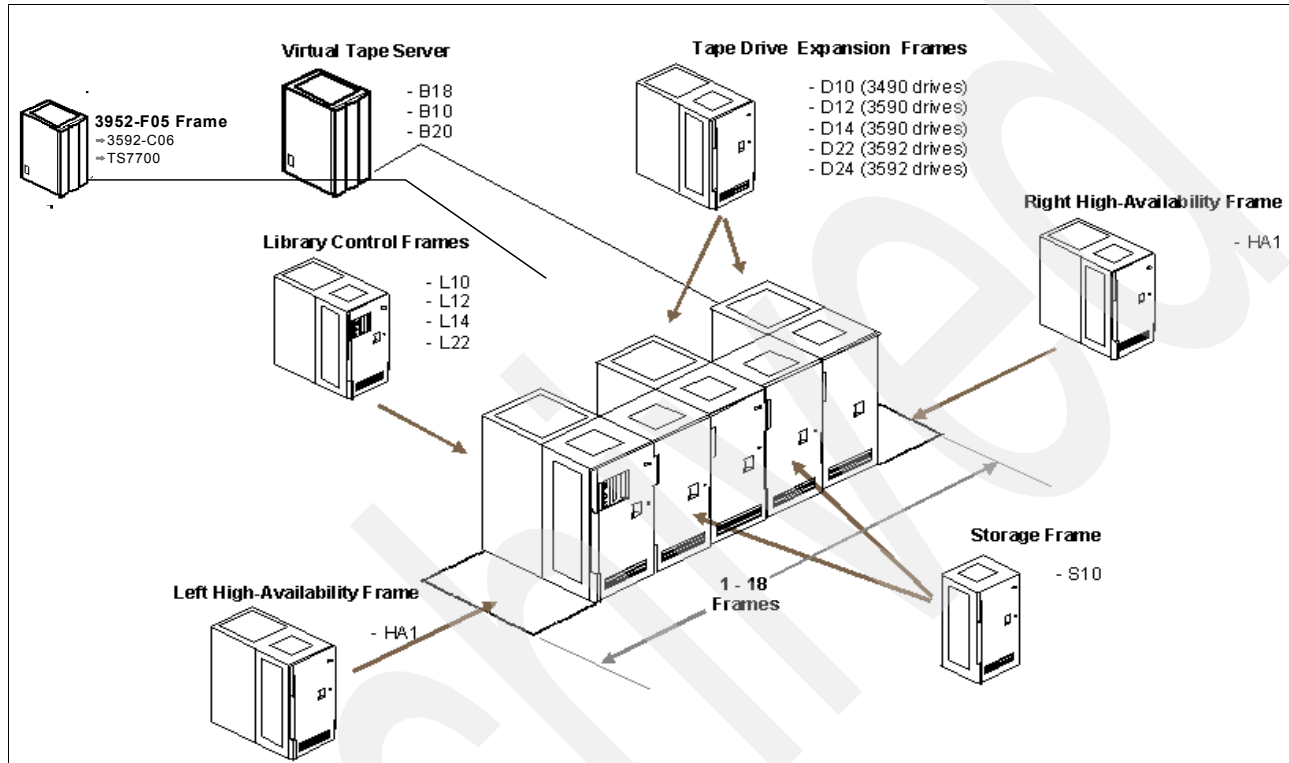


Figure 1-1 IBM TotalStorage Enterprise Tape Library 3494

A high availability model and a dual active access feature are available. The modular linear approach to tape automation is the perfect vehicle for the latest technology in storage. Integration of the IBM System Storage TS1120 Tape Drive and media into the library provides scalability of over 10 Petabytes of storage capacity, and with the integration of the new generation of IBM System Storage TS1130 Tape Drive, the storage capacity increase up to 15.36 PB. The 3494 library supports multiple generations of tape drives, tape controllers, and Virtual Tape Servers. The versatility of its design supports the increasing demands of today's storage growth. Figure 1-1 illustrates the modular flexibility of the library. In addition, you can share a tape library across multiple platforms, such as the IBM System z, IBM System x™, IBM System i, and System p® servers, as well as various non-IBM platforms. The IBM 3494 Tape Library has a small footprint, starting at 0.762 m (2.5 feet) wide by 1.524 m (5 feet) deep. This size allows the 3494 library to fit in many environments and makes it suitable for vaults. The 3494 library can also provide a significant savings in floor space.

New installations of an IBM 3494 Tape Library are no longer supported. Existing IBM 3494 Tape Libraries can be extended up to the maximum number of frames by adding additional Model D22 or D24 frames.

Note: The IBM System Storage TS3500 Tape Library is the library of choice when installing a new library. See the *IBM System Storage TS3500 Tape Library with System z Attachment: A Practical Guide to Enterprise Tape Drives and TS3500 Tape Automation*, SG24-6789, and the *IBM System Storage Tape Library Guide for Open Systems*, SG24-5946, for detailed information about the IBM 3500 Tape Library.

1.2 IBM System Storage 3952 Tape Frame Model F05

The 3952 Tape Frame Model F05 was introduced as a multipurpose system supporting components of various tape offerings, including the TS1120 Model C06 Tape Controller. It provides 36U of usable space to contain components. The 3952 Tape Frame includes an integrated power supply and optional dual power. It also includes a stability kit, which is designed to prevent the unit from falling over when component drawers are pulled out for servicing.

A 3952 Tape Frame can support up to three TS1120 Model C06 Tape Controllers; however, you cannot install more than two 3592 Model J70 Controllers in a single frame. This frame is not linear with the 3494 library frames, which allows you flexibility in determining where to place this frame on your raised floor.

The frame is required in an IBM 3494 Tape Library, because the 3592 Model J70 Controller was initially modified to allow service access in an IBM 3494 Tape Library Dxx frame. The TS1120 Model C06 Tape Controller is an unmodified pSeries® and cannot be serviced in an IBM 3494 Tape Library Dxx frame.

1.3 IBM Tape Controllers

The tape controllers described in this section are supported for installation in the IBM 3494 Tape Library.

1.3.1 IBM System Storage TS1120 Model C06 Controller

The IBM System Storage TS1120 Model C06 Controller in Figure 1-2 is the latest generation of IBM tape controller, replacing the 3592-J70 Controller.



Figure 1-2 TS1120 Model C06 Controller

The TS1120 Model C06 Controller is designed to exploit the performance and function of the TS1100 and 3592 tape drives, including the high capacity 1000 GB, 700 GB, 500 GB, 300 GB, and 60 GB fast access, and WORM tape formats. It has a higher throughput than its predecessor, the 3592-J70. It supports either one to four dual-ported 4 Gbps FICON®

channel adapters or two to eight ESCON® channel adapters for attachment to 3592-J1A, TS1120, and TS1130 tape drives. The IBM System Storage TS1120 Model C06 Tape Controller supports ESCON and FICON path group mixing, so there is no need to determine ESCON/FICON mix, thus reducing director port requirements. You can attach a mixture of up to sixteen TS1130, TS1120, and 3592-J1A tape drives using a supported SAN Fabric switch. You can identify supported switches at:

<http://www.ibm.com/support/techdocs/atsmastr.nsf/webindex/FQ115356>

The IBM System Storage TS1120 Model C06 Tape Controller supports tape drives installed in an IBM 3494 Tape Library but requires an external IBM System Storage 3952 Tape Frame Model F05. Refer to 1.2, “IBM System Storage 3952 Tape Frame Model F05” on page 3 for further information. The TS1120 Model C06 Tape Controller offers the same availability characteristics as the 3592 J70, such as:

- ▶ Redundant power supplies
- ▶ Redundant cooling
- ▶ Mirrored drives
- ▶ Nondisruptive drive code updates and nondisruptive drive installation
- ▶ Attachment to the TS3000 System Console, which can provide enhanced remote support to help improve availability

Enhancements include:

- ▶ Support for Encryption of data on a tape cartridge with TS1130 and TS1120 tape drives
- ▶ Up to 1.7 times the throughput of the 3592 Model J70 with 4-Gbps FICON attachment using 3592-E05 tape drives
- ▶ Attachment of TS1130 Tape Drive 3592 models E06 and EU6, TS1120 Tape Drive 3592 Model E05, or the 3592 Model J1A Tape Drive
- ▶ Support for IBM System Storage TS3400 Tape Library

Note that the TS1120 Model C06 Tape Controller does not support attachment of 3590 tape drives.

1.3.2 IBM TotalStorage Enterprise Tape Controller

The IBM TotalStorage Enterprise Tape Controller 3592 Model J70 in Figure 1-3 is designed to offer Enterprise Systems Connection (ESCON) and Fibre Channel Connection (FICON) attachment of either 3592 or 3590 tape drives in a 3494 Tape Library, StorageTek ACS, or stand-alone environment.



Figure 1-3 IBM TotalStorage Enterprise Tape Controller 3592 Model J70

The Model J70 is designed to support the performance and function of the 3592 Tape Drive, including the high capacity 700 GB, 500 GB, 300 GB, 60 GB fast access, and WORM tape formats.

In a z/OS® or OS/390® environment, an individual 3592 tape cartridge can be scaled to fast-access format (20% of the total media capacity). The effect of capacity scaling to 20% of the total media capacity is to reduce the average locate time to a random record (from load point) to less than 30% of the normal locate time. You can share tape drives among FICON and ESCON hosts, which allows effective drive utilization and helps to reduce hardware switching and fabric infrastructure requirements.

The J70 controller is built from IBM components, including the IBM pSeries, AIX® operating system, and PCI-X bus architecture. Redundant, hot-swappable power supplies and cooling components with automatic failover help to provide High Availability for the controller.

Support for the Encryption of data on a tape cartridge with TS1120 tape drives is available with microcode firmware 1.19.5.xx.

Note: IBM TotalStorage Enterprise Tape Controller 3592 Model J70 was withdrawn from marketing, effective September 29, 2006, and has been replaced by the IBM TS1120 Model C06 Controller.

1.4 IBM TS1100 and 3592 tape drives

The IBM TS1130, TS1120, and the IBM 3592 Model J1A are supported in the IBM 3494 Tape Library.

1.4.1 IBM System Storage TS1130 Tape Drive

The IBM System Storage TS1130 Tape Drive (Figure 1-4) is a single cartridge unit designed for automation and the third generation of a new family of tape products. The TS1130 Tape Drive is the follow-on to the TS1120 Tape Drive and the highly successful 3590 Enterprise Tape Drive. Two models are available:

- ▶ IBM System Storage TS1130 Tape Drive (3592 Model E06)
- ▶ IBM System Storage TS1130 Tape Drive (3592 Model EU6)

A 3592 Model E05 canister can be upgraded through the Miscellaneous Equipment Specification (MES) process to contain a 3592 Model E06 drive. The result is a 3592 Model EU6 Tape Drive, which is the functional equivalent of the Model E06.

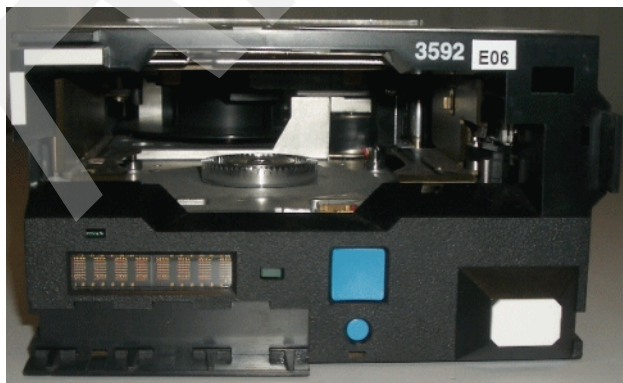


Figure 1-4 IBM System Storage TS1130 Tape Drive

With its higher performance, greater capacity, and smaller size, as compared to a TS1120 Tape Drive, the use of the TS1130 Tape Drive can help save costs as you reduce your number of tape drives and cartridges and the associated floor space.

Attachment to ESCON or FICON channels on IBM mainframe servers requires 3592 Model J70 or a TS1120 Model C06 tape controller and supports Tape Encryption.

See 3.2, “Common characteristics of the 3592 tape drive family” on page 93 and 3.3, “The IBM System Storage TS1130 Tape Drive” on page 111 for a detailed description of the TS1130 Tape Drive.

1.4.2 IBM System Storage TS1120 Tape Drive

The IBM System Storage TS1120 Tape Drive Model E05 offers a design that is focused on high capacity and performance, and high reliability for storing your mission critical data. It is the second generation of the 3592 tape drive and shown in Figure 1-5.



Figure 1-5 The IBM System Storage TS1120 Tape Drive Model E05

Whether configured as a stand-alone drive or part of an automated tape library, the TS1120 offers both fast access to data and high capacity in a single drive, helping to reduce the complexity of your tape infrastructure. The TS1120 has the same form factor as its predecessor and is machine type 3592 Model E05. The TS1120 Tape Drive was the first tape drive that supported Tape Encryption.

For a detailed description of the TS1120 Tape Drive, refer to 3.2, “Common characteristics of the 3592 tape drive family” on page 93 and 3.4, “The IBM System Storage TS1120 Model E05 Tape Drive” on page 119.

1.4.3 IBM System Storage 3592 Model J1A Tape Drive

Note: The 3592 Model J1A Tape Drive has been withdrawn from marketing.

The IBM TotalStorage Enterprise Tape Drive 3592 was the first generation and the base product for a 3592 line of tape drives. It laid the foundation for high capacity and performance and high reliability for storing your data (see Figure 1-6 on page 7).



Figure 1-6 IBM TotalStorage Enterprise Tape Drive 3592

Refer to 3.2, “Common characteristics of the 3592 tape drive family” on page 93 and 3.5, “IBM TotalStorage Enterprise 3592 Model J1A Tape Drive” on page 122 for more details about the 3592-J1A tape drive.

1.5 IBM Virtualization Solutions for System z hosts

The IBM Virtualization Engine TS7740 has replaced the IBM Virtual Tape Server, which has been withdrawn from marketing. We summarize the main characteristics of both the TS7700 and the VTS in this section.

Note: In this book, we describe the TS7700 features and functions up to and including TS7700 R1.4a. This release referred to the TS7740 only. Detailed information for R1.4a can be found in *IBM System Storage Virtualization Engine Release 1.4a: Tape Virtualization for System z Servers*, SG24-7312.

For information about the TS7700 R1.5, refer to *IBM Virtualization Engine TS7740 R1.5 and TS7720: New Virtualization Options for Mainframe Servers*, SG24-7712.

1.5.1 IBM TS7740 Virtualization Engine Release 1.4a

The TS7740 Virtualization Engine is a member of the TS line of products and builds upon previous implementations of tape storage virtualization. The TS7740 Virtualization Engine introduces a modular and scalable architecture to the tape virtualization market, allowing you to better customize the system to meet your particular requirements. It is the first offering based on this new architecture. Figure 1-7 on page 8 displays the TS7700 Virtualization Engine as viewed from the front of the machine.

The IBM Virtualization Engine TS7740 (TS7740 Virtualization Engine) is a mainframe virtual tape solution that is designed to optimize tape processing. Through the implementation of a fully integrated tiered storage hierarchy of disk and tape, the benefits of both technologies can be leveraged to help enhance performance and provide the capacity needed for today's tape processing requirements. Deploying this innovative subsystem can help reduce batch processing time, decrease the total cost of ownership and management overhead, alleviate bottlenecks, and reduce the batch window.



Figure 1-7 TS7700 Virtualization Engine

As the direct successor to the IBM TotalStorage Virtual Tape Server (VTS), the TS7740 Virtualization Engine implements many of its predecessor's 3494-related capabilities and improves on VTS technology. Specific functionality and enhancements include:

► **Incremental capabilities:**

- High performance disk cache capacity (increments of 1 TB up to 6 TB) FC5267
- Host data transfer performance (increments of 100 MB/s up to 600 MB/s) FC5268

► **On-demand capabilities:**

- Up to one million logical volumes per TS7700 Virtualization Engine, with a maximum not to exceed two million per Library Manager (LM)
- 256 virtual tape device addresses per TS7700
- 4 Gbit FICON host attachments
- Attachment to the following tape libraries:
 - IBM System Storage TS3500 Tape Library (TS3500 Tape Library) via the IBM TotalStorage 3953 Library Manager L05 (3953-L05 Library Manager)
 - IBM TotalStorage 3494 Tape Library

► **Support for the following tape drives:**

- IBM System Storage TS1120 Tape Drive (3592 Model E05)
- IBM TotalStorage 3592 Tape Drive J1A (3592-J1A Tape Drive)

Note: TS1120 tape drives, also referred to as 3592-E05 tape drives, can operate in native E05 mode or in 3592-J1A Emulation mode. To use TS1120 tape drives in E05 mode, all drives associated with the system must be TS1120 tape drives. If you intend to use TS1120 tape drives in native E05 mode, the minimum required microcode levels are 8.0.1.xx for the TS7700 Virtualization Engine and 534.2x for the Library Manager.

Use FC0521, Functional enhancement field, to receive the latest levels of TS7700 Virtualization Engine and Library Manager code. Encryption is only supported when all drives associated with the TS7740 Virtualization Engine are encryption-capable TS1120 tape drives (FC5592 or FC9592 is ordered against each TS1120 Tape Drive) and FC9900, Encryption configuration, is ordered against the TS7740 Server.

TS7740 component overview

The TS7740 Virtualization Engine consists of several primary components that can be described in terms of their system role or according to their technical functions.

The TS7740 Virtualization Engine is built on a distributed node architecture consisting of nodes, Clusters, and Grid. The nodes perform either virtualization (*vNode*) or hierarchical data storage management (*hNode*). The *vNode* presents the virtual image of the drives to a host system. It receives tape drive and library requests from the host and processes them as a real device processes them. It also translates the tape requests through a virtual drive and uses a file in a file system to represent the virtual tape image. After a logical volume has been created or altered by the host system through a *vNode*, it resides in disk cache or on physical tape, where it is managed by the *hNode*. The *hNode* is the only node that is aware of physical tape resources and the relationships between the logical and physical volumes. It is also responsible for any replication of the logical volumes and their attributes across site boundaries.

Based on the node architecture, a *vNode* or an *hNode* can run on separate virtualization hardware or be combined to run on the same hardware. When a *vNode* and an *hNode* are combined to run on the same virtualization hardware, they are referred to collectively as a *General Node*, or *gNode*. The TS7740 Virtualization Engine runs as a *gNode*. See Figure 1-8 for an illustration of the relationship between nodes.

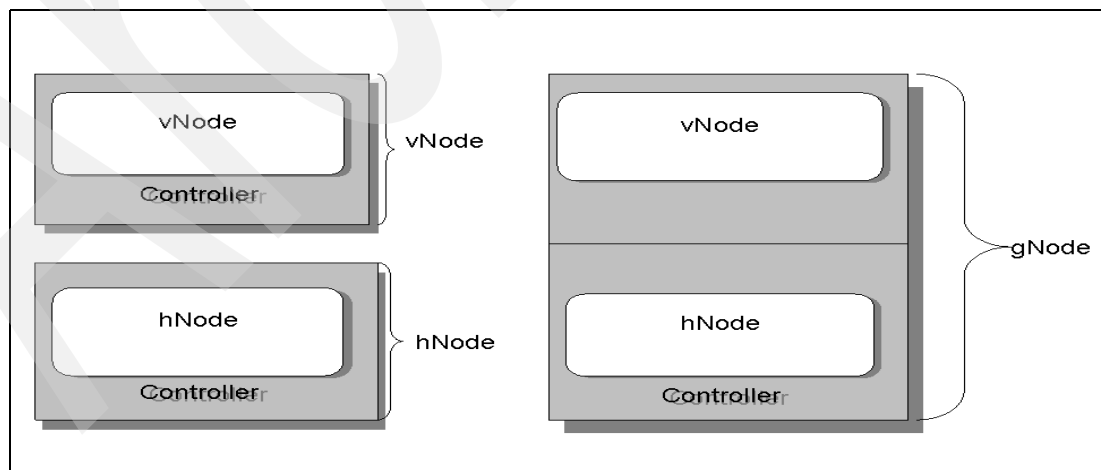


Figure 1-8 TS 7700 vNode, hNode, and gNode

The TS7740 Virtualization Engine Cluster combines the TS7740 Server with a disk subsystem, the TS7740 Cache Controller. This architecture will allow additional disks or

nodes to be added in future offerings to expand the capabilities of the system. Figure 1-9 displays a TS7740 Virtualization Engine configured as a Cluster.

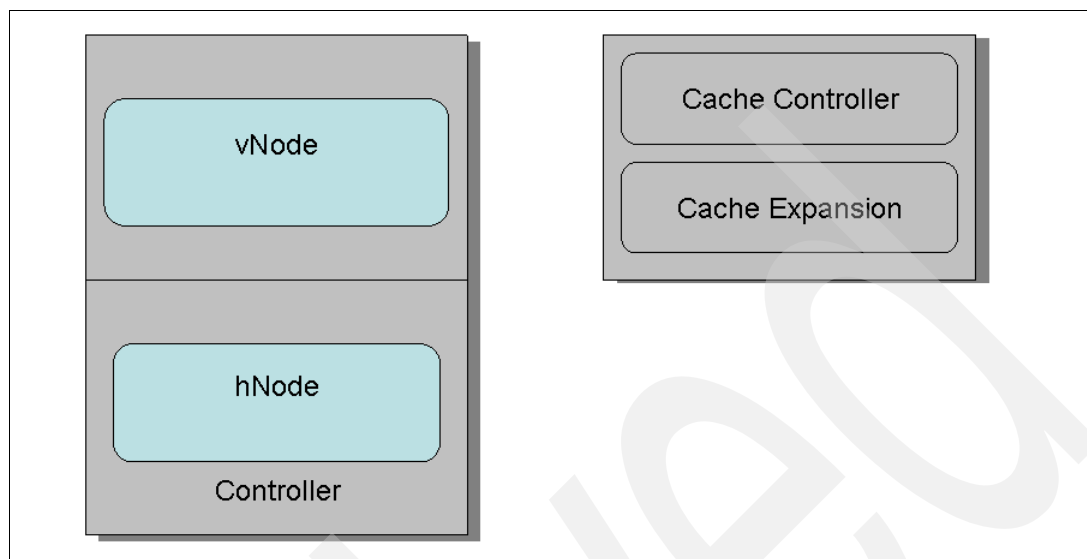


Figure 1-9 TS7740 Virtualization Engine Cluster configuration

The TS7740 Virtualization Engine Grid, or Grid configuration, is a series of two or three Clusters connected to one another to form a high availability and disaster recovery solution. Logical volume attributes and data are replicated across the Clusters in a Grid to ensure the continuation of production work in case a single Cluster becomes unavailable. A logical volume can be accessed from any virtual device in the system, even if the logical volume has only a single replica. If a failure occurs at the source Cluster, replicated logical volumes will still be available, because any data replicated between the Clusters is accessible through any other Cluster in a Grid configuration. Each copy is a valid source of the logical volume. A Grid configuration looks like a single storage subsystem to the hosts attached to the Clusters; it can be described as a composite library with underlying distributed libraries similar to the prior generation's Peer-to-Peer (PTP) VTS. For additional information about data accessibility in the event of a source Cluster failure, refer to "Data integrity by volume ownership" on page 15. Multiple TS7740 Virtualization Engine Grids can be attached to the same host system and will operate independently of one another. Figure 1-10 on page 11 shows a typical three-Cluster Grid.

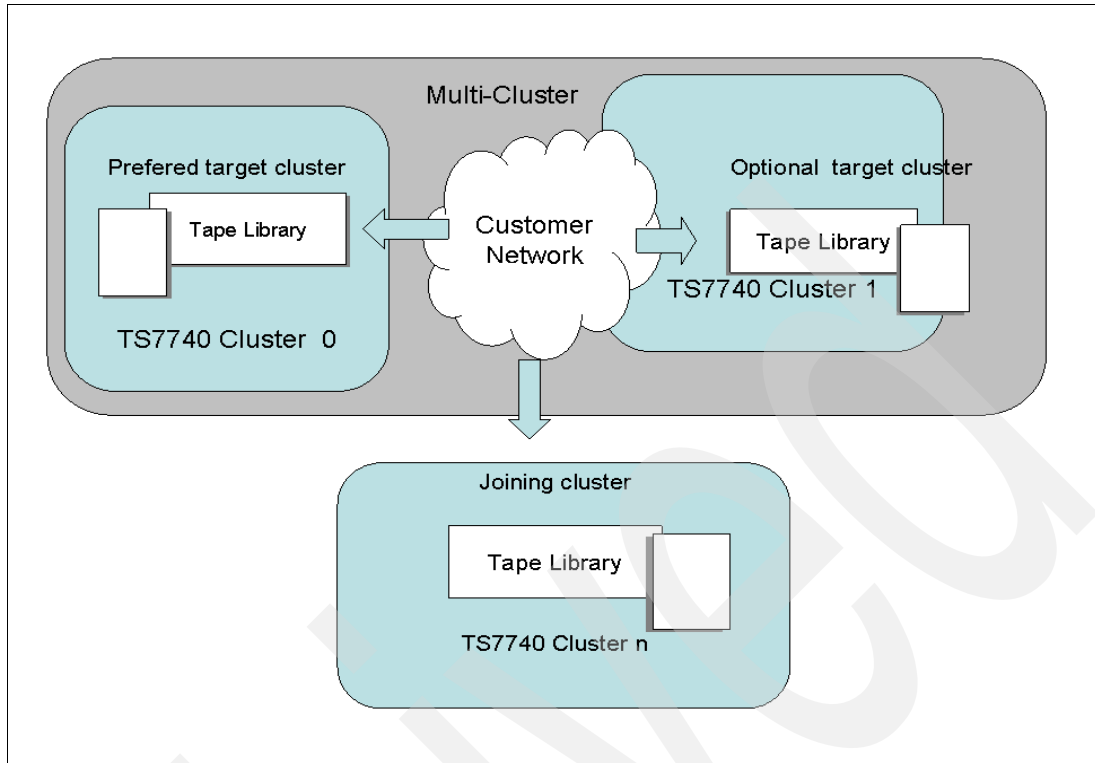


Figure 1-10 TS7740 Virtualization Engine three-Cluster Grid configuration

TS7740 operational components

Figure 1-11 shows the major operational components of the TS7740 Virtualization Engine configured as a gNode.

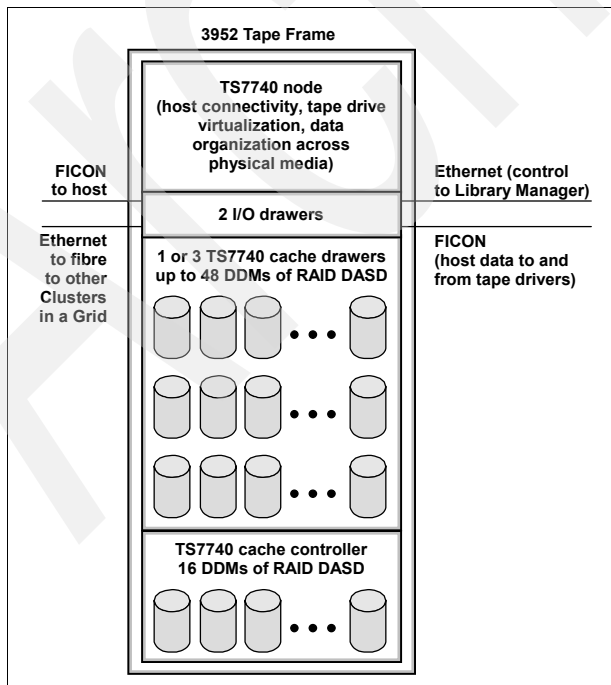


Figure 1-11 TS7740 Virtualization Engine

The primary operational components of the TS7740 Virtualization Engine are:

► **IBM System Storage 3952 Tape Frame F05 (3952 Tape Frame)**

The 3952 Tape Frame encloses the operational components described here, additional components, such as routers, and power distribution units for connection to independent power sources.

► **IBM Virtualization Engine TS7740 (TS7740 Server)**

The TS7740 Server provide the following major functions:

- Host connectivity
- Virtualization of tape drives and media
- Storage, replication, and organization of data across tape libraries, physical media, and geographic replication of volumes

The TS7740 Server System Unit includes Gigabit copper and optical fiber Ethernet adapters for Grid configuration connection. The TS7740 Server Expansion Unit includes two input/output (I/O) drawers, which are identically configured and simultaneously active. The I/O drawers contain ports for connection to the host, to other internal component interfaces, and to the tape drives in the tape library.

► **IBM Virtualization Engine TS7740 CX6 (TS7740 Cache Drawer)**

The TS7740 Cache Drawer acts as an expansion unit for the TS7740 Cache Controller. The TS7740 Cache Drawer contains 16 DDMs with a capacity of 146 GB each, for a total of 2.34 TB of cache.

► **IBM Virtualization Engine TS7740 CC6 (TS7740 Cache Controller)**

The TS7740 Cache Controller consists of a redundant array of independent disks (RAID) controller and associated disk storage media. These media act as cache storage for client data. There are 16 disk drive modules (DDMs) with a capacity of 146 GB each, for a total of 2.34 TB of cache.

Note: The 2.34 TB of cache reflects raw capacity and does not directly correlate to usable client capacity.

The TS7740 Cache Controller and the TS7740 Cache Drawers are collectively called the *TS7740 cache*. TS7740 cache is available in single-drawer, two-drawer, and four-drawer configurations. A single-drawer configuration of one TS7740 Cache Controller without an attached TS7740 Cache Drawer is supported with Release 1.4. A two-drawer cache configuration consists of one TS7740 Cache Controller attached to one TS7740 Cache Drawer, while a four-drawer cache configuration consists of one TS7740 Cache Controller attached to three TS7740 Cache Drawers.

Note: No miscellaneous equipment specification (MES) currently exists to allow a single-drawer TS7740 cache subsystem to be upgraded to a two-drawer or four-drawer TS7740 cache subsystem. An existing two-drawer TS7740 cache subsystem can be upgraded to a four-drawer TS7740 cache subsystem.

For significant details, refer to *IBM Virtualization Engine TS7700 Series Introduction and Planning Guide*, GA32-0567.

TS7740 concepts of storage virtualization

Virtualization permits the full utilization of modern tape technology's underlying storage capacity and decreases the logical volume access time of data storage and retrieval.

Virtualization reconfigures the relationship between a physical tape drive, storage media, and the application that reads and writes data. In addition, by presenting virtual tape drives and volumes to host systems, virtualization decreases the logical volume access time of data storage and retrieval.

The TS7740 cache uses DDMs as storage media, and the TS7740 Server emulates 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.

Data written or read through a virtual tape drive resides in a virtual volume on the DDMs in the TS7740 cache. To a host application, a virtual volume shows the same characteristics as a physical tape volume. The size of virtual volumes is dependent upon the size of data received from the host; virtual volumes will only be as large as necessary to hold the host data. This characteristic of virtual volumes increases the efficiency of layered storage and permits physical tape volumes to maximize available storage.

The TS7740 Server manages the physical tape drives, or physical volumes, in the tape library and controls the movement of data between physical and virtual volumes. The TS7740 cache temporarily holds data before writing it to tape, caches the data after a read or write operation to provide fast subsequent access, and provides source data when replicating to another Cluster in a Grid. Caching algorithms ensure the cache is full of the most recently created and accessed data. The caching algorithms can also be influenced by cache management policies as part of the advanced policy management functions.

When a virtual volume is read from the TS7740 cache DDMs and written to a physical volume, *premigration* is said to have occurred and the virtual volume becomes a logical volume. Conversely, when a logical volume is moved from a physical volume to the TS7740 cache, a *recall* is said to have occurred and the logical volume again becomes a virtual volume. A physical volume can contain one or more logical volumes; a physical volume that contains more than one logical volume is referred to as a *stacked volume*. The replication of a logical volume from one site to another site across the connecting infrastructure (Grid network) is referred to as a *copy*.

Each TS7740 Virtualization Engine manages a set of physical volumes; the TS7740 Server maintains the relationship between logical volumes and the physical volumes on which they reside.

TS7740 Grid

A TS7740 Grid refers to two or more physically separate TS7740 Clusters connected by means of a client-supplied TCP/IP network. The TCP/IP infrastructure connecting a TS7740 Grid is known as the *Grid Network*.

The Grid configuration is used to form a high availability and disaster recovery solution and provide remote logical volume replication. The term *Grid* refers to the code and functionality that provide the replication and the management of logical volumes and their attributes in Cluster configurations. A Grid can be used to form disaster recovery and high availability solutions. A disaster recovery solution is achieved when multiple Clusters are geographically distant from one another. A high availability solution is achieved when multiple Clusters are located in close proximity to one another.

Typically, the Clusters in a TS7740 Grid are geographically distant from each other. In a three-Cluster Grid configuration, two TS7740 Clusters might be located within 100 km (62.1 miles) of one another, while a third TS7740 Cluster might be located more than 1,000 kilometers (621.3 miles) from the other two Clusters. This arrangement provides both a highly available and redundant regional solution while also providing a remote disaster recovery

solution outside of the region. All three TS7740 Clusters can also be located in relatively distant proximity to one another; discuss this type of configuration with your IBM representative for any planning considerations. Any TS7740 Clusters located in relatively close proximity typically use an immediate mode copy policy; TS7740 Clusters located in relatively distant proximity typically use a deferred mode copy policy.

Refer to Figure 1-12 for an illustration of a typical three-Cluster Grid configuration.

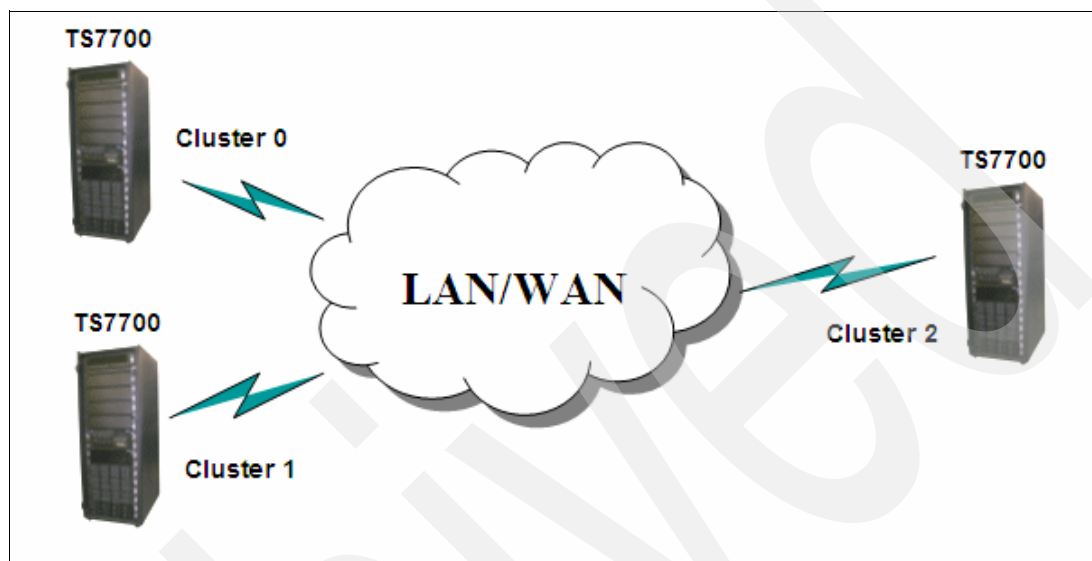


Figure 1-12 TS7740 Three-Cluster Grid

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 R1.4A) to remove a Cluster from a Grid nondisruptively. Furthermore, you might want to get rid of all of the information and data on this Cluster. Therefore, you can use the cleanup function. It is a one-time process and contains the following actions:

- ▶ Delete the TS7740 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 service support representative (SSR) during the installation to 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.

Copy Export function

An interesting function only supported on the TS7740 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 in a Multi Cluster Grid starting from Release 1.4, but the expected use is for clients with a Single Cluster Grid that require data to be moved off-site or for clients with Multi Cluster Grid where a primary need is validating and testing a client-described disaster scenario.

It supports moving the logical copy of the original to another location and keeping the original logical copy within the original TS7740 available for normal production. The companion to Copy Export is called *Copy Export Recovery*, where you insert the physical volumes and establish the TS7740 again based of the contents of the physical volumes. Copy Export Recovery requires an empty Single Cluster Grid.

Tape Encryption

Encryption is also supported on TS7740. Encryption of back-end 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 TS7740 Virtualization Engine, and Encryption on the TS7740 is controlled outboard on a physical stacked volume pool basis and is set on 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, where physical volumes are moved to another location.

Refer to 5.1, “Tape Encryption concepts” on page 240 for more details about Encryption.

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 access 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 additional direction is given. Volume ownership takeover provides the additional direction to transfer the 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 Ownership (read-only) or Write Ownership, through the TS7700 Management Interface.

Autonomic Ownership Takeover Manager

Autonomic Ownership Takeover Manager provides a means of allowing a subsystem to automatically take ownership of the volumes owned by a failed site. An Autonomic Ownership Takeover requires that a TotalStorage Service Console (TSSC) is attached to each Cluster in a Grid. The path between the 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. These are the settings:

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 Peer-to-Peer (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 Peer-to-Peer VTS.
No Copy	No copy is made.

For each Cluster in a Multi Cluster Grid, you specify a setting for the Cluster settings for the other Clusters. The settings do not need to be the same on all Clusters in a Grid. 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 Virtual Tape Controllers (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 into the Virtualization Engine Controller. 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 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), also known as Greenwich Mean Time (GMT). Statistics are also reported in relation to UTC.

The TS7700 logs its UTC time in the Library Manager logs every ten minutes, which 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/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.

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-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 16 3490E tape control units, each with 16 IBM 3490E tape drives, 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, attached through four, six, or eight FICON channel attachments.

Distributed Library

A *Distributed Library* is a single TS7700 Virtualization Engine and its associated partition in the IBM 3494 Tape Library. Within the 3494 Library Manager, the TS7700 occupies a Library Manager partition in the same manner that 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 Multi Cluster Grid configuration, which includes two or three TS7700 Virtualization Engines, each of which has the Grid Enablement Feature installed, a Distributed Library for each Cluster is 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.

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. Many of the tasks that you previously accomplished using the Library Manager Console have been consolidated into this interface.

Architectural capabilities

When you compare a Peer-to-Peer 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 PtP. 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 contains only one gNode per Cluster and two or three Clusters in a Multi Cluster Grid configuration.

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 one, so that it can eventually give you the capability to grow the solution with your needs.
- ▶ Allow vNode and hNode to run on separate hardware.
- ▶ Allow horizontal scalability, because it 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 is 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 give you better performance and increase availability. Instead of replacing one monolithic system with another, bigger system,

this modular design 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 1-13.

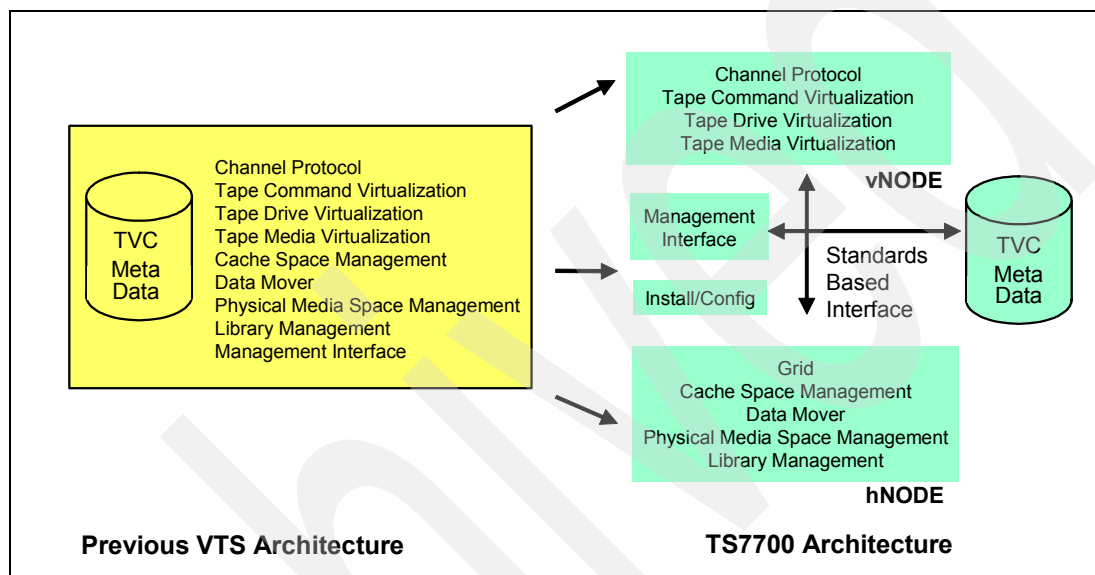


Figure 1-13 Monolithic design compared to modular design

Serviceability will 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 will 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 these designs are the only Grid configurations that we support today. From an architectural perspective, there is no need to limit the number to three Clusters in a Grid.

1.5.2 IBM Virtual Tape Server

Note: All Virtual Tape Server models have been withdrawn from Marketing. Models B10 and B20 were withdrawn effective 01 December 2006. Selected features are available for the upgrade of installed machines. For more details, refer to:

<http://www-01.ibm.com/common/ssi/index.wss>

The IBM System Storage Virtual Tape Server (VTS) shown in Figure 1-14 on page 20 is a hardware-based solution that addresses not only tape cartridge utilization, but also tape

device utilization and hence overall tape subsystem costs. The VTS is transparent to the host software, which eases the migration to this platform.



Figure 1-14 IBM 3494 Virtual Tape Server

The advent of high capacity tape drives, whose compressed capacity can be over 2 TB of data, creates the need to stack data on a single tape cartridge to fully utilize the tape media. The IBM System Storage Virtual Tape Server (VTS) is an effective way to store small files on tape media.

The VTS initially creates a virtual volume in a buffer known as the *Tape Volume Cache (TVC)*, a RAID-5 disk array. If the host needs to reference these virtual volumes again, they are accessed in most instances from the TVC, helping to eliminate many of the physical delays associated with tape I/O and improving the performance of the tape process. The virtual volume is also written to an attached IBM System Storage TS1120 Tape Drive as a logical volume. A copy of the virtual volume remains in the cache, which can provide fast access to critical data. The VTS stacks files on tape media, thus effectively utilizing your tape media. The use of a VTS to store data on tape can help reduce batch processing time and the total cost of ownership and management.

A VTS Peer-to-Peer (PtP) configuration can provide redundancy for greater disaster tolerance with features, such as remote dual copy, for use with Geographically Dispersed Parallel Sysplex™ (GDPS®), disaster backup and recovery, and remote tape vault. Advanced Policy Management allows selective dual copy for noncritical data. You can install the Virtual Tape Server and the new configurations at extended distances. These enhancements address planned outages, such as maintenance and upgrades, as well as unplanned outages by eliminating single points of failure. This data availability improvement further enhances the Virtual Tape Server as a business continuance solution.

The VTS design is based on the IBM Storage Enterprise Architecture (SEASCAPE) concept. Integrating built-in blocks of other product lines into the VTS exploits the rapid evolution of processors, disk, adapters, and tape. The result is an outstanding increase in performance, capacity, and functionality since its first availability.

VTS models

Since the introduction of the first IBM Model B16 Virtual Tape Server, IBM has introduced three additional models:

- Model B18 Virtual Tape Server

- ▶ Model B10 Virtual Tape Server
- ▶ Model B20 Virtual Tape Server

Note: Effective 30 June 2006, IBM withdrew from marketing all remaining features of the 3494 Virtual Tape Server Model B18 and the 3494 Model B18 to B20 miscellaneous equipment specification (MES) upgrade.

Effective 01 December 2006, IBM withdrew from marketing the 3494 Models B10 and B20. Some of the MES upgrades for the 3494 Model B10 and Model B20 are still available.

In addition, a PtP VTS configuration is available with the B10 and B20 models. By enhancing data backup and recovery capabilities, the PtP VTS configuration provides an outstanding business continuity solution for tape clients. Additionally, the PtP VTS configuration is designed to enhance data availability and to eliminate single points of failure. For an overview of the PtP VTS, refer to *IBM TotalStorage Virtual Tape Server*, SG24-2229.

The Model B10 VTS and Model B20 VTS are based on the pSeries 660 architecture, which features more powerful processors and expanded input/output (I/O) capability. The Model B10 VTS is configured as a cost-effective solution for modest throughput requirements. Meanwhile, the Model B20 VTS establishes higher standards for throughput performance and for the number of managed virtual devices.

IBM Peer-to-Peer VTS

The IBM TotalStorage PtP VTS was designed to eliminate all single points of failure and provide higher performance than the stand-alone IBM TotalStorage Enterprise Virtual Tape Server. IBM Peer-to-Peer VTS couples two IBM TotalStorage Enterprise VTSs into a single image with additional components and features. The two VTSs can be at the same site or geographically separated for disaster tolerance.

You can use the IBM Model B10 VTS or Model B20 VTS in PtP VTS configurations. In addition, with feature codes (FCs) FC4001-FC4004 (Advanced Policy Management), you can further tailor the PtP VTS configuration to suit individual site requirements. The PtP VTS gains control over either immediate or deferred logical volume copy modes. You can eliminate media errors as a single point of failure within each VTS with the ability to create dual copies of logical volumes on separate physical media.

A PtP VTS uses robust distributed servers, Virtual Tape Controllers (VTCs), to interconnect two Virtual Tape Servers (Model B10 or B20) using ESCON or FICON attachments. The VTC can be a Model AX0 housed in a Virtual Tape Frame 3494 Model CX0 or a feature on the Virtual Tape Frame 3494 Model CX1.

The combined libraries require the addition of one to four 3494 CX0 or CX1 frames, which respectively contain either two or four AX0 or VTC tape controllers each. In turn, each AX0 or VTC provides a total of four ESCON or FICON channel attachments. Two are attached to the host systems, and one is attached to each of the Model Bxx VTSs in the PtP configuration. The host systems no longer attach directly to the Model Bxx VTS. See Figure 1-15 on page 22.

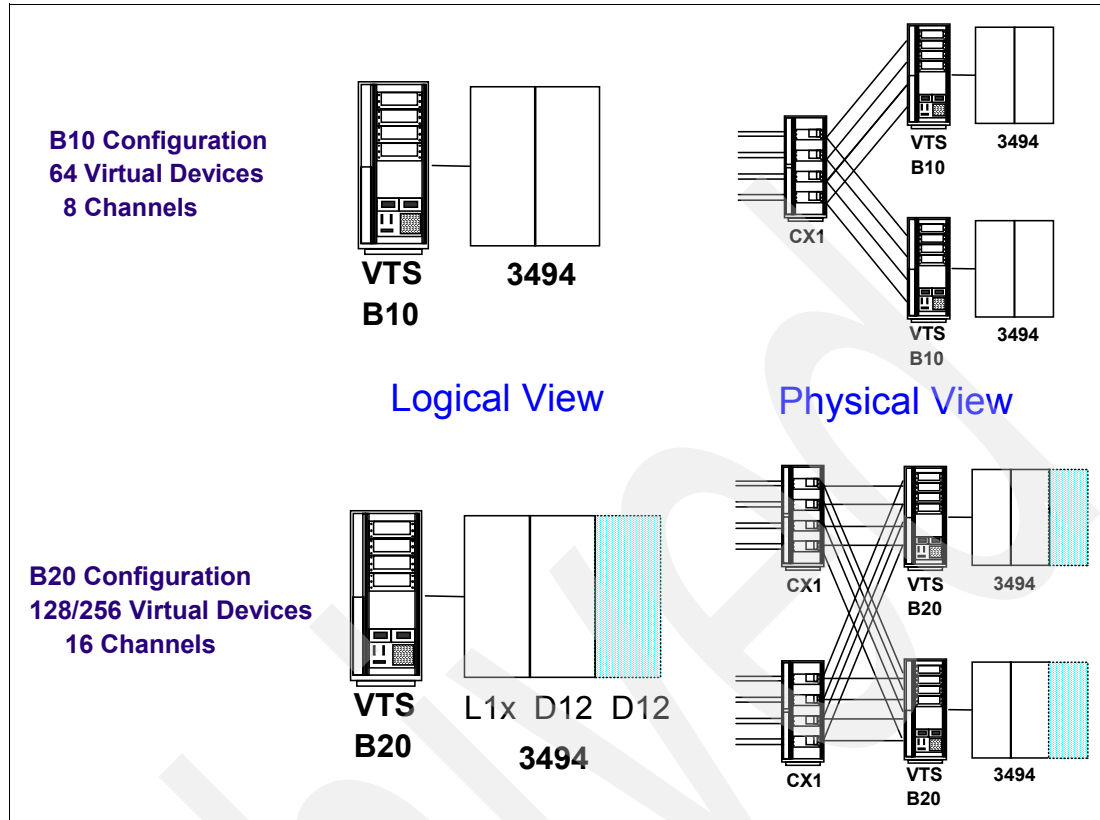


Figure 1-15 Sample PtP configuration

It is important to note that in a mixed PtP configuration the Composite Library assumes the attributes of the smaller VTS in relation to virtual drives.

Logical components

All IBM virtual tape solutions are integrated within a 3494 Tape Library. They appear to the host as a 3494 with their own library name, their own set of tape volumes (each VTS can have up to 500,000 standard 400 MB volumes or enhanced capacity up to 4000 MB volumes per 3494), and their own set of tape drives. The host sees 32, 64, 128, or 256 virtual 3490E drives, attached by up to:

- ▶ Sixteen Enterprise System Connection (ESCON) paths
- ▶ Eight SCSI paths that transfer data concurrently

Up to a maximum of eight FICON channels are supported on a VTS Model B20 and four on a VTS Model B10. However, you cannot intermix these channel types with SCSI.

The IBM TotalStorage Enterprise Virtual Tape Server can be shared between zSeries® servers and Open Systems servers by specifying up to four additional SCSI host attachment features. Each feature provides two SCSI buses and includes data compression compatible with the Enhanced High Performance Option (EHPO). Up to 64 virtual drives can be assigned to Open Systems.

Currently, you can integrate two VTS subsystems into a 3494 sharing the maximum number of 500,000 logical volumes equally and providing up to 256 virtual drives. The VTSs can coexist effectively in the same IBM 3494 Tape Library with native tape cartridges and drives.

With access to a virtual library with up to 500,000 logical volumes and up to 256 logical drives, the host can process significantly more tape workload in parallel without the expense of actually installing 256 physical tape drives. With so many virtual tape drives, you can dedicate drives to different hosts and platforms rather than manage a complex shared environment.

Archived

IBM TotalStorage Enterprise Automated Tape Library

This chapter provides detailed information about the IBM TotalStorage Enterprise Automated Tape Library (3494). The sample configuration in Figure 2-1 consists of a Model L12 Control Unit Frame, a Model D22 Drive Unit Frame, and a TS7700 Virtualization Engine.



Figure 2-1 IBM TotalStorage Enterprise Automated Tape Library

This chapter explains and examines:

- ▶ The functions of the Library Manager, which is the focal point of the 3494 Tape Library and communicates with the attached host systems
- ▶ The 3494 Tape Library basic frames, models, and their components
- ▶ The IBM TS7700 Virtualization Engine frame
- ▶ The IBM TotalStorage Enterprise Virtual Tape Server (VTS) and Peer-to-Peer (PtP) Virtual Tape Server frames
- ▶ The 3494 High Availability Frames that allow for nondisruptive operation even in the case of a library component failure
- ▶ The IBM 3953 Tape Frame Model F05
- ▶ The IBM System Storage (TS3000) System Console (TSSC)
- ▶ All feature codes (FCs) of the IBM 3494 Tape Library

For the remainder of this chapter, we will use the term 3592 models E tape drives to identify either the IBM System Storage TS1120 Tape Drive (Model E05) or the IBM System Storage TS1130 Tape Drive (Model E06 and Model EU6).

2.1 IBM 3494 Library Manager

The Library Manager, the operational focal point of the IBM 3494, provides the support to set up, maintain, configure, and operate the 3494 Tape Library. It consists of a controller (a personal computer (PC)), a display, a keyboard, and the Library Manager application.

This section describes the major functions and features of the IBM 3494 Library Manager.

2.1.1 User interfaces

The Library Manager graphical user interface (GUI) is provided by the Library Manager application, which runs on the Library Manager PC and is delivered as Licensed Internal Code (LIC). Backup, restoration, and maintenance of the application are the sole responsibility of an IBM service support representative (SSR).

The Library Manager provides four user interfaces:

- ▶ **Library Manager Console:** This interface is installed on the rear side of the IBM 3494 Model Lxx frame. It allows you to monitor the 3494 Tape Library and to take action.
- ▶ **IBM TotalStorage Enterprise Tape Library (ETL) Specialist:** A Web browser interface that allows you to monitor the 3494 Tape Library and to take specific actions for an installed VTS or Peer-to-Peer (PtP) VTS. The specialist also provides links to the TS7700 Management Interface, if applicable.
- ▶ **IBM System Storage TS3000 System Console:** This interface provides remote data monitoring of an attached 3494 library. This interface is explained in more detail in “IBM System Storage TS3000 System Console” on page 33.
- ▶ **Remote Library Manager Console:** This interface provides remote access to the Library Manager to issue commands or take action.

In addition, host software commands allow you to retrieve information from the Library Manager or to send commands to the library.

Library Manager Console

The operator menu is displayed when the Library Manager is powered on. The operator menu panel consists of a title bar and an action bar as shown in the System Summary window in Figure 2-2 on page 28. In the example shown, you see that this library has two Library Managers (LMs) and two accessors, which means Dual Library Manager and Dual Accessors library.

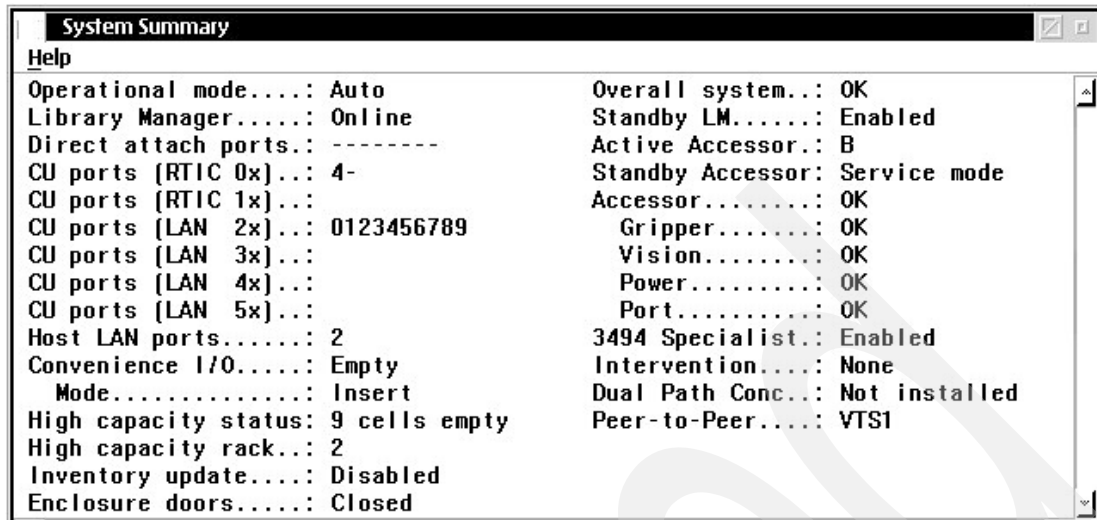


Figure 2-2 System Summary window

The Library Manager has three levels of operational authority:

- ▶ General operator
- ▶ Systems administrator
- ▶ Service

The general operator has the authority to perform the basic day-to-day operations of the library, such as inquiring about the status of the library and inserting or removing cartridges from the library.

The systems administrator can perform all of the functions of the general operator and administrative tasks that require more detailed knowledge of, and training in the use of, the Library Manager and the 3494. An example of a systems administrator function is to perform the initial inventory of the contents of a library or to perform a re-inventory of the library's contents. The systems administrator has no access to the functions specific to the repair or maintenance of the library.

Service access allows all Library Manager functions, including changing the systems administrator password if it is forgotten and backing up or restoring the Library Manager database to the diskette drive in the Library Manager PC.

The systems administrator and service levels can be password-protected. The IBM SSR selects this option during the Library Manager installation teach process, or during a re-teach operation at any other time. See 2.5.5, "IBM SSR initial operations (teach and initial inventory)" on page 70 for more information.

TotalStorage Enterprise Tape Library Specialist

The IBM TotalStorage family includes several IBM storage interfaces, or specialists, which enable operators and administrators to manage storage devices from any location in an enterprise using Microsoft® Internet Explorer® Version 5.0 and higher.

There are three Web-based specialists for the 3494:

- ▶ **Enterprise Tape Library (ETL) Specialist** is a Web-based interface to the 3494 Library Manager. It allows you remote access to the Library Manager, VTS status, and operations. If Advanced Policy Management (APM) is implemented, the ETL Specialist

also allows you to define and modify the constructs and volume pools. For additional details, refer to 9.5, “Enterprise Tape Library (ETL) Specialist operations” on page 424.

- ▶ **TS7700 Management Interface (MI)** communicates with the TS7700 Clusters to provide configuration details and status. The MI is used to perform TS7700-specific action, such as inserting logical volumes. The MI operates on the logical view of the TS7700, which is also the Host view.
- ▶ **PtP VTS Specialist** communicates with the Virtual Tape Controllers (VTCs) to provide configuration details and status. We recommend that you have a PtP VTS Specialist in every PtP VTS installation, which is the only way to receive real-time information about the operation of the PtP VTS Composite Library.

The Enterprise Tape Library Specialist allows access to Library Manager information, such as current library status and VTS statistics. This is done with the Web server on the Library Manager PC, which serves Hypertext Markup Language (HTML) pages to a remote Web browser over a user local area network (LAN) connection or through the Remote Service Access connection over a modem for service.

Figure 2-3 shows a sample Web page. Depending on the browser software that you are using, the pages might vary slightly.

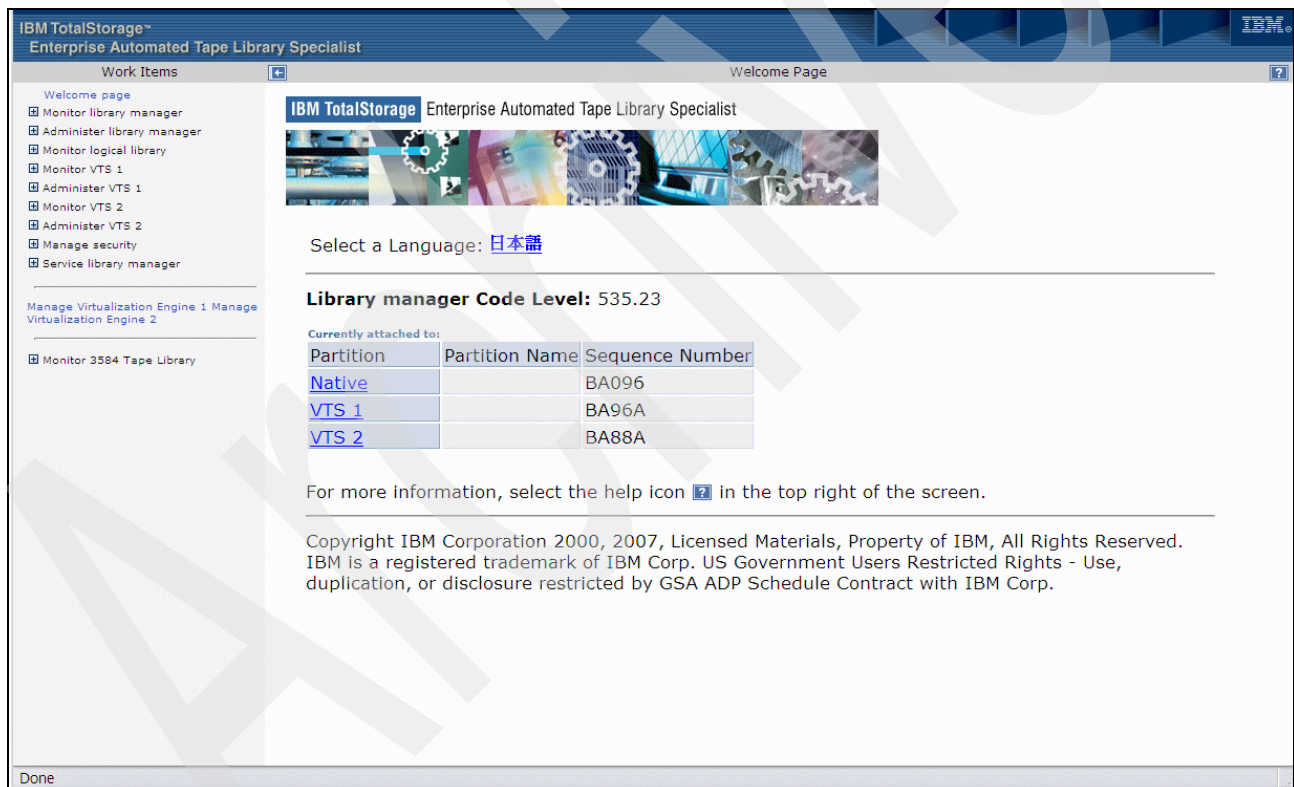


Figure 2-3 Enterprise Automated Tape Library Specialist home page

Note: The ETL Specialist does not provide an interface to all Library Manager functions, for example, setting the Cleaner Mask.

When you select the Library Manager options, you see a Web page like the example shown in Figure 2-4 on page 30. It shows the status information from the Library Manager.

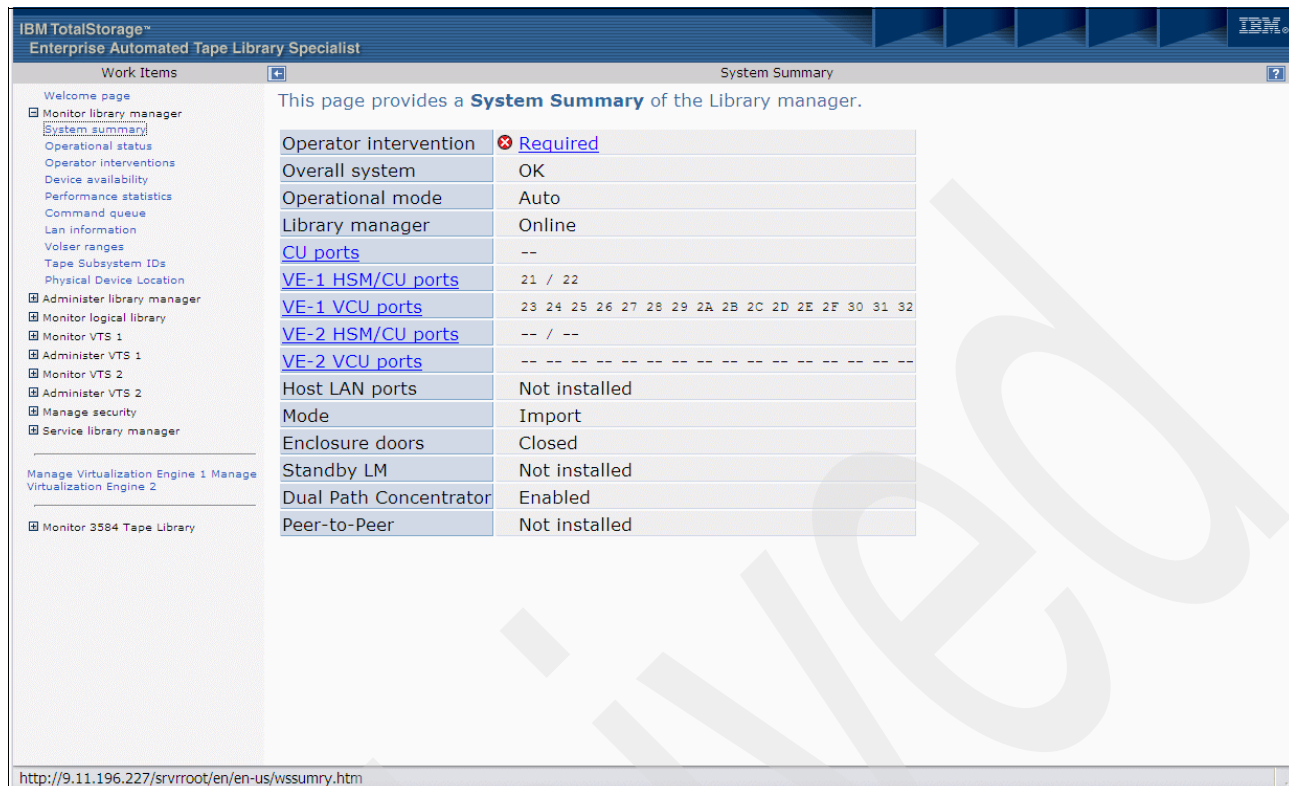


Figure 2-4 ETL Specialist: System Summary of the Library Manager

The capabilities of the IBM TotalStorage Enterprise Tape Library Specialist can simplify management of the VTS and allow management from remote locations. Recently enhanced capabilities are primarily related to the VTS APM functions. They include:

- Secure interface

Access to panels that allow modifications is restricted and only allowed with a valid user ID and password.

- Query to find the stacked volume containing a specified logical volume

This function was only available from the Library Manager Console. The function was enhanced to also show the second stacked volume in case of a spanned logical volume, and the same for the secondary copy of the logical volume if APM Selective Dual Copy was implemented. When a TS7700 is attached, the TS7700 Management Interface is used to obtain a stacked volume map for TS7700 stacked volumes.

- Request a map of the logical volumes on a specific stacked volume

This function was available only from the Library Manager before. It was enhanced to allow you to download the Stacked Volume Map to your PC for further processing.

- Eject or move one or more stacked volumes

The eject function was available only from the Library Manager before. It was enhanced to allow the ETL Specialist and the Library Manager to move stacked cartridges between physical pools when APM Physical Volume Pooling is implemented.

- Manage volume pools

This function was implemented together with APM Physical Volume Pooling. It allows you to define policies for physical pools.

- Manage Storage Group, Management Class, Storage Class, and Data Class definitions
This function was implemented together with APM. It allows you to define policies and constructs through the ETL Specialist.
- Administer security
The ETL Specialist administrator can define and change user IDs and reset passwords using this function.

For more information about implementation of the ETL Specialist, refer to the *IBM TotalStorage Enterprise Automated Tape Library (3494) Introduction and Planning Guide*, GA32-0448-14, which also provides a planning template. For more information about the usage of the ETL Specialist, see the *IBM TotalStorage Automated Tape Library (3494) Operators Guide*, GA32-0449-14.

Customer Network Interfaces

The 3494 Enterprise Automated Tape Library uses a Library Manager to control library operations. The Library Manager can optionally provide network connectivity on an external customer-specified network. The 3494 Library Manager connectivity can be used for establishing connections to Open Systems hosts via a 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. To enable this functionality in an IBM 3494 Library Manager, either 3494 FC5219 (for Token-Ring connections) or FC5220 (for Ethernet connections) must be properly installed and configured in the Library Manager. In environments where the tape configuration is separated from the LAN-attached hosts and Web clients by a firewall, these are the only ports that must be opened on the firewall; all other ports can be closed. See Table 2-1 for reference.

Table 2-1 Customer Network Interface firewall

Function	Port	Direction (from library)	Protocol
Library Operations	3494	Bidirectional	TCP/IP
ETL Specialist	80	Inbound	TCP/IP
SNMP Traps	161/162	Bidirectional	UDP/IP
Encryption Key Manager	1443	Outbound	SSL
Encryption Key Manager	3801	Outbound	TCP/IP

For more information about customer network interfaces, refer to:

- *IBM System Storage TS1120 Tape Drive and Controller Operator Guide*, GA32-0556-02
- *IBM System Storage TS1120 Tape Drive and Controller Introduction and Planning Guide*, GA32-0555-03
- *IBM TotalStorage 3494 Tape Library Introduction and Planning Guide*, GA32-0448-14
- *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*, GA32-0567-05

Remote Library Manager Console

The Remote Library Manager Console (FC5226) allows you to control or monitor the operations and status of the tape library from a remote location. The remote terminal can be located anywhere on the LAN. The remote terminal can control or monitor the status of up to

eight Library Managers. You can monitor multiple Library Managers, but you can control only one at a time.

Connection to the Library Manager is password-controlled. The remote console logon password can be changed only from the Library Manager.

The Remote Library Manager Console feature includes the software that is needed to control or monitor any Library Manager that is attached to the LAN. The tape library must have one of the LAN attachment features: Token-ring or Ethernet. The Remote Library Manager Console and the host system attachment can use the same LAN attachment feature of the tape library.

If the High Availability unit is installed in the IBM 3494, only one FC5226 is required for both Library Managers. The software provided is loaded on both Library Managers.

The client is responsible for supplying the remote terminal hardware and software. See the *IBM TotalStorage Enterprise Automated Tape Library (3494) Introduction and Planning Guide*, GA32-0448-14, for more information.

The Remote Library Manager Console provides the following functions:

► Switching keystrokes mode

The *keystrokes mode* determines whether the remote console's input and pointing device movements affect the remote console or one of the connected Library Managers. There are two keystrokes modes:

- **Keystrokes remote mode:** All of the keyboard input on the remote console affects the Library Manager, except the remote console operating system hot keys. The operating system hot keys are:
 - Press Ctrl+Esc to display its task list.
 - Press Alt+Esc to show the windows and full displays in an ordered rotation.
 - Press Alt+Tab to show the system menus for the windows and the full display in an ordered rotation.
- **Keystrokes local mode:** All of the keyboard input on the remote console affects the remote console only.

► Changing session state

The *session state* is the current state of the session between the remote console and the Library Manager. It can be changed from both consoles. If both users try to change the state at the same time, the Library Manager takes precedence. The session can be changed between the following states:

- **Active:** The remote consoles control the Library Manager. The Library Manager keyboard and pointing device are not processed. The Library Manager can regain control when you press a hot key combination to change the session state.
- **Monitor:** The remote console monitors the Library Manager Console, but the Library Manager user is in control of the keyboard and pointing device input.
- **Suspend:** The remote console session is stopped temporarily.
- **Terminate:** The remote console session is terminating.

► Transferring files

The file-transfer utility allows you to transfer files from the Library Manager to the remote console. You are not allowed to transfer files to the Library Manager. Only the Remote Library Manager Console can initiate a file transfer.

Tip: Either the remote console or the Library Manager Console can be active at one point in time. When using the remote console, make sure that you terminate the session to re-enable usage of the Library Manager Console.

IBM TotalStorage Master Console

Note: The IBM TotalStorage Master Console (TSMC) was withdrawn from marketing on 16 June 2006. We have included the following information describing the TSMC as a reference point for existing users.

TSMC has been replaced by the IBM System Storage TS3000 System Console (TSSC), which is described in detail in “IBM System Storage TS3000 System Console” on page 33.

The IBM TotalStorage Master Console (TSMC) is a PC running Linux® that can connect to the VTS B10, VTS B20, VTS B18, 3590-A60, J70, VTC, and Library Manager subsystems through an Ethernet switch. The TSMC allows data transfer to and from each subsystem in order to perform Call Home, remote services, and configuration tasks, including remote monitoring support.

The Call Home portion of the IBM TotalStorage Master Console (TSMC) is linked to the attached subsystems and has the capability to send and receive data to different IBM servers. This data is used for error notification, supporting repair actions, trace data offload, performance, and statistical analysis. The TSMC broadcasts both drive and functional microcode to the attached subsystems. The TSMC offers the advantages of reduced telephone line charges, faster data offload, lower repair costs, improved serviceability, and better proactive maintenance.

The TSMC is equipped with a feature known as Call Home *heartbeat*. The heartbeat validates that the Call Home function works and off-loads statistical analysis information. Dual modem connections to the TSMC prevent blocking a Call Home alert while a support person is dialed in to the machine. A Virtual Private Network (VPN) connection allows specialist functions to be accessed through browsers on the TSMC, while maintaining security.

The inability of a machine to Call Home through TSMC is caught by the *wellness check*. This is a command sent from the TSMC to the Library Manager once per hour. The failure of the wellness check is logged on the TSMC, and a Call Home is initiated by the TSMC. The TSMC waits 24 hours before sending another Call Home in response to failed wellness checks.

A tool contained in the TSMC GUI allows the transfer of microcode to all selected attached subsystems. This can be either 3592 drive code images or functional microcode images.

Note: Code loads through the non-TSMC method are still supported regardless of whether the machine is connected to the TSMC or not.

IBM System Storage TS3000 System Console

To enable improved serviceability, the TS3000 System Console (TSSC) connects the following components to a dedicated private local network:

- ▶ 3494 B18, B10, or B20 VTS
- ▶ Virtual Tape Controllers
- ▶ 3590-A60 Controller, TS1120 Model C06 Tape Controller, or 3592-J70 Controller
- ▶ Library Manager

This enables the same functionality as the TSSC's predecessor, the TSMC, such as the remote data monitoring of the subsystems attached to the TSSC. The new TS1120 Model C06 Controller can only be controlled by the TSSC. It is not supported in the TSMC.

FC2720 provides the enhanced TS3000 System Console, Ethernet switch, a cable, and the connectors for connecting one of the aforementioned components to an IBM-supplied modem to enable the remote enhanced service. You must specify this feature on the first unit in an installation connected to a TSSC. The Ethernet switch provides 14 additional connections for cables supplied with FC2714 or FC2715.

History table

With recent enhancements to the Library Manager functional microcode to support multiple and simultaneous user interfaces, the history table was created to prevent users from selecting duplicate functions concurrently. The history table:

- ▶ Controls multiple users from performing the same or similar actions at the same time
- ▶ Indicates in-progress and completed actions
- ▶ Can be used to coordinate remote users (Web Specialist and Library Manager operator)
- ▶ Notifies users of possible conflicts
- ▶ Retains the last 50 status lines

Figure 2-5 displays the History Table user interface.

Manage Management Classes							
	Name	Secondary Pool	PTP Copy Control	PTP I/O VTS	Description		
1	-----	00	VTC defined	VTC defined	Default management class		
2	TESTMC1	00	VTC defined	VTC defined	Management Class Test 1		
3	TESTMC2	00	Immediate copy	Dist. Lib 0	Management Class Test 2		

Manage Management Classes							
- History Table -							
To view the details for an entry, double click on that entry or highlight the entry and press 'Details'.							
Action	Name	Sec Pool	PTP Copy	Status	User ID	Date	Time
Add	TESTMC4	00	No Copy	Complete	LMOP	03-17-2004	16:16
Add	TESTMC4	00	No Copy	Started	LMOP	03-17-2004	16:16
Add	TESTMC3	00	Defer Copy	Complete	LMOP	03-17-2004	16:16
Add	TESTMC3	00	Defer Copy	Started	LMOP	03-17-2004	16:16
Add	TESTMC2	00	Immed Copy	Complete	LMOP	03-17-2004	16:16
Add	TESTMC2	00	Immed Copy	Started	LMOP	03-17-2004	16:16
Add	TESTMC1	00	VTC Defined	Complete	LMOP	03-17-2004	16:15
Add	TESTMC1	00	VTC Defined	Started	LMOP	03-17-2004	16:15

Details	Refresh	Exit	Help
---------	---------	------	------

Figure 2-5 User interface: History Table results

2.1.2 Databases

The Library Manager database is built during the installation of the IBM 3494. It consists of several tables and system files that contain information about the library and its volumes. The database tables are:

- ▶ Cell table
- ▶ Cartridge table
- ▶ Device table
- ▶ Rotating category table

These tables hold information about the logical and physical coordinates of all library components, the cartridge location, cartridge status, and cartridge category. The system files hold information about the library serial number, machine type and model, device cleaning schedule, operational statistics, and service information.

Database mirroring is available if the optional second hard disk (FC5214) is installed and enabled on older Library Manager PCs (pre-FC5046/FC9046 PCs). Database mirroring facilitates recovery if the primary Library Manager disk fails. An asynchronous Operating System/2® (OS/2®) task updates the second copy of the database each time that the primary database is updated. The secondary database is fully synchronized during the termination of the Library Manager. During Library Manager initialization, the primary and secondary databases are checked, and the Library Manager is initialized according to their status.

If a second copy or backup copy of the database does not exist, and the primary copy is lost, a lengthy library outage occurs. See 9.9.11, “Library Manager database recovery” on page 446 for more information about resynchronizing the Library Manager database with the host systems. We strongly recommend that you install and enable the second hard disk on all IBM 3494s.

When a second copy of the database exists, the primary hard disk only requires repair, and you only need to copy the secondary copy of the database back to the primary disk. Therefore, the duration of the outage is significantly reduced.

When the High Availability unit is installed, both Library Managers have the second hard disk feature installed, and there are four disks in the tape library. Although only two copies of the Library Manager database are kept at any one time, this configuration provides the maximum level of availability for the database.

The FC5046 and FC5047 Library Managers contain two disks and a mirroring card. In this case, the failure of one disk does not stop the Library Manager. The whole disk, not just the database, is mirrored. The mirroring card automatically fails over to the second, mirrored disk.

2.1.3 Volume categories

The Library Manager uses volume categories to manage and group the volumes in the tape library. The volume category is a four-digit hexadecimal number: X'0000' to X'FFFF'.

There are two kinds of volume categories: one category for hardware usage and one category for software usage. The hardware usage volume categories represent the IBM CE cartridge, cleaner volume, volume to be ejected, and other hardware usages.

The software usage volume categories identify the host software platform that owns the volume. Different host software platforms use different volume categories. The category is assigned to the volume during insert processing by the appropriate host system. In general, System z server platforms use preassigned volume categories; however, Open Systems and midrange servers can select the volume categories to use.

Refer to Appendix C, “Library Manager volume categories” on page 499 for a complete list of Library Manager volume categories and their preassigned usage.

2.1.4 Library Manager scratch selection

In the IBM tape library architecture, true scratch mount orders from the host are nonspecific and identify only the drive and the Library Manager category from which to choose the volume (mount from category). When the Library Manager receives a mount from category order, it selects the volume to mount. This applies to real volumes as well as virtual volumes in the VTS.

Normally, this selection occurs in a first-in-first-out (FIFO) order. This way, the most recently inserted or expired volume is placed at the bottom of the list and the oldest volume in the list is chosen next.

There are two exceptions to this FIFO selection:

- ▶ The selection of the next scratch volume is in a VTS/TS7700 logical library.
The Library Manager first checks the virtual drives to see whether there are more even or odd volume serial numbers (VOLSERs) currently mounted. It chooses the next VOLSER, so that the best even-odd balance is maintained. The reason for this is to balance the number of active (mounted) volumes in the file systems of the VTS/TS7700 Tape Volume Cache (TVC). The TVC is divided into two file systems: one file system with even VOLSERs and one file system with odd VOLSERs. Each file system maintains its own independent category list and selection pointer.
- ▶ The Dual Active Accessor feature is enabled.
The Library Manager attempts to provide cartridge drive affinity for true scratch mounts by choosing the next VOLSER that is in the same zone as the drive chosen by the host. This way, the accessor that is servicing this drive does not have to cross the zone boundary to select the cartridge. Any VOLSERs passed over by this selection are ineligible to be selected again until the selection has wrapped through the stack. Even if only one accessor in a Dual Active Accessor IBM 3494 is active, perhaps because of maintenance, the Library Manager still uses the cartridge drive affinity to select the next volume for a scratch mount.

These exceptions to the FIFO selection that is normally used might affect the age of scratch volumes in the scratch categories. These exceptions might be observed by operators as inconsistent, random, or unpredictable.

Figure 2-6 on page 37 illustrates the Library Manager scratch selection process.

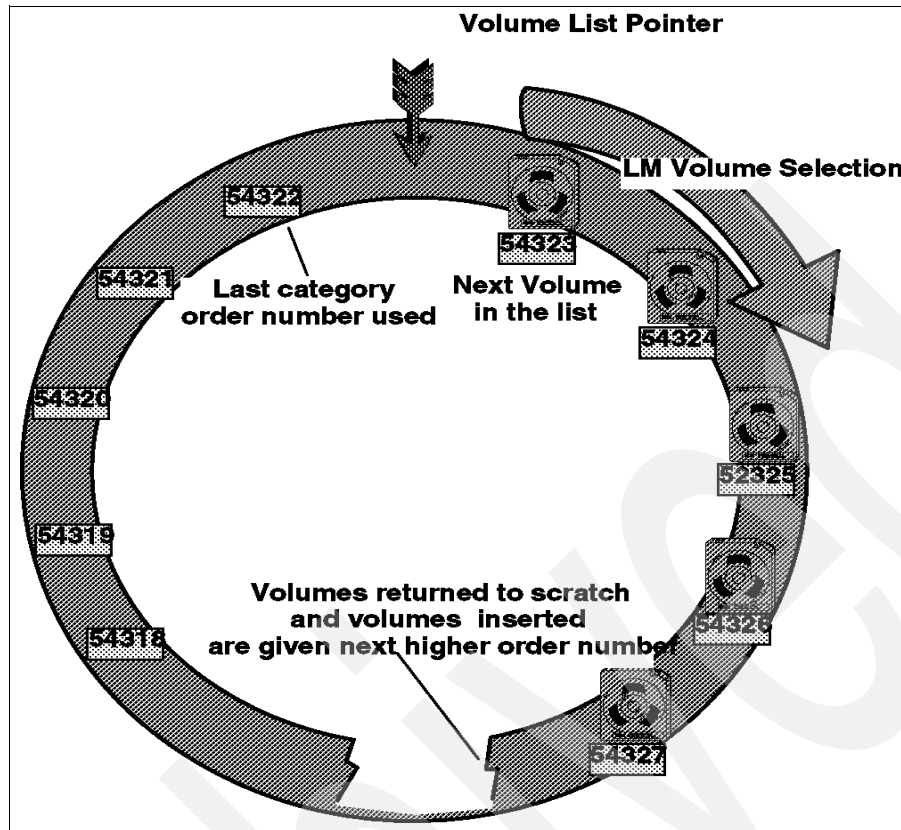


Figure 2-6 Library Manager scratch selection without skipping

Figure 2-6 represents one scratch category. However, a single library can have many categories. The five-digit numbers represent category order numbers, not volume serial numbers. Note the following points:

- ▶ Volumes are arranged in sequence of category order number, not by VOLSER.
- ▶ The pointer to the next volume moves in ascending sequence.
- ▶ Volumes returned to scratch (reassigned to this category) are given a new, higher category order number.
- ▶ Volumes inserted into the library (and assigned to this category) are given a new, higher category order number.
- ▶ Category order numbers are virtually infinite.

The Library Manager scratch selection process can skip volumes for the following reasons:

- ▶ Volumes are skipped in the VTS/TS7700 scratch categories to maintain an even-odd balance of volumes currently mounted on virtual drives.
- ▶ Volumes are skipped in a Dual Active Accessor library to facilitate drive and zone affinity to the selected volume.
- ▶ Skipped volumes must wait for the pointer to come around again. The counter begins again at 0 after it passes the highest category order number or after the Library Manager restarts.
- ▶ If volumes are assigned to this category by insertion or return-to-scratch faster than they are selected for use, the pointer does not start over at the bottom of the order numbers.

- Category order numbers are not reused. Volumes are placed in the category in the order in which they are received. They are assigned the next higher category order number. The category numbers that were used (not skipped) are removed from the database and never reused.

2.2 IBM 3494 basic tape library frames and models

The IBM 3494 is a self-contained and fully enclosed automated tape library. It is linear in design and can be installed on either a raised or solid floor. Its modular design allows you to install the 3494 Tape Library with the number of frames and the configuration that you require.

The minimum configuration consists of one IBM 3494 Model L12 or L22 frame, which contains all components for automated tape operation. Table 2-2 describes the base frames. This minimum configuration can be enhanced up to a 16-frame library that houses tape drives and cartridge storage cells. Or, this configuration can be enhanced up to an 18-frame library that includes two service bays of the High Availability Frames plus 16 frames with tape drives and cartridge storage cells. A 3952 Tape Frame Model F05 can also be added to the 3494 Tape Library to contain the TS1120 Tape Control Unit (3592-C06). Refer to 3.9, "IBM System Storage TS1120 Tape Controller" on page 144 for more information about the 3592-C06 Tape Control unit.

You can tailor configurations to provide performance, capacity, or a combination of both. For details about the configuration options, refer to 2.6, "Tape library configuration options" on page 73.

The IBM 3494 options include a convenience input/output (I/O) station, RS-232 or LAN host attachment, high-capacity input/output facility, dual gripper, remote console, and second Library Manager disk drive. There is also a wide range of host attachment capabilities and the Enterprise Tape Library (ETL) Specialist to communicate with the Library Manager, VTS, PtP VTS, or TS7700 through a Web browser interface.

Table 2-2 Base frames

Name	Description
L12 Frame (Model L12)	Contains: <ul style="list-style-type: none"> ► Cartridge storage cells ► Zero to two 3590 Model B1A, E1A, or H1A tape subsystems ► Library Manager ► Cartridge accessor ► Optional convenience I/O station feature (if installed)
L22 Frame (Model L22)	Note that it cannot contain 3590 drives. Contains: <ul style="list-style-type: none"> ► Cartridge storage cells ► Library Manager ► Cartridge accessor ► Optional convenience I/O station feature (if installed) ► Zero to four 3592 Model J1A or 3592 models E tape drives FC4800 is required to install the 3592-J1A or 3592 models E tape drives in a 3494 Tape Library.

2.2.1 Common IBM 3494 components

There are certain components in the 3494 Tape Library that are commonly used independently of the IBM 3494 Frame model. The following sections describe these common components.

Cartridge accessor

The cartridge accessor identifies and moves cartridges among the storage cells, tape drives, convenience I/O station, and high-capacity I/O facility. The cartridge accessor consists of a carrier, which provides a mounting platform for the gripper, a picker, X and Y axis motors, and a vision system. The cartridge accessor moves through the library on a rail system.

The High Availability Frames provide a second cartridge accessor in the IBM 3494. Without the Dual Active Accessor feature installed, at any time, one accessor is active and the other is in standby mode in one of the two service bays of the High Availability Frames. With the Dual Active Accessor feature installed and enabled, both accessors are active at the same time. This allows improved library exchange performance. In either case, if one accessor fails, the remaining accessor takes over all exchange responsibility.

Cartridge gripper

The cartridge gripper holds the cartridges when they are moved among the storage cells, tape drives, convenience I/O station, and high-capacity I/O facility. The gripper is mounted on the picker. The picker provides 180 degree movement, enabling access to cartridges at the front and rear of the library. The optional dual gripper adds a second gripper to the accessor mechanism.

Figure 2-7 shows the barcode reader, picker, first gripper, and second gripper mounted below it.

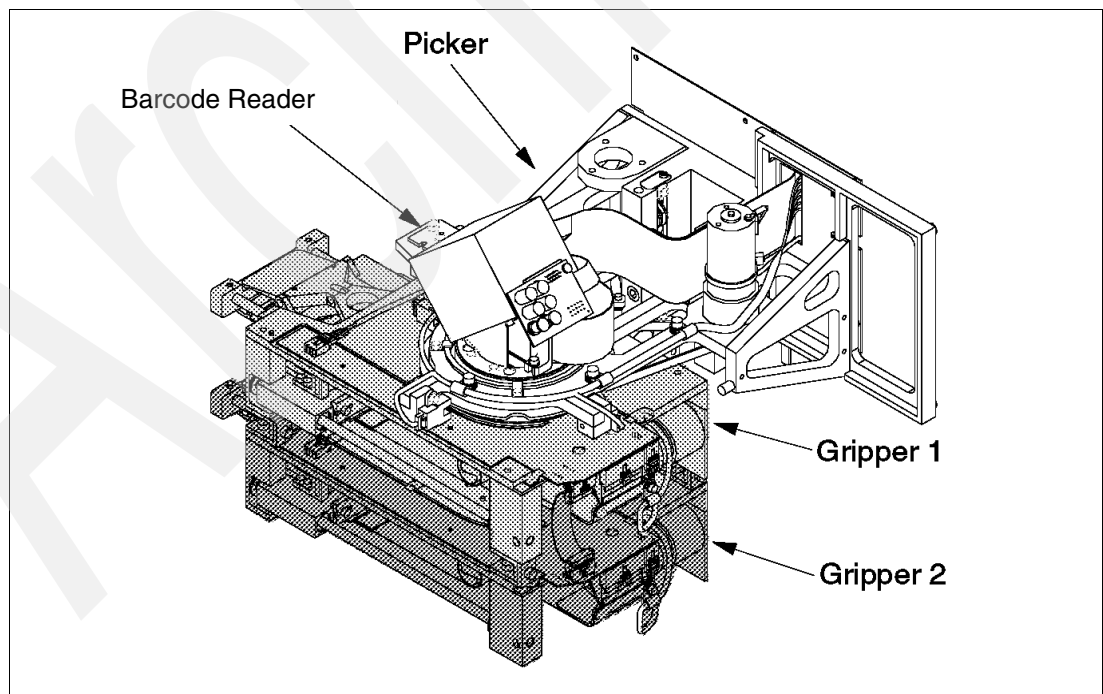


Figure 2-7 IBM 3494 gripper assembly

If a single gripper is installed, the IBM 3494 has to move to the target drive, remove the unloaded tape, and return it to its storage cell, before picking the new cartridge. When the

dual gripper is installed, both grippers operate simultaneously. When a mount is requested, the IBM 3494 picks the requested cartridge and delivers it to the drive. If the drive contains an unloaded cartridge, the second gripper removes that cartridge from the drive, and the first gripper inserts the required tape. If two cartridges are requested to be picked up and delivered, the dual gripper does not pick two cartridges at a time.

The operation of the dual gripper, therefore, improves the mount performance of the IBM 3494. Maximum performance is achieved by using a floating home cell mode, which is available only with the dual gripper.

The dual gripper reduces the number of available cartridge cells by approximately 10%, because the grippers cannot access the two top and bottom rows of cartridge storage cells.

The dual gripper is required on the High Availability Frames when a dual gripper is installed on the 3494 Model L22.

Vision system

The vision system of the IBM 3494 is a single barcode reader similar to those used in point-of-sale equipment (see Figure 2-7 on page 39). The vision system verifies the cartridge VOLSER and media type when a cartridge is inserted into the library by reading the cartridge barcode label.

The vision system is used in the teach process to establish the actual physical location of each component and the physical coordinates for each cartridge storage cell. It is also used to audit a specific cell and for library inventory processing.

The vision system is not used to verify a cartridge's VOLSER before mounting.

Rail system

The rail system consists of two separate horizontal rails, one at the top and one at the bottom of the tape library. The cartridge accessor is carried through the tape library on these rails. As frames are added, the rail system is extended to enable the cartridge accessor to operate throughout the tape library.

Cartridge storage

The IBM 3494 can provide cartridge storage for 140 to 6,240 tape cartridges, depending on the number of frames and the number of tape drives installed inside the 3494 Tape Library. Refer to 2.6, "Tape library configuration options" on page 73 for details about the number of cartridges available for each frame.

The cartridge storage cells are located on the rear wall and inside the front door of each unit. The storage cells are labeled to facilitate identifying the cartridge location. This identification consists of three characters. Figure 2-8 on page 41 shows the cartridge storage labeling for the 3494 Model L22 door.

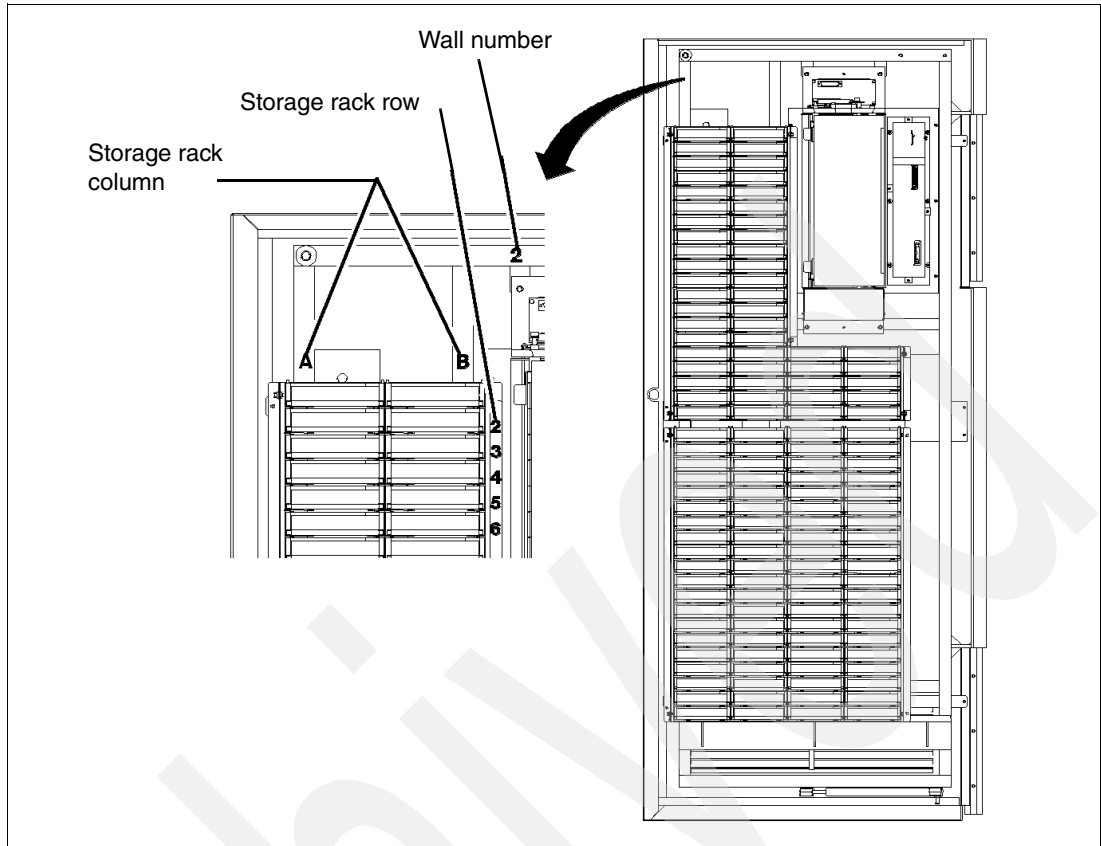


Figure 2-8 IBM 3494 cartridge storage cell labeling

An odd wall number indicates the rear wall of a unit, and an even wall number indicates the door. For example, cartridge storage location 1A4 is in the rear wall of the 3494 Model L22, in the first column from the left, the fourth cell down. The cells hold the cartridges horizontally, with the top of the cartridge facing up. Each cell has an empty cell marker. This marker is a barcode label that the vision system can see when a cartridge is not present. The empty cell marker reduces the time required for inventory processing or cell audits, because the IBM 3494 does not have to physically check the cell to verify that it is empty.

Storage cells can be either *regular cells* or *reserved cells*. As the name suggests, *regular cells* are used for storing cartridges. You cannot store cartridges in the convenience I/O station or the high-capacity I/O facility. The *reserved cells* are used to hold CE cartridges and for error recovery. The library reserves certain cells within the library for functions that the operator does not actively control. In non-High Availability models, these locations are error recovery cell 1A1 (1A3 instead of 1A1 if the optional dual gripper feature is installed) and CE cartridge cell 1A20. If 3490E, 3590, and 3592 tape subsystems are present, CE cartridge cells 1A19 and 1A18 are also reserved.

In High Availability models, these locations are error recovery cells 1A1 and 1A2, or if the dual gripper feature is installed, these locations are error recovery cells 1A3 and 1A4. CE cartridge cells are in the service bays.

Figure 2-9 on page 42 shows the various service cell locations.

Service Cell Locations

- Up to 3 cells used for service cartridge per accessor
- Based on lowest common denominator - (3490, 3590, 3592)

3592 only	3592 and 3490	3592 and 3590	3592, 3590 and 3490	Single <u>LM</u>	Dual <u>LMA</u>	Dual <u>LM B</u>
			3592	1A18	A1D18	B1D18
	3592	3592	3590	1A19	A1D19	B1D19
3592	3490	3590	3490	1A20	A1D20	B1D20

Figure 2-9 Service cell locations

Cartridge handling and placement

The 3494 Tape Library can operate in two modes regarding placement of cartridges in the storage cells. These modes are called *home cell modes* and depend on the tape library configuration. Special considerations might apply for overall mount performance.

Home cell modes

The tape library operates in either fixed or floating home cell mode. The home cell mode selection is made during the teach process as follows:

- **Fixed home cell:** This mode assigns each cartridge a fixed storage cell location when it enters the tape library. The cartridge is always returned to the same location after it is used.
- **Floating home cell:** In this mode, a cartridge is put into the most convenient storage cell location to minimize cartridge accessor movement and optimize performance.

In an IBM 3494, floating home cell mode is available only if the optional dual gripper (FC5215) is installed or if the Dual Active Accessor (DAA) feature is installed and activated (FC5050). In this mode, the IBM 3494 accessor returns a used cartridge to the nearest cell, rather than to the original cell (as it does in fixed home cell mode, which is the default). Therefore, floating home cell mode reduces robotic movement and improves mount performance.

If a gripper fails, the operation of the second gripper is unaffected, so system availability is maintained. Floating home cell mode is enabled during the Library Manager teach and reteach processes, which are carried out by an IBM service support representative (SSR).

Cartridge placement on initial load

For performance reasons, consider clustering cartridges near the tape subsystems that will use them, in particular:

- ▶ During initial population of the library with cartridges
- ▶ When using inventory update to add cartridges
- ▶ When the library has the Dual Active Accessor feature

This approach applies particularly to environments with mixed device types inside the library and with a mixed library that includes both VTS and native tape drives. This approach also applies to environments where multiple host systems are attached to dedicated tape drives inside the 3494 Tape Library.

Note, however, that initial cartridge placement does not remain the same over time, when using floating home cell mode.

Safety operations

The tape library uses a *safety interlock circuit*, which controls the aisle power to the cartridge accessor. This circuit separates motion and electrical hazards in the tape library from the operator and service personnel. The circuit is also used to minimize the damage to a cartridge accessor if its position control system fails.

There are also nonelectrical elements of the safety system. For example, the safety labels are placed inside and outside the tape library to caution operator and service personnel.

2.2.2 Model L22 Tape Library base frame

The Model L22 frame contains all of the components that are required for tape automation:

- ▶ The Library Manager to communicate with the host and to control cartridge movement and storage within the 3494 Tape Library
We describe the Library Manager in detail in 2.1, “IBM 3494 Library Manager” on page 27.
- ▶ The cartridge accessor to move the cartridge among drives, I/O stations, or storage cells
- ▶ The accessor rails on which the cartridge accessor travels
- ▶ Depending on the configuration, up to 240 cartridge storage cells for storage of ½-inch cartridges
- ▶ Up to four 3592 models E tape drives or 3592-J1A tape drives attached to Open Systems or midmarket servers, or to a TS1120-C06, or 3592 Model J70, controller installed in an adjacent Model D22 frame
- ▶ Convenience or high capacity I/O stations (optional)

Figure 2-10 on page 44 shows the front of the Model L22 frame. On the left side, you see the side cover, which includes a window through which you can look into the 3494 Tape Library.



Figure 2-10 IBM TotalStorage 3494 Model L22 Frame

In the front of the Model L22 Frame, you can see the operator panel on the left side, next to the convenience I/O station. It is divided and can be installed to hold up to 10 or up to 30 cartridges. If the 10-cartridge I/O station is installed, you only see the top part. On the right side of the Model L22 Frame door, you see the door handle. Refer to Figure 2-11.

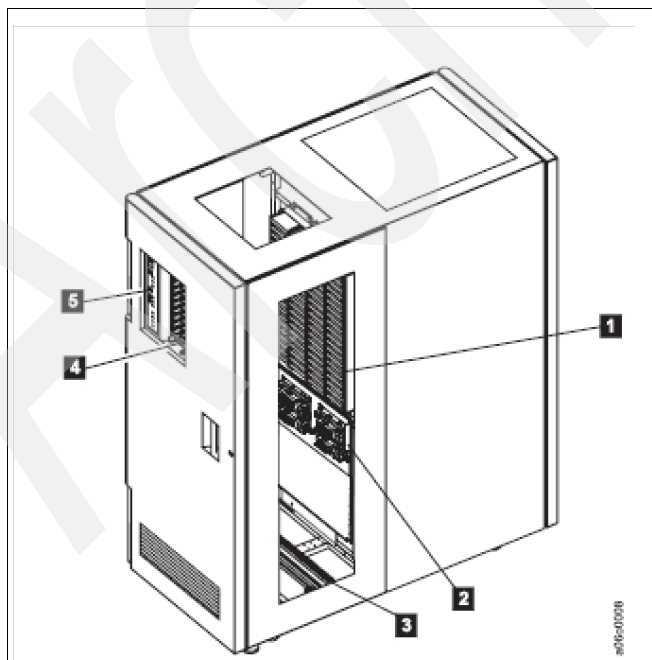


Figure 2-11 3494 Model L22 components with 3592 tape subsystem

Figure 2-11 on page 44 shows the following functional components of the IBM 3494 Model L22 Frame viewed from the front (the numbers relate to the numbers in Figure 2-11 on page 44):

1. Cartridge storage cells located on the interior side of the front doors and on the back walls of the IBM 3494 Tape Library
2. The 3592 tape subsystem can be either the 3592 model E tape drives or 3592-J1A tape drives
3. Rail system
4. Convenience I/O station, see “Convenience I/O station” on page 48
5. Operator panel, see “Operator panel” on page 46

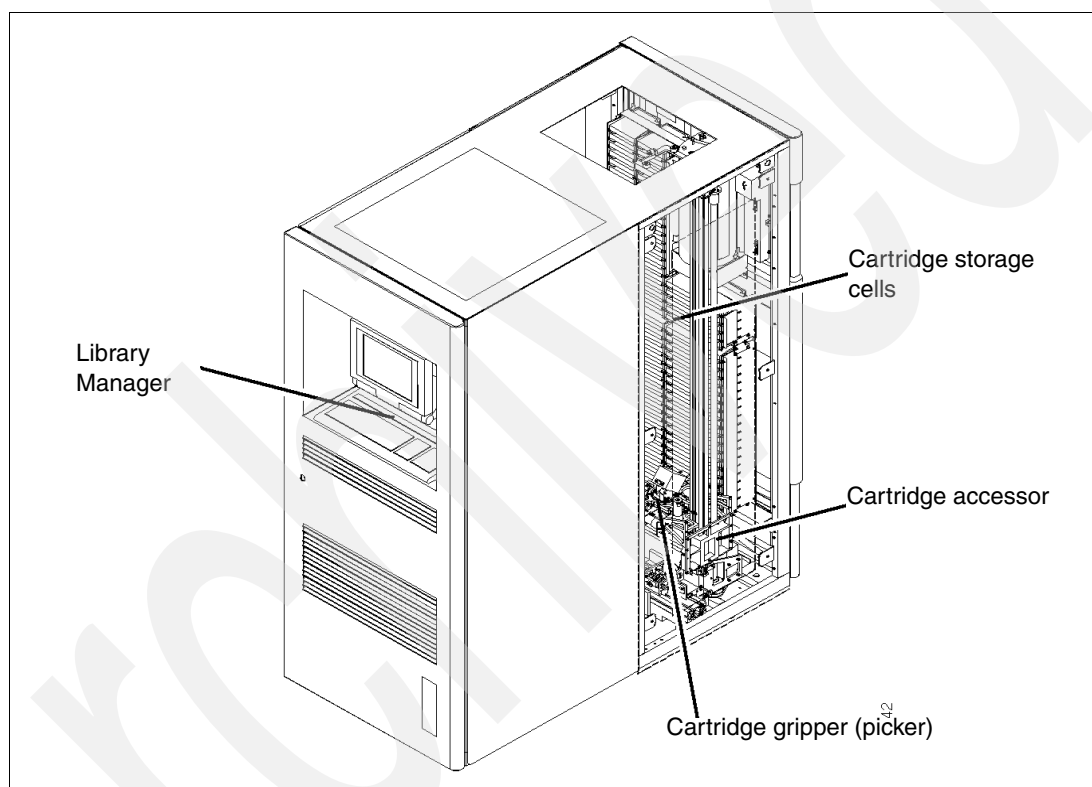


Figure 2-12 3494 Model L22 functional components (rear view)

Figure 2-12 shows the functional components of the IBM 3494 Model L22 Frame viewed from the rear.

Host attachment can be achieved through Ultra-SCSI channel attachments to either Open Systems hosts or to an IBM controller installed in an adjacent IBM 3494 Model D22 frame. The host connection to the Library Manager depends on the host support. Some hosts require a separate connection to the Library Manager to pass library commands. This connection can be either an RS-232 or a LAN.

The IBM L22 frame contains zero to four IBM 3592 Model J1A or E05 tape drives and cartridge storage cells, which means that you can install the IBM 3494 Model L22 frame without any tape drives installed.

In an Enterprise Systems Connection (ESCON) or Fibre Channel Connection (FICON) environment, both tape data and tape library commands are sent through the tape drive host

channels. Therefore, no additional connection is required between the host and the Library Manager.

Note: A single 3494 Model Lxx frame is the minimum configuration for a 3494 Tape Library.

The 3494 Model L10, Model L14, and Model L12 frames have been withdrawn from marketing.

Operator panel

The operator panel is located on the front door of the 3494 Model L22, to the left of the convenience I/O station if one is installed. Figure 2-13 shows the operator panel without the convenience I/O station. The controls enable you to perform most day-to-day library operations without using Library Manager.

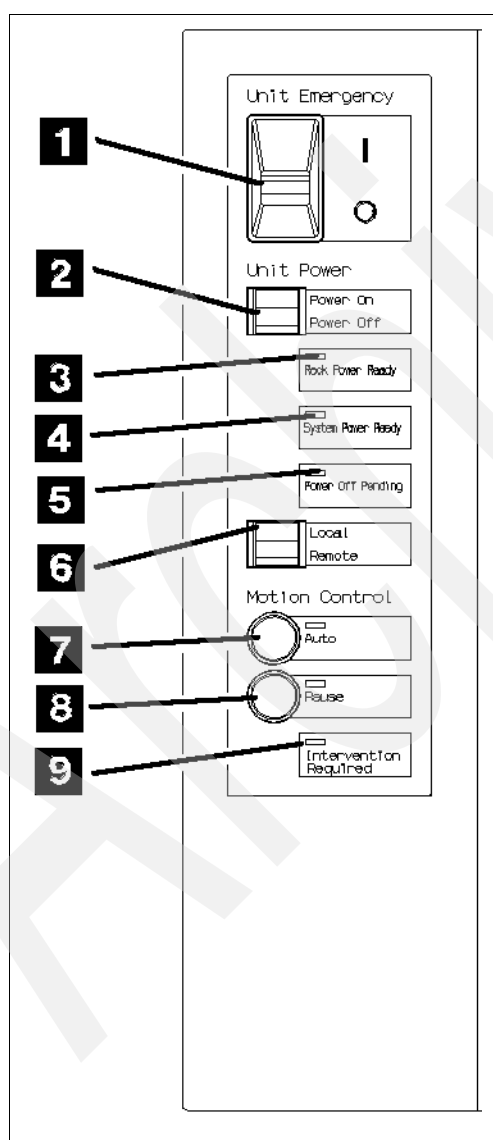


Figure 2-13 IBM 3494 operator panel (without convenience I/O station)

The operator panel controls are (the numbers relate to the numbers in Figure 2-13 on page 46):

1. The Unit Emergency switch shuts down the IBM 3494. Use only in an emergency. Administrator level Library Manager authority is required to recover.
2. Unit Power on/off is the normal way to shut down the IBM 3494. After the IBM 3494 powers off, wait at least 20 seconds before you power it back on.
3. Rack Power Ready, when lit, indicates that power is on to the 3492 Model L22.
4. System Power Ready, when lit, indicates that power is on to the tape subsystems within the IBM 3494.
5. Power Off Pending, when lit, indicates that the Power Off switch has been changed to the off position and the IBM 3494 is powering down.
6. Local/Remote enables the IBM 3494 to be powered on or off by any attached System i servers. If you want the operator panel to control the power, place the switch in the local position. If power is under the control of a remote System i server, place the switch in the remote position.

Important: If the switch is set to the remote position and no System i servers are attached that can remotely control the IBM 3494, the IBM 3494 powers off.

7. Auto changes the mode of the IBM 3494 from pause to auto. The LED indicator blinks while the mode of the IBM 3494 is in a transitional state. When the library is in manual mode, both LED indicators blink together. It is impossible to change the mode of the library from manual to auto by using the auto mode switch. Refer to 9.2.1, "Operational modes" on page 392 for more information about the modes. See 9.2.2, "Operational states" on page 393 for information about the operational states of the IBM 3494.
8. Pause changes the mode of the IBM 3494 from auto to pause. The LED indicator blinks while the mode of the IBM 3494 is in a transitional state. When the library is in manual mode, both LED indicators blink together. It is impossible to change the mode of the library from manual to pause by using the pause mode switch. Refer to 9.2.1, "Operational modes" on page 392 for more information about modes. See 9.2.2, "Operational states" on page 393 for information about the operational states of the IBM 3494.
9. Intervention Required is lit by the Library Manager when the IBM 3494 requires operator intervention. You use the Library Manager or Remote Library Manager Console to determine which operator intervention is needed. Library Manager also sends messages to all attached hosts. How these messages display varies from host to host.

Convenience I/O station

The convenience I/O station, if installed, allows you to add or remove cartridges from the IBM 3494 without interrupting automated operations. The station has a door that, when opened, gives you access to 10 or 30 cartridge locations, depending on which feature is installed. Figure 2-14 shows a 30-cartridge convenience I/O station.

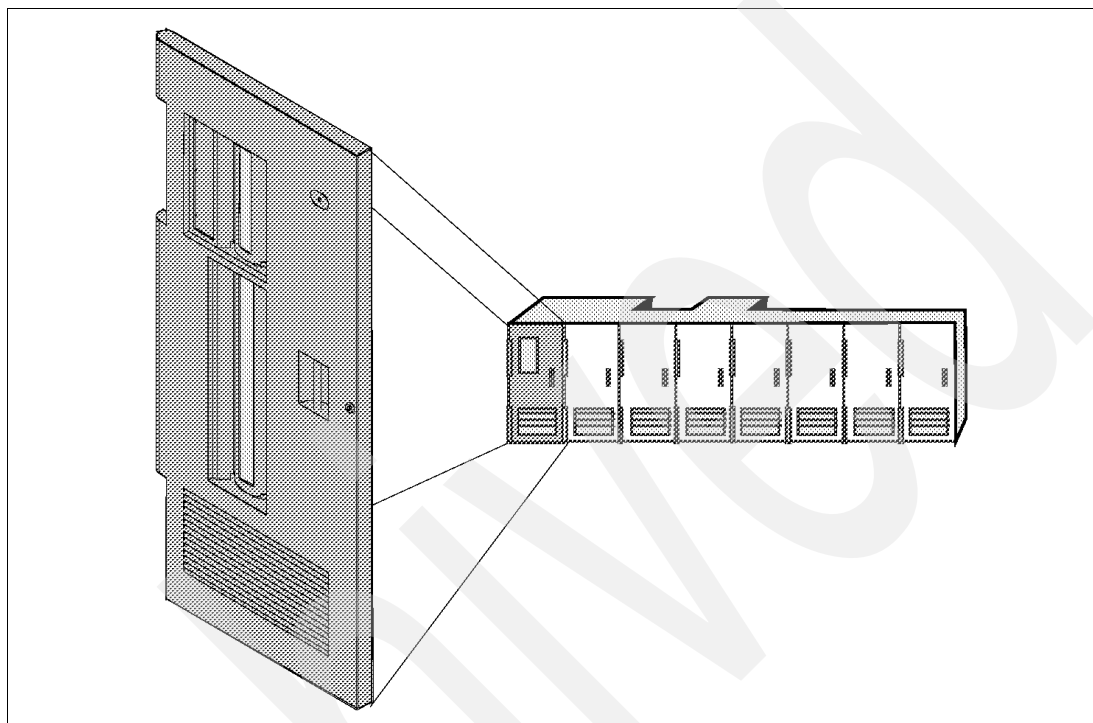


Figure 2-14 Thirty-cartridge convenience I/O station

The convenience I/O station doors are shaped in a way that makes it impossible to insert cartridges incorrectly with the wrong end visible. The doors only close if cartridges are inserted so that the vision system can read the external cartridge label.

The cell capacity of the library control unit frame (without the dual gripper installed) is:

- ▶ 240 if no convenience I/O station is installed
- ▶ 210 if the 10 cartridge capacity convenience I/O station is installed
- ▶ 160 if the 30 cartridge capacity convenience I/O station is installed

High-capacity input/output facilities

You can define two high-capacity cartridge handling facilities in an IBM 3494 as:

- ▶ High-capacity output
- ▶ High-capacity input/output

You can define only one type of high-capacity facility at one point in time in the library. The high-capacity facility type and size are not specified through a feature code. They are defined when the tape library is installed, during the teach process.

Cartridge cells allocated to the high-capacity facility are not available for cartridge storage.

High-capacity output facility

The high-capacity output facility reserves a section of the cartridge storage area of the 3494 Model L22 front door for ejecting cartridges. Table 2-3 shows the cartridge capacity sizes of the facility.

Table 2-3 IBM 3494 high-capacity output facility cartridge capacity sizes

Feature	Number of cartridges without dual gripper	Number of cartridges with dual gripper
Without convenience I/O station	10, 20, 40, 80, or 160	10, 20, 36, 72, or 144
With 10 cartridge convenience I/O station	10, 20, 40, 80, or 130	10, 20, 36, 72, or 122
With 30 cartridge convenience I/O station	10, 20, 40, or 80	10, 20, 36, or 72

Note: If you do not define a high-capacity output facility and you do not install a convenience I/O station, the library uses cartridge storage cell 2A1 as a default output facility (called the *single cell output facility*) when the dual gripper is not installed. Cell 2A3 serves the same purpose if the dual gripper is installed.

If you define a high-capacity output facility, the first and last cell locations depend on the facility size that you selected and whether you installed the dual gripper feature. See Table 2-4 for the cell locations of the various high-capacity output facility sizes.

Table 2-4 IBM 3494 high-capacity output facility cell locations

Number of cartridges	Without dual gripper	With dual gripper
10	2A1 - 2A10	2A3 - 2A13
20	2A1 - 2A20	2A3 - 2A23
36	N/A	2A3 - 2A38
40	2A1 - 2A40	N/A
72	N/A	2A3 - 2A38 2B3 - 2B38
80	2A1 - 2A40 2B1 - 2B40	N/A
122	N/A	2A3 - 2A38 2B3 - 2B38 2C16 - 2C38
130	2A1 - 2A40 2B1 - 2B40 2C16 - 2C40	N/A
144	N/A	2A3 - 2A38 2B3 - 2B38 2C16 - 2C38 2D16 - 2D38
160	2A1 - 2A40 2B1 - 2B40 2C16 - 2C40 2D16 - 2D40	N/A

High-capacity input/output facility

The high-capacity input/output facility reserves an area on an inside wall (drive side wall) of a frame *other than* the 3494 Model L22 so that both inserts (input) and ejects (output) can be performed.

You can configure a 3494 Model S10 or the former TotalStorage Enterprise Virtual Tape Server Model B16 control unit frame to use the upper storage racks (100 cells without the dual gripper feature) or the whole wall (200 cells without the dual gripper feature) as input/output cells.

You configure a 3494 Model D1x frame to use the available storage cells on the whole wall (50 to 135 cells depending on the model and the drive configuration).

Only a single wall can be configured at any time.

2.2.3 Model Dxx drive unit frames

The IBM TotalStorage Enterprise 3494 Model Dxx contains zero to six 3590 tape drives or zero to twelve 3592 tape drives, cartridge storage cells, and an accessor rail. The following types of drive unit frames are available:

- ▶ The 3494 Model D22 frame houses from zero to twelve 3592-J1A or 3592 models E tape drives for direct attachment to Open Systems or midmarket servers, to a Model J70 controller, installed in an adjacent Model D24 frame, or a 3592-C06 installed in a 3952-F05 frame.

You can install D22 frames that do not contain tape drives to provide additional cartridge storage cell capacity.

- ▶ The 3494 Model D24 frame houses from zero to eight 3592-J1A or 3592 models E tape drives and a Model J70 or Model A60 controller. 3592 drives in a D24 frame can also be attached to a 3592-C06 installed in a 3952-F05 frame.

You can install D24 frames that do not contain tape drives to provide additional cartridge storage cell capacity.

IBM TotalStorage Enterprise 3494 Model D22

You can attach the TotalStorage Enterprise 3494 Model D22 to any model of the library control unit. It provides an accessor rail, cartridge storage cells, and, optionally, housing for zero to twelve IBM 3592-J1A or 3592 models E tape drives that can attach to *one* of the following items:

- ▶ All Open Systems and midmarket hosts that support Ultra SCSI-attached or Fibre Channel-attached 3592 tape drives inside a 3494 Tape Library. The supported platforms are:
 - Operating System/400® (OS/400®)
 - AIX
 - Linux
 - SUN Solaris™
 - Hewlett-Packard UNIX (HP-UX)
 - Microsoft Windows 2000 and Windows NT®
 - Tru64

The library control unit requires additional features to provide (for library commands) host attachment in addition to the tape drive host attachment. For more details, refer to Chapter 8, “Software implementation: Open Systems environments” on page 331.

- ▶ A 3592 Model J70 tape control unit, or if the drives are 3592-J1A tape drives, an IBM 3590 Model A60 control unit that is installed in an adjacent Model D24 frame.
- ▶ A 3592-C06 installed in a 3952-F05 frame.
- ▶ A TS7700 Virtualization Engine.
- ▶ An IBM TotalStorage Enterprise Virtual Tape Server B10/B20.

The maximum number of cartridge storage cells in a single Model D22 frame is 400, if no tape drives are installed. Each tape drive installed inside a Model D22 frame reduces the number of available storage cells. Refer to 2.6, “Tape library configuration options” on page 73 for the exact number for every configuration.

IBM TotalStorage Enterprise 3494 Model D24

The IBM 3494 Model D24 frame provides an accessor rail, cartridge storage cells, and ESCON or FICON attachment of IBM 3592 tape systems for attachment to the following hosts:

- ▶ System z servers
- ▶ All ESA-capable S/370™ and S/390 systems that support ESCON channels

Attachment to the host is through the IBM 3592-J70, or 3590 Model A60 tape controller, which is installed in the Model D24 frame, or to the 3592-C06 tape control unit, which is installed in a 3952-F05 frame. The D24 frame can hold zero to eight IBM 3592-J1A or 3592 models E tape drives, according to the attachment specifications of the tape control unit as explained in 3.9.2, “Attachment features” on page 147.

For attachment of twelve 3592 models E or 3592-J1A tape drives to a single Model J70 control unit inside a 3494 Tape Library, you must meet the following requirements:

- ▶ One Model D24 drive unit frame housing the 3592 Model J70 control unit plus eight tape drives.
- ▶ One Model D22 drive unit frame installed adjacent to the Model D24 frame. The D22 frame can house the remaining four tape drives.

Depending on the number of tape drives installed inside the Model D24 frame, the number of cartridge storage cells will vary. With no drives and no tape drives installed, the maximum number of storage cells is 400. Refer to 2.6, “Tape library configuration options” on page 73 for the exact number for every configuration.

In an ESCON or FICON environment, both tape data and tape library commands are sent through the tape drive host channels. Therefore, the host-to-Library Manager connection is through the Model A60 control unit ESCON or FICON attachment to the host.

2.3 TS7700 Virtualization Engine and 3494 VTS frames

In this section, we describe the TS7700 Virtualization Engine and 3494 VTS frames.

2.3.1 TS7740 Virtualization Engine frames

Figure 2-15 on page 52 displays the TS7700 Virtualization Engine as viewed from the front of the machine. As the direct successor to the IBM TotalStorage Virtual Tape Server (VTS), the TS7700 Virtualization Engine implements many of its predecessor’s 3494-related capabilities and improves on VTS technology.

Attachment of the TS7700 Virtualization Engine to the 3494 Tape Library involves power control, an interface to tape drives in the tape library, and communication with the Library Manager in the tape library. The attachment of the TS7700 Virtualization Engine to the 3494 Tape Library involves the following connections:

- ▶ **Power control:** The 3494 Tape Library contains power sequencing and control equipment that remotely turns on and off the power to the TS7700 Virtualization Engine, which is the normal mode of power control for the TS7700 Virtualization Engine. This power control is not a physical connection. For power sequencing and shutdown information, refer to Chapter 5 of the *IBM TotalStorage 3494 Tape Library Operator Guide*, GA32-0449-14.
- ▶ **Library Manager and tape drives:** The 3494 Tape Library contains a minimum of one internal Library Manager. There is no need for an external Library Manager as there is for the TS3500 Tape Library.



Figure 2-15 TS7700 Virtualization Engine Frame

Communication and control signals travel among the Library Manager, the TS7700 Virtualization Engine, and the tape drives within the 3494 Tape Library through a local area network (LAN). Data between the host and the TS7700 Virtualization Engine travels along FICON connections, while data travels between the TS7700 Virtualization Engine and the tape drives within the 3494 Tape Library along Fibre Channel connections. A Fibre Channel switch routes the data to and from the correct tape drive. The TS7700 Virtualization Engine can only attach to 3592 tape drives. Up to twelve 3592 tape drives in a single model D22 frame in the 3494 Tape Library can be attached to the TS7700 Virtualization Engine. The term 3592 tape drives refers collectively to 3592-J1A tape drives and 3592 models E tape drives.

The following 3494 Tape Library feature codes are required to support attachment to the TS7700 Virtualization Engine:

- ▶ **FC5214:** Second Disk Drive for Library Manager, installed on all Library Managers in the 3494 Tape Library.
- ▶ **FC5246:** Dual Path Concentrator, installed on all frames in the 3494 Tape Library that contain a Library Manager.

Refer to *IBM TotalStorage 3494 Tape Library Introduction and Planning Guide*, GA32-0448-14, for additional information concerning 3494 Tape Library features.

Note: You can learn more about the components of the TS7700, including implementation, operation, monitoring, and more in:

- ▶ *IBM Virtualization Engine TS7700: Tape Virtualization for System z Servers, SG24-7312*
- ▶ *IBM Virtualization Engine TS7700 Series Introduction and Planning Guide: IBM Virtualization Engine TS7740, TS7740 Cache Controller, and TS7740 Cache Drawer, GA32-0567-05*

2.3.2 Virtual Tape Server frame

The minimum configuration of an IBM TotalStorage Virtual Tape Server is shown in Figure 2-1 on page 25. This configuration consists of:

- ▶ One 3494 Model L22 frame that contains all library relevant components.
- ▶ One 3494 Model D22 frame that can be located anywhere in the 3494 Tape Library and contains the 3592 tape drives dedicated to the VTSs. Refer to “IBM TotalStorage Enterprise 3494 Model D22” on page 50 for a description of the D22 frame.
- ▶ One IBM 3494 Model B10/B20 Virtual Tape Server frame that can be located at a distance of up to 25 m (82 ft.) from the D22 frame. This frame contains the Virtual Tape Server controller and the Tape Volume Cache.

In addition, if a PtP VTS is installed, one to four Model CX1 Virtual Tape Frames are required to house the Virtual Tape Controllers (VTCs).

The 3494 models Bxx and CX1 do not require tape automation. Therefore, they are not installed inside a 3494 Tape Library. Instead, they are located to the side of or at a distance from the actual tape library.

Note: You can learn more about the components of the VTS and PtP VTS, including implementation, operation, monitoring, and more in:

- ▶ *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*

The IBM TotalStorage Enterprise Virtual Tape Servers were available in four models: IBM 3494 Model B16, IBM 3494 Model B18, IBM 3494 Model B10, and IBM 3494 Model B20. They have all been withdrawn from marketing. The VTS Model B10 Frame is shown in Figure 2-1 on page 25 as the rightmost frame.

A VTS is transparent to the host. From a host perspective, data is processed as though it resides on actual 3490E cartridges. All data is accessed through the Tape Volume Cache, which is managed by the VTS on fault-tolerant RAID disks that go up to 5.1 TB, assuming a three to one (3:1) compression. The cache can hold hundreds or even thousands of virtual volumes. If a requested volume is not present in the cache, the required IBM TotalStorage Enterprise 3590 cartridge is mounted, and the logical volume is moved back into the cache from a stacked volume. A single VTS or PtP VTS can provide 64 up to 256 3490E devices and up to 250,000 virtual volumes.

Up to two IBM 3494 Model B10, B18, or B20 VTS systems can be integrated in one 3494 Tape Library. If a PtP VTS is installed, both VTS systems that make up the PtP VTS must be installed in different physical IBM 3494 Tape Libraries.

IBM TotalStorage Virtual Tape Server Model B10 (withdrawn)

The Model B10 VTS is packaged as a stand-alone unit that can be a maximum of 14 m (45.9 inches) from the associated IBM TotalStorage Tape Drive Expansion Frame. The Model B10 VTS provides host connection of up to four Extended Performance ESCON Channels, up to four FICON channels, or up to eight SCSI bus attachments. Each Model B10 VTS provides a maximum of 64 virtual tape drives and up to 250,000 logical volumes. Each virtual volume can have a maximum capacity of 2.4 GB (assuming a 3:1 compression ratio). This provides a total VTS capacity of up to 1.3 TB of effective Tape Volume Cache (assuming a 3:1 compression ratio).

You can interconnect a Model B10 VTS with PtP VTS copy features with another Model B10 or B18 VTS and four IBM TotalStorage Virtual Tape Controllers Model AX0 in a PtP VTS configuration. This combination provides both remote and local PtP copy capability between two VTSs using ESCON connections.

The Model B10 VTS provides the following significant capabilities:

- ▶ Tape volume cache capacity up to 1.3 TB (with a 3:1 compression)
- ▶ An advanced RISC controller
- ▶ Up to four Extended Performance ESCON host channels
- ▶ Up to four FICON host channels
- ▶ Up to eight SCSI bus attachments
- ▶ Attachment of up to two VTSs per 3494
- ▶ A maximum of 64 virtual tape drives can be addressed
- ▶ A maximum of 250,000 logical volumes per VTS can be included
- ▶ Two VTSs with PtP VTS copy features interconnected to provide remote copy using ESCON attachments
- ▶ With the Advanced Function feature:
 - DFSMS Tape Volume Cache management
 - Export/import of logical volumes
- ▶ With the Advanced Policy Management feature:
 - Volume pooling
 - Selective dual copy
 - Tape volume cache management
 - Export/import of logical volumes
- ▶ Improved reliability, availability, and serviceability

3494 Model B16 Virtual Tape Server (withdrawn)

Note: Effective 31 December 1998, the IBM 3494 Model B16 Virtual Tape Server was withdrawn from marketing.

The 3494 Model B16 provides a hierarchical storage management system to attached ESCON hosts by integrating IBM TotalStorage Enterprise 3590 tape drives, fault tolerant RAID disk storage, and a RISC-based controller. It appears to host systems as two fully configured 3490E tape subsystems. The Model B16 contains 400 tape cartridge storage cells. The 3494 Model B16 must be integrated with a Model D12 and attached to a Model L10, Model L12, or Model L14.

IBM TotalStorage Virtual Tape Server Model B18 (withdrawn)

Note: Effective 30 November 2001, the IBM TotalStorage Virtual Tape Server Model B18 was withdrawn from marketing.

The IBM TotalStorage Virtual Tape Server Model B18 is packaged as a stand-alone unit that can be a maximum of 14 m (45.9 inches) from the associated 3494 drive unit frame. The Model B18 VTS contains a RISC processor, host connection of up to eight Extended Performance ESCON Channels or up to four SCSI bus attachments, and over 5 TB of effective Tape Volume Cache (assuming a 3:1 compression ratio). Each Model B18 VTS provides a maximum of 128 virtual tape drives and up to 250,000 logical volumes. Each virtual volume can have a maximum capacity of 2.4 GB (assuming a 3:1 compression ratio).

You can interconnect a Model B18 VTS with the PtP VTS copy feature with another VTS B18 or VTS B20 and eight IBM TotalStorage Virtual Tape Controllers (Model AX0). Or, you can interconnect a Model B18 VTS with the PtP VTS copy feature with another VTS B18 or VTS B10 and four AX0s in a PtP VTS configuration to provide both remote and local PtP copy capability between two VTSs using ESCON connections.

The Model B18 VTS provides the following significant capabilities:

- ▶ Tape volume cache capacity over 5 TB (with a 3:1 compression ratio)
- ▶ ESCON High Performance Option (EHPO)
- ▶ Up to eight Extended Performance ESCON host channels
- ▶ Up to four SCSI bus attachments
- ▶ Attachment of up to two VTSs for each 3494
- ▶ A maximum of 128 virtual tape drives can be addressed
- ▶ A maximum of 250,000 logical volumes per VTS can be included
- ▶ Two VTSs with PtP VTS copy features interconnected to provide remote copy using ESCON attachments
- ▶ With the Advanced Function feature:
 - DFSMS Tape Volume Cache management
 - Export/import of logical volumes
- ▶ With the Advanced Policy Management feature:
 - Volume pooling
 - Selective dual copy
 - Tape volume cache management
 - Export/import of logical volumes

IBM TotalStorage Virtual Tape Server Model B20 (withdrawn)

Note: Effective 01 December 2006, the IBM TotalStorage Virtual Tape Servers Model B10/ B20 were withdrawn from marketing.

The Model B20 VTS is packaged as a stand-alone unit that can be a maximum of 14 m (45.9 inches) from the associated IBM TotalStorage Enterprise Tape Drive Expansion Frame (Model D10). You can configure an Enterprise Tape Library with up to two VTSs. The Model B20 VTS provides a host connection of up to 16 Extended Performance ESCON Channels, up to eight FICON channels, or up to eight SCSI bus attachments, and over 5 TB of effective Tape Volume Cache (assuming a 3:1 compression ratio). Each Model B20 VTS provides a

maximum of 256 virtual tape drives and up to 250,000 logical volumes. Each virtual volume can have a maximum capacity of 2.4 GB (assuming a 3:1 compression ratio).

You can interconnect a Model B20 VTS with PtP VTS copy features with another VTS B20 or VTS B18 and eight IBM TotalStorage Virtual Tape Controllers (Model AX0s) in a Peer-to-Peer VTS configuration to provide both remote and local PtP copy capability between two VTSs using ESCON connections.

The Model B20 VTS provides the following significant capabilities:

- ▶ Tape volume cache capacity over 5 TB (with a 3:1 compression ratio)
- ▶ An advanced RISC controller
- ▶ Up to 16 Extended Performance ESCON host channels
- ▶ Up to 8 FICON host channels
- ▶ Up to eight SCSI bus attachments
- ▶ Attachment of up to two VTSs for each 3494
- ▶ A maximum of 256 virtual tape drives can be addressed
- ▶ A maximum of 250,000 logical volumes for each VTS can be included
- ▶ Two VTSs with PtP VTS copy features interconnected to provide remote copy using ESCON attachments
- ▶ With the Advanced Function feature:
 - DFSMS Tape Volume Cache management
 - Export/import of logical volumes
- ▶ With the Advanced Policy Management feature:
 - Volume pooling
 - Selective dual copy
 - Tape volume cache management
 - Export/import of logical volumes
- ▶ Improved reliability, availability, and serviceability

2.3.3 Model CX1 Virtual Tape Frame (withdrawn)

Note: Effective 01 December 2006, the CX1 Virtual Tape Frame was withdrawn from marketing.

The IBM TotalStorage Virtual Tape Frame (Model CX1) provides the housing and power for two or four IBM TotalStorage Virtual Tape Controllers (VTCs). There are two power control compartments, each with its own power cord to allow connection to two power sources.

Virtual Tape Controller (VTC)

The VTC provides interconnection between two Virtual Tape Servers with the PtP VTS base copy (FC4010) and also provides two ESCON or FICON host system attachments for the PtP VTS.

Each VTC independently operates as a distributed node within the Peer-to-Peer VTS and continues to operate during scheduled or unscheduled service of another VTC. There must be four or eight VTCs in the Peer-to-Peer VTS with each one attaching two VTSs. Each VTC also provides two ESCON host attachments, each with 64 paths using appropriate ESCON directors. Each VTC also provides 16 or 32 virtual addresses and transfers data between

host channels and the VTSSs. For a virtual mount on any of its 16 or 32 addresses, the VTC selects one of the two VTSSs to support the requested volume processing activities.

Each VTC performs these functions:

- ▶ Maintains synchronization of the dual copy of logical volumes
- ▶ Uses large block transfers of compressed logical volumes to create logical volume copies
- ▶ Balances workload between the VTSSs
- ▶ Directs specific volume mounts to the VTSSs with a cached copy of the requested virtual volume

2.4 Model HA1 High Availability Frames

The IBM TotalStorage Enterprise 3494 Model HA1 High Availability Frames consist of two service bay unit frames that are installed adjacent to both ends of the other 3494 Tape Library frames. The leftmost HA1 frame, next to the IBM 3494 Model L12 frame, provides a garage for the active accessor in case it fails. The rightmost HA1 frame provides a second accessor and a second Library Manager.

None of the HA1 frames provides cartridge storage cells or the ability to install additional drives. In the case of an accessor failure, the cartridge storage cells are not accessible by the surviving accessor.

2.4.1 Model HA1 Library Frames

Figure 2-16 shows the functional components of service bay A, the leftmost frame, as shown from the right front.

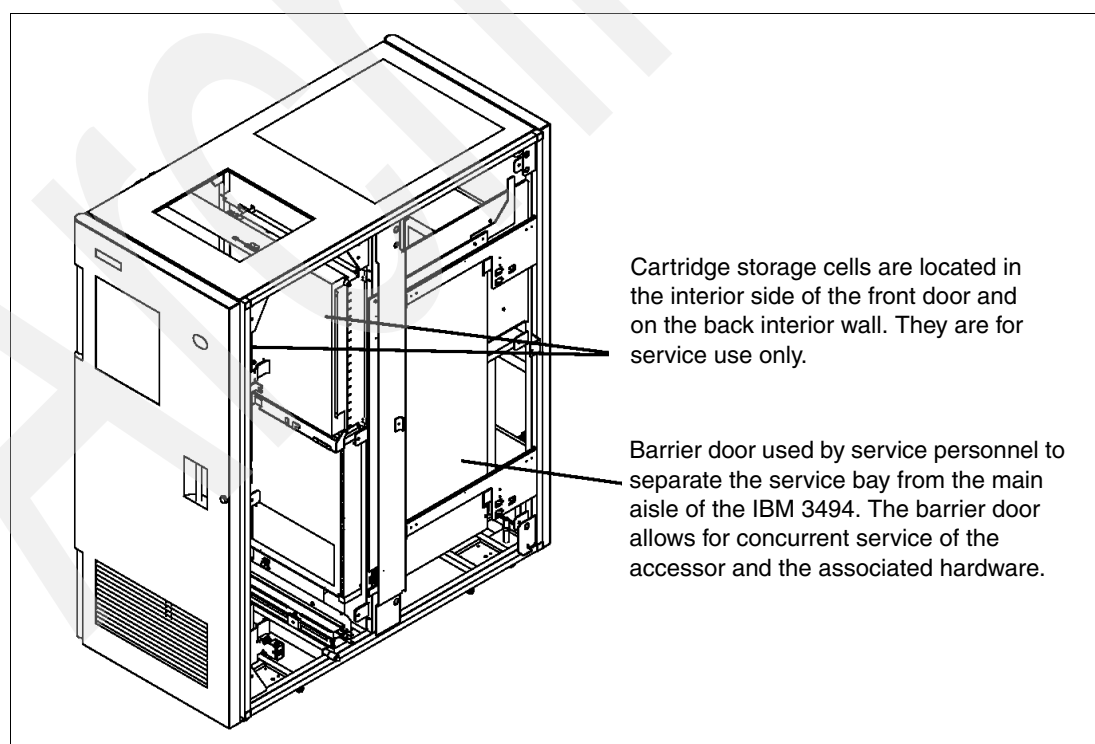


Figure 2-16 Service bay A functional components (right front)

Figure 2-17 shows the functional components of service bay B from the left front.

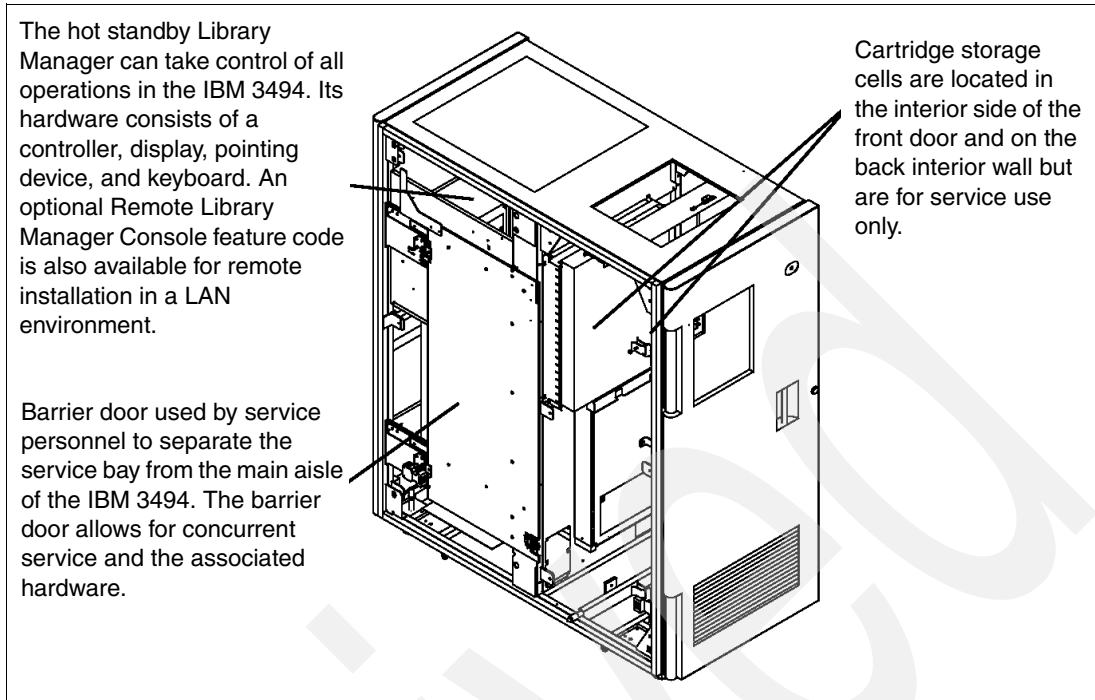


Figure 2-17 Service bay B functional components (left front)

The second accessor (not visible) is similar in function to the accessor of the 3494 Model Lxx. It can be controlled by either Library Manager.

The High Availability Frames must be configured the same as in the 3494 Model Lxx, with either one or two grippers.

2.4.2 Model HA1 components

When you install the High Availability Frames, the IBM 3494 configuration has two Library Managers and two cartridge accessors. Each Library Manager controls a cartridge accessor. In the event of a cartridge accessor or Library Manager failure, the IBM 3494 can continue operations after a short interruption. The High Availability Frames also allow concurrent maintenance of these components while the IBM 3494 operates.

The addition of the Dual Active Accessor feature allows higher library exchange performance, while preserving the high availability aspects of the Model HA1 unit. The Dual Active Accessor feature is a chargeable microcode feature of the IBM 3494.

Figure 2-18 on page 59 shows the components of the High Availability Frames.

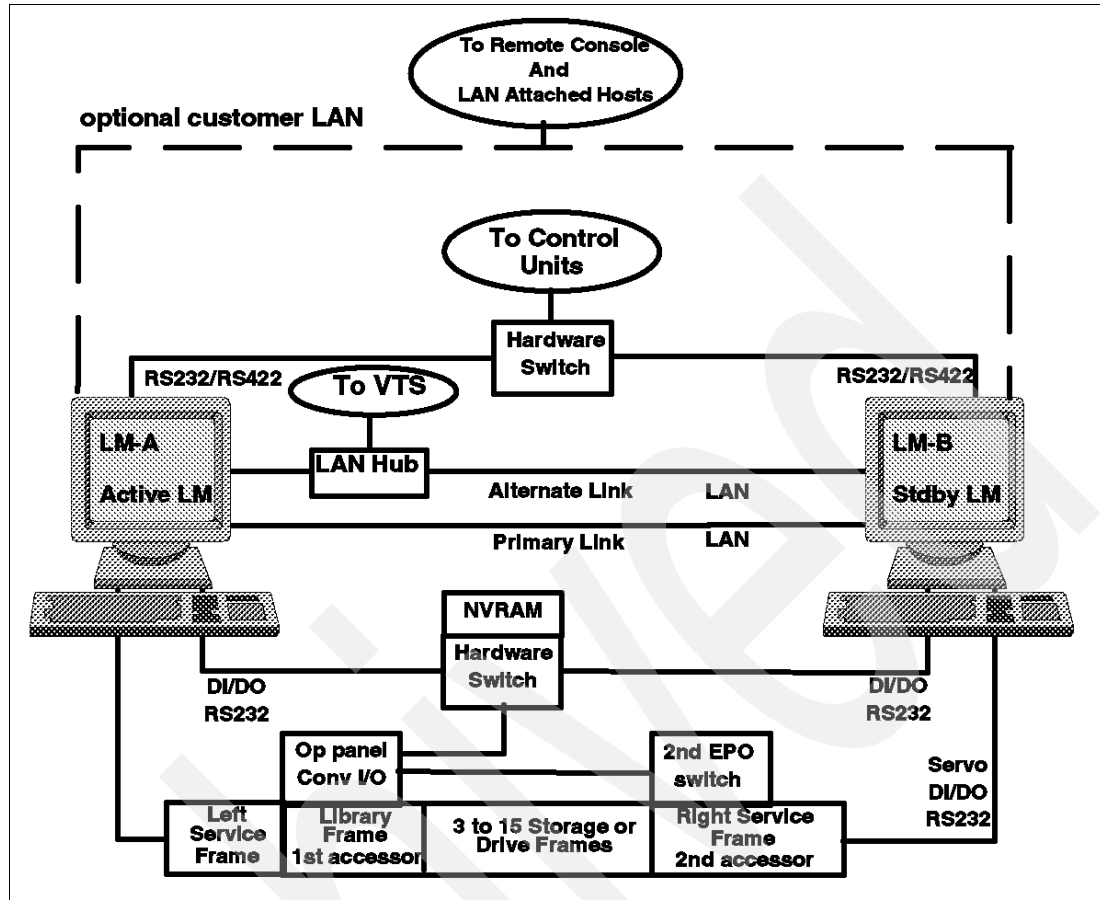


Figure 2-18 HA1 functional components

The HA1 components are:

- ▶ A second Library Manager, located in the right service frame.
- ▶ A second cartridge accessor.
- ▶ Communication links between the two Library Managers and a LAN hub if a VTS is integrated with the IBM 3494.
- ▶ Shared nonvolatile random access memory (NVRAM) holding the current state of the active and standby Library Manager. It is used when a Library Manager cannot communicate with the second Library Manager on either of the links to decide whether this Library Manager is active.
- ▶ Hardware switches to switch the operator panel from one Library Manager to the other, or to switch hosts or tape controllers to either Library Manager.
- ▶ Digital input/digital output (DI/DO) lines to communicate component commands and status between both Library Managers and the library components, such as the accessors.
- ▶ Two service frames (or bays) for storage of the inactive cartridge accessors, service diagnostics, or accessor repair. Service frames contain rail extenders (to allow the accessor to be stored within the frame) and a barrier door. The right service frame (when you look at the library from the front) contains the second Library Manager. A barrier door in the service frame is used to keep the functioning cartridge accessor from entering the service frame during service. Each service frame has its own AC power control compartment, which is different from the compartment of the 3494 Model L22.

- A second unit emergency power off (EPO) switch as in the 3494 Model L22 to drop power to the entire library.

The active Library Manager controls the active accessor, receives host commands over the control paths, and controls the convenience I/O station. Either Library Manager can be the active Library Manager and either accessor can be the active accessor. If the remote accessor for an active Library Manager is the active accessor (that is, accessor B for Library Manager A or accessor A for Library Manager B), the active Library Manager sends the accessor commands to the standby Library Manager, and the standby Library Manager passes them on to the accessor.

There is only one operator panel, which is located on the 3494 Model L22 frame. It is controlled by the currently active Library Manager.

With the High Availability Frames installed, the database on the primary disk in the active Library Manager is mirrored onto the primary disk of the standby Library Manager. If the standby Library Manager becomes unavailable, the secondary database is mirrored onto the secondary disk of the active Library Manager.

Also, additional circuitry is installed that supports concurrent maintenance. Specifically, when an IBM SSR services an accessor in its service bay and the service frame's barrier door is in place, the IBM SSR can open and close the service bay door without affecting the power of the other active accessor in the aisle.

2.4.3 Failover scenarios

The Model HA1 provides a high level of availability in the event of a failure of these two critical components of the IBM 3494: the Library Manager and the Cartridge Accessor. The following section discusses the basic failover processing. For a detailed description of operational considerations related to the High Availability Frames, refer to 9.8, "Error handling and recovery summary" on page 442.

Library Manager failure

The standby Library Manager (LMB) knows that the active Library Manager (LMA) is functioning properly by monitoring activity on the communication links between the two Library Managers. If LMA fails, LMB takes over the control of the library. This operation is called the *Library Manager switchover*. The host paths are now controlled by LMB. The operator panel is switched to LMB.

To the hosts, it appears as though the Library Manager failed and went through a recovery/restart procedure. The active Library Manager command queue is not maintained on the standby Library Manager, so jobs might abend. When the switchover begins, the host marks the library offline. After the switchover is complete, the operator must vary the library online.

If possible, LMB continues to use accessor A through LMA. If LMA cannot execute the accessor commands, accessor B is activated.

After the switchover, the primary database is on the primary disk of LMB. It is mirrored onto the secondary disk of LMB. The copy from the primary database to the secondary database occurs concurrently with online Library Manager operations, such as mounts and inserts. The copy operation involves copying the primary database record-by-record to the secondary database and mirroring any changes to the primary database as the Library Manager processes host commands.

When LMA comes back up, the secondary copy of the LMB database is copied to the primary disk of LMA. The primary disk of LMA now becomes the secondary copy for the active Library Manager.

If the Dual Active Accessor feature is installed and enabled, the operation of the Library Managers remains the same, which happens because there is still only one Library Manager designated as active. The other Library Manager, although it controls the robotics of the second accessor, is still designated as standby.

Cartridge accessor

If accessor A fails, LMA sends accessor commands to LMB over the communication links. LMB then executes the commands, using accessor B. The first operation is to gently push accessor A into its service bay (left side of the library) so that accessor B can access all cartridges in the library. A special pusher bar is added to one of the accessors for this purpose. This operation is called the *accessor switchover*.

On completion, normal library function resumes using accessor B. LMA remains as the active Library Manager. Operation continues automatically after a short time. No operator involvement is required.

2.4.4 Dual Active Accessors

The Dual Active Accessor feature improves performance of the 3494 with an attached Model HA1. It takes full advantage of having two accessors active at the same time for performing commands. When the Dual Active Accessor feature is active, both accessors service mount requests at the same time. The high availability of an HA1 model is maintained, because each active accessor can pick up the activities of the other accessor.

To reduce interference between accessors, the library is divided into two zones. The boundary between the two zones is established at library initialization and might change over time as the Library Manager attempts to keep the accessors equally busy.

For a detailed description of the techniques used to place and select tapes to optimize the performance of Dual Active Accessors, refer to “Performance with the Dual Active Accessor feature” on page 66.

If the Dual Active Accessor feature is installed and enabled, each accessor services the mounts within two zones. The partition between these zones is on a frame boundary, and this boundary might be defined as dynamic or static. If an accessor fails, the remaining accessor pushes the failed accessor into its service bay and takes over the operation of both zones until the failed accessor is repaired and reactivated.

Refer to 9.10.2, “Dual Active Accessor recovery scenarios” on page 453 for a detailed description of operational considerations related to the Dual Active Accessor.

2.5 Tape library planning

This section covers considerations that you need to take into account when planning a 3494 Tape Library.

2.5.1 Tape library frames and placement

The IBM 3494 can have a maximum of 16 frames plus the two attached service bays of the High Availability unit. Allowable configurations are 1 to 16 frames without the High Availability

unit. When the High Availability unit is installed, configurations of 3, 4, 6, 8, 10, 12, and 16 frames are allowed, not counting the two service bays of the High Availability unit. With the Dual Active Accessor feature, you must install at least four frames in the IBM 3494.

All configurations must have one 3494 Model Lxx control unit frame. The subsystem can include up to 15 additional frames (in the configurations previously listed).

An IBM 3494 can support up to two VTS subsystems. If one is a B16, the other must be a B10, B18, or B20 model. Each VTS requires a separate Dx2 frame to house 3592 or 3590 tape drives. The VTS frame is a stand-alone frame located within 14 meters of the attached D22. The B16 VTS frame is installed in the IBM 3494 and must be located to the immediate left of the associated D22. Except for this one restriction, the frames associated with the VTS subsystems can be in any position in the IBM 3494.

If more than eight frames are attached to a 3494 library, one drive frame Model Dx2 or FC9002, FC9003, or FC9006 must be installed in the first eight frames.

Feature codes are available to specify the number and position of frames installed in an IBM 3494. See 2.6.1, “Specific features” on page 73 for a detailed description of the available feature codes.

There might be a case where you must change the configuration of frames in an installed IBM 3494. For example, you must move the frames to install a Virtual Tape Server or move the frames from one IBM 3494 to another. In this case, you need to process a Request for Price Quotation (RPQ) before you can reconfigure the library. The RPQ provides the proper cables.

Figure 2-19 shows examples of configurations that provide capacity, performance, or both.

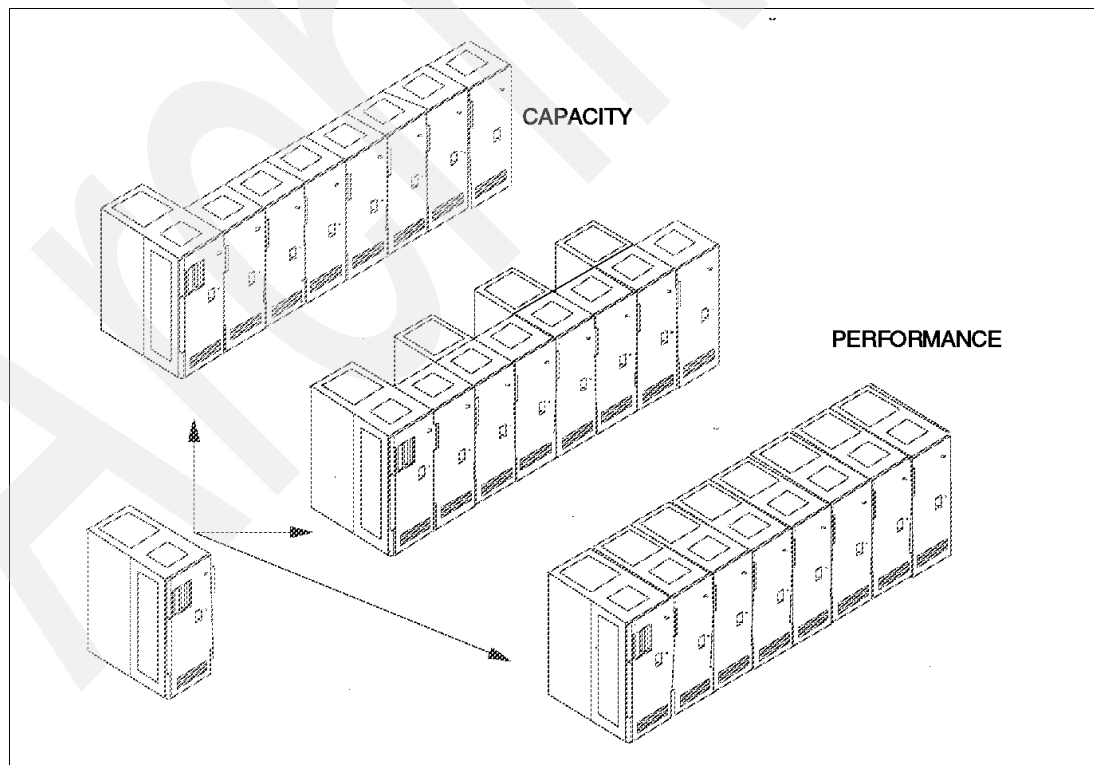


Figure 2-19 IBM 3494 capacity and performance configurations

In planning the configuration of an IBM 3494, consider the relative ease with which you can add additional frames to the end of an existing library, compared to inserting additional

frames. Similarly, it is easier to add drives to drive frames that are not fully populated with drives than it is to remove S10 frames and replace them with Dxx frames, or to add additional drive frames when enough free storage slots are available.

2.5.2 Frame capacities

The IBM 3494 allows for expandable configurations. For example, it can hold from 160 to 6,240 cartridges. The storage capacity is determined by the number of frames, installation of the optional convenience I/O station, installation of the optional dual gripper, the number and type of tape subsystems installed, and the definition of the high-capacity facility.

Table 2-5 shows the number of cartridge storage cells for each model of the IBM 3494. Selecting the high-capacity I/O facility reduces the cartridge capacity, depending on the options chosen.

Table 2-5 IBM 3494 configuration options and frame capacity

Frame model	With dual gripper	Without dual gripper
Lxx Frame	240 ^{1, 2, 3, 4, 5, and 6}	216 ^{1, 3, 4, 5, and 6}
S10 Frame with FC5400	400 ^{2, 3}	360 ³
D10 Frame (without 3490E Model CxA or F1A)	400 ^{2, 3}	360 ³
D10 Frame with FC5300 (with 3490E Model CxA of F1A)	300 ^{2, 3}	270 ³
D22 Frame, or D12 Frame with FC5500	400 ^{2, 3}	360 ³
3494 D22 Frame or 3494 D12 Frame (without tape drives) or 3494 D12 Frame with FC5302 (without 3590 x1A Tape Drive)	400 ^{2, 3}	360 ³
3494 D22 Frame (with one to four 3592 tape drives) or 3494 D12 Frame with FC5302 (with one or two 3590 x1A tape drives)	335 ^{2, 3}	305 ³
3494 D22 Frame (with five to eight 3592 tape drives) or 3494 D12 Frame with FC5302 (with RPQ), FC5502, or FC5503 (with three or four 3590 x1A tape drives)	290 ^{2, 3}	260 ³
3494 D22 Frame (with nine to twelve 3592 tape drives) or 3494 D12 Frame with FC5302 (with RPQs), FC5502, or FC5503 (with RPQ and five or six 3590 x1A tape drives)	250 ^{2, 3}	230 ³
3494 D24 Frame (without tape drives) or 3494 D14 Frame with FC5304 (without 3590 x1A tape drives)	400 ^{2, 3}	360 ³
3494 D24 Frame (with one to four 3592 tape drives) or 3494 D14 Frame with FC5304 or FC5504 (with one or two 3590 x1A tape drives)	345 ^{2, 3}	305 ³
3494 D24 Frame (with five to eight 3592 tape drives) or 3494 D14 Frame, FC5304, or FC5504 (with RPQ and three or four 3590 x1A tape drives)	305 ^{2, 3}	275 ³

Frame model	With dual gripper	Without dual gripper
B18, B10, and B20 VTS, CX0, Cx1, VTC	0	0
HA1 Frames (service bays)	0	0

¹Optional convenience I/O station features reduce the cartridge capacity by 30 cartridges (FC5210) or 80 cartridges (FC5230).

²With FC5215 (Dual Gripper) installed, the convenience I/O station features reduce the cartridge capacity by 26 cartridges (FC5210) or 72 cartridges (FC5230).

³Selecting the high-capacity I/O facility reduces the cartridge capacity, depending on the options chosen.

⁴One cell is reserved for ejecting cartridges if you do not install a convenience I/O station feature and you do not define the high-capacity output facility.

⁵A maximum of two cells is reserved for certain service representative functions. With the HA1 Frames installed, there are no cells reserved in the L Frame for service functions.

⁶One cell is reserved for error-recovery operations in libraries without the HA1 Frames configuration. Two cells are reserved for error-recovery operations in libraries with the HA1 Frames configuration.

Note: Cartridge cells allocated to the high-capacity facility are not available for cartridge storage. See “Convenience I/O station” on page 48 for a description of the high-capacity facility and the size of the corresponding reserved area.

You can gather information about the number of cartridge storage cells required inside the tape library by analyzing tape usage data generated by analysis tools, tape management software reports, or discussions with storage administrators. There is no one method of gathering this data that applies to all hosts that you can attach to the IBM 3494. For methods available in z/OS, refer to “Monitoring and reporting tools” on page 482.

2.5.3 Performance planning

Expectations of performance play an important role in planning for your IBM 3494. This section tries to demystify several of the performance characteristics of an automated tape library. The discussion includes:

- ▶ Accessor exchange performance for:
 - Native drive libraries
 - Virtual Tape Server virtual drives
- ▶ Performance implications of the Dual Active Accessor feature
- ▶ Inventory performance
- ▶ Mount performance
- ▶ Drive subsystem performance

Accessor exchange performance

Library performance is the number of volumes that the tape library can exchange in a one-hour period. An *exchange* involves moving a volume to a tape drive, drive residence time, and removal of the volume from the drive. This section uses exchange as a metric for hourly accessor performance. It uses *mount* to describe the mechanical actions of the library as the host sees them, such as *specific mount* or *scratch mount*.

The time to move a volume to a drive and remove the volume from the drive constitutes the library accessor capability. If the tape library has more tape drives, it can exchange more volumes concurrently. If the library is fitted with the Model HA1 and Dual Active Accessor

feature, its hourly exchange rate might increase. Therefore, the factors that affect tape library performance are:

- ▶ Number of tape drives
- ▶ Drive residence time
- ▶ Library accessor exchange time affected by:
 - Number of active accessors (Dual Active Accessor feature)
 - Relative placement of drives and volumes within the library

For example, consider four drives with a 5 minute residence time. It is impossible to have more than 48 exchanges per hour. These values are obtained by multiplying the number of drives by the quotient of 1 hour (60 minutes) divided by the residence time in minutes:

(number of drives) x (1 hour / drive residence time)

The exchange capability provided by the tape library accessor is the quotient of one hour (3600 seconds) divided by the library accessor exchange time in seconds. If the library accessor exchange time is 15 seconds, the mount capability of the tape library accessor is 240, which far exceeds the availability of volumes to exchange. Current measurements indicate a maximum of 305 cartridge mounts or demounts per hour for the IBM 3494. Therefore, the key to determining tape library performance is often based on drive residence time, not necessarily on library accessor exchange time.

Figure 2-20 on page 66 compares average volume residence time and the cartridge exchange capability provided by several configurations of the IBM 3494. The six solid lines in the graph show the maximum exchanges per hour possible for 2, 4, 8, 16, 32, and 66 tape drives with varying drive residence times. Analyses of client data show that average drive residence times typically range between 8 and 12 minutes. This range is indicated on the graph. The broken vertical lines are the maximum exchange rates that the IBM 3494 is capable of executing for several different-size tape libraries and with or without the dual gripper and Dual Active Accessor feature. The purpose of the graph is to show that you can use residence time and the number of drives to determine the accessor performance required in a library.

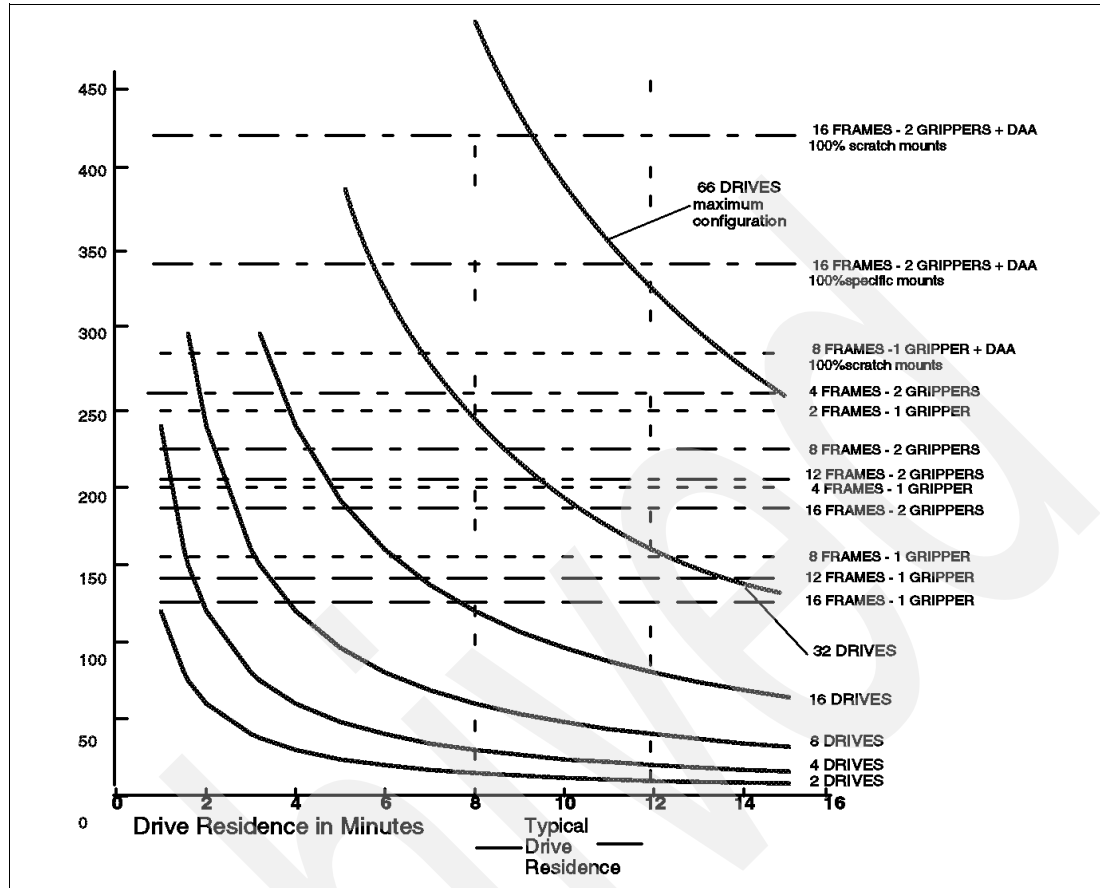


Figure 2-20 IBM 3494 exchange capability and tape drive residence time

Performance with the Dual Active Accessor feature

Exchange performance of the IBM 3494 with the Dual Active Accessor feature depends on the degree of independence with which the accessors can operate. Given totally independent operation, Dual Active Accessor can accomplish more than twice the number of exchanges possible for a single accessor in the same library. Given a high degree of interference between the two accessors, Dual Active Accessor might provide only slightly better exchange performance than a single accessor.

The two accessors service the drives in the library frames that are within the accessor's zone (see Figure 2-21 on page 67). The two zones are established by a dynamic or fixed boundary. A high degree of independence occurs when there is an affinity between the cartridge location and the location of the selected drive. Therefore, the accessor servicing the target drive does not have to cross the boundary line into the other accessor's zone to pick the cartridge.

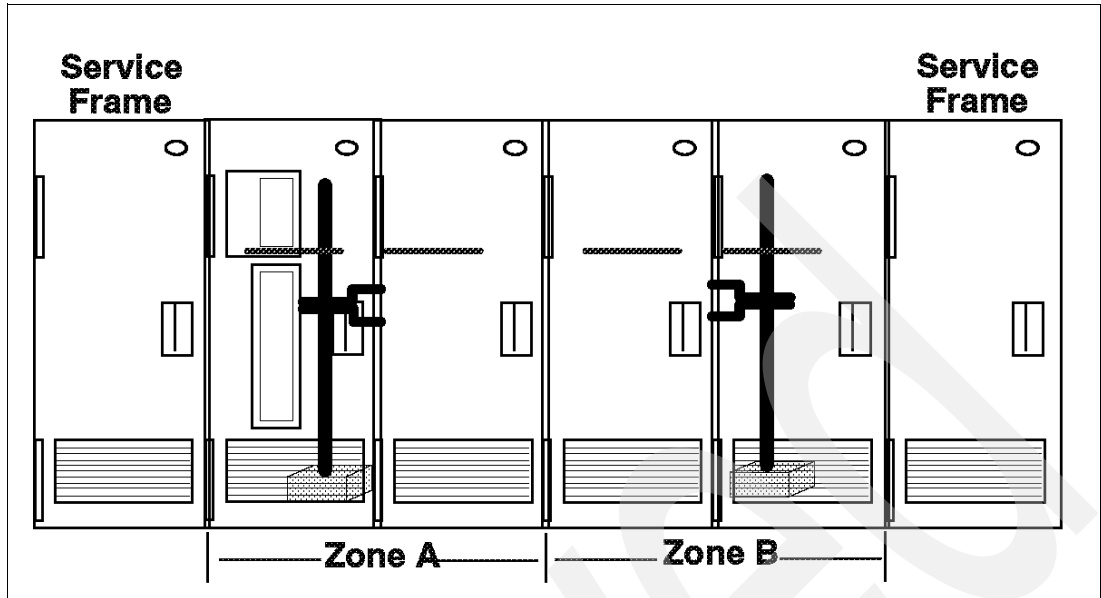


Figure 2-21 IBM 3494 Dual Active Accessor feature

With the Dual Active Accessor feature, cartridge-drive affinity can occur for both scratch and specific mounts. For scratch mounts, affinity is controlled by the Library Manager's ability to select the volume to mount from the specified category. See 2.1.4, "Library Manager scratch selection" on page 36 for details about Library Manager scratch selection. This affinity always occurs when the scratch mount is a true scratch mount (mount from category) and not a specific mount from a private scratch pool. Affinity for scratch mounts is applied to the set of drives in the zone in which the accessor normally operates, not to individual drives.

For specific mounts, affinity occurs if:

- ▶ The operating system or tape application uses the drive-string priority list that the Library Manager, on request, sends to the host processor.
- ▶ There is at least one unallocated drive in each zone.

Currently, z/OS running JES2 is the only operating system that exploits this priority list. In these environments, with a single accessor, cartridge-drive affinity also occurs (only for specific mounts). However, the effect on exchange capability is not as dramatic as it is in a Dual Active Accessor library.

Table 2-6 on page 68 summarizes the conditions under which the two types of cartridge-drive affinity occur.

Table 2-6 Cartridge-drive affinity for scratch and specific mounts

Accessor	Single	Single	Dual	Dual
Mount type	Scratch	Specific	Scratch	Specific
System z	No	Yes	Yes	Yes
System i	No	No	Yes	No
System p	No	No	Yes	No

A further natural cartridge-drive affinity occurs when the library is partitioned into sections by operating system or drive type. This way, all cartridges in each section are mounted only in the drives in that section.

Here are several Dual Active Accessor configuration scenarios that result in a high degree of cartridge-drive affinity and thus optimal Dual Active Accessor exchange performance:

- ▶ A z/OS environment where every host image has access to every library cartridge, and drives are balanced across the two library zones. For scratch mounts, the Library Manager always tries to pick a scratch cartridge in the same zone as the target drive. See 2.1.4, “Library Manager scratch selection” on page 36 for details about Library Manager scratch selection. For specific mounts, the Library Manager sends to z/OS an ordered list of drives, based on the zone containing the cartridge to mount. If not all drives in the cartridge’s zone are allocated, z/OS chooses a drive from the ordered list that results in at least cartridge-zone, if not cartridge-drive, affinity. This also assures optimal Dual Active Accessor exchange performance. Therefore, for applications with a high percentage of specific mounts, it is important to have sufficient drives so that cartridge-drive affinity can be achieved even in peak periods.
- ▶ A System i or System p server environment where applications use actual communal scratch pools for scratch mounts, and, if there are a significant number of specific mounts, the applications use the ordered list of drives to achieve cartridge-drive affinity. Note that neither the i5/OS® nor AIX operating systems use the ordered drive list for specific mounts.
- ▶ A mixed host environment where all cartridges and drives for one host are together in each library zone. The VTS drives and cartridges fall within this scenario.
- ▶ Any host environment where two drive types are geographically separated enough to be in the two zones. The two different cartridge types are also placed in the different zones. Fixing the zone boundary in the Library Manager might be advantageous for this scenario.

Here are two scenarios that do not result in a high degree of cartridge-drive affinity. Therefore, they show minimal performance benefit from the Dual Active Accessor feature:

- ▶ A System i or System p server environment where applications use private scratch pools, or where there are a significant number of specific mounts and the applications do not exploit the ordered drive list
- ▶ Any host environment with a high percentage of specific mounts where it often occurs that all drives in a zone are allocated

Laboratory measurements have shown that much better Dual Active Accessor exchange performance occurs when the library is in floating home cell mode rather than fixed home cell mode, for either single or dual grippers. Therefore, we strongly recommend the operation of the Dual Active Accessor in floating home cell mode. For both the single accessor and the Dual Active Accessor libraries, the best exchange performance occurs with dual grippers and floating home cell mode.

Configuration planning is important for achieving optimal exchange performance for the Dual Active Accessor feature. For sample IBM 3494 configurations, refer to the *IBM TotalStorage Enterprise Automated Tape Library (3494) Introduction and Planning Guide*, GA32-0448-14.

Follow these suggestions when planning the configuration of an IBM 3494 with the Dual Active Accessor feature to minimize accessor interference:

- ▶ Balance drive frames across both halves of the library, using the expected mount activity as the determining factor. Best performance comes from evenly distributed mount activity. If you add the Dual Active Accessor feature to an existing 3494, it might be advisable to redistribute the drives within existing or new drive frames.
- ▶ Try to place storage frames in the center of the configuration.
- ▶ Grouping 3490E drives at one end and 3590 tape drives at the other end helps to migrate cartridges to provide cartridge-drive affinity. Treat each VTS-owned drive frame as a separate drive type, because these frames are logically separate libraries sharing the accessors and slots with the native drives.
- ▶ If a host has access to only a subset of the tape subsystems in a library, attempt to keep all those subsystems in the same half of the library so that the volumes associated with the subsystems remain in the same zone. This consideration also applies to the situation where a library is partitioned between two z/OS hosts sharing all or a subset of the drives. If these drives are manually or automatically switched between the partitions, the volumes owned by the each partition lose the cartridge-drive affinity performance benefit that otherwise exists with the Dual Active Accessor feature. Be prepared to weigh the benefits of sharing drives against the benefits of increased exchange performance with the Dual Active Accessor feature.
- ▶ With the Dual Active Accessor feature installed, the library needs to use floating home cell mode even with single gripper accessors.
- ▶ On initial loading or inventory update, cluster cartridges around the subsystems that will mount them.
- ▶ Define the high capacity I/O near the drives that will write tapes that will be ejected.
- ▶ If you plan to grow the number of drive subsystems in the library over time, provide a balance of empty drive frames in both zones. You can use these D-frames for cartridge storage.

Clients can access many tape tools, including SMF94 reporting packages, on the Web at:

<ftp://ftp.software.ibm.com/storage/tapetool>

You can find useful information about the tools and their usage in “Monitoring and reporting tools” on page 482.

Mount performance in the VTS

Usually, the mount performance of IBM TotalStorage Enterprise Virtual Tape Server is not tied to the accessor exchange performance of the physical library. Most virtual mounts, that is, all scratch and most specific, do not involve a physical exchange. Therefore, it is unlikely that one or even two VTS logical libraries installed in an IBM 3494 will tax the accessor system. The average time for a virtual mount, however, can be affected by a high demand for accessor movement in the native (nonvirtual) portion of a mixed library.

The VTS offers fast mount times for scratch mounts and specific mounts stationed in the Tape Volume Cache. The remaining mounts (cache-miss mounts) are subject to possible queuing against the VTS tape drives, the individual stacked volumes, or the accessor resources. This queuing can extend the time for these mounts to complete to several minutes.

Inventory performance

The addition of the Dual Active Accessor feature improves the inventory performance of the IBM 3494. Inventory update processing for four frames of library storage was measured in the laboratory. Without the Dual Active Accessor feature, the inventory took 25 minutes. With the Dual Active Accessor feature, the inventory took 13 minutes, which calculates to 3 to 4 minutes per frame.

2.5.4 Installation planning

The following sections provide information to assist you in installation planning. It covers site preparation, IBM SSR initial operations, and environmental specifications.

Site preparation

You must include the following information in the floor plan for the installation of an IBM 3494; for additional detailed plan specifications, see the *IBM TotalStorage Enterprise Automated Tape Library (3494) Introduction and Planning Guide*, GA32-0448-14:

- ▶ The installation planning representative and client are responsible for:
 - Power outlet types, locations, and power ratings
 - Operator area (work area) for the Library Manager, convenience I/O station, and access doors
 - Locations of emergency power-off (EPO) switches
 - Frame locations
 - Service clearances
 - Total IBM 3494 area dimensions
- ▶ The client is also responsible for:
 - Cabling and wiring for connections to the host processor
 - Cabling for connection for the Remote Library Manager Console (FC5226). The Remote Library Manager Console also requires the token-ring adapter (FC5219) or the Ethernet adapter (FC5220) in the IBM 3494.
 - Cooling
 - Telephone lines for remote service support
 - Safety and security
 - Fire detection and suppression
 - Floor, raised or not raised, that meets the operational and structural requirements imposed by the IBM 3494. For a raised floor, we recommend that you install stringers between all corner posts and that you place a post under the areas where the 3494 leveling pads will sit.
 - Associated tape library cartridge storage for nonautomated tape library activities
 - Acoustical requirements

2.5.5 IBM SSR initial operations (teach and initial inventory)

After an IBM 3494 is first installed, a *teach* process must be performed. The teach process sets up and initializes the Library Manager database before the client uses it. An IBM SSR performs the teach operation from the Library Manager service menu.

For the teach operation, the IBM SSR specifies the following configuration information on the Library Manager windows:

- ▶ **Customer identifier:** Enter the client's name.
- ▶ **Library sequence number:** Enter a unique five-digit number for each logical library in the IBM 3494. A *logical library* is really a group of tape drives. All non-VTS drives are in one logical library. Each VTS within an IBM 3494 has its own library sequence number as well. The frame serial numbers of the L frame and any B frames are often used as the library sequence numbers, but this naming scheme is not required.

Note: The library sequence number is also important for the hardware configuration definition (HCD), the integrated storage management facility (ISMF), and JES3 definitions. To allow easy identification of the library, we recommend that you use the last five digits of the IBM machine number of the Model Lxx frame or, if a VTS is installed, of the Model Bxx frame, as the Library ID.

- ▶ **Default media type:** The options are:
 - 1 for CST cartridges (MEDIA1)
 - E for ECCST (MEDIA2)
 - J for 3590 HPCT (MEDIA3)
 - K for 3590 EHPCT (MEDIA4)
 - JA for 3592 ETC (MEDIA 5)
 - JW for 3592 EWTC (MEDIA 6)
 - JJ for 3592 EETC (MEDIA 7)
 - JR for 3592 EEWTC (MEDIA 8)
 - JB for 3592 EEETC (MEDIA 9)
 - JX for 3592 EEEWTC (MEDIA 10)
 - None in mixed 3490, 3590, and 3592 device type libraries

Use this default if a cartridge is inserted that is neither labeled with the seventh character identifying the media type nor defined to the Library Manager in a range of a given media type. You can specify none.

The barcoded seventh character, default media type, and definitions of volume ranges to the Library Manager are three ways that the IBM 3494 can distinguish to which media type a volume belongs (see 9.4.5, "Setting VOLSER ranges for media types" on page 410). All three ways can be in use.

- ▶ **Password required:** Specify whether the Library Manager systems administrator level and service level functions are to be password-protected.
- ▶ **Adjacent frame inventory update:** Specify whether the IBM 3494 inventories only the frame whose operator door has been opened or the frames next to that frame as well.

At any time, you can enable or disable the inventory update through the operator menu of the Library Manager.
- ▶ **Library frames:** Specify the number and types of frames in the IBM 3494 configuration: control unit frame, drive unit frames, storage unit frames, and Virtual Tape Server.
- ▶ **High availability unit:** When installed, specify the dual accessors and service bays.
- ▶ **Dual Active Accessor:** When installed, specify enabled or disabled.
- ▶ **Tape subsystems:** Specify the number and type of tape drives installed in the control unit frame and each drive unit frame.
- ▶ **Device addresses:** Specify the client-defined tape drive addresses to simplify identifying the drive if a problem occurs.
- ▶ **Dual gripper:** Specify whether the dual gripper (FC5215) is installed.

- ▶ **High-capacity output facility:** Specify the number of cells to reserve for the high-capacity output facility.
- ▶ **High-capacity input/output facility:** Specify the number of cells to reserve for the high-capacity input/output facility.
- ▶ **Convenience I/O station:** Specify whether the control unit frame contains the convenience I/O station (FC5210 or FC5230).
- ▶ **Plant of manufacture:** Enter the prefix from the machine serial number.
- ▶ **Home cell mode:** Specify the home cell mode as either fixed home cell mode or floating home cell mode. The floating home cell mode is allowed only when the dual gripper or Dual Active Accessor feature is installed.

The Library Manager database is then created with one cell table, one device table, and the system files.

Starting with the first component in the configuration and continuing until all components are taught, the cartridge accessor is directed to find one or more teach points on the components. The initial location for a teach point is established by the component type and location in the library. A sensor system is then used to center the cartridge accessor on a teach target. When the High Availability unit is installed, the teach process is repeated with the second cartridge accessor.

When all component positions are taught, the Library Manager reinitializes itself with the created database. The library can then proceed to the initial inventory operations.

A partial teach process is allowed if you add or remove features or frames, modify certain options, or an untaught component exists from a previously taught configuration. A partial teach does not create a new Library Manager database. It only updates the information for those components that changed.

After the library is taught, but before you can place it in the online operational state (see Chapter 9, “Operating the IBM TotalStorage 3494 Tape Library” on page 391), you must perform an initial inventory operation called *Inventory New Storage* to create entries in the database. The inventory operation uses the barcode reader to scan all cartridge storage cells of the library, looking for volumes with their VOLSER and media type labels. After all frames are inventoried, the database is completed, and the library is made available to enter the online operational state.

For libraries equipped with one or two VTS units, it is necessary to perform *Insert Virtual Volumes*. This insert is permanent, and you must plan this insert carefully. You must not insert more virtual volumes than are necessary. Even though the virtual volumes can be ejected one at a time, this approach is not desirable. It is simple to add more virtual volumes at any time. See *IBM TotalStorage Virtual Tape Server Planning, Implementing, and Monitoring*, SG24-2229.

The *IBM TotalStorage Enterprise Automated Tape Library (3494) Introduction and Planning Guide*, GA32-0448-14, provides information about the tasks that you must perform to continue the installation of the IBM 3494. The following chapters in this guide provide detailed information about installation verification and software implementation.

2.6 Tape library configuration options

This section provides information about IBM 3494 model conversions, chargeable and nonchargeable feature codes, media, language, and power feature codes. It also presents the RPQs that are available for the IBM 3494.

2.6.1 Specific features

You select specific features when ordering a 3494 from the plant (refer to Table 2-7). These features tell the plant which configuration you want and allow the plant to provide the right hardware for the installation of the 3494 frames and tape subsystems that will populate the tape library. Note that you must include the actual tape drives and control units (as well as their associated features) in the configuration and order them with their specific machine types, models, and feature numbers.

Note: For a complete list and description of the IBM 3494 models and feature codes, refer to the *IBM TotalStorage Enterprise Automated Tape Library (3494) Introduction and Planning Guide*, GA32-0448-14, or you can also reference the 3494 announcement letters.

Table 2-7 Specify feature codes

Feature code	Maximum quantity	Description
FC9002	7 (see Note 1)	Storage Unit Attach (2-8 frames)
FC9003	7 (see Note 2)	Drive Unit Attach (2-8 frames)
FC9004	4 (see Note 2)	Storage Unit Attach (9-16 frames)
FC9005	4 (see Note 2)	Drive Unit Attach (9-16 frames)
FC9006	1 (see Notes 3 and 4)	VTs Attachment < 9 frames
FC9007	1 (see Notes 3 and 4)	VTs Attachment < 9 frames
FC9010	1 (see Note 5)	Attach to a VTs
FC9011	1	Additional Drive Support
FC9012	1	Attach Additional Drives
FC9015	1 (see Note 6)	Attached to Control Unit
FC9020	2 (see Notes 7 and 8)	B20, B10, or B18 VTs Attachment
FC9021	2	Virtual Drives Enhancement
FC9040	1 (see Note 9)	High Availability Attachment
FC9041	1 (see Note 10)	High Availability Direct Attachment (withdrawn)
FC9045	1	Enhanced Library Manager (withdrawn)
FC9046	1	PCI Library Manager (withdrawn)
FC9047	1	LAN PCI Library Manager (Plant)
FC9060	15 (see Note 11)	Attach A60 to 3494 Concentrator
FC9061	15 (see Note 11)	Attach A60 to 3494 RS-422
FC9062	1	Adjacent Frame Drives: Plant Installation

Feature code	Maximum quantity	Description
FC9104	1 (see Note 12)	System i i5/OS Attach
FC9106	1 (see Note 12)	System p AIX attach
FC9109	1 (see Note 12)	Attach to S/390 or System z
FC9184	1 per Lxx Frame of HA1 Frame	Ethernet-Attached Serial Hub (EASH) Enablement
FC9200	1	Open Systems Device Drivers
FC9201	N/A	VTs Open Systems Device Drivers
FC9203	32	Virtual Storage Extended LAN Device Driver (withdrawn)
FC9204	32	Sun Device Driver (withdrawn)
FC9210	32	Hewlett-Packard UNIX (HP-UX) Attachment
FC9211	32	Sun Solaris Attach
FC9212	32	Microsoft Windows Attach
FC9215	1	Other Linux System Attach
FC9216	1	System z Linux Attach
FC9217	1	VTs attached to 3953 Library Manager
FC9492	1	External Fabric Support: Plant Installation
FC9493	1	Direct Connect Drives: Plant Installation
FC9510	6 (see Note 23)	Plant Install Fibre Drive
FC9511	4	Plant Install Fibre Drive
FC9540	1 (see Note 14)	No Data Cartridge
FC9601	1 (see Note 15)	3490E Model Cx/F1A Plant Installation
FC9602	2 (see Note 16)	3490E Model F1A Plant Installation
FC9630	x (see Notes 17, 18, and 19)	Field Merge Drives
FC9631	x (see Notes 17, 18, and 19)	3590 Model B1A Drive Plant Installation
FC9632	2 (see Note 16)	3490E Model F1A Attachment Hardware for Field Merge
FC9663	x (see Notes 17, 18, and 19)	3590 Model E1A Drive Plant Installation (withdrawn)
FC9665	1 (see Note 19)	3590 Model A60 Attachment Hardware for Field Merge (withdrawn)
FC9666	1 (see Note 20)	3590 Model A60 Controller Plant Installation
FC9669	x (see Note 21)	3590 H1A SCSI Tape Drive Plant Installation (withdrawn)
FC9670	x (see Note 21)	3590 H1A Fibre Channel Tape Drive Plant Installation (withdrawn)
FC9671	x (see Note 21)	Field Merge 3590 Model H1A Tape Drive (withdrawn)

Feature code	Maximum quantity	Description
FC9673	x (see Note 22)	Plant Install 3592 Model J1A Tape Drive (withdrawn)
FC9674	x (see Note 22)	Field Merge 3592 Model J1A Tape Drive
FC9676	x (see Note 22)	Plant Install 3592 Model E05 Tape Drive
FC9678	x (see Note 22)	Field Merge 3592 Model E05
FC9683	x (see Note 23)	Plant Install 3592-E06 Tape Drive
FC9684	x (see Note 27)	Field Merge 3592-E06 Tape Drive
FC9690	N/A (See Note 26)	Field Merge AX0
FC9691	N/A (See Note 26)	Plant Installation AX0
FC9694	x (see Note 28)	Field Merge 3592 EU6 Tape Drive
FC9700	N/A	FICON Cable From Plant
FC9702	4	Interposer, Double-Byte Wide
FC9775	16	62.5-Micron MT-RJ to ESCON 2 meter ESCON Jumper Cable
FC9780	1 (see Note 24)	Extended Media Support
FC9798	4	Inline SCSI Terminator (withdrawn from marketing)
FC9799	4	VHDCI Cable/Interposer
FC9865	1	Field Merge J70 in a 3494 Model D14/D24 Frame (withdrawn from marketing)
FC9866	1	Plant Install J70 in a 3494 Model D14/D24 Frame (withdrawn from marketing)
FC9986	1 (see Note 25)	Chicago Power Cable

Notes:

1. You can configure a maximum of seven FC5300, FC5302, FC5304, FC5400, FC9002, FC9003, and one FC9006 in any combination. When you install the 3494-HA1 option, you can expand the library to five through 10 frames, including the service bays, by the addition of FC9002, FC9003, and one FC9007.
2. You can expand the library to 16 frames by adding any combination of FC9004, FC9005, and one FC9007 for each library. When you install the 3494-HA1 option, you can expand the library to 18 frames, including the service bays, by the addition of any combination of FC9004, FC9005, and one FC9007 for each library.
3. To add a 3494-B16 VTS to a library, you must specify a maximum of one FC9006 or FC9007 for the 3494-Lxx frame to track the number of frames installed in the library and to provide any necessary hardware.
4. The 3494-B16 VTS attachment requires FC5214, FC5228, and FC5229.
5. This feature indicates that the 3590-x1A tape drives inside the 3494-D12 frame or the 3592 tape drives inside the 3494-D22 frame will be used in a VTS.
6. This feature indicates that you plan to use the 3592 tape drives inside the 3494-D22 frame for fibre attachment to the TS1120 Model C06 Controller.

7. FC9020 must be on the 3494-Lxx frame for each attached 3494-B18, 3494-B10, or 3494-B20 VTS.
8. There is a maximum of two FC9006, FC9007, and FC9020.
9. Within the 3494-Lxx frame, a maximum of one FC9040 is required if you install the 3494-HA1 option. FC9040 can also be an MES. FC9040 includes the Enhanced Library Manager when the existing Library Manager is not an Enhanced Library Manager.
10. If ordered on the 3494-HA1 option, it indicates LAN or SCSI attachment and you must order it on all library frames.
11. The maximum of 15 FC9060 or FC9061 applies only to the 3494-Lxx frame. A maximum of one FC9060 or FC9061 applies only to 3494-D14 frames that contain the 3590-A60 controller.
12. You must specify a minimum quantity of one FC9104, FC9106, or FC9109.
13. The maximum of six FC9510 applies to any 3494-D12 frame that contains Fibre Channel-attached 3590-E1A tape drives or 3590-H1A tape drives. For 3494-L12 frames that contain Fibre Channel-attached 3590-E1A tape drives or 3590-H1A tape drives, the maximum of FC9510 is two.
14. You must specify either FC9540, FC8410, FC8420, FC8510, FC8520, or FC8610 for each frame.
15. A maximum of one FC9601 or MES 4630 is permitted on a 3494-D10 frame.
16. A maximum of two FC9602, FC9632, or MES4632 is permitted on a 3494-L10 frame or a 3494-D10 frame.
17. A maximum of two FC9630, FC9631, FC9663, MES 4630, or MES 4663 is permitted on a 3494-L12 frame or a 3494-L14 frame.
18. A maximum of six FC9630, FC9631, FC9663, MES 4630, or MES 4663 is permitted on a 3494-D12 frame. When attached to a 3494-B16 VTS, the 3494-D12 frame must contain three, four, five, or six 3590-B1A tape drives. When attached to a 3494-B18 VTS, the 3494-D12 frame must contain three, four, five, or six 3590-B1A tape drives, 3590-E1A tape drives, or 3590-H1A tape drives. When attached to a 3494-B18 VTS with FC5236, the 3494-D12 frame must contain four, five, or six 3590-B1A tape drives, 3590-E1A tape drives, or 3590-H1A tape drives.
19. A maximum of four FC9630, FC9631, FC9663, MES 4630, or MES 4663 is permitted on a 3494-D14 frame.
20. A maximum of one FC9665, FC9666, MES 4665, or MES 4660 is permitted on a 3494-D14 frame.
21. There is a maximum of six FC9630, FC9631, FC9663, FC9669, FC9670, FC9671, FC4630, FC4663, FC4670, or FC4671 on a 3494-D12 frame. This maximum is four for the 3494-D14 frame and two for the 3494-L12 frame.
22. There is a maximum of four FC4673, FC4674, FC4675, FC9673, FC9674, FC9676, or FC9678 in a 3494-D22 frame when FC4065, FC4075, or FC4085 is installed. Otherwise, the maximum is twelve. This maximum is eight in a 3494-D24 frame and four for the 3494-L22 frame.
23. FC9683 causes the plant to install one 3592-E06 tape drive into one of L22 frame, D22 frame, and D24 frame. If you order FC9683 for a 3494-D22 frame or 3494-D24 frame, one of the cradle features, FC4800 or FC4803 with an available canister slot must also be installed.
24. FC9780 must be on the 3494-Lxx frame if 3590 K-type (EHPCT) cartridges exist in the IBM 3494 Tape Library. FC9780 must also be on the 3494-D12 frames and the 3494-D14 frames that contain 3590-x1A tape drives with Extended Media Support.

25. There is a maximum of one FC9986 per model except for the 3494-S10 frame, which cannot have any, and the 3494-HA1 option, which requires two.
26. FC9690 and FC9691 have been withdrawn from marketing as of 01 December 2006.
27. FC9684 provides for the installation of a client-owned 3592-E06 tape drive in a new order for any of L22 frame, D22 frame, and D24 frame. A cradle with an available canister slot must already be present in the rack to accept the drive canister. The drive installation is done by the IBM SSR at the client's site during the final installation of the 3494-D22 frame or the 3494-D24 frame.
28. FC9694 provides for the installation of a client-owned 3592-E06 tape drive in a new order for any of D22 frame or D24 frame. A cradle with an available canister slot must already be present in the rack to accept the drive canister. The drive installation is done by the IBM SSR at the client's site during the final installation of the 3494-D22 frame or the 3494-D24 frame.

2.6.2 Field MES features

Table 2-8 shows the field MES features for adding tape drives, controllers, or VTS controllers to, or removing them from, frames in the 3494.

Note: For a complete list and description of the IBM 3494 models and feature codes, refer to the *IBM TotalStorage Enterprise Automated Tape Library (3494) Introduction and Planning Guide*, GA32-0448-14, or you can also reference the 3494 announcement letters.

Table 2-8 Field MES feature codes

Feature code	Description
FC4062	FC4062 on an L12, L14, or D12 frame provides the hardware needed to attach 3590 tape drives to the 3590 Model A60 Controller in an adjacent D14 frame. The adjacent D14 frame must have four 3590 tape drives installed and be attached to the 3590 Model A60 Controller. You must specify FC4060 (Adjacent Frame Support) on the adjacent D14 frame. If you install another controller in the L14 frame, it will not function.
FC4074	FC4074 allows for a Fibre Channel cable from each tape drive to the 2109 Model F16 switch in a 3494-D14 frame with the 3590-A60 controller or the 3592-J70 Controller to be included, based on the number of tape drives installed in the frame.
FC4630	FC4630 provides the hardware needed to allow the field installation of one 3490E Model C1A or C2A in an L10 frame or D10 frame or one 3590 Model B1A or E1A tape subsystem in an L12, L14, D12, or D14 frame. If you order FC4630 for an L14 frame or D14 frame, one of the following must have been installed previously or you must order it: FC4635 FC9635 FC9636 FC4655 FC9655 FC9656 FC4665 FC9665 FC9666
FC4632	FC4632 provides the hardware needed to allow the field installation of one 3490E Model F1A tape drive. Order FC4632 for the L10 frame or D10 frame (maximum of two). A prerequisite on the L10 frame or D10 frame is FC9602 or FC9632.

Feature code	Description
FC4633	FC4633 provides the hardware needed to replace a 3490E Model C1A or C2A tape drive in a D10 frame with a 3490E Model F1A tape drive. There is a maximum quantity of one.
FC4646	FC4646 allows the field installation of a 3490E Model F1A FC3500 controller in an L10 frame or D10 frame. There is a maximum quantity of one for FC4646.
FC4660	FC4660 provides the hardware needed to replace a 3590 Model A00 or A50 controller with a 3590 Model A60 controller in a D14 frame.
FC4663	FC4663 is required to replace a 3590 Model B1A tape drive with a 3590 Model E1A tape drive in a currently installed 3494 frame. The Model B1A and E1A tape drives cannot be attached to the same VTS or the same 3590 Model A50 or A60 controller; therefore, both types of drives cannot be installed together in the L14 frame or D14 frame.
FC4665	FC4665 provides the hardware needed to allow the field installation of one 3590 Model A60 controller in a D14 frame. If you order FC4665 for a D14 frame, you must also order FC4630.
FC4670	FC4670 provides the mounting changes needed to replace a 3590-B1A or 3590-E1A tape drive with a 3590-H1A tape drive in a currently installed D12 frame, D14 frame, or L12 frame. The maximum number of features is six for the D12, four for the D14, and two for the L12.
FC4671	FC4671 is required on a D12 frame, D14 frame, or L12 frame in order to add a 3590 Model H1A tape drive to a D12 frame, D14 frame, or L12 frame. There is a maximum of six FC9630, FC9631, FC9663, FC9669, FC9670, FC9671, FC4630, FC4663, FC4670, or FC4671 on a D12 frame. This maximum is four for the D14 frame and two for the L12 frame.
FC4673	FC4673 is required to replace a 3592-J1A tape drive with a 3592-E05 tape drive in a currently installed 3494-D22 frame. The maximum is eight for the 3494-D22 frame if FC4065 or FC4075 is installed. Otherwise, the maximum is twelve. These maximums apply to the sum of FC4673, FC4674, FC4675, FC9673, FC9674, FC9676, and FC9678 in any 3494-D22 frame. FC4673 is not available if FC9010 is installed.
FC4674	FC4674 installs a 3592 Model J1A tape drive in a currently installed 3494 Model D22. A cradle with an available canister slot must already be present in the rack to accept the drive canister. The maximum is eight for the D22 frame if FC4065 or FC4075 is installed. Otherwise, the maximum is twelve. These maximums apply to the sum of FC4674 and FC9673 in any D22 frame.
FC4675	FC4675 installs a 3592-E05 tape drive in a currently installed 3494-D22 frame. A cradle with an available canister slot must already be present in the rack to accept the drive canister. The maximum is eight for the 3494-D22 frame if FC4065 or FC4075 is installed. Otherwise, the maximum is twelve. These maximums apply to the sum of FC4673, FC4674, FC4675, FC9673, FC9674, FC9676, and FC9678 in any 3494-D22 frame.

Feature code	Description
FC4676	FC4676 installs a 3592-E06 tape drive in a currently installed 3494-D22 frame, 3494-D24 frame, and 3494-L22 frame. A cradle with an available canister slot (FC4800 or FC4803) must be already present in the rack to accept the drive canister. The maximum is four. This maximum applies to the sum of FC9673, FC9674, FC9676, FC9678, FC4673, FC4674, FC4675, FC4676, FC4677, and FC9694.
FC4677	FC4677 installs a 3592-EU6 tape drive in a currently installed 3494-D22 frame, 3494-D24 frame, and 3494-L22 frame. A cradle with an available canister slot (FC4800 or FC4803) must be already present in the rack to accept the drive canister. The maximum is four. This maximum applies to the sum of FC9673, FC9674, FC9676, FC9678, FC4673, FC4674, FC4675, FC4676, FC4677, and FC9694.
FC4678	FC4678 replace existing 3592-J1A or E05 tape drives currently installed in a 3494-D22 frame, 3494-D24 frame, and 3494-L22 frame, with the 3592-E06 or EU6 tape drives. A cradle with an available canister slot (FC4800 or FC4803) must be already present in the rack to accept the drive canister.
FC4690 (withdrawn from marketing as of 01 December 2006)	FC4690 provides the hardware needed to allow the field installation of one AX0 in a CX0.
FC4691 (withdrawn from marketing as of 01 December 2006)	FC4691 provides the hardware needed to allow the field installation of one AX0 in a CX1. The maximum is two.
FC4700	FC4700 removes a 3490E Model F1A FC3000 or FC3500 controller from an L10 frame or D10 frame.
FC4701	FC4701 removes a 3490E Model F1A tape drive from an L10 frame or D10 frame.
FC4704	FC4704 provides for installation of a Fibre Channel cable from each tape drive to the 2109 Model F16 SAN switch in the 3494-D14 frame with the 3590-A60 controller or the 3592 tape drive for inclusion based on the number of tape drives installed in this frame.
FC4730	FC4730 removes a 3590 tape drive from an L12, L14, D12, or D14 frame.
FC4734	FC4734 removes the 3490E Model F1A FC3000 or FC3500 controller mounting hardware from an L10 frame or a D10 frame.
FC4735	FC4735 removes a 3590 Model A00 controller from an L14 frame or a D14 frame.
FC4755	FC4755 removes a 3590 Model A50 controller from an L14 frame or a D14 frame.
FC4765	FC4765 removes a 3590 Model A60 controller from a D14 frame.
FC4772	FC4772 removes a 3592 Model J1A tape drive from a L22 frame.

Feature code	Description
FC4800	FC4800 provides the hardware needed to allow the field installation of two drive-pair cradles for accepting 3592 Model J1A tape drives in a 3494.
FC4801	FC4801 removes two drive-pair cradles used for accepting 3592 Model J1A tape drives in a 3494.
FC4803	FC4803 reinstalls two drive-pair cradles for accepting 3592 Model J1A tape drives in a 3494. It is equivalent to FC4800, except the assumption is that the majority of the hardware is already available from a previous installation.
FC4855	FC4855 provides the hardware needed to allow the field installation of a 3592 Model J70 Controller in a currently installed D14 or D24 frame.
FC4860	FC4860 provides the hardware needed to allow the field replacement of a currently installed controller with a 3592 Model J70 Controller in a D14 or D24 frame.
FC4865	FC4865 removes a 3592 Model J70 Controller from a D14 or D24 frame.
FC5238	FC5238 provides two fibre cards to support operation of 3592 tape drives in a 3494-B20 VTS. You can only order this feature as a field MES for a 3494-B20 VTS.
FC5264	FC5264 provides 64 additional virtual tape drives. FC5264 is only available for 3494-B18 VTS to 3494-B20 VTS conversions in which the 3494-B18 VTS has 128 virtual tape drives (one FC5264) and the 3494-B20 VTS has 256 virtual tape drives (two FC5264s).
FC5265	FC5265 provides 64 additional virtual tape drives for the 3494-B20 VTS. You can order this feature in a quantity of zero, two, or four for each VTS. FC5265 is not available if FC5264 is installed. In a PtP VTS configuration: <ul style="list-style-type: none"> ▶ Zero FC5265s allow 128 virtual devices with eight VTCs. ▶ Two FC5265s allow 128 virtual devices with four VTCs. ▶ Four FC5265s allow 256 virtual devices with eight VTCs.
FC5593	Router for Encryption Key Manager (EKM) Attachment. Install one of FC5593 on the 3494 Library Manager (Model L10, L12, L14, and L22) to support up to seven 3592 tape controllers. FC5246, Dual Path Concentrator, is required on the Library Manager, before you can install FC5593. You can install a second Router for EKM Attachment feature on the 3494 Library Manager to support up to fourteen 3592 tape controllers. FC5593 provides two routers for redundant connections between the Encryption Key Manager and the tape control unit. This feature code also provides Ethernet cables from the routers to the control unit.

2.6.3 IBM 3494 feature code summary

The following section explains various feature codes available for the IBM 3494 Tape Library. You can order these features from the plant, or you can field-install them.

Note: For a complete list and description of the IBM 3494 models and feature codes, refer to the *IBM TotalStorage Enterprise Automated Tape Library (3494) Introduction and Planning Guide*, GA32-0448-14, or you can also reference the 3494 announcement letters.

Table 2-9 IBM 3494 Tape Library special features

Feature code	Maximum quantity	Description
FC0201	8	9 micron LC/LC 31 meter (100 ft.)
FC0202	8	9 micron LC/LC 31 meter (100 ft.)
FC0203	8	50 micron LC/LC 31 meter (100 ft.)
FC0204	8	50 micron LC/LC 31 meter (100 ft.)
FC0205	8	62.5 micron LC/LC 31 meter (100 ft.)
FC0206	8	62.5 micron LC/LC 31 meter (100 ft.)
FC0520	N/A	Library Functional Enhancement (Field Install) (see Note 1)
FC0521	N/A	Microcode Update for VTS/VTC (Field Install) (see Note 2)
FC1001	4 per CX1	ESCON Virtual Tape Controller (Plant Install) (withdrawn from marketing as of 01 December 2006)
FC1011	4 per CX1	FICON Virtual Tape Controller with Host to VTC: Longwave (LW) LW and VTC to VTS: LW LW (Plant Install) (withdrawn from marketing as of 01 December 2006)
FC1012	4 per CX1	FICON Virtual Tape Controller with Host to VTC: LW LW and VTC to VTS: Shortwave (SW) SW (Plant Install) (withdrawn from marketing as of 01 December 2006)
FC1013	4 per CX1	FICON Virtual Tape Controller with Host to VTC: LW LW and VTC to VTS: LW SW (Plant Install) (withdrawn from marketing as of 01 December 2006)
FC1014	4 per CX1	FICON Virtual Tape Controller with Host to VTC: SW SW and VTC to VTS: LW LW (Plant Install) (withdrawn from marketing as of 01 December 2006)
FC1015	4 per CX1	FICON Virtual Tape Controller with Host to VTC: SW SW and VTC to VTS: SW SW (Plant Install) (withdrawn from marketing as of 01 December 2006)
FC1016	4 per CX1	FICON Virtual Tape Controller with Host to VTC: SW SW and VTC to VTS: LW SW (Plant Install) (withdrawn from marketing as of 01 December 2006)

Feature code	Maximum quantity	Description
FC1017	4 per CX1	FICON Virtual Tape Controller with Host to VTC: LW SW and VTC to VTS: LW LW (Plant Install) (withdrawn from marketing as of 01 December 2006)
FC1018	4 per CX1	FICON Virtual Tape Controller with Host to VTC: LW SW and VTC to VTS: SW SW (Plant Install) (withdrawn from marketing as of 01 December 2006)
FC1019	4 per CX1	FICON Virtual Tape Controller with Host to VTC: LW SW and VTC to VTS: LW SW (Plant Install) (withdrawn from marketing as of 01 December 2006)
FC1020	4 per CX1	FICON Virtual Tape Controller with Host to VTC: LW LW and VTC to VTS: SW LW (Plant Install) (withdrawn from marketing as of 01 December 2006)
FC1021	4 per CX1	FICON Virtual Tape Controller with Host to VTC: SW SW and VTC to VTS: SW LW (Plant Install) (withdrawn from marketing as of 01 December 2006)
FC1022	4 per CX1	FICON Virtual Tape Controller with Host to VTC: LW SW and VTC to VTS: SW LW (Plant Install) (withdrawn from marketing as of 01 December 2006)
FC1023	16 per CX1, 4 per VTC	Convert Longwave (LW) to Shortwave (SW) Adapter (return LW adapter) (withdrawn from marketing as of 01 December 2006)
FC1024	16 per CX1, 4 per VTC	Convert Shortwave (SW) to Longwave (LW) Adapter (return SW adapter) (withdrawn from marketing as of 01 December 2006)
FC1025	8 per CX1, 2 per VTC	Reposition Longwave (LW) and Shortwave (SW) Adapter
FC1026	4 per CX1	8-VTC to 4-VTC PtP VTS Conversion
FC1101	4 per CX1	ESCON Virtual Tape Controller (Field Install) (withdrawn from marketing as of 01 December 2006)
FC1111	4 per CX1	FICON Virtual Tape Controller with Host to VTC: LW LW and VTC to VTS: LW LW (Field Install) (withdrawn from marketing as of 01 December 2006)
FC1112	4 per CX1	FICON Virtual Tape Controller with Host to VTC: LW LW and VTC to VTS: SW SW (Field Install) (withdrawn from marketing as of 01 December 2006)
FC1113	4 per CX1	FICON Virtual Tape Controller with Host to VTC: LW LW and VTC to VTS: LW SW (Field Install) (withdrawn from marketing as of 01 December 2006)

Feature code	Maximum quantity	Description
FC1114	4 per CX1	FICON Virtual Tape Controller with Host to VTC: SW SW and VTC to VTS: LW LW (Field Install) (withdrawn from marketing as of 01 December 2006)
FC1115	4 per CX1	FICON Virtual Tape Controller with Host to VTC: SW SW and VTC to VTS: SW SW (Field Install) (withdrawn from marketing as of 01 December 2006)
FC1116	4 per CX1	FICON Virtual Tape Controller with Host to VTC: SW SW and VTC to VTS: LW SW (Field Install) (withdrawn from marketing as of 01 December 2006)
FC1117	4 per CX1	FICON Virtual Tape Controller with Host to VTC: LW SW and VTC to VTS: LW LW (Field Install) (withdrawn from marketing as of 01 December 2006)
FC1118	4 per CX1	FICON Virtual Tape Controller with Host to VTC: LW SW and VTC to VTS: SW SW (Field Install) (withdrawn from marketing as of 01 December 2006)
FC1119	4 per CX1	FICON Virtual Tape Controller with Host to VTC: LW SW and VTC to VTS: LW SW (Field Install) (withdrawn from marketing as of 01 December 2006)
FC1120	4 per CX1	FICON Virtual Tape Controller with Host to VTC: LW LW and VTC to VTS: SW LW (Field Install) (withdrawn from marketing as of 01 December 2006)
FC1121	4 per CX1	FICON Virtual Tape Controller with Host to VTC: SW SW and VTC to VTS: SW LW (Field Install)
FC1122	4 per CX1	FICON Virtual Tape Controller with Host to VTC: LW SW and VTC to VTS: SW LW (Field Install) (withdrawn from marketing as of 01 December 2006)
FC1901	1	Dual AC Power
FC2710	1 (see Note 3)	Remote Support Facility (Withdrawn as of 31 December 2004)
FC2711	1 (see Note 3)	Remote Support Switch (Withdrawn as of 31 December 2004)
FC2712	1 (see Note 3)	Remote Support Attachment (Withdrawn as of 31 December 2004)
FC2713	1 (see Note 3)	Master Console for Service (Withdrawal from Marketing as of 9 May 2006)
FC2714	1 (see Note 3)	Console Expansion
FC2715	1 (see Note 3)	Console Attachment
FC2716	1	Console Additional Modem

Feature code	Maximum quantity	Description
FC2717	1	Console A60 Enablement
FC2720	1 (see Note 3)	TS3000 System Console
FC3000	1 (B10); 1 (B20)	FICON Enablement
FC3060	4 through 12 (see Note 4)	3592 Drive-to-Switch Cables
FC3061	16	3592 Drive-to-Switch Cables
FC3200	1 (B18 only)	ESCON High Performance Option (withdrawn from marketing)
FC3302	1 (B18 only)	Additional Enhanced ESCON Channel Attachment (withdrawn from marketing)
FC3400	1	Extended High Performance Option (withdrawn from marketing as of 01 December 2006)
FC3412	2 (B10); 4 (B20)	Extended Performance ESCON Channels (withdrawn from marketing as of 01 December 2006)
FC3415	4 (B10); 8 (B20)	FICON Channels (longwave)
FC3416	4 (B10); 8 (B20)	FICON Channels (shortwave)
FC3418	1 (B10); 4 (B20)	Activate Additional ESCON Channels
FC3422	2 (B10); 4 (B20)	Activate Additional ESCON Channels (withdrawn from marketing as of 01 December 2006)
FC3464	1	SC Fibre Drive Attached Controller
FC3474	1	LC Fibre Drive Attached Controller
FC3486	1	Fibre Channel switch Mount Kit
FC3487	2	2 Gbit Fibre Channel switch (withdrawn as of 29 September 2006)
FC3488	2	4 Gbit Fibre Channel switch
FC3490	1	Redundant Fibre Channel Attach
FC3491	1	External Fabric Support - Field (J70)
FC3492	1	External Fabric Support - Field (C06)
FC3493	1	Direct Connect Drives - Field
FC3511	6 (see Note 5)	Install Fibre Channel Drive
FC3701	4 (see Note 6)	36 GB Disk Storage Capacity for Tape Volume Cache, Model B16 (withdrawn from marketing)
FC3702	4 (B18) (see Note 7)	Disk Storage Capacity (withdrawn from marketing)
FC3703	1 (B18) (see Note 8)	72 GB Disk Storage (withdrawn from marketing)
FC3704	1 (B10)	144/216 GB Disk Storage (withdrawn from marketing as of 01 December 2006)

Feature code	Maximum quantity	Description
FC3705	1 (B10); 4 (B20)	288/432 GB Disk Storage
FC4000	1 (see Note 9)	Advanced Function
FC4001	1	Advanced Policy Management up to 250 GB
FC4002	1	Advanced Policy Management up to 500 GB
FC4003	1	Advanced Policy Management up to 1000 GB
FC4004	1	Advanced Policy Management up to 2000 GB
FC4010	1 (see Note 10)	PtP Copy Base
FC4011	1 (see Note 10)	PtP Copy Increment 1
FC4012	1 (see Note 10)	PtP Copy Increment 2
FC4013	1 (see Note 10)	PtP Copy Increment 3
FC4020	1	High Capacity Cache (withdrawn from marketing as of 01 December 2006)
FC4021	3	Expanded Storage Capability
FC4036	5 (see Note 11)	Logical Volume Expansion
FC4060	1	Adjacent Frame Support
FC4064	1	Multiframe Fibre Drives
FC4065	4	Adjacent Frame 3592 Drive Connection for SC-Duplex Switch Port
FC4075	4	Adjacent Frame 3592 Drive Connection for LC-Duplex Switch Port
FC4084	2	Adjacent Frame 2 Gbit (3590)
FC4085	2	Adjacent Frame 2 Gbit (3592)
FC4086	2	Adjacent Frame x22 to D22 (3592)
FC5001	8 (see Note 12)	4.5-Meter SCSI Cable (withdrawn from marketing as of 01 December 2006)
FC5002	8 (see Note 12)	10-Meter SCSI Cable (withdrawn from marketing as of 01 December 2006)
FC5003	8 (see Note 12)	20-Meter SCSI Cable (withdrawn from marketing as of 01 December 2006)
FC5004	8 (see Note 12)	10-Meter SCSI VHDCI Cable (withdrawn from marketing as of 01 December 2006)
FC5045	1 (see Note 13)	Enhanced Library Manager (withdrawn)
FC5046	1 (see Note 14)	PCI Library Manager (withdrawn as of 29 October 2004)
FC5047	8 (see Note 14)	LAN PCI Library Manager (Field)
FC5050	1 (see Note 15)	Dual Active Accessors
FC5184	1 per Lxx or Dxx frame	Ethernet-Attached Serial Hub (EASH)

Feature code	Maximum quantity	Description
FC5210	1 (see Note 16)	10-Cartridge Convenience I/O Station
FC5211	8 (see Note 17)	System i Host Attachment
FC5212	8 (see Note 17)	RS/6000 Host Attachment (withdrawn from marketing)
FC5213	8 (see Notes 17 and 18)	Extended Length RS-232 Host Attachment for System i
FC5214	1 (see Notes 9 and 19)	Second Disk Drive for Library Manager (withdrawn from marketing as of 2 July 2004)
FC5215	1 (see Note 20)	Dual Gripper
FC5216	1	Remote Power Sequence for System i
FC5217	8	RS-232 15 m (50 ft.) Extension Cable
FC5219	1 (see Notes 9, 21, and 22)	Token-Ring Adapter (withdrawn from marketing as of 2 July 2004)
FC5220	1 (see Notes 20 and 21)	Ethernet Adapter
FC5222	1	Additional 32 LAN Host Attachments
FC5224	16 (see Note 22)	AIX Parallel Channel Tape Attachment/6000 (withdrawn from marketing)
FC5225	1	Base Tape Control Unit Attachment
FC5226	1	Remote Library Manager Console
FC5227	1 (see Notes 20 and 23)	32 Port Attachment
FC5228	2 (see Note 24)	Tape Control Unit Expansion
FC5229	1 (see Notes 20, 21, and 24)	Expansion Attachment Card
FC5230	1 (see Note 16)	30-Cartridge Convenience I/O Station
FC5232	1 (see Notes 25 and 26)	Attachment Concentrator
FC5233	1	SCSI Extender
FC5234	1	18-Meter SCSI Cables (withdrawn from marketing)
FC5235	2 (see Note 27)	20-Meter SCSI Drive Cables
FC5236	1	Performance Accelerator
FC5237	1 (B18)	Additional VTS Drives
FC5238	1 (B10), 1 (B20), (see Note 28)	3592 Drive Attached to VTS
FC5244	1 (B18)	Mirrored VTS Boot Disk
FC5245	1 (see Note 29)	Dual Path Attachment

Feature code	Maximum quantity	Description
FC5246	1	Dual Path Concentrator
FC5250	1 (B20)	FICON Performance Accelerator (withdrawn from marketing as of 01 December 2006)
FC5264	1 (B18) (see Note 30)	64 Additional Virtual Drives
FC5265	4 (B20)	Incremental Virtual Drives
FC5266	1	Outbound TS1120 C06 Controller (installed in 3952-F05 frame) attach to 3494-D24 frame
FC5273	1	SCSI converter
FC5300	7 (see Note 31)	Additional Drive Unit Frame (similar to D10 Frame) (withdrawn from marketing)
FC5302	7 (see Note 31)	Additional Drive Unit Frame (similar to D12 Frame) (withdrawn from marketing as of 01 December 2006)
FC5304	7 (see Note 31)	Additional Drive Unit Frame (similar to D14 Frame)
FC5400	7 (see Note 31)	Additional Storage Unit Frame (similar to S10 Frame) (withdrawn from marketing)
FC5500	1 (see Notes 31 and 32)	Additional Storage Unit (similar to D12 frame without 3590 Model B1As)
FC5502	1 (see Notes 31 and 32)	Drive Unit for B18 (withdrawn from marketing as of 01 December 2006)
FC5503	1 (see Notes 31 and 32)	SCSI Drive Unit
FC5504	1 (see Notes 31 and 32)	ESCON Drive Unit
FC5593	2	Router for EKM Attach
FC8002	10 (see Note 9)	One 3590 Cleaning Cartridge (withdrawn from marketing)
FC8005	10 (see Note 9)	One 3490E Cleaning Cartridge (withdrawn from marketing)
FC8410	1	210 Cartridges (3490E Data Cartridges) (withdrawn from marketing)
FC8420	1	420 Cartridges (3490E Data Cartridges) (withdrawn from marketing)
FC8510	2 (see Note 9)	210 Cartridges (3590 Data Cartridges)
FC8520	1	420 Cartridges (3590 Data Cartridges) (withdrawn from marketing)
FC8610	2 (see Note 9)	210 Cartridges (3590 Extended Length Cartridges)
FC8802	5	One 3592 Cleaning Cartridge

Feature code	Maximum quantity	Description
FC8820	25 sets	Twenty 3592 Data Cartridges (withdrawn as of 29 September 2006)
FC9491	1	External Fabric Support - Plant (J70)
FC9492	1	External Fabric Support - Plant (C06)
FC9493	1	Direct Connect Drives - Plant

Notes:

1. You must order FC0520 against Library Managers installed in 3494-Lxx frames (and the 3494-HA1 option if applicable) shipped prior to 28 October 2005, and also against any installed 3590-A60 Controllers or 3592-J70 Controllers shipped prior to 28 October 2005, in order to support the 3592-E05 tape drive or the 4 Gbit Fibre Channel switch.
2. FC0521 is required to support the 3592-E05 tape drive or the 4 Gbit Fibre Channel switch in VTSs shipped before 28 October 2005.
3. Each 3494-Lxx Frame, 3494-B10 or 3494-B20 VTS, or TS1120 Model C06 Controller must specify one of FC2713, FC2714, FC2715, FC2718, or FC2720. VTCs associated with a 3494-B10 or 3494-B20 VTS in a PtP VTS must have one of these features installed. A 3494-B18 VTS or 3494-AX0 VTC associated with a 3494-B18 VTS in a PtP VTS can optionally have one of these features installed.
4. Each 3592 tape drive ordered for the VTS requires one FC3060. You must order a minimum of four tape drives for the VTS.
5. The maximum of six FC3511 applies to any 3494-D12 frame that contains Fibre Channel-attached 3590-E1A tape drives. For 3494-L12 frames that contain Fibre Channel-attached 3590-E1A tape drives, the maximum of FC3511 is two.
6. FC3701 provides for 36 GB of usable storage capacity for the tape volume cache in a 3494-B16 VTS. You must order a quantity of two or four.
7. You must order FC3702 in a quantity of one, two, three, or four for the 3494-B18 VTS or when converting a 3494-B16 VTS to a 3494-B18 VTS. Ordering FC5236 for an existing 3494-B18 VTS requires a quantity of two or four FC3702.
8. FC3703 is not available for a 3494-B18 VTS with FC5236.
9. Withdrawn as of 2 July 2004.
10. Withdrawn for the 3494-B18 VTS.
11. For the 3494-B20 VTS, you can perform the second through fifth installations of FC4036 concurrently.
12. The maximum of eight FC5001, FC5002, FC5003, or FC5004 applies only to 3494-B10 and 3494-B20 VTSs. For 3494-B18 VTSs, the maximum is four.
13. If the 3494-HA1 option is installed and you order FC5045, you must order FC5045 for *both* the 3494-Lxx frame and the 3494-HA1 option.
14. If you have the 3494-HA1 option installed and you order FC5046 or FC5047, we *strongly* recommend that you order FC5046 or FC5047 for *both* the 3494-Lxx frame and the 3494-HA1 option for performance purposes. However, the intermix of a FC5045 400 MHz processor speed Library Manager and a FC5046 or FC5047 1.2 GHz processor speed Library Manager is supported.
15. FC5050 is available only when the library includes the 3494-HA1 option. This feature is available only for systems with at least four frames, not including service bays and 3494-B18, 3494-B10, or 3494-B20 VTSs.

16. You can select either FC5210 or FC5230.
17. Any combination of FC5211, FC5212, and FC5213 can total no more than eight with FC5229. If you use the LAN attachment, you can attach up to 32 host processors with the appropriate drive switching equipment.
18. Four attachments are standard (up to eight attachments with FC5229).
19. If a 3494-B16, 3494-B18, 3494-B10, or 3494-B20 VTS or a 3494-HA1 option is in the library, FC5214 is required on the 3494-Lxx frame. FC5214 does not apply to 3494-Lxx frames manufactured after October 1999.
20. If FC5215, FC5219, FC5220, FC5227, or FC5229 exist in the Library Manager, you also need to order them for the 3494-HA1 option.
21. You can select an Expansion attachment card and either Token-Ring or Ethernet.
22. Licensing is required for each attached System p. In addition, up to eight System p features are available to permit AIX ESCON tape attachments.
23. If the 3494-Lxx frame was shipped before September 1997, FC9020, FC9040, FC5045, FC5046, or FC5047 is a prerequisite.
24. A 3494-B16 VTS installed in the library requires FC5228 and FC5229.
25. You must order FC5232 for the 3494-Lxx frame when a 3494-B18, 3494-B10, or 3494-B20 VTS or FC9060 is present.
26. If the 3494-Lxx frame was shipped before August 1998, FC9020, FC9040, FC5045, FC5046, or FC5047 is a prerequisite.
27. The maximum of two FC5235s applies only to the 3494-B20 VTS. For the 3494-B10 VTS, the maximum is one.
28. For the 3494-B10 VTS, FC5238 is plant only. For the 3494-B20 VTS, this feature is either plant or field.
29. Ordering FC5245 also requires FC5246 on the 3494-Lxx frame.
30. FC5264 is only allowed for a 3494-B20 VTS for model conversions where the 3494-B18 VTS has FC5264 and the 3494-B20 VTS is ordered with 256 devices (that is, two FC5264s). You are not allowed to order FC5264 against a 3494-B18 VTS in a PtP VTS configuration.
31. A maximum 3494 Tape Library configuration consists of 16 frames: one 3494-Lxx frame and any combination of up to 15 additional frames, not including service bays. You can configure a maximum of 15 FC5300, FC5302, FC5304, FC5400, FC5500, FC5502, FC5503, FC5504, FC9002, FC9003, FC9004, FC9005, FC9006, and FC9007.
32. You must order FC5500, FC5502, FC5503, or FC5504 for the 3494-Lxx frame when converting a 3494-B16 VTS to a 3494-B18 VTS.

Archived

Tape drives and controllers

This chapter describes the IBM System Storage TS1120, IBM TotalStorage Enterprise 3592, and 3590 tape drives, as well as the TS1120 Tape Controller Model C06, and J70 controller, which are part of the IBM System Storage family. You can install the tape drives stand-alone in a rack, within an IBM Enterprise 3494 Tape Library, or in a StorageTek Silo. This chapter also includes information about the IBM 3599 Tape Media models that are available for the 3590 models B, E, and H tape drives, and the new 3599 Tape Media models available for the 3592 Model J1A and Model E05 tape drives.

The IBM System Storage TS1120 Model C06 Tape Controller and its predecessor, the IBM TotalStorage Enterprise Tape Drive Model J70, provide new levels of performance and attachment capabilities for S/390®, zSeries, and System z. This chapter describes the drives and controller technology, the attachment options, and the configuration options.

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

For information about the hardware installation of the IBM 3590 and 3592 tape drives in the IBM 3494 Tape Library, refer to Chapter 2, “IBM TotalStorage Enterprise Automated Tape Library” on page 25. For information about the installation of the IBM 3590 and 3592 tape drives inside a StorageTek Silo, see Appendix A, “Tape drives in silo compatible frames” on page 457.

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 IBM 3494 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/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 MES upgrade model for E05 to E06 conversions.

The 3592 Model E06 and EU6 drives display as a 3592-3E, which indicates that this drive 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 make reading more convenient, we will 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 drives 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 100).
- ▶ 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. See Figure 3-1 on page 94. The servo bands provide location information to control the positioning of the head as it writes and reads data within the data band. This design is explained in detail in “Servo tracks” on page 96.

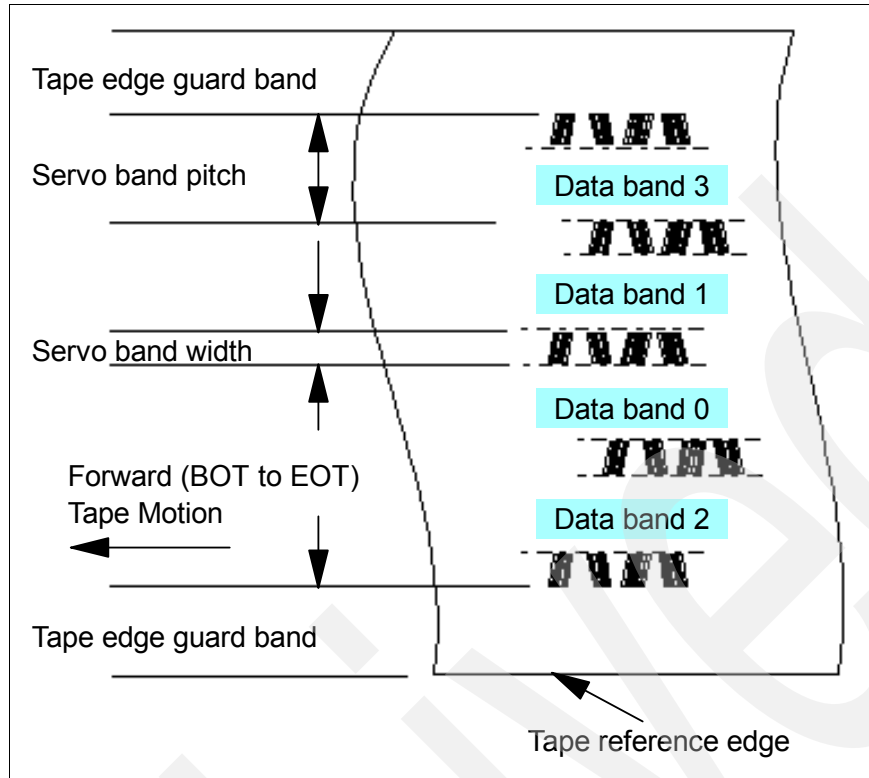


Figure 3-1 The layout of the servo and data bands on the 3592 media

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 and different 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 95 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 technique makes it possible to write multiple distinct tracks in a given data sub-band.

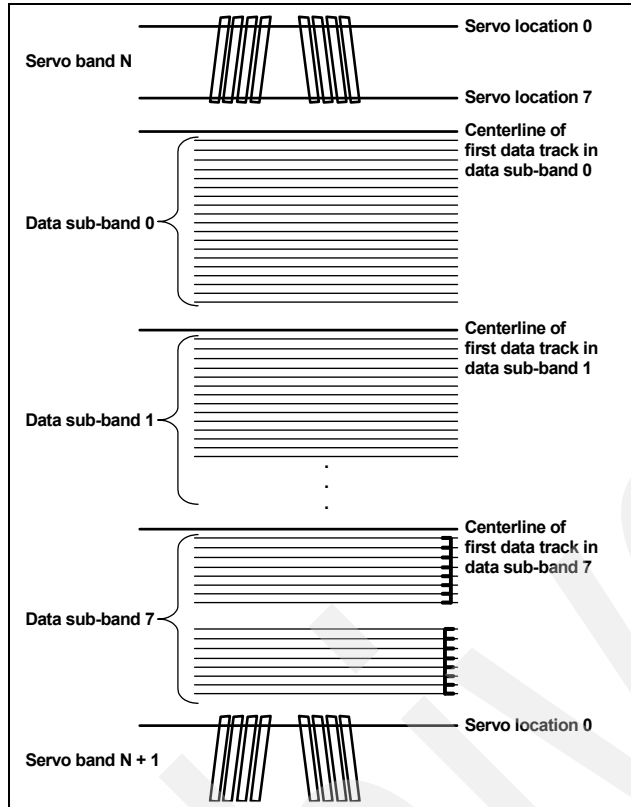


Figure 3-2 Section of tape showing one data band and its surrounding servo bands

Figure 3-3 on page 96 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.

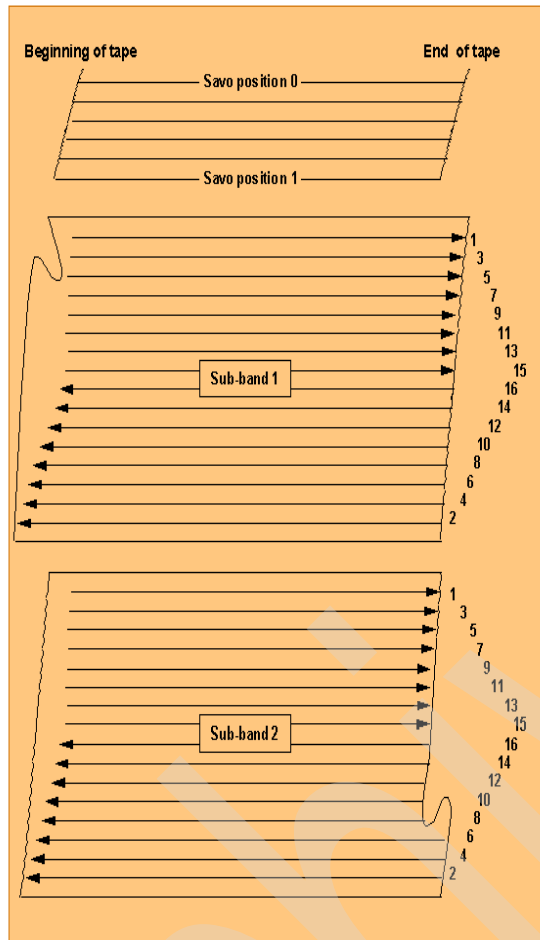


Figure 3-3 Close-up view of two data sub-bands here for J1A with eight tracks and one servo band

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 94, 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 edge. 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 (see Figure 3-4 on page 97). Provided that the servo head element follows a straight line along the servo band, then the distance “x” shown in the figure remains constant.

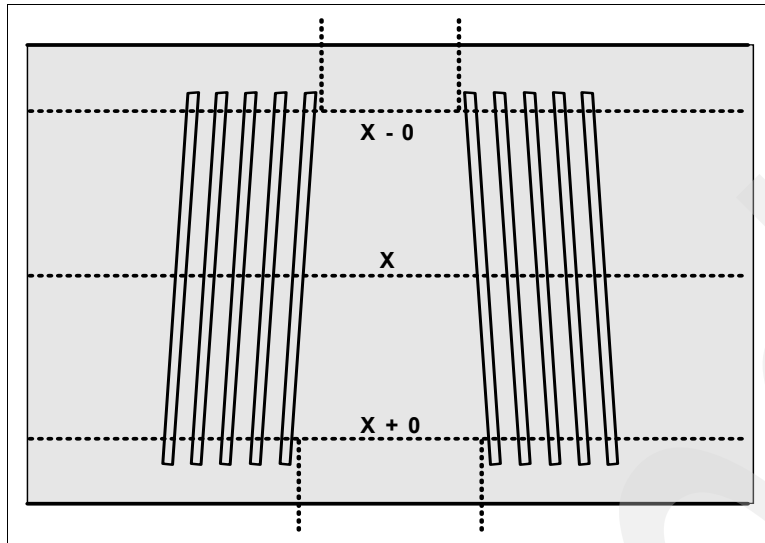


Figure 3-4 Diagram of the timing-based servo track

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, this means that 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 (IBM 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

This retention means that when a failed drive is exchanged; you do not have to reconfigure the attached hosts to recognize a replacement drive. This retention also eliminates any issues with SAN hosts finding incorrect addresses during a system reboot.

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 feature 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 99 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 caused by continual 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 that was previously available only from this panel from the 3494 Library Manager interface, which is more convenient and accessible to clients, as well as service personnel.

- Concurrent microcode update, 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 (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 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 some 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, cantilevered silicon storage device (4,096 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 (see “High resolution tape directory” on page 100). 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 independent 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 the J1A Tape Drive requires less than 82 seconds to retrieve. No block typically exceeds this locate time.
- ▶ A block closer to beginning-of-tape (BOT) takes a linear proportionately 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. This requirement 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 system 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, 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 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 and 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 a 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.

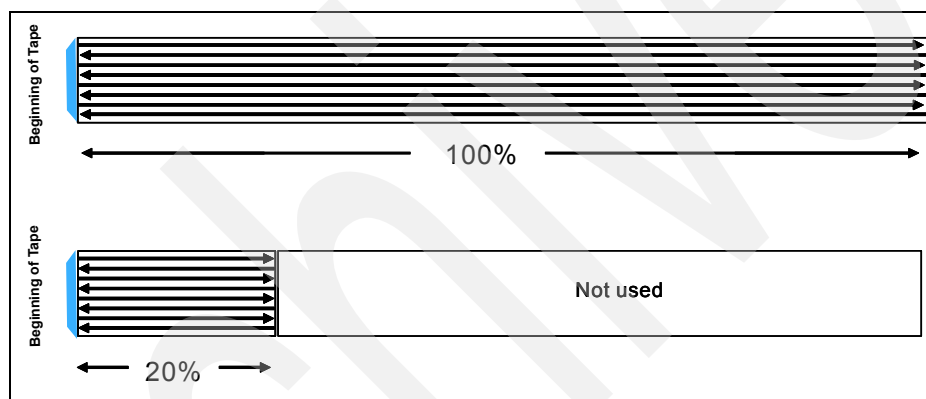


Figure 3-5 Examples for a 100% tape and tape scaled by 20%

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 $N/256$ ths 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 103 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 must flush buffers and close

volume) and reports the physical end-of-tape check condition at the end of the scaled region just as it does at the real 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. 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%.

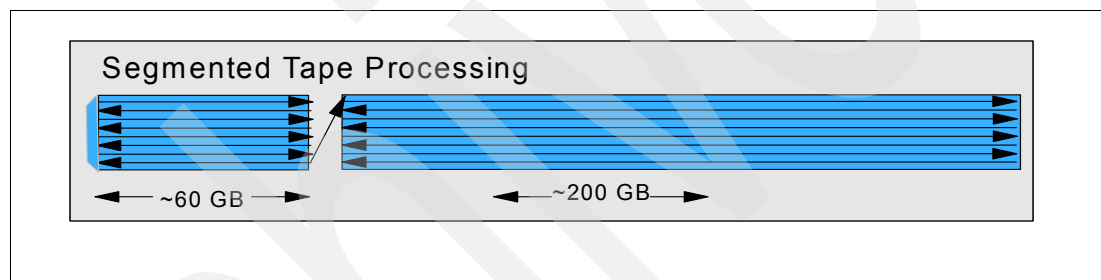


Figure 3-6 Example for a segmented tape on 3592-J1A

Table 3-1 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 4.3.9, “Defining SMS constructs through ISMF” on page 199.

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 for the 3592 models E drives Fibre Channel attachments 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 the drive 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 automatically inherits 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 what drive and recording format you use or what cartridge model 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 0.15 m (.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 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 shows the six media types and the capacity options that are available with 3592 tape drives.

Table 3-2 IBM 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 (1998 ft)	300 GB	300 GB	500 GB	640 GB	500 GB
MEDIA6 ECONOMY	JW	609 m (1998 ft)	300 GB	300 GB	500 GB	640	500 GB
MEDIA7 WORM	JJ	246 m (807 ft)	60 GB	60 GB	100 GB	128 GB	100 GB
MEDIA8 ECONOMY WORM	JR	246 m (807 ft)	60 GB	60 GB	100 GB	128 GB	100 GB
MEDIA9 EXTENDED DATA	JB	825 m (2706.9 ft)	N/A	N/A	700 GB	1 TB	700 GB
MEDIA10 EXTENDED WORM	JX	825 m (2706.9 ft)	N/A	N/A	700 GB	1 TB	700 GB

Figure 3-7 on page 106 shows four of the media types. The WORM cartridges pictured on the left have a platinum color 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.

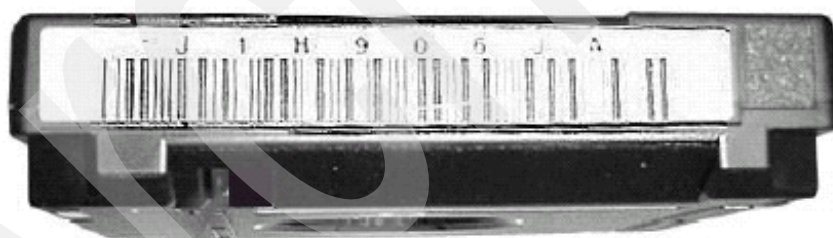


Figure 3-8 View of the 3592 cartridge label

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 the cleaning cartridge 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-movable 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, such as 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 differentiation 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 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.

3.2.9 Ordering media

You can order IBM System Storage Tape Cartridge 3592 media in the following ways.

The 3599 Tape Media Method provides the ability to order prelabeled, unlabeled, initialized, and bulk-packaged data cartridges in a wide variety of combinations. Model numbers and feature codes are used to identify the cartridge types, quantities, labeling, and initialization options. Table 3-3 shows a few examples of ordering options and features for each cartridge type.

Table 3-3 3599 media examples

Media type	3599 model	Format L=Labeled I= Initialized	External Media ID		Quantity 20-pack feature code	RFID label	Description
			Yes	No			
JA	011	L + I ^{a, b}	9030	9031 ^c	1020	Yes	3592 Enterprise Tape Cartridge with Labeling and Initialization
	012	L			2020	Yes	3592 Enterprise Tape Cartridge with Volume serial labels only
	013	Not L + I	N/A	N/A	3020	No	3592 Enterprise Tape Cartridge without Labels or Initialization

Media type	3599 model	Format L=Labeled I= Initialized	External Media ID		Quantity 20-pack feature code	RFID label	Description
			Yes	No			
JB	014	L + I ^{a, b}	9032	9034 ^c	4020	Yes	Tape Cartridge 3592 Extended with Labeling and Initialization
	015	L			5020	Yes	Tape Cartridge 3592 Extended with Volume serial labels only
	016	Not L + I	N/A	N/A	6020	No	Tape Cartridge 3592 Extended Data without Labeling or Initialization
JJ	E11	L + I ^a	9050	9051 ^c	1120	Yes	3592 Enterprise Tape Cartridge (Economy) with Labeling and Initialization
	E12	L			1220	Yes	3592 Enterprise Tape Cartridge (Economy) with Volume serial labels only
	E13	Not L + I	N/A	N/A	1320	No	3592 Enterprise Tape Cartridge (Economy) without Labels or Initialization
JR	E21	L + I ^a	9042	9043 ^c	3120	Yes	3592 Enterprise Tape Cartridge (Economy WORM) with Labeling and Initialization
	E22	L			3220	Yes	3592 Enterprise Tape Cartridge (Economy WORM) with Volume serial labels only
	E23	Not L + I	N/A	N/A	3320	No	3592 Enterprise Tape Cartridge (Economy WORM) without Labels or Initialization

Media type	3599 model	Format L=Labeled I= Initialized	External Media ID		Quantity 20-pack feature code	RFID label	Description
			Yes	No			
JW	021	L + I ^a	9040	9041 ^c	2120	Yes	3592 Enterprise Tape Cartridge (WORM) with Labeling and Initialization
	022	L			2220	Yes	3592 Enterprise Tape Cartridge (WORM) with Volume serial labels only
	023	Not L + I	N/A	N/A	2320	No	3592 Enterprise Tape Cartridge (WORM) without Labels or Initialization
JX	024	L + I ^d	9044	9045 ^c	2420	Yes	Tape Cartridge 3592 Extended WORM with Labeling and Initialization
	025	L			2520	Yes	Tape Cartridge 3592 Extended WORM with Volume serial labels only
	026	Not L + I	N/A	N/A	2620	No	Tape Cartridge 3592 Extended WORM without Labels or Initialization
JA	017	L + I	7005	7006	N/A	No	5-pack 3592 Cleaning Cartridges, 50 uses

a. FC9080 is related to E1 Format (3592-J1A), FC9081 is for E2 Format (3592-E05), and FC9082 is for E3 Format (3592-Ex6).

b. 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.

c. If the cartridges are to be used on a Silo Compatible Tape Drive Frame 3592 Model C20, order FC described to provide the Cartridge without Media ID Letters.

d. Only FC9081 (E2 Format) and FC9082 (E3 Format) are supported.

For ordering using the IBM part number through an IBM authorized distributor, IBM Business Partner, or IBM marketing representative, refer to Table 3-4 on page 111, which lists the data cartridges and media supplies that you can order using part numbers.

For information about the closest distributor, refer to the following Web site:

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

Table 3-4 Ordering media using part number examples

Supply item	Capacity	Part number
IBM System Storage Tape Cartridge 3592 - Data	300/500 GB	18P7534
IBM System Storage Tape Cartridge 3592 - Economy	60/100 GB	24R0316
IBM System Storage Tape Cartridge 3592 - WORM	300/500 GB	18P7538
IBM System Storage Tape Cartridge 3592 - Economy WORM	60/100 GB	24R0317
IBM System Storage Tape Cartridge 3592 - Cleaning	Cleaning, 50 uses	18P7535
IBM System Storage Tape Cartridge 3592 - Extended	700 GB	23R9830
IBM System Storage Tape Cartridge 3592 - Extended WORM	700 GB	23R9831

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 is downward write compatible ($n-1$) to the 3592 Model E05 formats (EFMT2/EEFMT2). All current media types are supported.

Host interfaces to z Series 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 Virtual Engine using 4 Gb dual port fiber cards. It allows for integration into the IBM TotalStorage 3494 library, the TS3500 library, the TS3400 library, stand-alone rack-mounted, and the Sun/STK Silo. There is no support for the 3494 Model B10/B20 Virtual Tape Server.

Figure 3-9 on page 112 shows the front view of the IBM TS1130 Tape Drive.

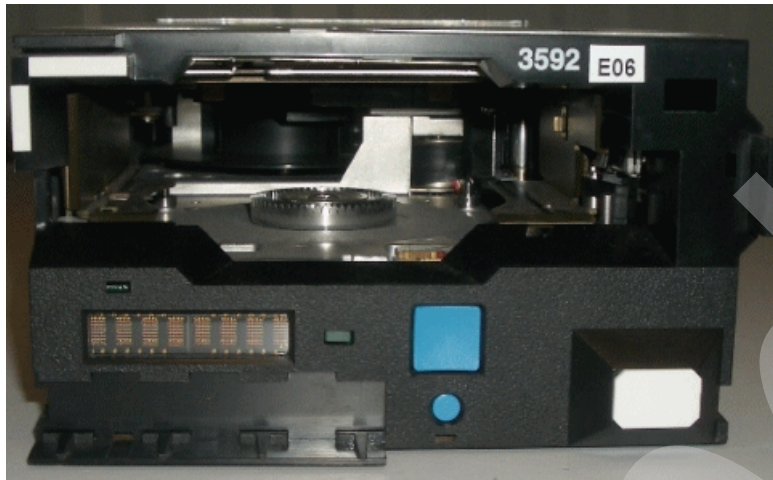


Figure 3-9 Front view of the IBM TS1130 Tape Drive

The IBM 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 3-5 on page 113.

Table 3-5 Subsystem support summary

Subsystem	3592-E06	3592-E05	3592-J1A
3494-L22	Four drives per frame	Four drives per frame	Four drives per frame
3494-D22	12 drives per frame	12 drives per frame	12 drives per frame
3494-D24	Eight drives per frame	Eight drives per frame	Eight drives per frame
Support within a frame	Must be all of the same model	Mix with 3592-J1A is allowed	Mix with TS1120 is allowed
3584-L23	12 drives per frame	12 drives per frame	12 drives per frame
3583-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 ^a	Supported	Supported
SUN/STK 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 (two drives/unit)	Supported (two drives/unit)	Not supported
Rack-mounted	Supported (12 drives/frame)	Supported (12 drives/frame)	Supported (12 drives/frame)

a. IBM intends to provide this support after general availability of the TS1130.

3.3.2 Media reuse

The IBM TS1130 Tape Drive provides capacity and performance improvements on the 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 writing 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 reuse 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 IBM TS1120 Tape Drive for all of the media types and for all of the 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 various improvements, such as higher data rates, a 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:

- ▶ E06 format data rates go up to 160 MB/s maximum native and to 360 MB/s maximum compressed.
- ▶ E05 format data rates go up to 150 MB/s maximum native and to 360 MB/s maximum compressed.
- ▶ 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 rates is different.

Capacity and performance characteristics are summarized in Table 3-6 on page 115.

Table 3-6 Capacity and performance summary

Media	E06 format capacity data rate (min - max)	E05 format capacity data rate (min - max)	J1A format capacity data rate (min - max)
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 read and write performance.

Speed matching

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

- ▶ Seven R/W speeds are supported for JB media:
 - For EFMT3/EEFMT3 format, the range is 31 MB/s to 163 MB/s
 - For 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 for EFMT2/EEFMT2, the range is 27 MB/s to 139 MB/s
 - For 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 workload. Find more about write synchronize in “Virtual backhitch (nonvolatile caching)” on page 100.

Faster high speed space/locate

The load time and unload times have been slightly improved. The maximum locate/rewind speed is increased to 12.4 m/s (20.6 inches/s). With these enhancements, average first file access time has improved. Refer to Table 3-7 on page 116.

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 allows faster code downloads and dump uploads from the library. In 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 very 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 with this unique functionality competitive drives that simply stop and wait for the next command.

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 implement any scaling with JB media, because there is still no software available to use any other segment except the first one, and therefore, there is a higher waste of capacity.

3.3.4 Access performance specifications and drive characteristics

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 are summarized in Table 3-7.

Table 3-7 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	20 s for JA/JW 9 s for 20% scaled JA 27 s for JB/JX 12 s for 20% scaled JB	23 s 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

Parameter	3592-E06 EFMT3 or EEFMT3	3592-E05 EFMT2 or EEFMT2	3592-J1A EFMT1
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 kbp	282 kbp	282 kbp
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 physical characteristics

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 as 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:

- ▶ 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 5 minute interval.

3.3.7 Upgrade considerations

A drive field-MES conversion feature is available to allow for a 3592-E05 to 3592-EU6 model conversion in fact 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, C20 frame attached to a silo, and a rack-mounted drive.

3.3.8 Firmware updates

We describe the minimal changes to the firmware update mechanisms for the TS1130.

Note: We never recommend that you perform a firmware update in a z/OS environment where all drives are attached to a controller or a TS7700/VTs, and a change of the drive code has implications for the code of the controller and the library.

The changes are:

- ▶ All four mechanisms currently supported for microcode updates on the 3592-E05 also provide support on the E06:
 - 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 unique from previous models.

3.3.9 RAS

With the TS1130 Tape Drive, the reliability, availability, and serviceability (RAS) features are improved or maintained. As with its predecessor models, the TS1130 is a single field-replaceable unit (FRU), is hot-pluggable without a maintenance window, and allows for nondisruptive code load. Fan speed management and a 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 becomes activated on full file pass usage. Nearing Media Life (alert x13) is given at 19900 mounts or 295 full-file passes and media Life (alert x07) is given at 20000 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 passed, or write pass count, as well as the total number of mounts (already supported).
- ▶ The media SARS summary is maintained in the cartridge memory (CM) so that it can be rebuilt on tape in the event that SARS records on tape cannot be read and must be

reinitialized. 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 it is attached to a tape controller. There is no need to enable the drive explicitly as there was with the TS1120 Tape Drive. Refer to Chapter 5, “Tape Encryption” on page 239.

3.3.12 Tracking data written

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 possibility exists with the 3592 Model E06 to overflow some of the 4-byte fields that contained these values, particularly, 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 5, “Tape Encryption” on page 239. 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 Engine¹
- ▶ B10 and B20 Virtual Tape Server (VTS) (in J1A Emulation mode)

Figure 3-10 on page 120 shows the front view of the IBM TS1120 Tape Drive.

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.



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.

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 99.

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 3-7 on page 116 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 3592-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 the **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 Models 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 a native data rate of up to 40 MB/s. Figure 3-11 on page 123 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 Fibre Channel (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 number 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 the first segment of 60 GB and a slower access segment of 200 GB of capacity.

3.6 IBM TotalStorage Enterprise Tape Drive 3590

The initial 3590 Tape Drive offering, the 3590 B Model, was introduced in 1995. It provided a native cartridge capacity of 10 GB in a linear tape format and a native drive data rate of 9 MB/s. The 3590 B model was upgraded with a new head, deck modifications, and operating software in 1999. It was introduced as the E model. This E model provided a 20 GB native cartridge capacity, which was double the B model's native cartridge capacity, and an increased native data rate of 14 MB/s, which was over 50% greater than the B model's native data rate. The introduction of the 3590 Extended Length (XL) Cartridge in 2000 allowed the 3590 Model E to extend its native capacity to 40 GB and the B model to extend its native capacity to 20 GB. The newest enterprise tape drive, the 3590 H model, provides a native capacity of 60 GB on existing XL media and 30 GB on the standard length media, and the 3590 H model provides a native data rate of 14 MB/s.

Note: The IBM TotalStorage 3590 Tape Drive and its associated features were withdrawn from marketing effective 29 September 2006.

The IBM TS3500 Tape Library does not support 3590 tape drive technology.

Figure 3-12 shows an IBM TotalStorage Enterprise Tape Drive Model E1A.

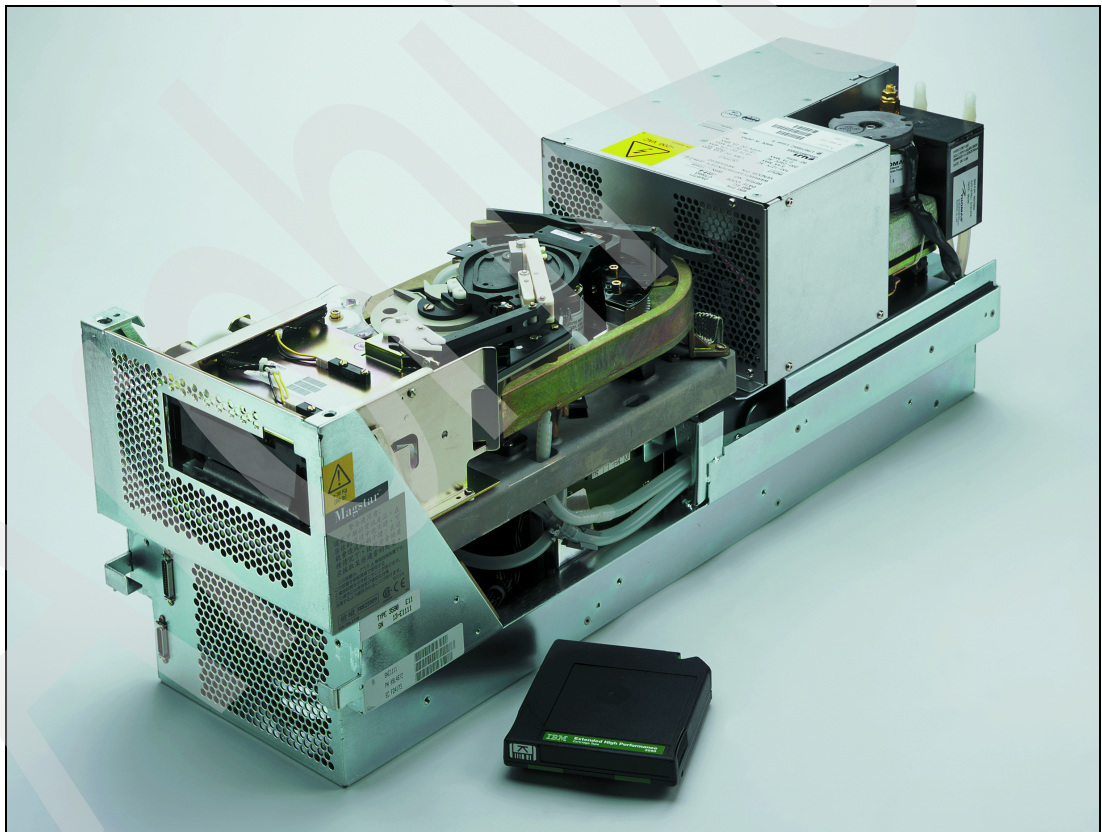


Figure 3-12 IBM TotalStorage Enterprise Tape Drive 3590 Model E1A

3.6.1 Technology

The IBM 3590 High Performance Tape Subsystem provides high capacity, performance, reliability, and a wide range of host connectivity. This technology exploits a fourth generation

magneto resistive (MR) head, a 16 MB buffer, predictive failure analysis, and state-of-the-art electronic packaging.

While reading or writing 16 tracks at a time, the 3590 models use serpentine, interleaved, and longitudinal recording technology for a total of four, eight, or twelve round-trips from the physical beginning to the physical end of the tape and back again. The tape R/W head indexes, or moves vertically, when it completes each round-trip so that the recorded tracks are interleaved across the width of the tape.

The IBM 3590 tape drives use a metal particle medium in the tape cartridge that can store 10, 20, 30, 40, or 60 GB of uncompressed data, depending on the cartridge type and the drive model. The integrated control unit uses a compaction algorithm that can increase the storage capacity of these cartridges. Assuming a compression ratio of three to one (3:1), the cartridge capacity increases to 120 GB on E models and to 180 GB on H models when using an extended length cartridge.

High-speed data access

The 3590 longitudinal serpentine recording technique allows for high performance read operations.

The 3590 Model E tape drive makes eight round-trip passes over the tape, compared to the Model H tape drive, which makes 12 passes. If a required block of data is, logically, one-eighth or one-twelfth of the way along the length of the tape, the read head only needs to index upward by one position to access this data, which requires no tape movement.

Unlike any previous tape products, the IBM Magstar 3590 tape subsystem uses a volume control region, inaccessible to user applications, to locate data on the tape. When a read request takes place, the tape drive uses a high-speed block search to position the tape directly at the required data block. This facility allows for access speeds that are significantly faster than previous generations of tape technology. The 3590 can search for data at up to 332 MB/s, compared to the 3490 rate of 10.6 MB/s.

Predictive failure analysis (PFA)

With PFA, both the tape cartridge and drive contain a history of performance and position, making more information available to hardware service personnel. You can set up your system to automatically transmit this information to an IBM Hardware Support Center, allowing the initiation of preventive maintenance actions. PFA can result in a reduction in incidents that affect user applications and data availability.

Here are several examples to help explain this feature:

- ▶ Keeping an ongoing history of the last 100 tape R/W operations performed on a particular tape cartridge: This history tracks the type of error, location by sector and block, drive ID, and cartridge volume. This history also tracks good mounts where no error occurred.
- ▶ Keeping an ongoing history of the last 100 tape R/W operations performed on a particular drive: This drive history can track the same data as the cartridge history and additional information for hardware isolation.
- ▶ If a particular tape sector shows a high error rate, PFA partitions off that sector and renders that sector unusable for future write operations.
- ▶ If a tape cartridge shows a high and increasing number of overall R/W errors, PFA sends a message alert to the operator to copy the contents of the cartridge to another cartridge and retire the current cartridge from use.
- ▶ PFA can isolate a high number of R/W errors to a particular drive and then send a message to the operator to call the maintenance provider to repair the drive.

Data integrity with the 3590 tape system

A unique feature of the IBM TotalStorage Enterprise 3590 Tape System is *striping* data horizontally and vertically (see Figure 3-13).

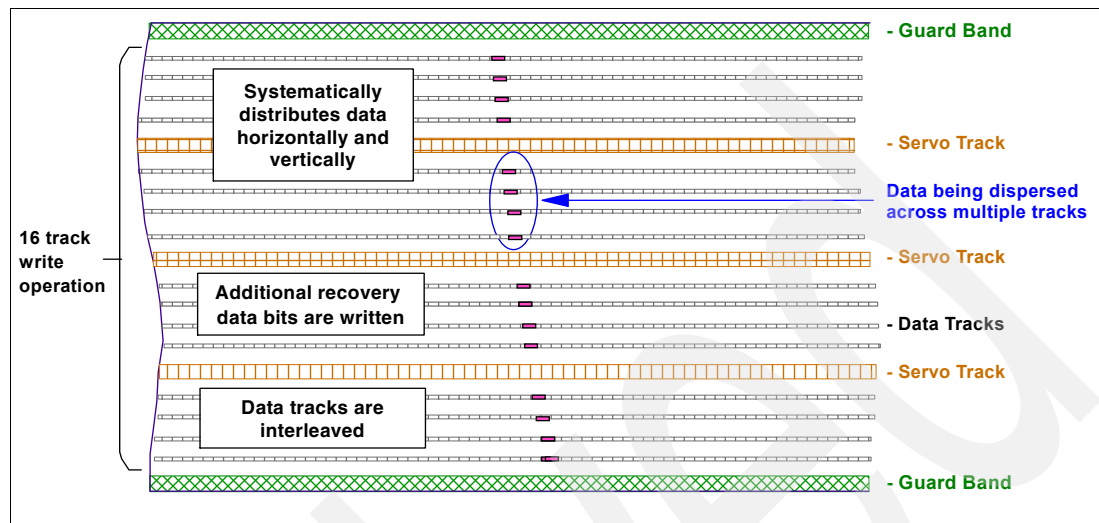


Figure 3-13 IBM TotalStorage 3590 tape data integrity

Because of the way that the 3590 tape drive writes data onto the tape, we achieve RAID-like tape storage:

- ▶ Multiple write elements are used for improved performance.
- ▶ Data is spread across multiple tracks to achieve improved availability.
- ▶ Recovery bits are written for improved error recovery.

Service and Media Information Messages (SIMs and MIMs)

The Service Information Message (SIM) and Media Information Message (MIM) functions are the primary factors for improved product availability. They generate messages that are sent to the host console in a z/OS environment.

A *SIM* contains the machine type, machine serial number, and field-replaceable unit (FRU), which allows the dispatch of the appropriate service personnel with the replacement parts that are required to correct the machine fault. This procedure helps to improve service response time and helps to reduce the time required for machine repair.

A *MIM* identifies problems with the media (tape) and the volume number of the bad cartridge. This message allows the client to perform maintenance within the tape library and to prevent unnecessary service calls when the problem is the media.

Refer to *IBM TotalStorage Enterprise Tape System 3590 Introduction and Planning Guide*, GA32-0329, for detailed information about these messages.

Statistical Analysis and Reporting System (SARS)

SARS assists you in determining whether the media (tape) or the hardware in the drive caused the R/W errors. The 3590 tape drive microcode contains a volume SARS (VSARS) algorithm and a hardware SARS (HSARS) algorithm to analyze errors. SARS algorithms report messages through SIMs and MIMs.

For more information about SARS, refer to the *IBM TotalStorage Enterprise Tape System 3590 Introduction and Planning Guide*, GA32-0329, and the SARS documentation, which you can find on the Web at:

<http://www-1.ibm.com/support/docview.wss?uid=ssg1S7000247>

3.6.2 Characteristics

Table 3-8 compares the drive capabilities and provides an overview of the characteristics of the IBM TotalStorage Enterprise Tape Drive models H, E, and B.

Table 3-8 IBM TotalStorage Enterprise tape drive characteristics

	3590 Model H	3590 Model E	3590 Model B
Display panel	Alphanumeric liquid crystal display		
Cartridge Loader ► Models x1A ► Models x11	None 10-cartridge capacity Automatic Cartridge Facility (ACF)		
Host attachment	FICON through 3590-A60 ESCON through 3590-A60 SCSI direct attach Fibre Channel attach	FICON through 3590-A60 ESCON through 3590-A60 SCSI direct attach	
Native device data rate	14 MB/s		9 MB/s
Sustained device data rate (3:1 compression)	34 MB/s with Ultra™ SCSI 42 MB/s with Fibre Channel		27 MB/s with Ultra SCSI
Maximum instantaneous data transfer rate	100 MB/s with FICON 17 MB/s with ESCON 40 MB/s with Ultra SCSI 100 MB/s with Fibre Channel		100 MB/s with FICON 17 MB/s with ESCON 40 MB/s with SCSI
Tape R/W access speed	3.14 m/sec (124 inches/sec)		2.0 m/sec (79 inches/sec)
Search/rewind speed	5 m/sec (198 inches/sec)		
Data search rate	332 m/sec (1089.3 ft/sec)		166 m/sec (544.6 ft/sec)
Full cartridge rewind time (at end of volume)	2 seconds		
Media	3590 High Performance Cartridge Tape (HPCT) 3590 Extended High Performance Cartridge Tape (EHPCT)		
Maximum cartridge rewind time	60 seconds for 3590 High Performance Cartridge Tape 120 seconds for Extended High Performance Cartridge Tape		
Tape length	300 m (984.3 ft) for 3590 High Performance Cartridge Tape (HPCT) 600 m (1968.5 ft) for Extended High Performance Cartridge Tape (EHPCT)		
Uncompressed data capacity HPCT	30 GB	20 GB	10 GB
Uncompressed data capacity EHPCT	60 GB	40 GB	20 GB

3.6.3 Attachment options

The 3590 B models are SCSI drives and do not provide Fibre Channel connections. The Model E and H tape drives attach through Ultra SCSI and Fibre Channel attachments to the IBM System p, System i, or System x servers, and other Open Systems or midmarket servers, and to the Model J70 controller. The Model J70 controller provides FICON and ESCON channel connections to IBM System z servers.

Figure 3-14 presents an overview of these attachment possibilities. It does not include the number of combinations of possible attachments when attaching 3590 tape drives to a System z server.

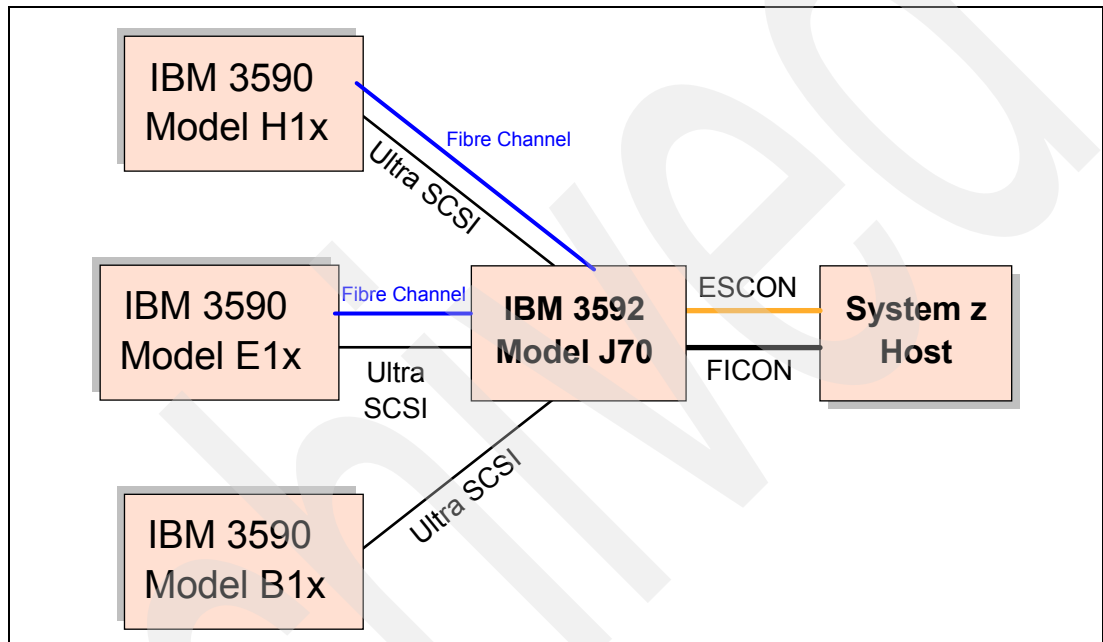


Figure 3-14 3590 Model A60 attachment options for System z servers

Table 3-9 details the attachment options provided for the 3590 models B, E, and H tape drives to the server platforms.

Table 3-9 IBM TotalStorage Enterprise tape drive attachment summary

Server	3590 Model H	3590 Model E	3590 Model B
	Ultra SCSI	Ultra SCSI	Ultra SCSI
System z	Using J70	Using J70	Using J70
System i	Yes	Yes	Yes
System p	Yes	Yes	Yes
System x	Yes	Yes	Yes
SUN	Yes	Yes	Yes
Hewlett-Packard	Yes	Yes	Yes
Intel® Compatible	Yes	Yes	Yes
Compaq Alpha	No	No	No

Server	3590 Model H	3590 Model E	3590 Model B
	Ultra SCSI	Ultra SCSI	Ultra SCSI
IBM 3494 Virtual Tape Server (VTS) ^a	Yes	Yes	Yes

a. 3590 tape drives, when attached to an IBM TotalStorage Virtual Tape Server, are exclusively used by the VTS and are not available to any other host.

For a detailed list of supported servers and adapters, go to:

<http://www.storage.ibm.com/hardsoft/tape/3590/3590opn.pdf>

For the latest information about applications and which application levels support 3590 tape drives, refer to the Independent Software Vendor (ISV) matrixes on:

<http://www.storage.ibm.com/hardsoft/tape/conntrix/index.html>

3.6.4 Media considerations

The IBM TotalStorage Enterprise tape drives use cartridges of the same form factor as the IBM 3490 tape drives. This design ensures automation hardware compatibility in an automated tape environment. The IBM TotalStorage Enterprise 3590 tape cartridges are incompatible with previous tape subsystems.

Cartridge types

All 3590 tape drive models support the use of the two existing cartridge types:

- ▶ High Performance Cartridge Tape (HPCT): An HPCT cartridge is also called a *J-cartridge*, because the media type is identified by a J as the seventh character of the external volume label that is used inside a 3494 Tape Library. In a system managed storage (SMS) environment, HPCT cartridges are also referred to as MEDIA3. The length of the tape is 300 m (984.2 ft). The capacity varies depending on the tape drive model as described in Table 3-8 on page 127.
- ▶ Extended High Performance Cartridge Tape (EHPCT): An EHPCT cartridge is also called a *K-cartridge*, because the media type is identified by a K as the seventh character of the external volume label that is used inside a 3494 Tape Library. In an SMS-managed environment, they are also referred to as MEDIA4. The length of the tape is 600 m (1968.5 ft). The capacity varies depending on the tape drive model as described in Table 3-8 on page 127.

If you have different 3590 models installed, you can use cartridges on either of these drive models. The tape drives are *upward read compatible*, which means:

- ▶ Cartridges that were written on a Model B tape drive can be read on a Model E or Model H tape drive.
- ▶ Cartridges that were written on a Model E tape drive can *also* be read on a Model H tape drive.
- ▶ Cartridges that were written on a Model H tape drive can *only* be read on a Model H tape drive.
- ▶ Cartridges written with a specific recording technology (128, 256, or 384 tracks) can only be modified on a drive using the same technology with which the cartridge was written before.

- Cartridges that were returned to scratch and are then written from load point can be reused on any tape drive. In this case, the cartridge is internally relabeled.

For a detailed description of the required specifications for read compatibility in a z/OS environment, refer to 6.3, “Managing different 359x models in a 3494 Tape Library” on page 269.

3.6.5 3590 feature codes

This section lists the available feature codes for the 3590 tape drives. Table 3-10 shows device attachment, installation, and media feature codes for the 3590 models B11, B1A, E11, E1A, H11, and H1A. It also provides a description of the tape drive-related feature codes.

For feature codes related to the Model J70 tape controller, refer to Table 3-12 on page 140. For feature codes related to the 3494 Tape Library with 3590 tape drives installed, see Chapter 2, “IBM TotalStorage Enterprise Automated Tape Library” on page 25.

Table 3-10 Feature codes for 3590 tape drives

Feature code	Description	Hxx models	Exx models	Bxx models
0500	Drive microcode update	H1x	E1x	B1x
1748	Custom quickship expedite	H1x	E1x	B1x
2003	3590 Model C12 or C14 attachment	H1A	E1A	B1A
2004	Field install silo attachment	H1A	E1A	B1A
2005	Remove silo attachment from 3494	H1A	E1A	B1A
2006	Remove silo attachment for A14	N/A	E1A	B1A
2200	Decksides enclosure	H11	E11	B11
3510	Field install Fibre Channel attachment	H1x	E1x	N/A
8001	Cartridge magazine	H11	E11	B11
8002	Cleaner cartridge	H11	E11	B11
8130	30 High Performance Cartridge Tapes	H11	E11	B11
8140	30 Extended High Performance Cartridge Tapes	H11	E11	B11
9000	ES/9000, ES/3090, S/390, or zSeries attachment	H1x	E1x	B1x
9066	Pearl white cover (default color)	H11	E11	B11
9068	Raven black cover	H11	E11	B11
9070	128-track preformatted High Performance Cartridge Tape	H1x	E1x	B1x
9071	256-track preformatted High Performance Cartridge Tape	H1x	E1x	N/A
9072	384-track preformatted High Performance Cartridge Tape	H1x	N/A	N/A
9200	Open Systems device drivers	H11	E11	B11
9210	Hewlett-Packard (HP) UNIX® attachment	H1x	E1x	B1x

Feature code	Description	Hxx models	Exx models	Bxx models
9211	SUN attachment	H1x	E1x	B1x
9212	Windows® or xSeries® attachment	H1x	E1x	B1x
9213	Other non-IBM attachment	H11	E11	B11
9221	First B11 or E11 plus rack shelf installed in a rack	H11	E11	B11
9222	Second or fourth B11, E11, or H11 installed in a rack	H11	E11	B11
9223	Third B11 or E11 plus rack shelf installed in a rack	H11	E11	B11
9400	AS/400 or iSeries® attachment	H1x	E1x	B1x
9510	Fibre Channel attachment (plant install)	H1x	E1x	N/A
9590	No data cartridges	H11	E11	B11
9600	RS/6000®, pSeries, or RS/6000 SP attachment	H1x	E1x	B1x
9702	Interposer, double-byte	H1x	E1x	B1x
9790	Ultra SCSI attachment (plant install)	N/A	N/A	B1x
9798	Inline SCSI Terminator	H1x	E1x	B1x
9799	VHDCI cable/interposer	H1x	E1x	B1x

For a detailed description of the feature codes listed in Table 3-10 on page 130 and the IBM 3599 models, refer to the *IBM TotalStorage Enterprise Tape System 3590 Introduction and Planning Guide*, GA32-0329.

3.7 Fibre Channel connection (FICON) overview

The System z FICON architecture addresses the constraints in the existing ESCON architecture. It also improves utilization of the existing fiber infrastructure:

- ▶ The System z architecture only allows 256 channels.
- ▶ Some installations have processors that are at, or close to, the limit of 256 channels. Consolidating multiple ESCON channels onto a single FICON channel provides relief and allows the input/output (I/O) bandwidth for the server to continue to grow.
- ▶ The z/OS architecture allows a maximum of 1,024 addresses per channel.
The FICON architecture supports up to 16,384 addresses on a channel. This support is important for control units, such as the IBM Enterprise Storage Server®, which provide large numbers of addresses.
- ▶ The data rate drops for ESCON distances in excess of 9 km (5.59 miles).
The fact that the FICON channel can span up to 100 km (62.1 miles) before a significant data rate drop occurs enables enhanced distance connectivity. However, this implementation requires repeaters.
- ▶ You can obtain a higher data rate.

When compared with ESCON, FICON reduces protocol overhead. This capability, combined with technology advances, allows a Fibre Channel link to perform at up to 100 MB/s full duplex. In a normal operation, this capability gives a sustained throughput of 60 to 70 MB/s, which equates to approximately up to five concurrent ESCON bulk-data I/O

operations. Or, it might yield up to eight concurrent ESCON transaction I/O operations (depending on the channel utilization of the ESCON channels), because ESCON provides 17 MB/s, half duplex.

- ▶ A higher data rate means less fiber for a given rate.

In certain countries or regions, fiber is very expensive. Therefore, FICON, by allowing aggregation of paths onto a single fiber, might be extremely cost-effective.

- ▶ Utilization of fiber infrastructure is improved.

The same amount of fiber and repeaters might be used to carry significantly more traffic, offsetting a possible future cost of additional fiber and repeaters needed to carry more data.

- ▶ You can obtain a greater distance with dark fiber.

In certain countries or regions, clients typically use dark fiber without retransmission through repeaters. The use of FICON can provide a significantly greater distance of 10 km (6.2 miles), or 20 km (12.4 miles) with a Request for Price Quotation (RPQ), compared to ESCON light emitting diode (LED) limits of 3 km (1.86 miles) for 62.5 micron fiber, or 2 km (1.24 miles) for 50 micron fiber.

FICON channels can use existing 9 micron single-mode fiber, or 50 or 62.5 micron multimode fiber. FICON can use any existing fiber in use by ESCON. Note that 50 and 62.5 micron fiber is only supported up to 550 m (1804.6 ft), where 9 micron fiber is supported up to 10 km (6.2 miles) (or 20 km (12.4 miles) with an RPQ).

FICON is the foundation for high-performance channels. The architecture and implementation allow for:

- ▶ Initial implementation to ESCON devices through the IBM 9032 Model 5 ESCON director acting as a bridge
- ▶ Point-to-point to I/O subsystems with System z FICON interfaces
- ▶ Switched point-to-point through a FICON director to I/O subsystems with System z FICON interfaces

Figure 3-15 on page 133 presents an overview of the components of the fiber optic technology. It shows the dimension of a human hair compared to the diameter of the fiber. The bottom of Figure 3-15 on page 133 shows the connectors used for multimode and single mode fiber, as well as for ESCON attachment.

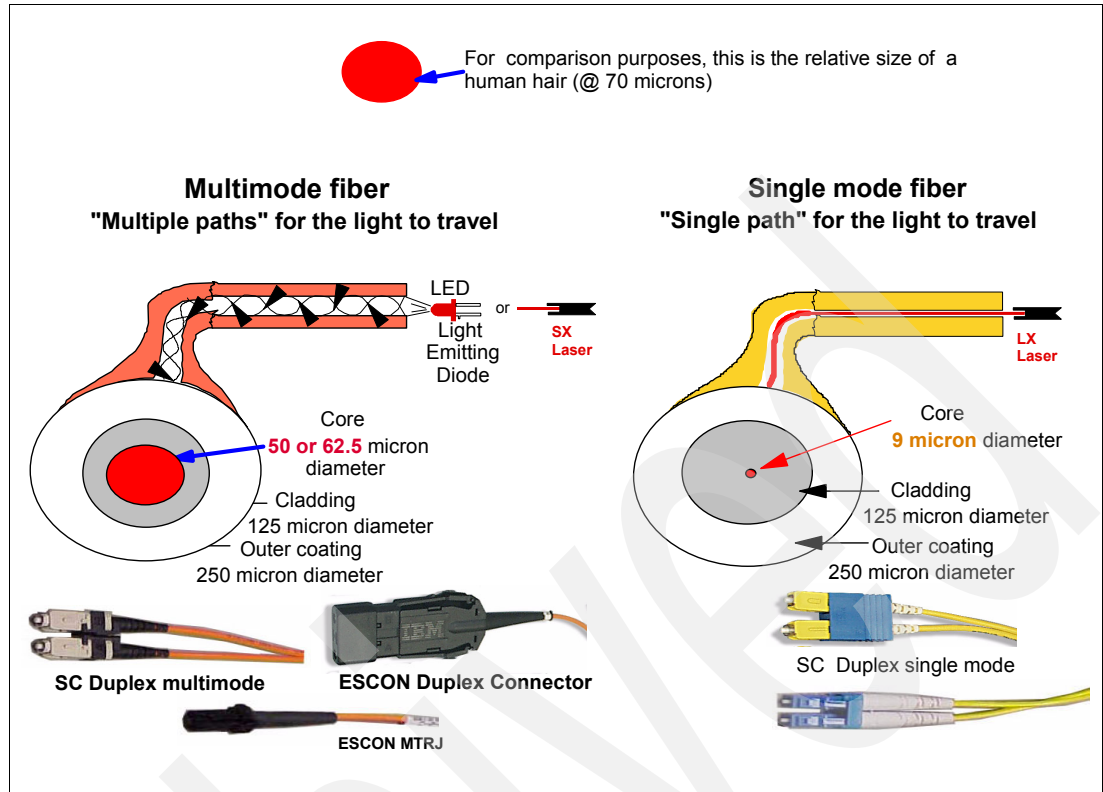


Figure 3-15 Fiber optic technology

FICON attachment allows for longer distances between the host and the tape controller than ESCON without the performance drop known from ESCON attachments at longer distances.

3.8 3592 Model J70 Tape Controller

The IBM Enterprise Tape Controller 3592 Model J70 is the follow-on to the highly successful Enterprise Tape Controller 3590 Model A60 and is designed for environments with ESCON-attached or FICON-attached servers. The 3592-J70 Controller is designed for installation in the same frames as the current 3590-A60 controller. These frames include the 3494 frames, 3592 Tape Frame Model F05, and stand-alone racks. The J70 (shown in Figure 3-16 on page 134) 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 it weighs 39 kg (86 lb.) including mounting hardware.



Figure 3-16 3592-J70 Controller

As well as supporting the new 3592-J1A drives, the 3592-J70 is capable of attaching 3590 tape drives. It is a suitable replacement for users of 3590-A00, A50, and A60 controllers, who need the additional performance and attachment capabilities that the 3592-J70 Controller provides.

Enhancements incorporated into the 3592 Model J70 Tape Controller include:

- ▶ Support for an intermix of ESCON and FICON attachments
- ▶ Attachment of up to twelve 3592-J1A or 3590 B, E, and H tape drives
- ▶ Up to 1.5 times the throughput of the 3590-A60, with FICON attachment using the 3592-J1A tape drive
- ▶ Support for capacity scaling with the 3592 Model J1A tape drive
- ▶ Support for 3592 drive hot swap capabilities
- ▶ Dual-mirrored hard drive for redundancy
- ▶ Redundant, hot-swappable power supplies and cooling components with automatic failover
- ▶ Support for Tape Encryption with the TS1130 Tape Drive

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.

The minimum level of microcode firmware is 1.19.5.x for the 3592-J70 Enterprise Tape Controller, 1.21.x.x for the TS1120 Tape Controller (3592-C06), and 1.16.1.11 for the 3590-A60 Enterprise Tape Controller.

Note: You cannot intermix 3592 and 3590 drive models behind a single 3592-J70 Controller.

You cannot intermix 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*, behind a single 3592-J70 Controller.

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

Figure 3-17 Illustrates the characteristics of the 3592 Model J70.

IBM TotalStorage Enterprise Tape Controller 3592 Model J70 at a glance			
Characteristics			
Number of ESCON interfaces	up to 8		
Number of FICON interfaces	up to 4		
ESCON maximum channel link speed	17MB/sec		
FICON maximum channel link speed	2Gb/sec		
ESCON maximum distance (unrepeated, single link to controller)	3km		
FICON long wavelength maximum distance (unrepeated, single link to controller)	10km		
FICON short wavelength maximum distance (unrepeated, single link to controller)	300m		
Warranty	1 year		
Physical characteristics			
Dimensions	222 mm H x 445 mm W x 603 mm D 8.7 in H x 17.5 in W x 23.8 in D		
Weight	39 kg (86 lb)		
Operating environment			
Temperature (with media)	16° to 32° C (60° to 90° F)		
Relative humidity	20% to 80% non-condensing (limited by media)		
Wet bulb maximum	23° C (73.4° F)		
Heat output	2.05 BTU/hr		
Power requirements	600 Watts		
Maximum drive attachment capability	3592 Model J1A	3590 Model E, H FC Attached	3590 Model B, E, H SCSI Attached
Stand alone rack	12	12	8
3494 Library	12	10	10
Silo compatible frame	12	12	8
A14	NA	12	8

Figure 3-17 Model J70 at a glance

3.8.1 Model characteristics

The 3592-J70 Controller is designed to offer ESCON and FICON attachment of either 3592 or 3590 tape drives in 3494 Tape Library, StorageTek ACS, and stand-alone environments. The

Model J70 is designed to exploit the performance and function of the 3592 tape drive, including the high capacity, fast access, and the WORM tape formats.

To assist in data migration to new more cost-effective technologies, you can install the 3592-J70 with its associated tape drives in the same IBM 3494 Tape Library with existing 3490 or 3590 models. You can intermix the 3592-J70 in the same 3494 Tape Library with the predecessor 3590 Model A60, A50, or A00 controllers, offering a unique and flexible growth opportunity. A 3592 Tape Frame Model F05 is now available for connection to the 3494 Tape Library, a StorageTek Silo, or as a stand-alone frame. Refer to 2.2, “IBM 3494 basic tape library frames and models” on page 38 for more details about this new frame.

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.

3.8.2 Attachment features

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

- ▶ Host attachment:
 - ESCON
 - FICON
 - A 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, or up to four FICON attachments, or an intermix of ESCON and FICON attachments.

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

- ▶ FC3413 dual ESCON attachment

Each feature provides a dual-ported ESCON host adapter. 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.
- ▶ FC3434 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).
- ▶ FC3435 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 3-11 on page 137 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), and the ESCON columns show the number of ESCON channels (which is double the number of ESCON features).

Table 3-11 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 Controller can be ordered with a choice of either:

- ▶ Two LC Fibre Channel adapters (FC3476)
- ▶ Two dual-ported SCSI adapters (FC3477)

The SCSI adapters are only required if you want to attach 3590 drives with SCSI adapters. Otherwise, for 3590 (E or H) models with FC adapters, 3592-J1A drives, or TS1120 tape drives, the FC adapter feature is required. In order to provide Fibre Channel connectivity between a maximum of 12 drives and the controller, you also need to configure a 2109 Model F16 switch. You can use a Model S16 switch to provide a valid configuration, and you will see that many of the available features refer to the use of the S16 switch, although it is no longer marketed by IBM. In general, the required cabling between the controller and the drives for a particular configuration will be supplied, provided that all the correct features have been specified, validating any orders with IBM representatives or IBM Business Partners who will use the IBM configuration tool. It is essential that the 2109 Model F16 or S16 switch has the appropriate number of Gigabit Interface Converter (GBIC) features configured to support the drives, because these features are not automatically supplied. Detailed feature descriptions and information about the required features in specific configurations are described in the *IBM System Storage Tape System 3592 Introduction and Planning Guide*, GA32-0464.

We provide a general example of the drive attachment requirements that is designed to demonstrate how the configurations in different frames are built up. Figure 3-18 on page 138 shows a simplified diagram of twelve 3592-J1A drives within a 3494 library attached to a 3592-J70 Controller using a 2109-F16 switch. Eight of the drives are in the same frame as the controller and switch, and the other four drives are in the adjacent frame.

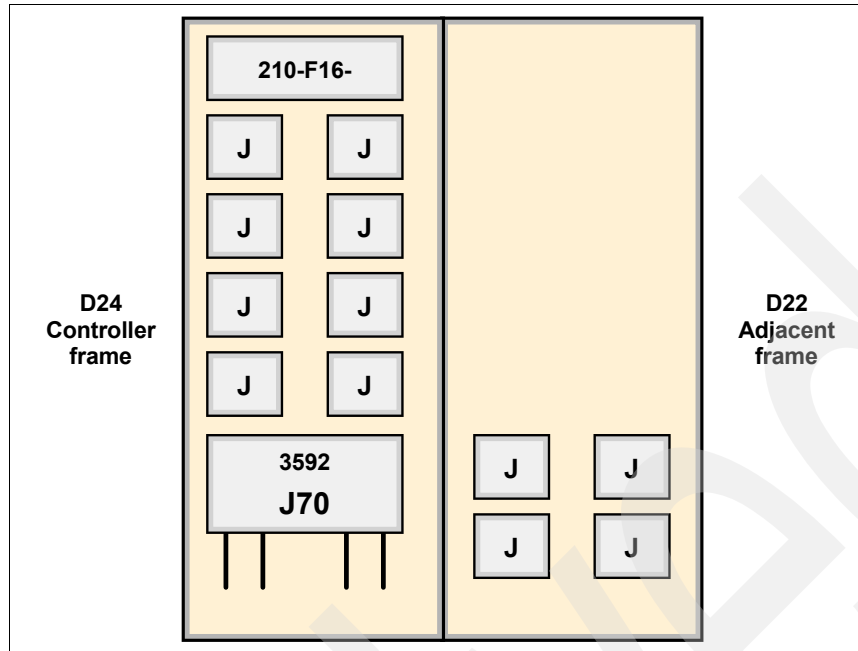


Figure 3-18 Example of drive connection to controller

Sample configuration

Figure 3-19 on page 139 shows in more detail the connections between host, controller, switch, and drive. In order to deliver the correct licensed internal code and hardware to install this configuration, a number of features are required for the controller, the switch, and the frames in which they are housed.

Features on the 3592-J70 in our sample configuration include:

- ▶ FICON and ESCON features (either FC3434, FC3435, or FC3413)
The number and type of these features are dictated by throughput and connectivity requirements for the System z host.
- ▶ Fibre Channel adapter feature (FC3476)
This feature provides the adapter hardware to attach the drives. For 3592 drives, the FC adapters are required, because the 3592 drive has only FC connectivity. (The other option is FC3477 for SCSI adapters if 3590 drives are used.)
- ▶ J1A drive attached to controller feature (FC9476)
This is a mandatory feature on the controller to provide code support for the 3592-J1A drives. It is mandatory on both the J70 and the A60 controllers to support the new drives.
- ▶ Fibre drive attach LC switch feature (FC3484)
This feature indicates that the configuration includes an F16 switch that has LC connectors. For an SC switch (the S16), FC3483 is required. This feature ensures the correct type of cables are shipped to attach the drives to the switch. In our example, LC connectors are required at both ends of the cables, because both the drive and the switch have LC connectors. The 3590 drives have SC connectors. Each of these different combinations triggers the shipment of different cables of the required length.
- ▶ Drive-to-switch cables (FC3059)
In our configuration, we need eight of these features, because one feature must be specified on the J70 for each 3592 tape drive attached to the Model J70 controller in the

rack that contains the Model J70. These features ensure shipment of the correct number of cables to use between the drives and the switch. Use FC9059 for 3590 drives.

Features on the 3494 in the sample configuration:

► LC Fibre Drive-attached controller feature (FC3474)

This feature is required to install the 3592-J70 Controller in conjunction with the 2109-F16 switch into the 3494-D24 frame. A different feature is required for the 3590 drives in a D14 frame. Different features are required if the switch is an SC switch (that is, the Model S16).

► Adjacent frame 3592 with LC attachment feature (FC4075)

This feature provides the hardware to support the attachment of the 3592-J1A drives housed in a 3494-D22 frame to the 3592-J70 Controller housed in the adjacent Model D24 frame, using the F16 switch. This feature ensures that the correct type of cables (in our example, LC/LC) are shipped to connect the four drives in this frame to the switch in the adjacent frame. The correct number is shipped based on the number of drives installed in this frame (in our example, four). This feature also applies if all twelve 3592 drives are attached to a Model A60 controller. However, if the switch used was a Model S16 (SCC-attached), FC4065 applies. If 3590 drives are used, different features are used on the D12 frame.

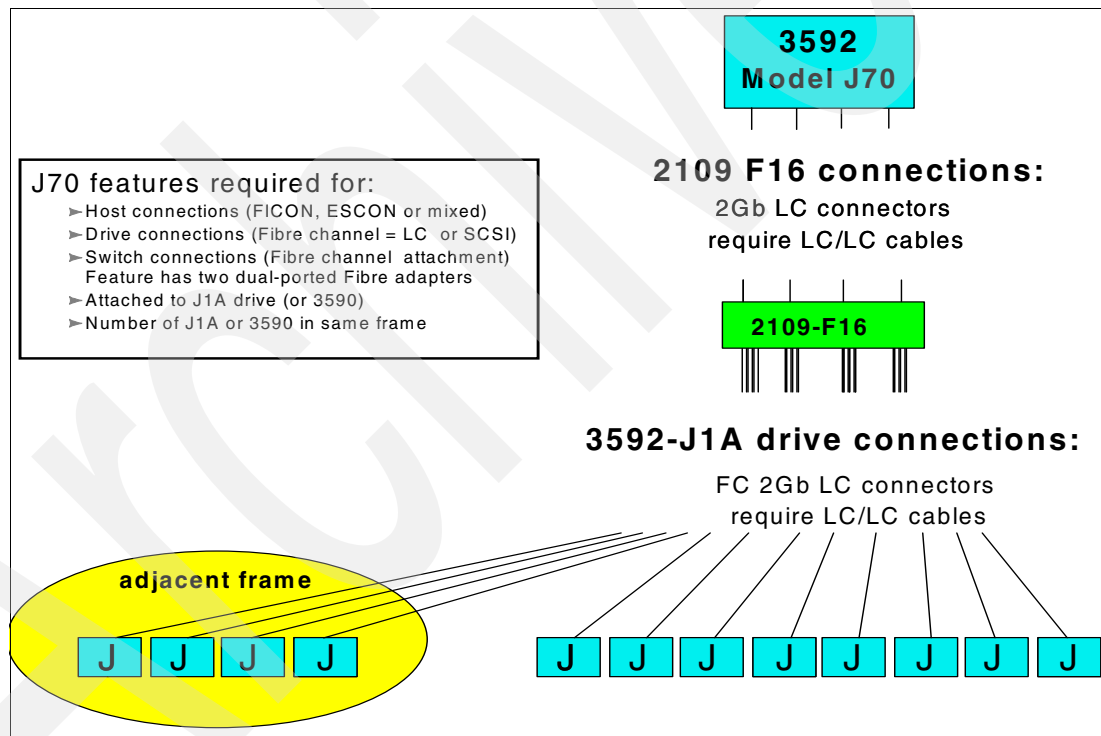


Figure 3-19 Example of the drive connection to the controller installed in a 3494

Fibre Channel SAN switch

The 2109 SAN Fibre Switch Model F16 must be configured as a separate machine type in our example. Although the required cables are generated by other features in the configuration as we previously described, you must explicitly specify the required number of IBM Gigabit Interface Converters (GBICs) on the switch. Each Model F16 switch comes with eight shortwave GBICs as standard, which is sufficient to connect to the four FC attachments in the controller, leaving six to attach up to six 3592 or 3590 tape drives. You must order additional features (FC2210, additional shortwave transceiver) when you plan to attach more than six drives to the controller. The quantity of this feature needs to equal at least the number of tape

drives attached to the controller beyond six. So, in our example, order six FC2210s to attach 12 drives to the controller. The 2109 switch also has an optional feature (FC6203) for an additional redundant power supply, enabling dual power source configurations to minimize power outages. Do not specify the “non-rack install” feature (FC9205), because the switches are dedicated to the controller and are always housed in a frame or rack.

3.8.3 Feature codes

Table 3-12 lists the Model J70 feature codes that are available for device attachment and installation.

Table 3-12 Model J70 feature codes

Feature code	Description
2714	Console Expansion
2715	Console Attachment
2720	IBM System Storage TS3000 System Console
3059	3592 Tape Drive-to-Switch Cables
3413	Dual ESCON Host Adapter
3434	2-Gbps FICON Long Wave Attachment
3435	2-Gbps FICON Short Wave Attachment
3465	SC Fibre Switch Controller in a Rack
3475	LC Fibre Switch Controller in a Rack
3476	Two LC Fibre Channel Drive Adapters
3477	Dual-Ported SCSI Drive Adapters
3483	Fibre Drive Attachment for Controller with 2109 S16
3484	Fibre Drive Attachment for Controller with 2109 F16
4065	Multiframe SCSI Rack Attach
4641	Install J70 Controller in a Rack
4860	Replace Controller with a 3592 Model J70
4865	Remove J70 Controller from a 3494 Model D14 or D24 Frame
4868	Field Install J70 in a 3590 Model A14 Frame
5245	Dual Path Attachment
5593	Router for EKM Attachment
5595	CU Encryption Configuration - Field-Installed
9000	Attach to S/390or System z
9059	J70 to 3590 Drive Attachment
9060	Multiframe SCSI A14
9476	3592 Model J1A Drive Attached to Controller

Feature code	Description
9595	CU Encryption configuration - Plant-Installed
9700	No Factory Cables
9752	9-micron LC/LC 31 m Fibre Cable
9753	9-micron LC/LC 2 m Fibre Cable
9762	50-micron LC/LC 31 m Fibre Cable
9763	50-micron LC/LC 2 m Fibre Cable
9770	62.5 Micron MT-RJ to ESCON Riser-Rated 31 meter ESCON Cable
9771	62.5 Micron MT-RJ to ESCON Plenum-Rated 31 meter ESCON Cable
9775	62.5 Micron MT-RJ to ESCON 2 meter ESCON Jumper Cable
9789	62.5 Micron MT-RJ to MT-RJ Plenum-Rated 31 meter ESCON Cable
9790	62.5 Micron MT-RJ to MT-RJ Riser-Rated 31 meter ESCON Cable
9793	9-micron LC/SC 31 m Fibre Cable
9794	50-micron LC/SC 31 m Fibre Cable
9861 ^a	Field Merge J70 in C10
9862 ^a	Plant Install J70 in C10
9865	Field Merge J70 in a 3494 Model D14 or D24 Frame
9866	Plant Install J70 in a 3494 Model D14 or D24 Frame
9867	Plant Install J70 in a 3590 A14 Frame
9868	Field Merge J70 in a 3590 A14 Frame
9877	Field-Installed J70 in 3952-F05

a. Applies only to the C20 frame in a StorageTek (ACS) environment. Refer to the *IBM TotalStorage Silo Compatible Tape Frame 3592 Introduction, Planning, and User's Guide*, GA32-0463, for information regarding this installation.

For a full description of the 3592 Model J70 Controller features, refer to the publication *IBM System Storage Tape System 3592 Introduction and Planning Guide*, GA32-0464.

3.8.4 Reliability and availability

The J70 Controller is built from IBM components, including the IBM pSeries, 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 Master Console (TSMC), 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. An IBM SSR can then respond to fix the problem.

The Call Home feature is now available through the IBM TS3000 System Console, which we explain in “Call Home” on page 152. IBM 3494 Tape Libraries that were already configured and using the TotalStorage Master Console (TSMC) will still function, and they will only need to use the new features with any additional frame that is purchased.

3.8.5 Compatibility considerations for upgrade and migration

The IBM System Storage Tape 3592 Model J1A drive and 3592 Model J70 Controller can be used in various combinations with 3590 drives and the 3590-A60 controller, which is intended to provide the maximum configuration flexibility when upgrading in order to add to or replace existing 3590 installations.

The 3592 Model J70 (and the 3590 Model A60) can be used 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 3592 Model J1A drives cannot be attached to the same controller with 3590 tape drives, and you cannot intermix 3590 models B, E, or H on the same controller.
- ▶ The 2109 Model F16 or S16 switch must be used exclusively by the 3592-J70 or 3590-A60 controller. The 2109 switch and attached 3592 or 3590 tape drives cannot be shared with Open Systems servers.
- ▶ The controller must have dedicated access to the 3592 and 3590 tape drives attached to the 2109 switch. You cannot attach the second Fibre Channel port on the tape drives to another 2109 switch or an Open Systems server.
- ▶ The 3592 drives are not supported for attachment to a 3590 Model A50 or A00 controller.

The 3592 tape cartridge has external dimensions (form factor) that allow it to be used within existing storage cells of libraries containing 3590 tapes. However, the 3592 tape drives must be installed in frames that are separate from any 3590 drives. The 3592 tape cartridges are incompatible with IBM 3590 tape drives, and likewise, you cannot use the 3590 tapes in the 3592 drives.

Compatibility considerations include:

- ▶ The 3592 tape drives cannot read cartridges written by 3590 or 3490 drives. Cartridges written by IBM 3592 drives cannot be read by the 3590 or 3490 drives. Even though the cartridges are similar in size, they contain different media and media format, and thus are not interchangeable.
- ▶ Although you can attach multiple systems to a 3592 drive, the systems cannot use the drive simultaneously. You can only vary the 3592 drive online to one system at a time.

The IBM System Storage Tape 3592 Model J1A drive and TS1120 Tape Drive can be attached to the same 3592 Model J70 Controller with the following restrictions:

- ▶ The TS1120 Tape Drive cannot be attached to the same 3592 Model J70 Controller with 3590 tape drives.
- ▶ TS1120 tape drives will operate in J1A Emulation mode when attached to the same 3592 J70 Controller with 3592-J1A tape drives. This mode is set automatically by the

microcode. In this mode, the TS1120 Tape Drive will read and write only in J1A format at the J1A capacity and approximate performance ratings. This configuration requires J70 code level 1.19.1.xx and Library Manager 532.xx.

- Encryption-enabled TS1120 tape drives in a library cannot be attached to the same 3592 Model J70 with TS1120 tape drives that are not encryption-enabled or 3592-J1A drives.

3.8.6 Performance overview

The chart in this section compares the performance of the 3592-J70 and 3590-A60 controllers with twelve attached 3592-J1A tape drives. Figure 3-20 shows the throughput of a 3592-J70 Controller when data is highly compressible, and Figure 3-21 on page 144 illustrates the performance advantage of the 3592-J1A tape drive over the 3590 tapes when data compresses only 1:1.



Figure 3-20 J70 and A60 write throughput comparison

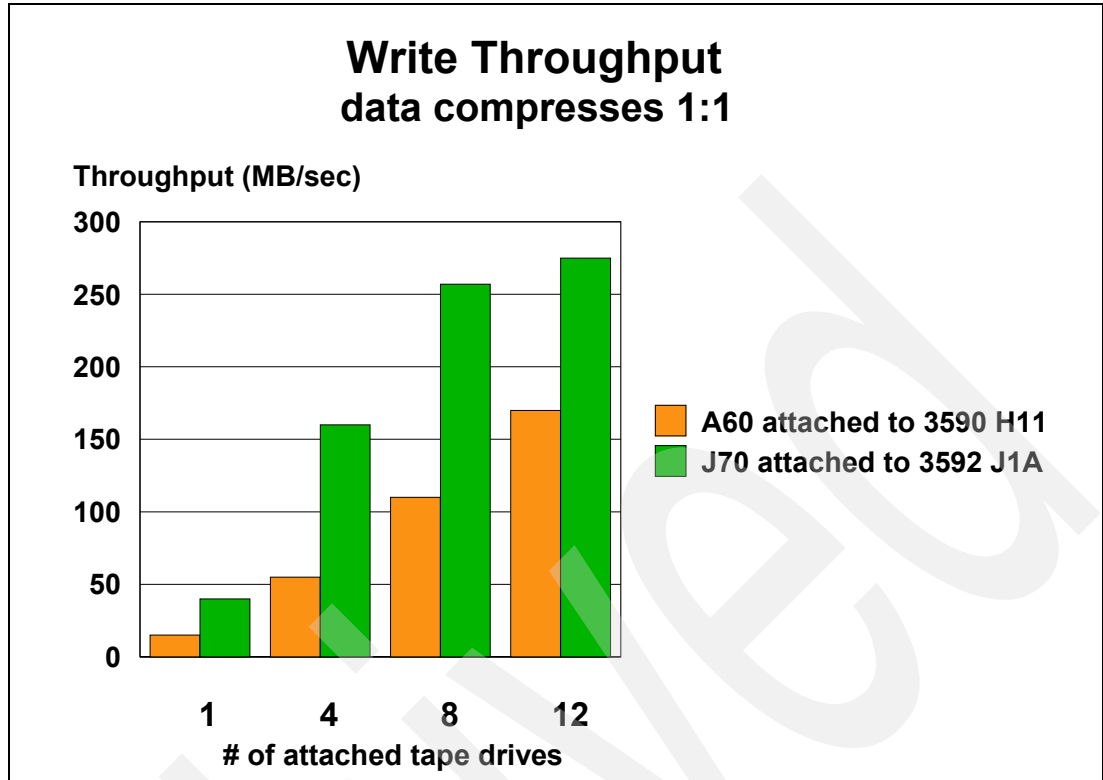


Figure 3-21 J70 with 3592 drives and A60 with 3590 drives

Summary

The J70 Controller has been designed to provide up to one and a half times the throughput of the A60. It has been designed to provide numerous functions to allow better performance for applications that require high data transfer rates, write many files to a tape cartridge, regularly synchronize records to the cartridge, or randomly retrieve records or files from a high capacity tape cartridge. This functionality is delivered by a combination of the J70 Controller microcode and OS/390 or z/OS operating system support. Figure 3-20 on page 143 and Figure 3-21 illustrate the J70 Controller; when attached to the 3592-J1A tape drive, it offered significantly better performance than its predecessor.

Although designed to complement the high capacity and high performance of the 3592 tape drive, the J70 Controller is backward-compatible with the 3590 tape drive. This compatibility enhances the flexibility of the J70 Controller to fit into various storage environments, including those environments with existing 3590 tape systems, which helps to protect prior investments in tape storage hardware.

3.9 IBM System Storage TS1120 Tape Controller

The IBM System Storage TS1120 Tape Controller (TS1120 Model C06 Controller) is the Removal of Hazardous Substances (RoHS) compliant replacement to the 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 appropriate levels of system software. The TS1120 Model C06 Controller (shown in Figure 3-22 on page 145) 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 it weighs 39 kg (86 lb.) with mounting hardware.



Figure 3-22 TS1120 Model C06 Controller

The TS1120 Model C06 Controller is supported in the following configurations:

- ▶ Silo: The TS1120 Model C06 Controller resides in a rack or in a 3952-F05 frame (replaces 3590-C10 frame). This controller is then connected to the 3592 drives residing in a 3592-C20 frame.
- ▶ Stand-alone: The TS1120 Model C06 Controller 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 and TS1120-E05 tape drives; it does not support 3590 tape drives.

The TS1120 Model C06 Controller within a 3952 Tape Controller Model F05 frame can go to different library models.

3.9.1 IBM TS1120 Model C06 Controller characteristics

The TS1120 Model C06 Controller is designed to offer ESCON and FICON attachment to 3592-J1A and 3592-E05 drives. It also provides 3494 Library Manager, StorageTek ACS, and stand-alone support through the 3952 Tape Frame. The TS1120 Model C06 Controller further exploits the performance and functions of the 3592 tape drives, including increased capacity to 500 GB when data is written with the 3592-E05 tape drive in E2 format or 700 GB when data is written with the 3592-E05 tape drive on extended 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.

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 or 2 Gbps for 3592 Model J70 controllers
- ▶ Up to eight ESCON attachments
- ▶ Support for an intermix of ESCON and FICON attachments

- ▶ Up to sixteen attached 3592-E05 (or 3592-J1A) tape drives (up to twelve in a stand-alone rack)
- ▶ Two 4 Gbps Fibre Channel adapters for attaching 3592 tape drives or switches
- ▶ Support for 3592 drive hot swap capabilities
- ▶ Support for capacity scaling and 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, DFSMSHsm™ audit is the only application written to take advantage of this capability.
- ▶ Support for Tape Encryption

Note: For Encryption support, the minimum level of microcode firmware for the TS1120 Controller is 1.21.x.x.

Note: When using Tape Encryption in a library that has a mix of controller models, you will need to upgrade the microcode firmware of your controllers if you intend to use tape cartridges from a common tape cartridge scratch pool.

The minimum level of microcode firmware is 1.19.5.x for the 3592-J70 Enterprise Tape Controller, 1.21.x.x for the TS1120 Model C06 Controller (3592-C06), and 1.16.1.11 for the 3590 A60 Enterprise Tape Controller.

When using Tape Encryption, you can only attach TS1120 tape drives that are encryption-enabled to a single TS1120 Tape Controller.

When using a TS1120 Model C06 Controller with an IBM 3494 Tape Library, the controller resides in a 3952 Tape Frame that is detached from the library. This extra frame is required, because the TS1120 Model C06 Controller is an unmodified System p processor. The drives and operator panels are on one side, and the cable connections are on the other side. The controller cannot be serviced in an IBM 3494 Tape Library, because only one side is accessible. This design differs from the 3592-J70 Controller that was modified so that the drives, operator panels, and cables were all on one side, which enabled access and service in an IBM 3494 Tape Library.

There are two versions of the 3952 tape frame: the 3494 attachment frame and the silo-attached frame. A maximum of three TS1120 Model C06 Controllers can be installed in the 3494 attachment frame, as detailed in Table 3-13.

Table 3-13 TS1120 Tape Controllers in 3952 tape frames

Frame	Attachments
3952 Tape Frame Model F05 (3494 attachment)	One to three TS1120 Model C06 Controllers
3952 Tape Frame Model F05 (Silo attachment)	One to three TS1120 Model C06 Controllers

The TS1120 Model C06 Controller connects to the library through a 3494-D24 or 3494-D22 frame. The 3494-D24 frame or 3494-D22 frame contains the Fibre Channel switches that the controller uses to communicate to the TS1120-E05 (or 3592-J1A) drives, the Ethernet router through which the controller communicates with the Library Manager, and up to 12 IBM TS1120-E05 (or 3592-J1A) tape drives. You can connect additional drives (up to a total of 16

per TS1120 Model C06 Controller) in an adjacent 3494-D22 frame or 3494-L22 frame with current feature codes. Table 3-14 lists the frame capacities for drives and controllers.

Table 3-14 3494 maximum frame capacities for drives and controllers

Frame	Attachments
3494 Model L22	Up to four 3592 tape drives Note: <ul style="list-style-type: none"> ▶ If a Model D22 frame is installed with the adjacent frame FC4085, the maximum number of attached 3592 drives is four. ▶ If a Model D22 frame is installed with the adjacent frame FC4086, the maximum number of attached 3592 drives is four.
3494 Model D22	Up to twelve 3592 tape drives Note: <ul style="list-style-type: none"> ▶ If a Model D22 frame is installed with the adjacent frame FC4085, the maximum number of attached 3592 drives is eight. ▶ If a Model D22 frame is installed with the adjacent frame FC4086, the maximum number of attached 3592 drives is four.
3494 Model D24	One 3592 Model J70 or 3590 Model A60 controller, or TS1120 Model C06 Controller ^a and up to eight 3592 tape drives
3494 Model D14 ^b	One 3592 Model J70 or 3590 Model A60 controller or attachment through the outboard TS1120 Model C06 Controller, and up to four model H1A, four model E1A, or four model B1A 3590 tape drives

a. The TS1120 Model C06 Controller is installed remotely from the tape library in an IBM 3952 frame.

b. This frame and controller combination is supported only for 3590 drive attachments.

3.9.2 Attachment features

The IBM TS1120 Model C06 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 3-15 on page 148 shows how you can intermix the attachments.

Table 3-15 Permitted combinations of FICON and ESCON attachments

TS1120 Model C06 Tape Controller		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 or 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. 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 and, using ESCON directors, can be up to 43 kilometers (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 meters (492 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 kilometers (2.48 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 10 kilometers (6.2 miles) and can connect up to 128 logical paths.

Drive attachment

The TS1120 Model C06 Controller is attached through FC3478 to up to sixteen 3592 tape drives. This feature installs two short wavelength 4 Gbps dual-ported Fibre Channel adapters with LC connectors. The following features are available depending on how you install the controller:

- ▶ FC3488 4 Gbit Fibre Channel switch, maximum of two
- ▶ FC4888 or FC4887 Fibre Channel switch mount kit, one for each controller
- ▶ FC3492 external fabric support, maximum of one
- ▶ FC3493 or FC9493 direct connect drive, maximum of one
- ▶ FC3494 Fibre Channel switch rack mount, maximum of one
- ▶ FC9885 field merge TS1120 Model C06 Controller into 3952 Tape Frame, maximum one
- ▶ FC9886 plant install TS1120 Model C06 Controller into 3952 Tape Frame, maximum one

Note: For a complete list of the required feature codes for 3494 attachment, their prerequisites, or corequisites, refer to Table 2-7 on page 73.

IBM TotalStorage 3494 Tape Library features

If you are going to install a TS1120 Model C06 Controller in a 3952-F05 attached to a 3494, you must order the following features:

- ▶ FC3486 Switch Mount Kit: You must specify this feature on the 3494 model D22 or D24 frame that attaches to the TS1120 Model C06 Controller.
- ▶ FC3490 Redundant FC attachment: Add this feature for redundancy.
- ▶ FC4085 Adjacent Frame Fibre Channel 3592: You must specify this feature code on the associated 3494 Model L22 or D22 frame that contains the other 3592 tapes drives that will be attached to the TS1120 Model C06 Controller.
- ▶ FC3061 3592 Drive-To-Switch cables: Specify one feature code on the 3494 D24 frame for each 3592 tape drive attached to the switches.

Attaching the TS1120 Model C06 Controller to 3592 tapes drives in an IBM TotalStorage 3494 Tape Library can vary, because tape drive placement is independent of controller location. In fact, the TS1120 Model C06 Controller is outboard to the 3494 library. Figure 3-23 gives you several examples of how this can look.

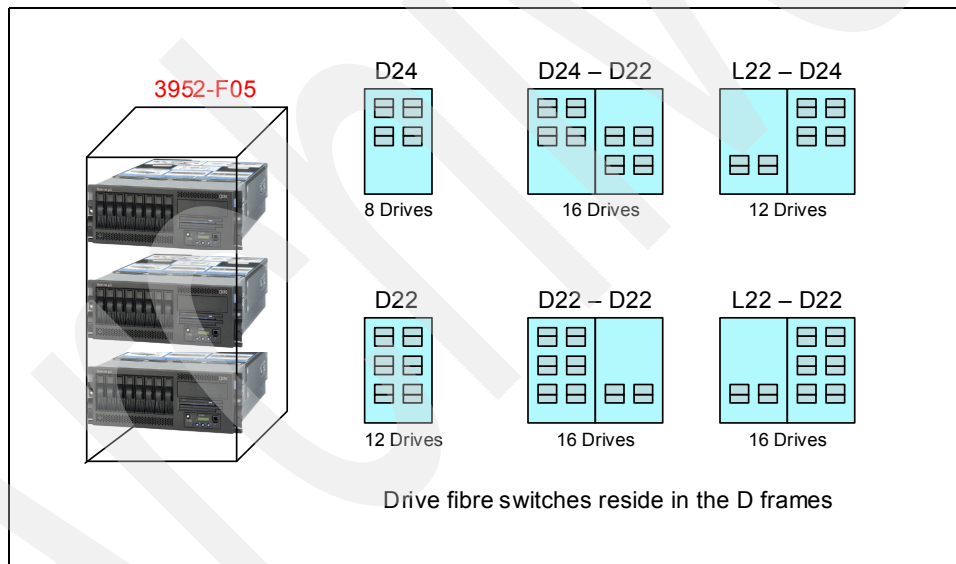


Figure 3-23 Examples of drive connection with TS1120 Model C06 Controller

Direct Connect

For limited configurations, the TS1120 Model C06 Controller can have four 3592-E05 (or 3592-J1A) tape drives attached using direct connect support (FC3493 or FC9493). This configuration is only supported if the number of tape drives is four or less. The client is responsible for providing the cables from the TS1120 Model C06 Controller installed in a 3952 Tape Frame to the 3592 tape drives. Cables from the controller to the tape drives can be ordered with the tape drives or supplied by the client.

3.9.3 Feature codes

Table 3-16 on page 150 lists the TS1120 Model C06 Controller feature codes that are available for device attachment and installation.

Table 3-16 TS1120 Model C06 Controller feature codes

Feature code	Machine type and model	Description
0520	TS1120 (3592-C06) Controller, 3592 Model J70, 3494 models Lxx	Functional Enhancement Field
2714	TS1120 (3592-C06) Controller	Console Expansion
2715	TS1120 (3592-C06) Controller	Console Attachment
2720	TS1120 (3592-C06) Controller	IBM System Storage TS3000 System Console
3062	TS1120 (3592-C06) Controller	Drive-to-Switch Cables/Rack
3440	TS1120 (3592-C06) Controller	Dual ESCON Attachment for C06
3441	TS1120 (3592-C06) Controller	FICON Short Wavelength Attachment
3442	TS1120 (3592-C06) Controller	FICON Long Wavelength Attachment
3443	TS1120 (3592-C06) Controller	FICON 10 km Long Wavelength Attachment
3478	TS1120 (3592-C06) Controller	Two Dual-Ported Fibre Drive Adapters
3488	TS1120 (3592-C06) Controller	4 Gbit Fibre Channel Switch
3492	TS1120 (3592-C06) Controller, 3952 Frame F05	External Fabric Support (Field install)
3493	TS1120 (3592-C06) Controller, 3952 Frame F05	Direct Connect™ Drives (Field install)
3494	TS1120 (3592-C06) Controller	Fibre Channel switch Rack Mount Kit
3495	TS1120 (3592-C06) Controller	Redundant Fibre Channel Attach
3516	3952-F05 Frame	Fibre Channel switch Mount Kit
3517	3952-F05 Frame	Redundant Fibre Channel Attach
4641	TS1120 (3592-C06) Controller	Install Controller in Rack
4870	3952-F05 Frame	Replace Controller with TS1120 (C06) Controller
4887	TS1120 (3592-C06) Controller	Reinstall 2 Gbit Fibre Channel switch
4897	TS1120 (3592-C06) Controller	Reinstall 4 Gbit Fibre Channel switch
5593	TS1120 (3592-C06) Controller, 3952-F05 Frame	Router for Encryption Key Manager (EKM) Attach
5594	3952-F05 Frame	Attach Additional CU to Router

Feature code	Machine type and model	Description
5595	TS1120 (3592-C06) Controller	CU Encryption Configuration (Field install)
5875	3952-F05 Frame	Field Merge 3592-J70 Controller
5877	3952-F05 Frame	Field Install 3592-J70 Controller
5878	3952-F05 Frame	Field Merge TS1120 (C06) Controller
5879	3952-F05 Frame	Field Install TS1120 (C06) Controller
5880	3952-F05 Frame	Field Install TS1120 (C06) Controller in a 3952-F05 Frame
7315	3952-F05 Frame	TS7640 Silo Compatible Controller Attachment
7316	3952-F05 Frame	Enterprise Tape Library Attachment (3494 Outbound Controller Frame)
9000	TS1120 (3592-C06) Controller	Attach to S/390 or System z
9478	TS1120 (3592-C06) Controller	3592 Drive Attach to C06 Controller
9492	TS1120 (3592-C06) Controller, 3952-F05 Frame	External Fabric Support (Plant install)
9493	TS1120 (3592-C06) Controller, 3952-F05 Frame	Direct Connect Drives (Plant install)
9595	TS1120 (3592-C06) Controller	CU Encryption configuration (Plant install)
9885	TS1120 (3592-C06) Controller, 3952-F05 Frame	Field Merge C06 into 3952-F05
9886	TS1120 (3592-C06) Controller, 3952-F05 Frame	Plant Install C06 into 3952-F05
9887	TS1120 (3592-C06) Controller, 3952-F05 Frame	Field Merge C06 into 3953-F05
9888	TS1120 (3592-C06) Controller	Plant Install C06 into 3953-F05
9889	3592-F05 Frame	Plant Install C06 in 3952 for 3494

For a full description of the TS1120 Model C06 Controller features, refer to *Introduction and Planning Guide 3592 Models J1A, E05, J70 and C06, GA32-0555*.

3.9.4 Reliability and availability

The new IBM System Storage TS1120 Tape Controller, Model C06 is designed to provide performance and reliability for IBM System z clients. The TS1120 Model C06 Controller combined with the TS1120-E05 tape drive provides up to 1.7 times the throughput of the

3592-J70 Controller with 3592-J1A tape drives. 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 TS3000 System Console (TSSC) attachment (this attachment was previously known as the IBM TotalStorage Master Console (TSMC)).

The Call Home function can report any error alerts for early detection of problems, might expedite microcode updates, reduce service times, and enhance local service. FC2720 TS3000 System Console replaces FC2713, Master Console for Service. Call Home functionality with features FC2714, FC2715, and FC2720 connected through Ethernet to the various 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-J1A in a stand-alone frame or rack
- ▶ TS1120 Model C06 Controller or 3592-J1A in the 3494 Tape Library
- ▶ TS1120 Model C06 Controller or 3592-J1A in the 3952 Tape Frame
- ▶ TS1120 Model C06 Controller or 3592-J1A in the 3952-F05 Tape Frame
- ▶ TS1120 Model C06 Controller or 3592-J1A in a StorageTek Automated Cartridge System environment

3.9.5 Compatibility considerations for upgrade and migration

Use the IBM System Storage TS1120 Tape Controller and 3592 (either J1A or E05) tape drives in various combinations to provide the flexibility to maximize your configuration when upgrading or adding to your existing tape installations. Be sure to obey the configuration rules in mixed environments:

- ▶ You cannot intermix SCSI-attached and Fibre Channel-attached tape drives on a single TS1120 Model C06 Tape Controller.
- ▶ TS1120 Model E05 and J1A tape drives can be attached to the same controller when TS1120-E05 drives emulate 3592-J1A drives².
- ▶ You cannot attach TS1120-E05 tape drives to the same 3592-J70 Controller with 3590 tape drives. Also, you cannot intermix 3590 B, E, or H models 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 Fibre Channel switch, 2-Gbps Fibre Channel switch, 2109 Model F16 switch, or 2109 Model S16 switch must be used exclusively by the 3592-J70 Controller.
- ▶ The 3592-J1A or TS1120-E05 and 3590 tape drives attached to the 4-Gbps or 2-Gbps Fibre Channel switch or 2109 switch can only be accessed by the 3592-J70 Controller.
- ▶ External fabric is supported as of 23 October 2004.
- ▶ 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.

² To take advantage of the performance improvements of the TS1120 Model E05 drive or its Encryption capability, you must only attach native TS1120-E05 drives to the TS1120-C06 Controller.

Compatibility considerations include:

- ▶ The TS1120 Model C06 Controller must be installed in a 3952 Tape Frame Model F05 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.

3.9.6 Performance overview

Figure 3-24, Figure 3-25 on page 154, Figure 3-26 on page 154, Figure 3-27 on page 155, and Figure 3-28 on page 155 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.

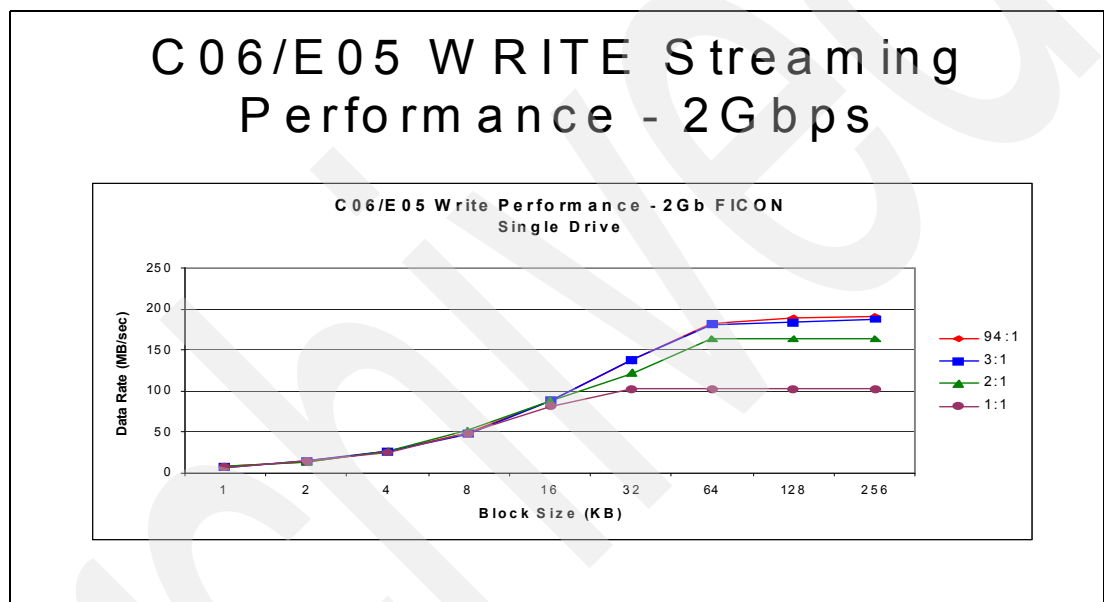


Figure 3-24 TS1120 Model C06 Controller write streaming performance with 2 Gbps

C06/E05 WRITE Streaming Performance - 4Gbps

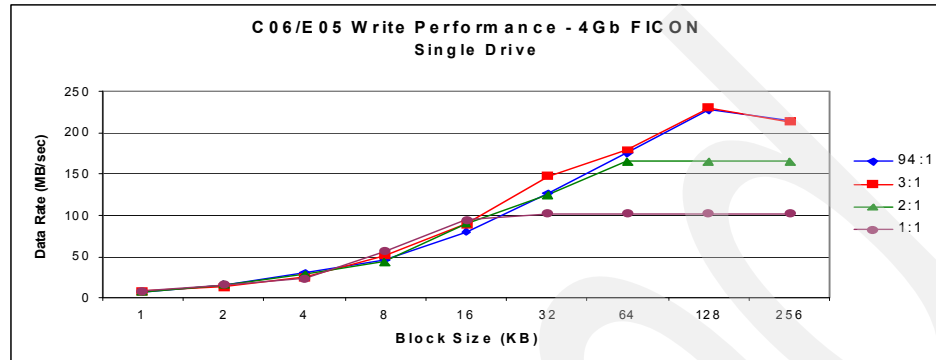


Figure 3-25 TS1120 Model C06 Controller write streaming performance with 4 Gbps

Streaming Write Performance Comparison

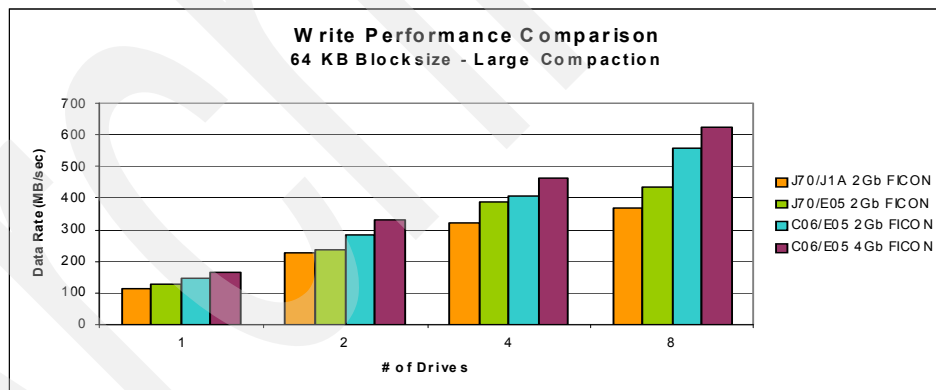


Figure 3-26 Write Performance comparison

z/OS DFSMSdss Full Volume Dump

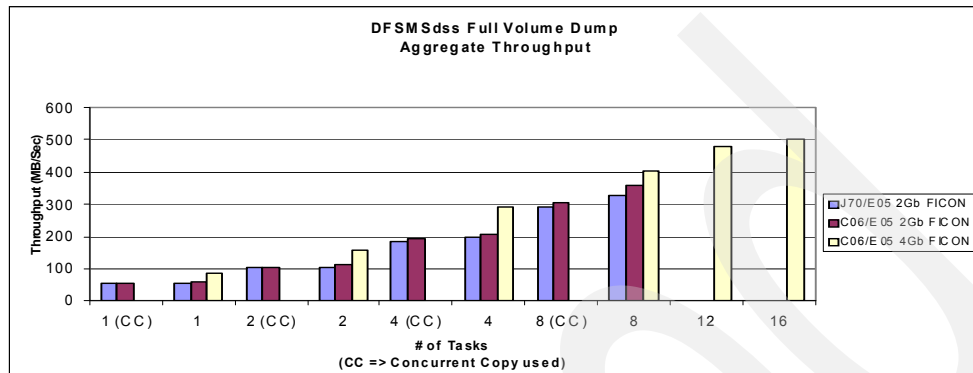


Figure 3-27 Aggregate throughput for DFSMSdss™ full volume dump

z/OS DFSMSdss Full Volume Restore

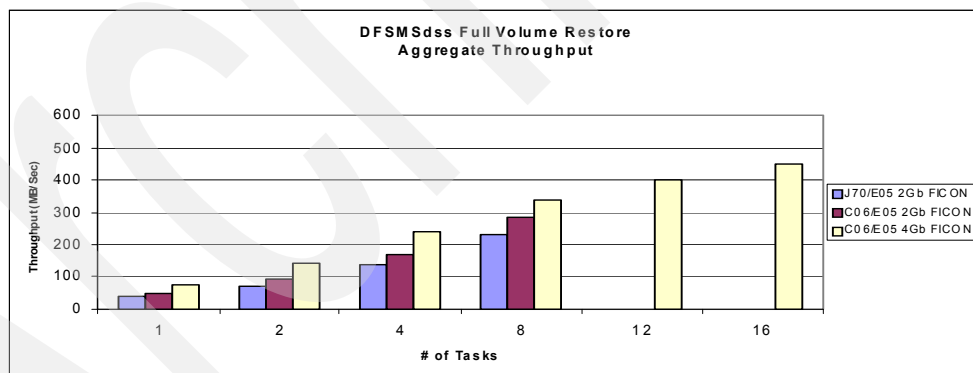


Figure 3-28 Aggregate throughput for DFSMSdss full volume restore

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, the TS1120 Model C06 Controller can also use the existing 3592-J1A tape drive. You can utilize the TS1120 Model C06 Controller in an existing IBM TotalStorage 3494 Tape Library, therefore, protecting the investment made in this infrastructure. The

TS1120 Model C06 Controller can be used in concert with the 3592-J70 to further utilize your already implemented tape infrastructure.

Software implementation in z/OS

This chapter discusses how to implement and run IBM TotalStorage Tape subsystems in z/OS and OS/390. It covers software requirements, implementation, customization, and platform-specific considerations for operation and monitoring.

This chapter only provides information about the system-managed tape environment. If you want to use an IBM 3494 Tape Library in a z/OS environment without system-managed tape, you must have Basic Tape Library Support (BTLS). For reference purposes, you can obtain information about BTLS in Appendix D, “Basic tape library environment” on page 509.

The new functions and the VTS and TS7700 support are only integrated in the system-managed tape environment. If you have BTLS, and you want to migrate to system-managed tape, refer to *BTLS V1R1 User's Guide and Reference*, SC26-7016.

For information about using IBM TotalStorage Enterprise 3590 or IBM TotalStorage Enterprise Tape Drive 3592 Model J1A or IBM System Storage Tape Drive Model E05 and E06 in a StorageTek Silo, refer to Appendix A, “Tape drives in silo compatible frames” on page 457.

4.1 z/OS and OS/390 software support

For software support information regarding the implementation of the IBM TotalStorage Enterprise Drive 3590 and IBM System Storage 3592 Tape Drive, refer to the most current Product Support Planning (PSP) Bucket. To find the relevant PSP bucket for your environment, go to:

<http://www.ibm.com/support>

Select **Search technical support** and type `psp` for the search argument.

4.2 z/OS software environments

This section describes the software environment for system-managed tape. *System-managed tape* allows you to manage tape volumes and IBM 3494 Tape Libraries through a set of policies that determines the type of service to give to the datasets on the volume.

The automatic class selection (ACS) routines process every new tape allocation in the system managed storage (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 the IBM 3494.

For SMS-managed requests, the storage group routine assigns the request to a storage group. The assigned storage group determines which IBM 3494s to use. A tape storage group is associated with one to eight tape libraries and the tape volumes stored inside the libraries. All volumes of a multivolume dataset must be contained within a single library and a single storage group as well.

Figure 4-1 on page 159 shows the process flow of the automatic class selection routines.

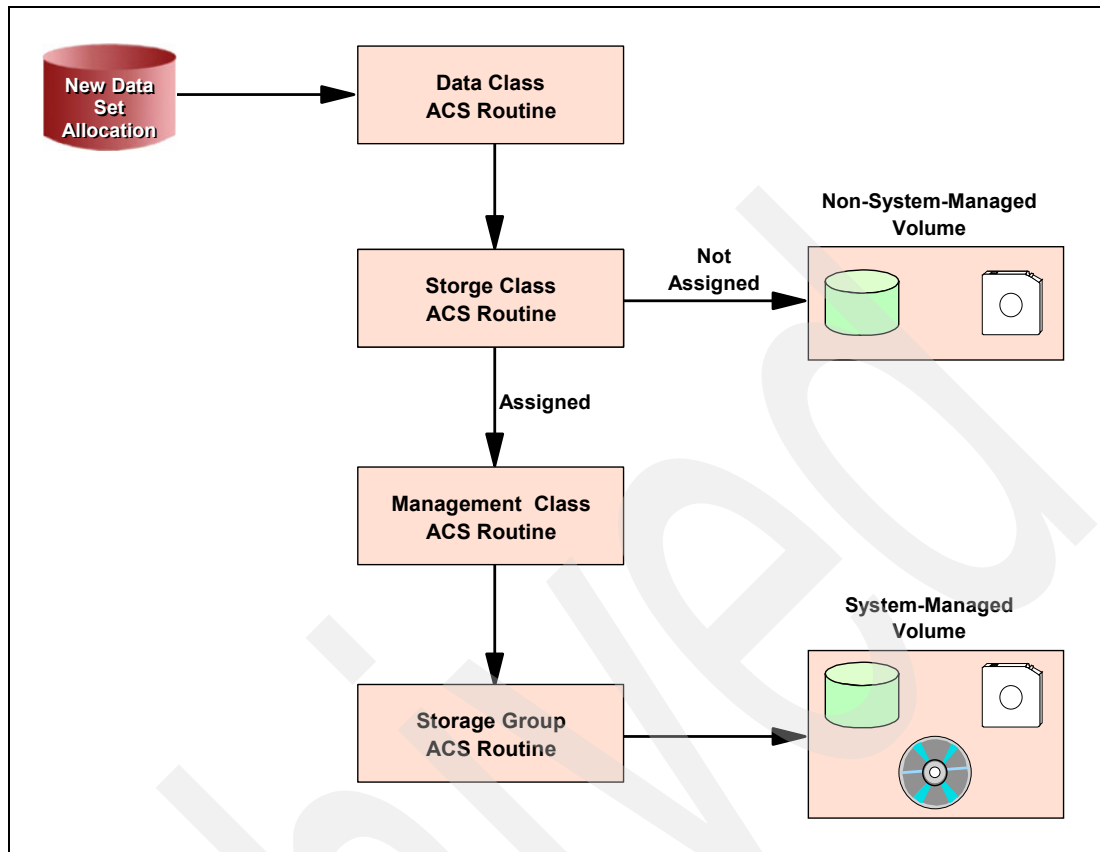


Figure 4-1 ACS process flow

Here are some examples of what system-managed tape allows you to do:

- ▶ Direct all of your off-site backup volume allocations to an IBM 3494 Tape Library in an off-site, protected location for disaster recovery.
- ▶ Ensure that all volumes for a particular application use the same kind of drives in an intermixed library.
- ▶ Migrate easily to a new drive generation.
- ▶ Encrypt selected data.

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 4-2 on page 160 shows an overview of the system-managed tape environment.

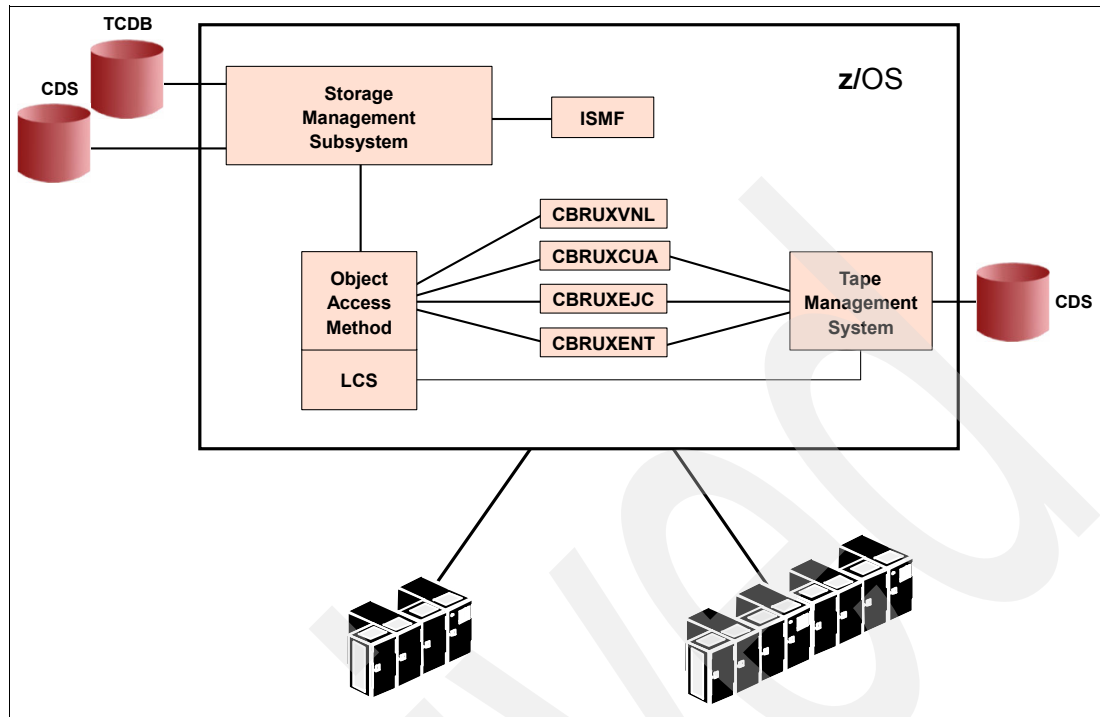


Figure 4-2 System-managed tape overview

The basics of system-managed tape are:

- ▶ OAM and LCS
- ▶ Storage management subsystem (SMS address space)
- ▶ Tape configuration database (TCDB)
- ▶ Integrated storage management facility (ISMF)
- ▶ Tape management system
- ▶ Additional z/OS commands

Note: The discussion in this chapter addresses the most common situation in which you have system-managed tape in an automated tape library (ATL) environment, such as an IBM 3494 Tape Library.

Nevertheless, you can also have system-managed tape in a manual tape library (MTL) environment. In this situation, users can define one or more manual tape libraries with each library consisting of a set of stand-alone drives and volumes. Read about this support in *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 3494.

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 these components, refer to *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 certain tape management systems also use this interface. Library functions, such as entering cartridges and inventories, communicate through this interface with the TCDB and with the tape management systems.

Certain programming interfaces and installation exits belong to the OAM LCS component:

- ▶ The programming interface provided by the LCS External Services macro (CBRXLCS) to support functions, such as:
 - 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) VTS library

Note: For a complete list of the functions that you can perform when invoking the LCS External Services programming interface through the CBRXLCS macro, refer to Chapter 6 of *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 IBM 3494 Tape Library.

For more information about OAM, see *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 TCDB, which is an integrated catalog facility (ICF) catalog 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 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, either:
 - None
 - Read only

A *volume catalog* contains entries for tape volumes and tape libraries but does not contain entries for individual datasets. You must define at least one general volume catalog and any number of specific volume catalogs. 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 through IDCAMS commands in the TCDB are not transferred to the Library Manager in the IBM 3494 Tape Library. Therefore, discrepancies can occur. Use the IDCAMS CREATE, ALTER, and DELETE commands only to recover from volume catalog errors.

If you run SMSplex (more than one z/OS image uses the same SMS), the TCDB must be shared in this SMSplex. Therefore, it is possible to allow access to a volume by more than one system in the SMSplex.

Integrated storage management facility

The user communicates with an IBM 3494 Tape Library mainly through ISMF. Panel driven and easy to use, 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 functionalities for 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. Eject, change location, and other commands referring to a physical location movement immediately create an action in the library. The easiest way to have consistency 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 are 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 the IBM 3494 Tape Libraries. If you use an ISV product, we recommend that you contact the vendor to learn which release provides this support. 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 re-enable exits, eject volumes, query and set cartridge loaders, and display the status of tape drives. Also, LIBRARY commands drive the import and export of logical volumes in a VTS and Copy Export of logical volumes in a TS7700.
- ▶ **DISPLAY SMS:** Use this command to display library information or data about a volume.
- ▶ **VARY SMS,LIBRARY:** Use this command to vary libraries online and offline.
- ▶ **MODIFY OAM:** Use this command to audit volumes.

For more information about these commands, see 9.7.2, “MVS operator commands” on page 438.

4.3 Software implementation and customization

This section explains the necessary steps to implement system-managed tape in your environment. Implementing and activating SMS is not part of this section. 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. Set up the hardware configuration definition (HCD).
2. Update SYS1.PARMLIB.
3. Define the security profiles.
4. Allocate the TCDB.
5. Prepare and start OAM.
6. Customize OAM.
7. Update and customize your tape management system.
8. Define the library through ISMF.
9. Define the DFSMS constructs through ISMF.
10. Perform a pre-ACS installation exit (optional).
11. Write ACS routines.
12. Activate the SMS configuration and restart OAM.
13. Set up JES3 support (only where applicable).
14. Perform DFSMSHsm customization (only where applicable).
15. Verify your installation.

4.3.1 Set up the hardware configuration definition (HCD)

HCD is used to define the tape drives that belong to an IBM 3494 Tape Library to the input/output (I/O) definition file. The LIBRARY-ID and LIBPORT-ID are not mandatory but recommended.

This section explains how to define an IBM TotalStorage Enterprise Tape Controller 3590 Model A60 control unit with 10 tape drives attached to it, as well as the IBM TotalStorage Enterprise Tape Controller 3592 Model J70 with 12 drives attached to it. Figure 4-3 shows the first HCD panel. If you have a different level of z/OS installed, the example panels that we show in this section might differ slightly.

Follow these steps:

1. From the HCD primary panel (Figure 4-3), enter the name of the input/output definition file (IODF) that you want to update and select option 1.

If this is not an IODF work file, you will be prompted to create one. The name of the IODF file is in the format *hlq.IODFcc.yyyyyyyy*.

Note the following explanation:

- *hlq* is a high-level qualifier of up to eight characters.
- *cc* is any two hexadecimal characters.
- *yyyyyyyy* is up to eight optional characters.

```
CBDPM000                                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 . . . 'SYS1.IODF02.ATLGUIDE.WORK'      +

F1=Help    F2=Split    F3=Exit    F4=Prompt    F9=Swap    F12=Cancel
F22=Command
```

Figure 4-3 Hardware Configuration definition primary display

- To define the control unit, select option **4** on the Define, Modify, or View Configuration Data panel (see Figure 4-4).

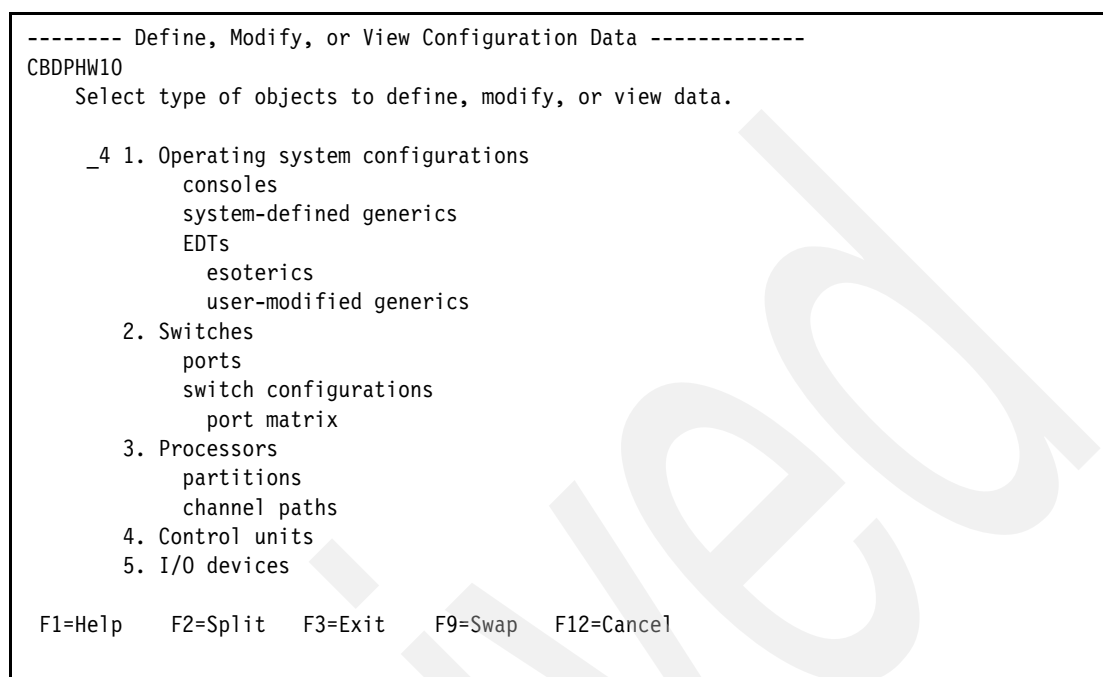


Figure 4-4 HCD display: Define, Modify, or View Configuration Data panel

- Press F11 (Add) on the Control Unit List panel (Figure 4-5).

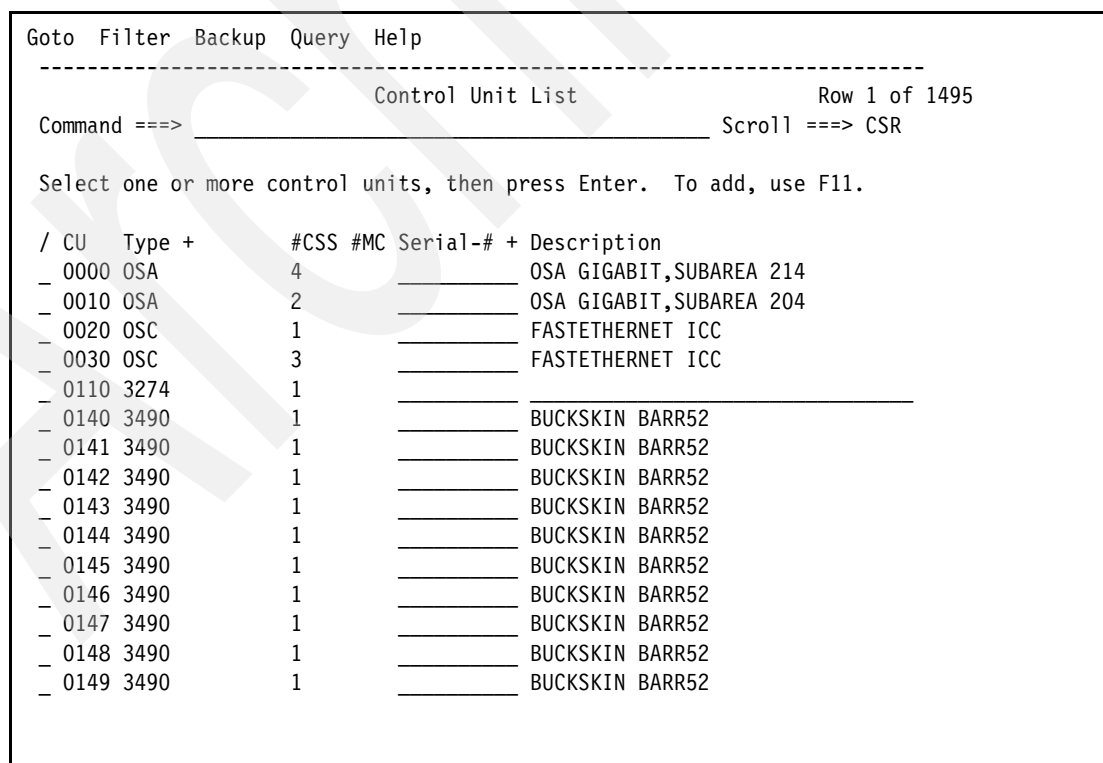


Figure 4-5 HCD display: Control Unit List panel

- When the Add Control Unit panel displays (Figure 4-6), 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 next to them return prompts when you press F4. We do not have a switch in our configuration. Press Enter.

```

----- 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

F1=Help  F2=Split  F3=Exit  F4=Prompt  F5=Reset  F9=Swap
F12=Cancel

```

Figure 4-6 HCD display: Add Control Unit panel

- On the Select Processor/Control Unit panel (Figure 4-7), select the processor to which you will attach the control unit. Type an s next to its entry and press Enter. If you will attach the control unit to multiple processors, type a g next to each processor that you want attached to the control unit.

```

----- Select Processor / Control Unit -----
CBDPCUP0                                     Row 1 of 3 More:
Command ==> _____ Scroll ==> PAGE

Select processors to change CU/processor parameters, then press Enter.

Control unit number . . : 0700      Control unit type . . . : 3590

/ Proc. ID Att. Log. Addr. -----Channel Path ID . Link Address + -----
(CUADD) + 1---- 2---- 3---- 4---- 5---- 6---- 7---- 8----
s PROC1          -          _____
_ PROC2          -          _____
_ P9021          -          _____
***** Bottom of data *****

F1=Help      F2=Split      F3=Exit      F4=Prompt      F5=Reset
F6=Previous  F7=Backward  F8=Forward  F9=Swap       F12=Cancel
F20=Right    F22=Command

```

Figure 4-7 HCD display: Select Processor/Control Unit panel

- The Add Control Unit panel displays (see Figure 4-8). For each processor to which you will attach the control unit, add the channel path ID (CHIPID), the base unit address, and the number of units. Press Enter.

```

----- Add Control Unit -----
CBDPCU12

Specify or revise the following values.

Control unit number . : 0700          Type . . . . . : 3590
Processor ID . . . . . : PROC1        This is the main processor

Channel path IDs . . . . 38 39  _ _ _ _ _ +
Link address . . . . . _ _ _ _ _ _ _ _ _ _ +

Unit address . . . . . 00 _ _ _ _ _ _ _ _ _ +
Number of units . . . . 4 _ _ _ _ _ _ _ _ _

Logical address . . . . _ + (same as CUADD)

Protocol . . . . . _ + (D,S or S4)
I/O concurrency level . 2 + (1, 2 or 3)

F1=Help    F2=Split    F4=Prompt    F5=Reset    F9=Swap    F12=Cancel

```

Figure 4-8 HCD display: Add Control Unit panel

This completes the definition of the control unit.

Note: There is no difference in the HCD definitions for the control units and the devices between the attachment to a Fibre Channel Connection (FICON) and an Enterprise Systems Connection (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.

Table 4-1 summarizes the major HCD panel fields for the control unit definitions. You use the same panels to define 3490E control units, 3590-A60 tape controllers, and the new 3592 Model J70 Tape Controller.

Note: The IBM System Storage TS1120 Tape Controller and the IBM TotalStorage Enterprise Tape Controller 3592 Model J70 use the same definition as the 3590 Model A60 controller, but the total number of drives can be up to 16 (TS1120) or 12 (J70).

Table 4-1 HCD configuration options for 3590, 3592, and 3490 control units

Model	3590-A60	3592-J70 3592-C06	3490-F1A (FC3000)
Control unit type	3590	3590	3490-C2A ^a
Unit address	0	0	0
Number of units	10	12/16 ^b	4

- a. The FC3000 Controller with attached 3490E-F1A devices is defined as a 3490-C2A controller in the HCD dialog.
- b. When attached to a TS1120 Tape Control Unit, up to 16 tape drives are supported.

Next you must define the devices that attach to this controller.

7. Press F3, save your responses, and exit from the Control Unit Definition menu.
8. Go to the Add Device panel (Figure 4-9) by choosing either of the following options:
 - Select option **1** and then option **5** from the main panel (Figure 4-4 on page 165).
 - Type an **s** next to the control unit that you defined on the Control Unit List panel (Figure 4-5 on page 165).
9. On the Add Device panel, add the device number, number of devices, device type, and connected control unit (CU). Press Enter.

```

----- Add Device -----
CBDPDV10

Specify or revise the following values.

Device number . . . . . 0700 (0000 - FFFF)
Number of devices . . . . . 12
Device type . . . . . 3590 +

Serial number . . . . . 
Description . . . . . 

Connected to CUs . . 0700 +

F1=Help    F2=Split  F3=Exit    F4=Prompt  F5=Reset   F9=Swap
F12=Cancel
  
```

Figure 4-9 HCD display: Add Device panel

Restriction: You cannot use device number 0000. As documented in APAR OW56336, a restriction exists on 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.

10. The Device/Processor Definition panel (Figure 4-10) displays. Type an s next to the processor that will use the devices. Press Enter.

```

----- Device / Processor Definition -----
CBDPDV11                                     Row 1 of 1
Command ==> _____ Scroll ==> PAGE

Select processors to change device/processor definitions, then press
Enter.

Device number . . : 0700          Number of devices . : 12
Device type . . . : 3590

/ Processor ID   UA + Time-Out STADET Preferred Explicit Device
                  CHPID + Candidate List
s_ PROC1        _ No          Yes    _ No
*****
***** Bottom of data *****

F1=Help      F2=Split      F3=Exit      F4=Prompt      F5=Reset
F6=Previous  F7=Backward  F8=Forward  F9=Swap       F12=Cancel
F22=Command

```

Figure 4-10 HCD display: Device/Processor Definition panel

11. The Define Device/Processor panel displays (Figure 4-11). This panel describes the processor's view of the device. Press Enter.

```

----- Define Device / Processor -----
CBDPDV12

Specify or revise the following values.

Device number . . : 0700          Number of devices . . . . : 12
Device type . . . : 3590
Processor ID . . . : PROC1        This is the main processor

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)

F1=Help      F2=Split      F4=Prompt      F5=Reset      F9=Swap      F12=Cancel

```

Figure 4-11 HCD display: Define Device/Processor panel

12. The Define Device to Operating System Configuration panel (Figure 4-12) displays. Type an s next to the operating system or systems that will use the IBM 3494 Tape Library. Press Enter.

```
----- Define Device to Operating System Configuration -----
CBDPDVOS                                         Row 1 of 5
Command ==> _____ Scroll ==> PAGE

Select OSs to connect or disconnect devices, then press Enter.

Device number . : 0700          Number of devices : 12
Device type   . : 3590

/ Config. ID  Type      Description          Defined
s AB          MVS       MVS operating system
_ AC          MVS       MVS operating system
_ MVSFP1      MVS
_ OPSYS01     MVS       MVS operating system
_ OPSYS02     VM        VM operating system
***** Bottom of data *****

F1=Help      F2=Split    F3=Exit      F4=Prompt    F5=Reset
F6=Previous  F7=Backward  F8=Forward   F9=Swap      F12=Cancel
F22=Command
```

Figure 4-12 HCD display: Define Device to Operating System Configuration panel

13. The Define Device Parameters/Features panel (Figure 4-13) displays. On this panel, link the operating system to the tape subsystem that you plan to install.

CBDDPDV13
Define Device Parameters / Features
Row 1 of 9

Command ==>
Scroll ==> PAGE

Specify or revise the values below.

Configuration ID . : AB
MVS operating system
Device number . . : 0A40
Number of devices :12
Device type . . . : 3590

Parameter/ Feature	Value	P Req.	Description
OFFLINE	No		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	12345		5 digit library serial number
LIBPORT-ID	02		2 digit library string ID (port number)
SHARABLE	No		Device is Sharable between systems
COMPACT	Yes		Compaction

***** Bottom of data *****

F1=Help

F2=Split

F4=Prompt

F5=Reset

F7=Backward

F8=Forward

F9=Swap

F12=Cancel

F22=Command

Figure 4-13 HCD display: Define Device Parameters/Features panel

You can accept all of the default parameters, except the following parameters:

- **OFFLINE** depends on your environment. It specifies whether z/OS is to consider 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 COMMNDxx 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 is 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 optional parameters.

LIBRARY-ID is the unique identification number of a tape library. It specifies the hardware ID associated with the tape library that you define. The IBM service support representative (SSR) defines it at the time of the library installation. The value is returned by the control unit in response to a Read Device Characteristics command. See 4.3.8, “Defining the library through ISMF” on page 195 for the method to identify the LIBRARY-ID to DFSMS.

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 LIBPORT-ID provides the tape drive pool ID, which is transparent and only used by allocation.

For each logical library (LIBRARY-ID) in the 3494, the LIBPORT numbers always start with 01, and increase as you move away from the L frame. Therefore, the first 3490, 3590, or 3592 tape drives in the frame have a LIBPORT of 01, and as you move out, each frame increments by 1. There is one *exception* to this rule. Each IBM 3490E Model F1A tape drive has its own LIBPORT-ID. That is, the devices do not share LIBPORTS.

Also, each SCSI-attached drive (non-VTS/TS7700, non-ESCON) counts as one LIBPORT, even though you do not define it through HCD.

Note: You can refer to the Library Manager configuration panels to match the information for the LIBPORT-IDs assigned to the drives.

For the VTS or TS7700, it is much simpler. Each VTS or TS7700 has its own LIBRARY-ID, so the LIBPORTs start at 01 again. The lowest order logical drives attached to the first control unit (with a CUADD or logical address of 0) are given 01 as a LIBPORT. Each group of 16 is then increased by an increment of 1.

These parameters allow HCD to provide the library configuration information that is normally obtained from the device at IPL time. For devices that are available during IPL, the HCD information is redundant.

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.
- ▶ The LIBRARY-ID coded in HCD and later in ISMF must match exactly the LIBRARY-ID specified during the library installation. Otherwise, the library cannot be varied online to z/OS.

In an existing installation, you can use the new DEVSERV QTAPE system command to see the LIBRARY-ID and LIBPORT-ID. Refer to 9.7.2, “MVS operator commands” on page 438 for the syntax of the z/OS DEVSERV QTAPE operator command. The LIBRARY-ID also shows on the Library Manager display (see 9.4.1, “Discovering the LIBRARY-ID given during the teach process” on page 402).

- **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.

14. The Assign/Unassign Device to Esoteric panel displays. You do not have to define IBM 3494 Tape Library resident devices to an esoteric in system-managed tape. Use esoteric device names when the number of physical installed drives is less than the number of devices defined to the HCD to prevent allocations going to offline devices in the tape library. You must handle the esoteric device names in your SMS ACS routines and assign them to an appropriate tape storage group. Your IBM 3494 Tape Library and drives are now defined, and a production IODF is built and then activated.

Table 4-2 summarizes the major HCD panel fields for IBM 3590, IBM 3592, and IBM 3490E tape device definitions.

Table 4-2 IBM 3494 HCD configuration options for 3590, 3592, and 3490E devices

Model	3590-B1A 3590-E1A 3590-H1A	3592-J1A 3592-E05 3592-E06	3490E-F1A
Number of devices	10	12 or 16 ^c	4
Device type	3590	3590	3490
Number of LIBPORT-IDs	1 ^a	1 ^a	1 to 2 ^b

a. Specify one LIBPORT-ID. Each tape unit attached to the control unit has the same LIBPORT-ID assigned.

b. Specify one LIBPORT-ID per F1A tape unit. Each physical installed F1A tape unit attached to the FC3000 control unit has its own LIBPORT-ID assigned.

c. When attached to a TS1120 Tape Controller, up to 16 TS1120 drives are supported; otherwise, only 12 drives can be attached to a single controller.

Note: *IBM TotalStorage Virtual Tape Server Planning, Implementing and Monitoring*, SG24-2229, describes the HCD definitions for a VTS.

IBM Virtualization Engine TS7700 Series Introduction and Planning Guide, GA32-0567, describes the HCD definitions for a TS7700.

4.3.2 Updating SYS1.PARMLIB

You need to update and verify the following PARMLIB members:

- ▶ **SCHEDxx:** Add the OAM initialization module CBROAM to the system program property table (PPT).
- ▶ **IGDSMSxx:** 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.
- ▶ **IEFSSNxx:** Add or update the OAM1 entry with the name of the initialization module (CBRINIT) executed at IPL.
- ▶ **CONSOLxx:** Update the CONSOLxx member referenced by IEASYSxx if you want to receive library messages at a specific console. You must also define this console name during ISMF library definition to SMS.
- ▶ **DEVSUPxx:** Device support options for the 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 added to the IBM 3494 Tape Library partitioning for 3592 support:
 - MEDIA5=xxxx
 - MEDIA6=xxxx
 - MEDIA7=xxxx
 - MEDIA8=xxxx
 - MEDIA9=xxxx
 - MEDIA10=xxxx

– where xxxx is a 4-digit hexadecimal category code

- ▶ **COMMNDxx**: Add the VARY XXXX,ONLINE command if you want to bring certain tape drives online after IPL.
- ▶ **GRSCNFxx (optional)**: If you plan to share the tape library among two or more systems in an SMS complex, a global resource serialization ring can be created to include all sharing systems, which allows OAM to serialize the cartridge entry process.
- ▶ **LOADxx (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 LOADxx member can reside in SYS1.PARMLIB or SYSn.IPLPARM. When used, SYSn.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.

- ▶ **COFVLfxx (optional)**: Add the volume catalogs to the IGGCAS class definitions where you have other ICF catalogs.
- ▶ **ALLOCxx (optional)**: Add policies for tape automation.
- ▶ **IECIOSxx (optional)**: Set values for Missing Interrupt Handler (MIH).

SCHEDxx member of SYS1.PARMLIB

You use SCHEDxx to define programs requiring special attributes to include 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.

IGDSMSxx member of SYS1.PARMLIB

IGDSMSxx 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 to start the OAM address space 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 is not using OAM to store objects but uses OAM for tape library management only.

IEFSSNxx member of SYS1.PARMLIB

You use IEFSSNxx 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, English Mixed Case) and EU represents uppercase (for example, English UPPERCASE). If MSG is omitted, EU is the default.

CONSOLxx member of SYS1.PARMLIB

You update the CONSOLxx 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,I0)
          (...)
```

You must also define this console name during ISMF library definition to SMS (see 4.3.8, “Defining the library through ISMF” on page 195). The library console name is the name that is used when you define the IBM 3494 Tape Library to SMS through the ISMF panels. We recommend that the console is authorized for SYS and I0, which allow an operator to issue z/OS MODIFY and VARY commands.

DEVSUPxx member of SYS1.PARMLIB

DEVSUPxx controls installation-wide default tape device characteristics:

```
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
```

- ▶ **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. The DATACLAS cannot override the JCL parameter if specified.
- ▶ **VOLNSNS = YES:** This setting is only necessary if you have different generations of one device type installed, such as a mix of 3590-Bxx, 3590-Exx, and 3590-Hxx, or a mix of 3592-J1A and TS1120 tape drives. It allows cartridges to be relabeled from a device, which cannot read the actual label (for example, EFMT2 relabeled to EFMT1 or 256 tracks relabeled to 128 tracks). The relabel process to a higher format (for example, EFMT1 to

EMFT2 or 128 tracks to 256 tracks) is always possible, regardless of what you specify in this parameter.

To partition the tape library into logically independent libraries, the following parameters are available. Use these parameters only if you plan to share the library among other systems. Use the DEVSUPxx 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 (300 GB) 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 (300 GB) 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 (60 GB) 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 (60 GB) 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 (700 GB) 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 (700 GB) 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.

You might need to update member IEASYSxx to point to a new DEVSUPxx member.

If a syntax error occurs because of a missing comma in DEVSUPxx, no error message is issued, and your partitioning efforts will yield unpredictable results.

Note that updating DEVSUPxx can require an IPL, which you might want to schedule in advance.

COMMNDxx member of SYS1.PARMLIB

When defining the tape drives to the HCD, the specification of OFFLINE on the Define Device Parameters/Features panel (Figure 4-13 on page 172) controls whether the devices are brought online automatically at IPL time:

```
COM='VARY dddd,ONLINE'
```

It is a common practice to not bring tape drives online at IPL time, but rather to vary them online with the COMMNDxx member.

If you define the drives in the HCD to come online at IPL and no cartridge is mounted in the drive, the drive will not be ready and will remain OFFLINE. We recommend that you add VARY statements for all drives that need to be online to a particular system after that system runs the IPL.

GRSCNFxx member of SYS1.PARMLIB (optional)

If you plan to share the tape library among two or more systems in an SMS complex, a global resource serialization ring can be created to include all sharing systems. This global resource serialization ring allows OAM to serialize the cartridge entry process. The global resource serialization (GRS) configuration is defined in member GRSCNFxx 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, and 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 obtain relevant information in *z/OS DFSMS Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries*, SC35-0427.

LOADxx 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 LOADxx can require an IPL, which you might want to schedule in advance.

COFVLFxx 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 specific 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) function 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.

ALLOCxx member of SYS1.PARMLIB (optional)

When you introduce automation, you must review the settings of the ALLOCxx member. By default, most of the parameters cause write to operator with reply (WTOR) messages. You must automate the parameters to achieve real lights-out operation. We explain the parameters that affect tape handling in the following sections.

VOLUME_ENQ POLICY (WTORICANCELWAIT)

This parameter specifies the installation policy for enqueueing 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 the 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 you use WAIT for the default, tape volumes might encounter deadlocks with other jobs in the system.

- ▶ **Default:** WTOR

VOLUME_MNT POLICY (WTORICANCEL)

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 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 (WTORIWAITHOLDIWAITNOHICANCEL)

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 volume on 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 been allocated to this job before it waits for the required units or volumes.

Note: Use of WAITHOLD can result in deadlock, particularly when the device is in use by a job that is going to wait. The system does not release any direct access storage devices (DASDs) that have been allocated to the job before it waits for the 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 option compared to the 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*):** Specifies the number of WAITNOH decisions that are allowed for the specific volume or unit allocation request before the default specified on the POLICYNW parameter takes effect. The WAITNOH decisions that are 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.

- **Default:** 5

POLICYNW(CANCEL|WTOR)

This parameter specifies how the system should handle 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 you select CANCEL, 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 4-14 shows a sample ALLOCxx member in an unattended environment. Figure 4-14 shows only those parameters that affect tape allocation.

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 4-14 Sample ALLOCxx member

IECIOSxx member of SYS1.PARMLIB (optional)

Update or set the values for the Missing Interrupt Handler (MIH).

The IBM 3590 and 3592 return the recommended MIH timeout values to the host operating system in Read Configuration Data. Therefore, it is unnecessary to specify MIH timeout values for IBM 3590 and 3592 devices. The device-supplied values handle all MIH timeouts.

The VTS and TS7700 emulate 3490E devices and do not automatically upload the MIH timeout values to the host operating system in Read Configuration Data. Therefore, you must specify MIH timeout values for IBM 3490E devices.

If you currently specify your own MIH timeout values for non-3590 or 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 timeout for each device. You specify MIH timeout values only by class (for example, all tapes) or on an individual device basis. Specification of an MIH timeout value for the entire tape class negates the 3590 or the 3592 device's recommended values. It adversely affects MIH recovery processing on 3590 or 3592 devices. You can specify the MIH values either in PARMLIB member IECIOSxx or with the OS/390 operator command SETIOS.

Figure 4-15 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/TS7700 virtual drives (A40 through A5F) at 25 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.

```
MIH=(0800-0807),TIME=03:00
MIH=(0900-0907),TIME=10:00
MIH=(09E0-09EF),TIME=20:00
MIH=(0A40-0A5F),TIME=25:00
```

Figure 4-15 Sample MIH specification in PARMLIB member IECIOSxx

4.3.3 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(userid)
```

See 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 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, whose profile names begin with STGADMIN. For tape library operations, the following profiles are important:

- ▶ 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(userid)
```

- ▶ 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(userid)
```

For a complete list of RACF profiles protecting 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:

```
REDDEFINE FACILITY STGADMIN.EDG.MASTER UACC(NONE)
PERMIT STGADMIN.EDG.MASTER CLASS(FACILITY)
ACCESS(CONTROL) ID(userid)
```

- ▶ Use of the INIT and ERASE function:

```
REDDEFINE FACILITY STGADMIN.EDG.OPERATOR UACC(NONE)
PERMIT STGADMIN.EDG.OPERATOR CLASS(FACILITY)
ACCESS(UPDATE) ID(userid)
```

- ▶ Changing information recorded by DFSMSrmm during O/C/EOV processing:

```
REDDEFINE FACILITY STGADMIN.EDG.FORCE UACC(NONE)
PERMIT STGADMIN.EDG.FORCE CLASS(FACILITY)
ACCESS(UPDATE) ID(userid)
```

For a complete list of RACF profiles protecting DFSMSrmm resources, refer to the *z/OS DFSMSrmm Implementation and Customization Guide*, SC26-7405.

z/OS operator commands

An installation can audit the use of commands and limit the use of commands by the operator and the console. You can restrict access to z/OS commands, such as LIBRARY or VARY SMS, which affect the operation of your IBM 3494 Tape Library:

- ▶ Access to the z/OS LIBRARY command:

```
REDDEFINE OPERCMDS MVS.LIBRARY UACC(NONE)
PERMIT MVS.LIBRARY CLASS(OPERCMDS) ACCESS(UPDATE) ID(userid)
```

- ▶ Access to the z/OS VARY SMS command:

```
REDDEFINE OPERCMDS MVS.VARY.SMS UACC(NONE)
PERMIT MVS.VARY.SMS CLASS(OPERCMDS) ACCESS(UPDATE) ID(userid)
```

Stacked volume

As long as a 3494 has installed native drives with the same device capabilities, there is a slight chance that stacked volumes from a VTS/TS7700 can be corrupted. A user with Bypass Label Processing (BLP) rights 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 beginning with any character and with the second character “P” 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 for more information.

4.3.4 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 an IBM 3494 Tape Library or a VTS/TS7700 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 4-3 shows the contents of the TCDB library and the volume record.

Table 4-3 Content of the TCBD library and the volume record

Library record	Volume record
Library name LIBRARY-ID Library description Library device type Number of slots Number of empty slots Number of scratch volumes Scratch volume message threshold Library Console Name	Volume serial number Volume use attribute Volume error attribute Write protection status Checkpoint volume indicator Tape device selection information Library name Storage group 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 can define an IBM 3494 Tape Library to the system. Define one general volcat in a system-managed tape SMSplex.

Figure 4-16 on page 185 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 4-16 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 LOADxx member in PARMLIB. Select the HLQ name carefully. There is no documented easy way to rename the VGENERAL after you define and use 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 that 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 GRS or another means to serialize access to tape drives. Figure 4-17 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 4-17 Import connect TCDB

Optionally, you can define one or more specific volcats. For example, consider SYS1.VOLCAT.Vx, 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 EFMT3/EEFMT3 volume records can coexist with lower level systems. OAM's existing coexistence support prevents the lower level system from retrieving and displaying an unsupported volume record.

- The application's use of confined tape ranges

Figure 4-18 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 4-18 Creating a specific SYS1.VOLCAT.VT

Notes:

It is important that you remember that:

- Library records cannot be stored in a specific volume catalog.
- 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 is minor. With z/OS V1R5, factor in 2,000 bytes for each library record.

When estimating, allow room for growth so that secondary extents are not created.

4.3.5 Preparing and starting OAM

To allow communication with your 3494 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 (see Figure 4-19 on page 187).

```
//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 4-19 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 on an SMS Control Dataset (SCDS) activation. 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 the defined libraries to the defined state in SMS, regardless of their current operational state

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 SMS-SCDS activation. If a library is set offline for a reason (such as maintenance), a manual restart does not set it online again. A restart caused by SMS-SCDS activation sets the specific library online.

First start of OAM and considerations

When you start OAM the first time, no library or tape records are available. OAM asks for the SMS-activation, because there is no information available for tape processing. After you introduce the IBM 3494 Tape Library through ISMF and restart OAM, the library comes online for the first time.

If you updated the IGDSMSxx member accordingly, OAM starts automatically during IPL.

4.3.6 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)**

The cartridge entry installation exit routine is called during cartridge entry processing to approve or disapprove entry of a cartridge into the library and to determine the TCDB volume record contents for each volume entered into the library:

- 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 a volume record for the entered MEDIA5-MEDIA8 volume does not exist in the TCDB and the volume is being entered as a private volume, EFMT1 will be passed to the exit.
- If the exit returns with a recording technology for a MEDIA5-MEDIA8 volume and the recording technology is not EFMT1, EFMT2, EEFMT2, EFMT3, or EEFMT3, the specification is considered invalid and the exit is disabled.
- If a volume record for the entered MEDIA9 or MEDIA10 volume does not exist in the TCDB and the volume is being entered as a private volume, EFMT2 will be passed to the exit.
- If the exit returns with a recording technology for a MEDIA9 or MEDIA10 volume and the recording technology is not EFMT2, EEFMT2, EFMT3, or EEFMT3, the specification is considered invalid and the exit is disabled.
- If a volume record for the entered MEDIA5-MEDIA10 volume does not exist in the TCDB and the volume is being entered as a scratch volume, UNKNOWN will be passed to the exit and will be assigned when the volume is used during job processing.
- If a TCDB volume record exists and the volume's recording technology or media type is not supported on the system processing the volume, in an ATLDS, the volume is left in the library manager insert category to be processed by a system with appropriate support.

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 ($S \rightarrow S$, $S \rightarrow P$, $P \rightarrow P$, or $P \rightarrow S$). The exit is called to approve or disapprove of the change and is called before the TCDB volume record and the LM database record are updated. If you need to code this exit routine, use SYS1.SAMPLIB member CBRSPUXC as a model.

► **Cartridge 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 an IBM 3494 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 does not use DFSMSrmm and your tape management vendor has not supplied an exit, OAM provides a sample exit in SAMPLIB that you can customize to fit your needs.

The OAM installation exits have been changed to support the EFMT3 recording technology:

- ▶ Change use attribute (CBRUXCUA) installation exit: Tape recording technology fields for EFMT3 and EEFMT3 have been updated.
- ▶ The UXCVWORM indicator is set to on if MEDIA10 to indicate that this is a WORM volume as was done with previous WORM media types. The tape management system is alerted that the CUA function is performed for a WORM volume when invoking the CBRUXCUA installation exit.
- ▶ Cartridge entry (CBRUXENT) installation exit: Tape recording technology fields and media type fields have been updated with EFMT3.
- ▶ Cartridge eject (CBRUXEJC) installation exit: Tape recording technology fields and media type fields have been updated with EFMT3.
- ▶ Volume not in library (CBRUXVNL) installation exit: Tape recording technology fields and media type fields have been updated with EFMT3.

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 the CBRUXCUA or CBRUXEJC exit, 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 SMP/E installation of DFSMSrmm. No customization is needed at all.

To obtain information about the recording technology and the media type for volume AN4441, issue the command:

```
DISPLAY SMS,VOLUME(AN4441)
```

If you use any other tape management system, contact your software vendor. Most of them support several or all OAM exits.

Note: With the introduction of Advanced Policy Management (APM) for VTS/TS7700, 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 Object Access Method Planning, Installation and Storage Administration Guide for Tape Libraries*, SC35-0427.

4.3.7 Updating and customizing your tape management system

System-managed tape and the Library Manager do not manage the contents of the cartridges. System-managed tape manages the physical characteristics of the cartridge and assigns appropriate drives and media at allocation time. The Library Manager manages the physical location of the cartridge within the library. DFSMSrmm manages your installation's tape volumes and the datasets on those volumes. DFSMSrmm is fully integrated into system-managed tape and uses the CBRXLCS general use programming interface: entry, eject, change use attributes, and volume not in library exits.

DFSMSrmm can automatically perform insert, scratch, and movement processing. Its partition support allows for easy control of cartridge entry where the library is partitioned between two or more systems. For a discussion about partitioning a tape library, refer to 6.2, "Partitioning tape libraries among multiple z/OS systems" on page 267.

DFSMSrmm is enhanced to support the new recording formats (EFMT3 and EEFMT3).

Note: A tolerance/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 an IBM 3494 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 extremely 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 an IBM 3494 Tape Library, their barcodes are validated. If acceptable, the cartridge is placed into the insert category.

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. This process is controlled by REJECT statements in the EDGRMMxx member of PARMLIB. 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 4-20 on page 191, 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 not known to DFSMSrmm from being 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 MEDIAx category value that is specified in DEVSUPxx. For more information about categories, see Appendix C, “Library Manager volume categories” on page 499.

```
REJECT ANYUSE(DD3*)
REJECT OUTPUT(CC12*)
REJECT ANYUSE(*)
REJECT ANYUSE(PRD*),OUTPUT(PR*)
```

Figure 4-20 RMM REJECT statements in EDGRMMxx

Important: Missing EDGRMM entries can cause you many problems if you share a library among different z/OS users. We strongly recommend that you do *not* implement new sharing partners without reviewing the EDGRMM member of all users of this library.

Defining library resident cartridges to DFSMSrmm

You can perform this step for new and existing cartridges.

New cartridges

If the EDGRMMxx 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 IBM 3494 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 LOCATION is 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; you can either issue multiple commands or use 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.

Note: To use the EFMT2 recording technology, you must specify the MEDIATYPE(MEDIA5, MEDIA6, MEDIA7, MEDIA8, MEDIA9, or MEDIA10) operand of the CHANGEVOLUME TSO subcommand.

The DFSMSrmm ADDVOLUME, CHANGEVOLUME, and SEARCHVOLUME commands have been expanded for RECORD FORMAT to include the EEFMT2, TS1120 Tape Encryption. See *IBM System Storage TS1120 Tape Encryption Planning, Implementation, and Usage Guide*, SG24-7320, for more information about TS1120 Tape Encryption.

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.

You need to add an additional step or job to the DFSMSrmm housekeeping run 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 eject. Refer to the RMM EJECT sample step shown in Figure 4-21.

```
//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 4-21 RMM EJECT sample step

Note: DFSMSrmm sets the INTRANSIT(YES) flag for ejected volumes as soon as EJECT occurs. You must then issue the CONFIRMMOVE command just as you do without an IBM 3494 Tape Library.

Tape initialization

For volumes in an automated tape library data server, you have the option to use DFSMSdftp™ 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/TS7700. Stacked and logical volumes are initialized transparently to the user and host at the time of the first use. Also, initialization for native 3590 or 3592 drives is not required. In an environment with a mixed 3590 or 3592, it is not even useful. 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 (vision system working) and the VOL1 label for a scratch volume does not match the external label, DFSMSdftp rewrites the VOL1 label with the correct volume serial number (VOLSER).

DFSMSrmm turns off the initialization action to defer the labeling to OPEN processing under DFSMSdftp 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 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.

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 IBM 3494 while DFSMSrmm is active.
 - Define the volumes as scratch to DFSMSrmm with `LOCATION(atlname)` and enter the volumes into the IBM 3494 with DFSMSrmm active.

2. Volumes are now defined to DFSMSrmm with scratch status. They are known to be in the library.

3. Use the RMM CV `VOLSER INIT(Y)` command to set the initialization action for each volume. Use the following command to build the commands:

```
RMM SV VOL(*) STATUS(SCRATCH) LOC(atlname)
```

4. Run EDGINERS in automatic mode.

In the sample DFSMSrmm EDGINERS (Figure 4-22 on page 194), 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 initialize, because no specific mounts (because 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. There is no verification performed. 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 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 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 asking the operator to correct the error.

```
//STEP1 EXEC PGM=EDGINERS,
//      PARM='COUNT(99),LOCATION(MYATL),INITIALIZE,NOVERIFY'
//SYSPRINT DD SYSOUT=A
```

Figure 4-22 Sample DFSMSrmm EDGINERS

Scratch pooling

The system-managed tape does not support multiple scratch pools of a single media type in its current release. The libraries can contain different types of scratch cartridges (Table 4-4).

Table 4-4 Media type descriptions

Media type	Name	Device type	Recording format	WORM or R/W	Cartridge capacity
MEDIA1	Cartridge System Tape (CST)	3490 or VTS/TS7700	32-track	R/W	400 MB
MEDIA2	Enhanced Capacity Cartridge System Tape (ECCST)	3490 or VTS/TS7700	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

Media type	Name	Device type	Recording format	WORM or R/W	Cartridge capacity
MEDIA9	IBM 3592 Extended Tape Cartridge (EETC)	3592	EFMT1	R/W	500 GB
			EFMT2	R/W	700 GB
			EEFMT2	R/W	700 GB
			EFMT3	R/W	1000 GB
			EEFMT3	R/W	1000 GB
MEDIA10	IBM Extended Tape WORM Cartridge (EETWC)	3592	EFMT1	WORM	500 GB
			EFMT2	WORM	700 GB
			EEFMT2	WORM	700 GB
			EFMT3	WORM	1000 GB
			EEFMT3	WORM	1000 GB

The scratch cartridges are selected according to DATACLAS 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 must partition the library as explained in 6.2, “Partitioning tape libraries among multiple z/OS systems” on page 267. For detailed coverage of sharing and partitioning, see the *Guide to Sharing and Partitioning IBM Tape Library Data*, SG24-4409.

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.

Many installations have tape volume serial number standards that match the media format to tape VOLSER. However, if you use different 3590 models in one installation, this practice does not work when managing a single scratch pool.

Note: For specific details about the changes in DFSMSrmm for the new IBM TotalStorage Enterprise Tape Media models support, refer to the *DFSMS Software Support for IBM TotalStorage Enterprise Tape System 3592*, SC26-7514-01.

Duplicate volume serial numbers

For system-managed tape, all VOLSERs in the same SMSplex must be unique across tape, DASD, and optical environments. DFSMSrmm does not support duplicate VOLSERs and cannot manage volumes that are not defined to it. You must use DFSMSrmm IGNORE support to process duplicate tapes.

Within the IBM 3494 Tape Library, all volumes, including native, stacked, and logical, must be unique. You have to use distinct volume serial number ranges for the three volume types.

4.3.8 Defining the library through ISMF

You define your IBM 3494 Tape Library to the system through the ISMF library application.

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:** Enter the five-character hardware ID associated with the IBM 3494 Tape Library.
- ▶ **Console name:** Type the optional z/OS console name if you defined one in SYS1.PARMLIB member CONSOLxx.
- ▶ **Entry default Data Class:** This name is the Data Class that you want as the default for tape cartridges entered into the IBM 3494 Tape Library that you define.
- ▶ **Entry default use attribute:** This use attribute is for cartridges that are entered into the library (scratch or private).
- ▶ **Eject default:** This value is the default action for the TCDB volume record when a tape cartridge is ejected from the library (PURGE or KEEP).
- ▶ **Scratch threshold:** Enter the threshold below which a message is issued to the operator requesting that scratch volumes of the specified media type are entered into the library.
- ▶ **Initial online status:** This status specifies whether the IBM 3494 Tape Library is online, offline, or unconnected 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 activation of an updated SCDS.

Note: When you connect a 3494 Tape Library to a system group rather than to a system, you lose the ability to vary that library online or offline to the individual system in the group. We recommend strongly that you connect the 3494 Tape Library to individual systems only.

Defining the library (example)

This section shows you an example of 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 4-23 on page 197.

```

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. 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 4-23 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, which is that the first character of a library name must not be V. Also, the library name must not be 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 4-24 on page 198 and Figure 4-25 on page 198.

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 . : SCDS.TEMP.PRIMARY	
Library Name : LIB1	
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 4-24 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 ==> YES
*SYSPLX03 ==> NO	*SYSPLX04 ==>
SYSSTM01 ==> YES	SYSSTM08 ==> YES
SYSSTM02 ==>	SYSSTM09 ==>
SYSSTM03 ==>	SYSSTM10 ==>
SYSSTM04 ==>	SYSSTM11 ==>
SYSSTM05 ==>	SYSSTM12 ==>
SYSSTM06 ==>	SYSSTM13 ==>
SYSSTM07 ==>	SYSSTM14 ==>
SYSSTM15 ==>	SYSSTM16 ==>
SYSSTM17 ==>	SYSSTM18 ==>
SYSSTM19 ==>	SYSSTM20 ==>
SYSSTM21 ==>	SYSSTM22 ==>
SYSSTM23 ==>	SYSSTM24 ==>
SYSSTM25 ==>	SYSSTM26 ==>
SYSSTM27 ==>	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 4-25 TAPE LIBRARY DEFINE panel (page 2 of 2)

5. Specify the following information for the tape library:

- **Description:** This 120-byte field 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 hardware ID associated with the tape library you define. One physical 3494 library has more than one LIBRARY-ID if it holds native drives and VTS/TS7700 subsystems. All LIBRARY-IDs have to be defined to ISMF. A valid value is

entered as five hexadecimal digits. To learn how to find the correct LIBRARY-ID, see 9.4.1, “Discovering the LIBRARY-ID given during the teach process” on page 402.

- **Console name:** Specify the name of the z/OS console associated with the tape library defined in the CONSOLxx PARMLIB member.
- **Entry default Data Class:** Specify the name of the Data Class that you want as the default for tape cartridges that are entered into this tape library.
- **Entry default use attribute:** Specify the default cartridge use attribute for the cartridges that are entered into this library:
 - Private: Use these tape cartridges to satisfy specific cartridge requests.
 - Scratch: Use these tape cartridges to satisfy nonspecific 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 eight recognized media types (see Table 4-4 on page 194).

Note: When the number of scratch cartridges in the library falls below the scratch cartridge threshold for that media type, an operator action message displays requesting that scratch cartridges of the required media type are entered 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 the VTS/TS7700, the above numbers apply to the number of logical cartridges (CST or ECCST) available inside the VTS/TS7700.

- **Initial online status:** Specify whether the library you define will be online (YES), offline (NO), or unconnected (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 this information, an entry containing the 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 offline according to the attributes 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. They might get discarded during the restart.

4.3.9 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.

Two new recording techniques EFMT3 and EEFMT3 (for Encryption) are available in the Data Class definitions to support the TS1130 Tape Drive. In addition, the SMS Configuration Services validate and allow MEDIA5 through MEDIA10 be specified with recording format

EFMT3 or EEFMT3. Performance scaling and performance segmentation options are also allowed for MEDIA5 and MEDIA9 with EFMT3 or EEFMT3.

You do not have to specify new Storage Classes. You can use existing classes. The Storage Class is used only to indicate 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 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 IBM 3494 Tape 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 IBM 3494 Tape Library. The blank Storage Group is always enabled for all attached systems. You can specify the Storage Group during definition of an existing private volume to DFSMSrmm or during cartridge insert processing.

For information about VTS, TS7700, and Advanced Policy Management, refer to the following publications:

- ▶ *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
- ▶ *IBM Virtualization Engine TS7700 Series Introduction and Planning Guide*, SG24-0567

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 cataloged, the tape datasets are cataloged 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 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.

In the following sections, we discuss the SMS constructs and their role in 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
- ▶ The maximum volume count that your dataset can span
- ▶ Recording technology (18 track, 36 track, 128 track, 256 track, 384 track, EFMT1, EFMT2, EEFMT2, EFMT3, and EEFMT3)

Note: Tape Encryption can be requested through the Data Class construct. The Recording Technology specified in the Data Class determines whether a cartridge is written in native TS1120 format (EFMT2) or in encrypted format (EEFMT2).

Use ISMF displays 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 display. Figure 4-26 shows the panel where you specify the Data Class name.

Figure 4-26 DATA CLASS APPLICATION SELECTION panel

4. Now, the first page of the DATA CLASS DEFINE or ALTER panel displays as shown in Figure 4-27 on page 202. The panels are the same for both Data Class Define and Data Class Alter. In our example, we chose DATA CLASS ALTER.

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Panel Utilities Scroll Help	
DGTDCDC1	DATA CLASS ALTER Page 1 of 5
SCDS Name . . . : DFSMS150.SCD.SYS32	
Data Class Name : HSMDC1M	
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 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 4-27 DATA CLASS ALTER panel (page 1 of 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 4-34 on page 209).
- **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, especially if you migrate from a native 3590 or 3592 environment to a VTS/TS7700 solution without changing your JCL. Job abends occur because the cartridge capacity is significantly different between a 3590 or a 3592 and a 3490E.

5. Figure 4-28 on page 203 shows the second page of the Data Class definition process. You use this display to specify compaction:

DGTDCDC2		DATA CLASS ALTER	Page 2 of 5
SCDS Name . . . : DFSMS150.SCD.SYS32			
Data Class Name : HSMDC1M			
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 4-28 DATA CLASS ALTER panel (page 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, the 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/TS7700. The compaction attribute overrides the system default that is located in PARMLIB member DEVSUPxx, but is overridden by JCL specification TRTCH. The valid Data Class values for the compaction attribute are Y, N, T (TCOM), G (GEN), or blank. TCOM and GEN do not apply to tape.

6. On the third page of the Data Class definition (Figure 4-29), you provide the Media Type and Recording Technology:

DATA CLASS ALTER		Page 3 of 5
Command ==>		
SCDS Name . . . : DFRMM1.SCD.STEST		
Data Class Name : DUMMY		
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)
Csize 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 4-29 DATA CLASS ALTER panel (page 3 of 5)

- **Media Type:** Specify the tape cartridge type used for datasets associated with this Data Class. If this field is not specified (field is blank), the library that has the most scratch cartridges is selected. This field is optional if only one media type is used within a 3494 library.

However, the definition is mandatory to allow selection of a media pool for nonspecific mounts if multiple media types are present (see Table 4-4 on page 194).

Note:

- ▶ Logical volumes in a VTS/TS7700 are 3490 volumes and, therefore, MEDIA1 with 400 MB of uncompressed capacity or MEDIA2 with 800 MB. Larger logical volumes are supported with VTS Release 7.4, which provides support for 1000, 2000, and 4000 MB logical volumes. Larger logical volumes are supported in the TS7700 from the initial delivery.
- ▶ MEDIA3 and MEDIA4 are invalid in a TS3500 Tape Library, because the library only supports 3592 media types.
- ▶ Support for MEDIA9 and MEDIA10 requires z/OS V1R5 or later.

If you use a VTS/TS7700, you must verify the type of logical volumes that you defined on the Library Manager and select MEDIA accordingly (MEDIA1 or MEDIA2 only). Refer to *IBM TotalStorage Virtual Tape Server Planning, Implementing and Monitoring*, SG24-2229.

- **Recording Technology:** Specify the number of tracks on tape cartridges used for datasets associated with this Data Class. This field is optional unless MEDIA TYPE is specified. MEDIA2 is recorded only in 36-track mode, and MEDIA3/MEDIA4 is either 128-track, 256-track, or 384-track mode.
- If you are using MEDIA5 to MEDIA10, you must specify the EFMT1, EFMT2, or EFMT3 option for using the 3592 media.
- **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) or 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.

7. Press F8 after you have entered or updated the Recording Technology. On the following panel, you specify whether to encrypt the data. If you plan to encrypt the data in this Data Class, you need to enter the Key Labels and the Encoding for the Key Labels as shown in Figure 4-30.

DGTD CDC8	DATA CLASS ALTER	Page 4 of 5
SCDS Name . . . : DFSMS150.SCD.SYS32		
Data Class Name : HSMDC1M		
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 4-30 DATA CLASS ALTER panel (page 4 of 5)

To activate the new SMS definitions:

1. Translate the Data Class ACS routine.
2. Validate the ACS routines.
3. Activate the SMS Control Dataset (SCDS).

If you change existing Data Classes, verify your Data Class ACS routine to make sure that you assign the correct constructs. If you create new Data Classes, update your Data Class ACS routine to assign the new constructs to those tape datasets that you want to encrypt.

In addition to using a Data Class construct or instead of using a Data Class construct, you can also request Tape Encryption through job control language (JCL) as shown in Example 4-1.

Example 4-1 Sample JCL to write an encrypted cartridge

```
//C02STRW1 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.C02M5CX2.PC5.NOP00L.C02STRS1.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=C02M5CX2,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 4-1 on page 205 lists the keys that were used. See Figure 4-31.

```
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 O

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 IEF2330 M 0780 J1G151 C02STRW1 CREATE1
JOB05753 IEC205I SEQ001,C02STRW1,CREATE1,FILESEQ=2, COMPLETE VOLUME LIST, 15
VOL=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 4-31 MSG/IEC205I indicates the key labels and the key codes that were used

Note: The JCL data definition (DD) statements overwrite Encryption specifications in the Data Class. If only one KEYLABL1 statement and only one KEYENCD1 are coded in the JCL, a second key label and key code with the same information are generated on the cartridge automatically. Whenever the first standard label (SL) on a cartridge contains encrypted data, all following SL file data after that is encrypted. Therefore, you do not need any further JCL or Data Classes to write encrypted data to the same cartridge; you prepare cartridges for Encryption purposes by writing a small file with 'LABEL=(1,SL)' to a cartridge.

4. In the fifth page of the Data Class definition (Figure 4-32), nothing applies to tape datasets. We provide this display for your convenience.

DGTD CDC6	DATA CLASS ALTER	Page 5 of 5
SCDS Name . . . : DFSMS150.SCDS.SYS32		
Data Class Name : HSMDC1M		
To ALTER Data Class, Specify:		
Shareoptions Xregion	-	(1 to 4 or blank)
Xsystem	-	(3, 4 or blank)
Reuse	N	(Y or N)
Initial Load	B	(S=Speed, R=Recovery or blank)
BWD	-	(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 4-32 DATA CLASS ALTER panel (page 5 of 5)

Note: Remember that the Data Class ACS routine is driven for both system-managed and nonsystem-managed datasets. Currently, Data Class definitions are not used by APM.

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 (see Figure 4-33 on page 208).

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 4-33 STORAGE CLASS DEFINE panel (page 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.

If you have a VTS or TS7700 subsystem installed and use native 3490 drives within the library, we recommend that you use the STORCLAS as a means to distinguish between native and emulated drives. The STORCLAS then allows you to influence allocation by using simple ACS routines. If you want to migrate a given subset of tape data to a VTS or TS7700, you only have to define another STORGROUP for the respective STORCLAS.

If you want to hold virtual volumes longer in cache than others, specify an Initial Access Response Time (IART) value of 0. To choose volumes that are unlikely to be recalled for migration first, assign a Storage Class with an IART value of 100 or greater. See Table 4-5. Using IART requires FC4000, Advanced Function.

Table 4-5 Cache preference group summary

Cache group preference	IART	Management technique
0	100 seconds or more	Preferred removal of cache, largest first
1	Fewer than 100 seconds	Removal of volumes after group 0, least recently used first

With the introduction of Advanced Policy Management (sometimes referred to as *Outboard Policy Management* (OPM)) for VTS/TS7700, cache management has been moved outboard.

Refer to *IBM TotalStorage Virtual Tape Server Planning, Implementing and Monitoring*, SG24-2229, for detailed information.

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 display. The MANAGEMENT CLASS APPLICATION SELECTION panel displays.
2. On the MANAGEMENT CLASS APPLICATION SELECTION panel, specify the name for **Management Class Name**.
3. Choose option **3 (Define)** on the panel. The MANAGEMENT CLASS DEFINE panel (Figure 4-34) displays.

```

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 4-34 MANAGEMENT CLASS DEFINE panel (page 1 of 5)

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 required value 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.

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/TS7700, you can use the Management Class to create a selective dual copy for virtual volumes. You do not define these functions in the SMS Management Class directly, but the assigned Management Class value transfers to the Library Manager.

If there is a matching construct (the same name) defined in the OPM, the defined values for dual copy or PtP copy mode are used. The control of the PtP copy mode is based on a single volume. That way, you can control the copy mode (certain workloads are handled in IMMEDIATE mode and other workloads are handled 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 TotalStorage Virtual Tape Server Planning, Implementing and Monitoring*, SG24-2229.

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 names. One tape library can contain more than one tape Storage Group. Figure 4-35 on page 211 shows the relationships among libraries and Storage Groups with four Storage Groups defined.

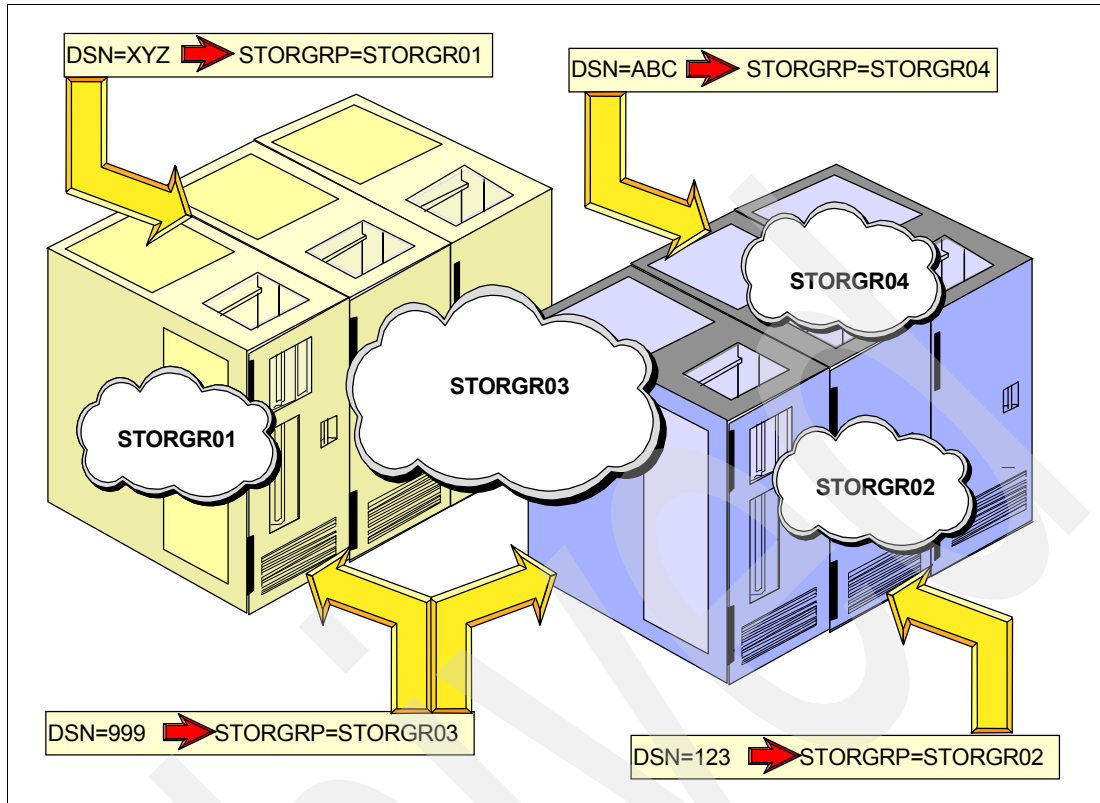


Figure 4-35 Relationships among libraries and Storage Groups

With the Storage Groups defined as shown in Figure 4-35, 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 display. The STORAGE GROUP APPLICATION SELECTION panel (Figure 4-36 on page 212) displays.

```

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. 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 4-36 STORAGE GROUP APPLICATION SELECTION panel

- On the STORAGE GROUP APPLICATION SELECTION panel, enter a name for the **Storage Group Name**, and enter a type for **Storage Group Type** (TAPE, in our case).
- Choose option **2 (Define)**. The TAPE STORAGE GROUP DEFINE panel (Figure 4-37) displays.

```

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 4-37 TAPE STORAGE GROUP DEFINE panel

The parameter explanations are:

- **Description:** This 120-byte field 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 character (*) or the last value used displays in this field.
- **DEFINE SMS Storage Group Status:** Use this field to indicate that you want the SMS STORAGE GROUP STATUS DEFINE panel to display after you press Enter. You can enable up to 32 systems to the Storage Group. Additional systems are on page 2 of 2.

4. Enter Y for the DEFINE SMS Storage Group Status field. Then, the SMS STORAGE GROUP STATUS DEFINE panel (Figure 4-38) displays:

```

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/
Sys Group Status, Specify:

System/Sys      SMS SG      System/Sys      SMS SG
Group Name      Status      Group Name      Status
-----
MVS1            ==> ENABLE   MVS2            ==> ENABLE
*SYSPLX1        ==> NOTCON   ==>
==>
==>
==>
==>
==>
==>

( Possible SMS SG
Status for each:
- Pool SG Type
  NOTCON, ENABLE
  DISALL, DISNEW
  QUIALL, QUINEW
- Tape SG Type
  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 4-38 SMS STORAGE GROUP STATUS DEFINE panel

- **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. Typically, you specify ENABLE for all systems that are going to use the IBM 3494. A Storage Group can share up to 32 systems. Each system must be physically connected to the storage devices in its Storage Group. To change the status of a system, type one of the described values.

Note: When a private cartridge is entered into the library and the cartridge entry exit (CBRUXENT) does not supply a Storage Group name, OAM sets the Storage Group name to blank. The blank Storage Group name is enabled on all systems within the SMSplex. For considerations about sharing and partitioning tape Storage Groups among systems in an SMSplex, see the *Guide to Sharing and Partitioning IBM Tape Library Data*, SG24-4409.

Use care when you must connect multiple libraries to the same Storage Group. The algorithm used to select a library and 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:

- ▶ The number of available drives inside the library, as long as there are enough drives to satisfy the total number of concurrent allocation requests
- ▶ The number of available scratch cartridges, as long as the library is above the defined threshold
- ▶ A busy condition of the control unit or the accessor
- ▶ A busy condition of the VTS/TS7700 subsystem or its components

Note: With the introduction of APM, 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 on physical volumes in specific pools. For more information, refer to *IBM TotalStorage Virtual Tape Server Planning, Implementing and Monitoring*, SG24-2229.

4.3.10 Pre-ACS installation exit

The pre-ACS routine exit (IGDACSXT) enables a tape management system to influence ACS routine construct selection. You can use this exit, for example, to direct allocation requests into or outside of a tape library by using the tape management system software functions.

Through this interface, your tape management system can set four new read-only variables, and then you can use these variables in 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 provide 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, you need to match the allocation to a particular library or VTS/TS7700 to the

vaulting requirements of the datasets that are allocated. 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.

4.3.11 Writing ACS routines

To direct new tape allocations to an IBM 3494 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 the activation of SMS. We cover 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 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 displays.
2. On this panel, select option **1 (Edit)** and press Enter to update the ACS routines.

Table 4-6 through Table 4-9 on page 216 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 4-6 Sample Data Class attributes

Data Class name	Compaction	Media type	Recording technology
DCTAPEX	No	1	36
DCTAPSM	Yes	1	36
DCTAPLR	Yes	3	128
DCTAP5E	Yes	3	256
DCTAP5H	Yes	5	E1
DCTPA5EX	Yes	4	256

Table 4-7 Sample Storage Group attribute

Storage Group name	Library name	Accessible system
SGTAPLCL	LIBLCL	MVS1, MVS2
SGTAPRMT	LIBRMT	MVS1, MVS2

Table 4-8 Sample Management Class attribute

Management Class name	Retention limit
MCTAPE	NOLIMIT

Table 4-9 Sample Storage Class attributes

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 an IBM 3494.
- ▶ MEDIA1, MEDIA2 (36 track), MEDIA3, and MEDIA4 (128-track, 256-track, and 384-track Read/Write (R/W)) and MEDIA5 to MEDIA8 (EFMT1) are possible.
- ▶ Tape mount management (TMM) methodology is not included.
- ▶ DASD DFSMS is not described.
- ▶ The libraries contain DFSMSHsm-owned data.
- ▶ The extended length cartridge is introduced.
- ▶ The libraries are in different buildings: local (LCL) and remote (RMT).

Data Class ACS routine

The Data Class ACS routine (see Example 4-2 and Example 4-3 on page 217) is driven for both system-managed and nonsystem-managed datasets. Specify NON-IDRC 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 extremely simple. They only provide basic information about how to code ACS routines. The ACS routines in your environment will contain many more definitions for tape support. With the introduction of APM, you must redo the ACS routines.

Example 4-2 Sample Data Class ACS routine (page 1 of 2)

```

PROC DATACLAS
/*****
/* DEFINE TAPE DATASETS 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('ADRDSU',I%%GENER)

FILTLIST ABARS INCLUDE(outputdatasetprefix.%.C%%V%%%)

FILTLIST TAPEDC INCLUDE(DCTAP*)

FILTLIST TAPESC INCLUDE(SCTAP%%)

/*****
/* SELECT DATA CLASS FOR DATASET 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

```

Example 4-3 Sample Data Class ACS routine (page 2 of 2)

```

  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 ( &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
    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 4-4 and Example 4-5 show a sample Storage Class routine.

Example 4-4 Sample Storage Class ACS routine (page 1 of 2)

```

PROC STORCLAS
/*****/
/* DEFINE TAPE DATASETS 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*,**,I0000.**.SARTAPE.T*)

FILTLIST VITALREC INCLUDE(**.LEGAL.***)

FILTLIST EXCHANGE INCLUDE(Portable.**,*CITI*.*,SWISSBNK.CORP.***)

FILTLIST HSM INCLUDE(*.HMITAPE.DATASET,*.BACKTAPE.DATASET)

FILTLIST HSMCOPY INCLUDE(*.COPY.HMITAPE.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%%)

```

Example 4-5 Sample Storage Class ACS routine (page 2 of 2)

```

/*****/
/* SELECT STORAGE CLASS FOR DATASET GOOD FOR 3494 */
/*****/

SELECT

    WHEN (&DSN = &HSMCOPY | &DSN = &DUMPATL) DO /* this data is kept in the remoteLib*/
        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 to manage anything else */
      *****/

      OTHERWISE
      DO
        SET &STORCLAS = ''
        EXIT
      END
    END          /*End of Dataset selection */
  END          /*End of storage Class PROC for dataset*/

```

Management Class ACS routine

You can use the Management Class ACS routine (Example 4-6) to assign a MGMTCLAS to each tape allocated under system-managed tape. For detailed coverage of how MGMTCLAS works with system-managed tape; see Figure 4-34 on page 209.

Example 4-6 Sample Management Class ACS routine

```

PROC MGMTCLAS
  /*****
  /* DEFINE TAPE DATASETS FILTERING CATEGORY */
  *****/

  /*****
  /* SELECT MGMT CLASS FOR DATASET GOOD FOR 3494 */
  *****/

  SELECT
    WHEN (&DATACLAS = DCTAP* ) DO
      SET &MGMTCLAS = 'MCTAPE'
      EXIT
    END

  /*****

```

```

/* WE DO NOT INTEND TO MANAGE ANYTHING ELSE */
/*****/

    OTHERWISE
    DO
        SET &MGMTCLAS = ''
        EXIT
    END
END          /* END OF DATASET SELECTION */
END          /* END OF MGMT CLASS PROC FOR TAPE DATASET */

```

Storage Group ACS routine

The Storage Group ACS routine (Example 4-7) 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 4-7 Sample Storage Group ACS routine

```

PROC STORGRP

/*****/
/* DEFINE TAPE DATASETS FILTERING CATEGORY */
/*****/

/* Since all filtering is done in the SC routine, no */
/* additional code is needed */

/*****/
/* DETERMINE STORAGE GROUP FOR DATASET 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 DATASET 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 successfully completes and syntax checking is performed, you validate your routines against the constructs and defined libraries. 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 character (*) 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 unsuccessful, it prevents the configuration from activating.

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 the contents of the partitioned dataset directly without going through the panels. Just add the variables as you use them in the ACS routines. See Example 4-8.

Example 4-8 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, you can detect errors before you activate a new configuration and run into any trouble that might affect your production environment. Refer to 4.3.16, “Testing ACS logic with NaviQuest” on page 233 for additional information about testing ACS routines.

The ACS TESTING RESULTS panel in Figure 4-39 on page 222 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 4-39 ISMF display: ACS TESTING RESULTS panel

4.3.12 Activating the SMS configuration and restarting OAM

You must activate the SMS configuration before you can start to use your IBM 3494 Tape Library. Activating an SCDS validates its contents and copies the contents into the ACDS specified in IGDSMSxx. If the SCDS is invalid, activation fails.

Note: If you activate another SCDS or reactivate the current SCDS while OAM is running, OAM restarts if the Restart parameter in the Started Task is set to YES. During this reinitialization, *all* IBM 3494 Tape Libraries are set to either offline or online according to the tape library definition in the active SCDS.

If you defined the IBM 3494 Tape Library as *online* during library definition, it is brought online as part of the OAM address space initialization. Otherwise, vary the IBM 3494 Tape Library online using this z/OS operator command:

```
VARY SMS,LIBRARY(libname),ONLINE
```

During the restart, OAM requests information about volumes left in the INSERT category (FF00) as soon as the IBM 3494 Tape Library comes online. If the TCDB does not contain a volume record for a volume processed, and the volume is not rejected in the EDGRMMxx member, the volume record is created according to information from:

- ▶ DFSMSrmm provided through the CBRUXENT installation-wide exit
- ▶ The Library Manager for the media type
- ▶ The default Data Class specified in the ISMF library definition

Note: Before you activate the SCDS or vary the 3494 Tape Library online, make sure that the tape management system is active and customized. Refer to 4.3.7, “Updating and customizing your tape management system” on page 190.

4.3.13 DFSMSHsm customization

The most significant change resulting from support of system-managed tape units and tape volumes is the transition of device selection capabilities. See the *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
- ▶ Aggregate backup and recovery support (ABARS)
- ▶ Tape copy for migration and backup tapes
- ▶ Duplex tape for migration and backup tapes

Note: HSM can use the IBM 3592 Extended WORM, IBM TotalStorage Enterprise Tape Cartridge 3592 WORM, and Economy WORM, but because these cartridges cannot be overwritten, it defeats the purpose of the recycle function of HSM. We do not recommend that you use WORM cartridges to hold HSM data.

DFHSM considerations using TS1130 tape drives

We have collected all of the TS1130-related considerations under this heading.

Mixed tape devices and non-SMS tape

In a non-SMS mixed tape hardware environment, where multiple types of tape hardware are used to emulate 3590 devices, unique esoterics must be defined for each type of tape hardware. Defining unique esoterics is necessary to avoid the unpredictable mixing of incompatible recording technologies. The esoteric must be made known to DFSMSHsm through the SETSYS USERUNITTABLE command, for example, SETSYS UUT(3592E06:3592E06 3590H:3590H). The defined esoterics can then be used to direct output to the desired set of drives, for example, SETSYS BACKUP(TAPE(3592E06)), and so forth.

Userunittable

The 3592-2, 3592-2E, 3592-3E tape units are allowed into the same esoteric, because they also share common write formats. Careful planning is required to ensure that the drives in a mixed esoteric will be used with a common recording technology. For example, if any 3592-1 drives are included, all drives in the esoteric must use EMFT1 for output. If the esoteric mixes 3592-2 and 3592-2E drives, all drives must be set up to use EFMT1 or EFMT2. If the esoteric contains mixed 3592-3E and 3592-2E tape units, all drives must be set up to use EFMT2 or EEFMT2, the write formats that they have in common.

Media utilization

The 3592-E06 can utilize scratch MEDIA5, MEDIA7, and MEDIA9 tapes for all DFSMSHsm functions, and also MEDIA6, MEDIA8, and MEDIA10 tapes for ABARS. Because the 3592-E06 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 3592-E06 uses a partial tape for output, the existing data on tape can be in either the EFMT2 or EFMT3 recording technologies. 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 (unless patched by the client) only used by ABARS and only as scratch tapes.

The 3592-J1A and 3592-E05 also consider using the same partial tapes. The 3592-J1A must not select EFMT2 or EFMT3 partial tapes. The 3592-2 must not select EEFMT2 or EFMT3 partial tapes. The 3592-2E must not select EFMT3 partial tapes. The 3592-E06 must not select EFMT1 partial tapes.

Input tapes

DFSMSHsm can utilize the following media types:

- ▶ MEDIA5, MEDIA7, and MEDIA9 can be used as 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 the tapes are mounted on a TS1130 will be transparent to DFSMSHsm.

Reuse capacity

The current scheme has one reuse capacity for each media type regardless of the recording technology, which encourages media used with multiple recording technologies to move from older to newer technologies. This scheme will continue with the 3592-E06.

Mixed device esoteric support

It is in every environment's best interest to allow only write compatible tape devices to coexist in the same esoteric. Thus, the 3592 Model E06 drives will be allowed in the same esoteric with 3592 Model E05 drives (both encryption-capable and non-encryption-capable), but the 3592 Model E06 drives will be not allowed in the same esoteric with 3592 Model J1A drives.

The read compatibility of the E06 and J1A does not meet the compatibility requirements for a mixed esoteric. In a stand-alone (non-IBM library) tape environment, you must make sure that all drives in a mixed esoteric will use a recording technology that they have in common when they write data to tape. For E06 and E05 drives, EFMT2 is the common recording technology for read and write.

Conversion of tape from D/T3490 to D/T3590

This function enables you to re-ADDVOL partial D/T3490 tapes created by 3592 Model J1A drives to D/T3590 tapes associated with 3592 Model E06 unit names. The tapes will be marked full so that the 3592 Model E06 drives do not try to extend them, and the tapes can only be mounted for input.

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 do so might result in either failure when the duplex tape is mounted for output, or failure 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. The support code is also needed to handle the change in units for certain logical size fields from 1 KB to 16 KB when the HSMplex contains tapes recorded with the EFMT3 and newer recording formats.

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 effect on allocation. However, the names are passed to the ACS routines. See the DFSMSHsm unit parameters in Table 4-10 for a complete list of all 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, see 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 controls.

Note: If you are using the &UNIT variable in your ACS routines to select HSM datasets as candidates for the library, you must explicitly specify a unit name in the respective HSM parameters.

Table 4-10 DFSMSHsm unit parameter

Command	Parameter
ABACKUP	UNIT(<i>tape-unitname</i>)
ADDVOL	UNIT(<i>tape-unitname</i>)
ARECOVER	UNIT(<i>tape-unitname</i>) TARGETUNIT(<i>tape-unitname</i>)
DEFINE	UNIT(<i>tape-unitname</i>) ABARSUNITNAME(<i>tape-unitname</i>) ARECOVERML2UNIT(<i>tape-unitname</i>) ARECOVERUNITNAME(<i>tape-unitname</i>) BACKUPTAPE(<i>tape-unitname</i>) CDSVERSIONBACKUP(UNITNAME(<i>tape-unitname</i>)) MIGUNITNAME(<i>tape-unitname</i>) RECYCLEOUTPUT(BACKUP(<i>tape-unitname</i>) migration(<i>tape-unitname</i>)) SPILL(TAPE(<i>tape-unitname</i>)) TAPEMIGRATION(DIRECT(TAPE(<i>tape-unitname</i>)) - ML2TAPE(TAPE(<i>tape-unitname</i>)) - NONE(ROUTETOTAPE(<i>tape-unitname</i>))) TAPEUTILIZATION(UNITNAME(<i>tape-unitname</i>)) UNITNAME(<i>tape-unitname</i>)
TAPECOPY	ALTERNATEUNITNAME(<i>tape1-unitname</i> , <i>tape2-unitname</i>) ALTERNATE3590UNITNAME(<i>tape1-unitname</i> , <i>tape2-unitname</i>)
TAPEREPL	ALTERNATEUNIT(<i>tape-unitname</i>)

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 ARCCMDxx 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 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 the recording format, and a Storage Group for tape.

To use tape hardware encryption, you must modify your SMS Data Class definitions to request Encryption from the encryption-enabled tape drives. With the support for the encryption-enabled 3592-E tape drive, hardware Encryption joins software (or host-based) Encryption as another means of encrypting your installation's dump data. As a result, the method for requesting Encryption now depends on whether you plan to use hardware Encryption or host-based Encryption:

- ▶ To request hardware Encryption for a dump class, specify it in the SMS Data Class for the dump data.
- ▶ To request host-based Encryption for a dump class, use the DFSMSHsm **DEFINE DUMPCLASS(ENCRYPT)** command. With **ENCRYPT**, include the Rivest-Shamir-Adleman (RSA) or **KEYPASSWORD** subparameters (or **NONE**) to specify the type of host-based Encryption.

If your dump classes are currently defined to use host-based Encryption (and possibly host-based compression before Encryption), we recommend that you remove the host-based Encryption requests from any dump classes for which you plan to use tape hardware Encryption. See *IBM System Storage TS1120 Tape Encryption Planning, Implementation, and Usage Guide*, SG24-7320, for more information.

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, 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(MARKFULLIREUSE)**: Migration and backup tapes that are partially filled during tape output processing are marked full if you specify the **MARKFULL** option. This enables a scratch tape to be selected the next time the same function begins. When the total tape-media use and low recycle overhead are more important (and for all IBM 3494s), specify **PARTIALTAPE(REUSE)**. Specifying a **REUSE** environment fully uses the tapes and reduces the amount of recycle processing.

We recommend that you use **PARTIALTAPE(MARKFULL)** for VTS/TS7700 logical volumes. It enables the VTS/TS7700 to use "fast ready" allocation in the Tape Volume Cache. **MARKFULL** is also a requirement if you use **TAPECOPY** 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 relation to the original DASD level 0 user's dataset name. The 3592-E05 can write in either of two recording formats **EFMT1** or **EFMT2**. The 3592-E06 can write in either of two recording formats **EFMT2** and **EFMT3**, but only read the **EFMT1** format. You must modify

your installation's ACS routines to select the recording format to use on a scratch mount (through the Data Class assigned to the tape) to allocate the correct device type and recording technology. Here is a list of the dataset names 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.VVOLSER.Dyyddd.Tssmmhh (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 used for tape allocation with control dataset backups:

- ▶ uid.BCDS.BACKUP.Vnnnnnnnn (DATAMOVER=HSM)
- ▶ uid.MCDS.BACKUP.Vnnnnnnnn (DATAMOVER=HSM)
- ▶ uid.OCDS.BACKUP.Vnnnnnnnn (DATAMOVER=HSM)
- ▶ uid.JRNL.BACKUP.Vnnnnnnnn (DATAMOVER=HSM)
- ▶ uid.BCDS.BACKUP.Dnnnnnnnn (DATAMOVER=DSS)
- ▶ uid.MCDS.BACKUP.Dnnnnnnnn (DATAMOVER=DSS)
- ▶ uid.OCDS.BACKUP.Dnnnnnnnn (DATAMOVER=DSS)
- ▶ uid.JRNL.BACKUP.Dnnnnnnnn (DATAMOVER=DSS)

If you use multiclust 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.DSy.Dnnnnnnnn (DATAMOVER=DSS)
- ▶ uid.MCDS.BACKUP.DSy.Dnnnnnnnn (DATAMOVER=DSS)
- ▶ uid.OCDS.BACKUP.DSy.Dnnnnnnnn (DATAMOVER=DSS)
- ▶ uid.JRNL.BACKUP.DSy.Dnnnnnnnn (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 multiclust CDS.

Here is a list of the dataset names used for tape allocation with ABARS:

- ▶ outputdatasetprefix.C.CccVnnnn (control file)
- ▶ outputdatasetprefix.D.CccVnnnn (data file)
- ▶ outputdatasetprefix.I.CccVnnnn (instruction file)
- ▶ outputdatasetprefix.O.CccVnnnn (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.

4.3.14 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(YIN))
- ▶ SETSYS DUPLEX(MIGRATION(YIN))
- ▶ DEFINE ABARSTAPES(STACKINOSTACK)

- ▶ `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, and MEDIA8 tapes unless otherwise specified. You can specify other percentages 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 copy 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 the 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/TS7700 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 a value of 118%. Specifying PERCENTFULL(118) 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 that are not actually written to a virtual tape.

SETSYS TAPESPANSIZE

Set this parameter 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 your installation has 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 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.

DFSMSHsm calculates the estimated size based on the IDRC effect and gaps for 3490 and position information reported by the tape subsystem if a 3590 or a 3592. If the dataset is larger than SPANSIZE, it is written on the tape. Otherwise, DFSMSHsm compares the dataset size with the remaining media space. If the small dataset is calculated to fit entirely on the current tape, DFSMSHsm begins to write. If it is calculated not to fit, DFSMSHsm issues an FEOV to change tapes.

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 one, and so on, extends the size of the connected volume group. An FEOV between datasets reduces the occurrence of datasets spanning tape volumes.

If you specify SETSYS TAPEUTILIZATION(NOLIMIT), 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 the original and alternate tapes need different media or machine types, see APARs OW52309, OA04821, and OA11603 for more information.

DEFINE ABARSTAPES(STACKINOSTACK)

If you use a native 3590 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 DUMPCCLASS (*dclass* STACK(*nn*)) or BACKVOL SG(*sgname*)VOLUMES(*VOLSER*) DUMP(*dclass* STACK(*nn*))

Using the STACK keyword with the AUTODUMP definitions allows DFSMSHsm to use the capacity of 3590 or 3592 cartridges. Multiple volume dumps are written to a single tape. The value of 20 causes DFSMSHsm to write dump copies of 20 DASD volumes to a single 256 track cartridge. Using a value of 50 causes DFSMSHsm to write dump copies of 50 DASD volumes, which exploits the capacity of 3592 media, thus, maximizing tape usage. Use the value 10 for 128 track media.

You can increase or decrease the value, depending on the average disk capacity used and the number of tape drives available. If you have 50 source DASDs, choosing STACK(50) single threads all dumps to a single tape drive and results in a connected set of tapes. Using STACK(10) instead allows five drives to dump 10 volumes each. Recovery is faster in the second case, because you can only recover one volume from a 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 to other tapes must all be together 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 indicates that all connected groups are listed or that all unconnected volumes are listed. You can 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 other volumes are outside of the same library.

The LIST TTOC SELECT(LIBINOLIB) command can list only original backup or migration volumes that are in libraries, or it can list volumes that are outside all libraries.

The LIST TTOC SELECT(LIB(ALT)INOLIB(ALT)) command can list information about original volumes whose alternate tape is or is not in a library.

The LIST TTOC SELECT(FULLINOTFULLIEMPTY) 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 you with 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 therefore, you need to be copy these volumes.

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) lists all volumes recorded in EFMT1 or EFMT2 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 help you select and migrate data to and from an IBM 3494 or a VTS/TS7700. Its immediate purpose is to enable you to set up volume ranges for different media types and different emulation types, such as VTS/TS7700 logical volumes and 3490-emulated cartridges.

There are no special dataset names for RECYCLEOUTPUT, although you must code your ACS routines. See 4.3.13, “DFSMSHsm customization” on page 223 for a discussion about DFSMSHsm.

You can direct the data to a 3590 or 3592 tape subsystem by assigning a new Data Class that specifies:

- ▶ The desired media type
- ▶ The desired recording technology
- ▶ Whether you want performance scaling or not
- ▶ Compaction set to YES or not

DFSMSHsm takes full advantage of the capacity of the 3590 or 3592 tape cartridge.

Recycling to a library containing high capacity cartridges entails moving more data for each cartridge when using the same thresholds that you used for the previous cartridges. This action 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 reconnect to that ML2 tape. This function eliminates unnecessary data movement

and tape mounts during premigration. It also reduces the need to recycle the tape. Reconnection 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 remigrated in the normal 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. You enable Fast Subsequent Migration by specifying the RECONNECT subparameter of the SETSYS TAPEMIGRATION command. For more information about this parameter, see *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, particularly in a tape environment where contention for tape drives can 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 is processed. Specifying 0 retains the input unit until recycle processing completes. 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 compared to emulated 3490.

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 an IBM 3494 Tape Library or a VTS/TS7700. ABARS has the advantage that you can specify dataset name patterns that are 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, certain 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 attributes of private and Storage Groups.

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 value specified must fit on the tape being 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 prevents TAPESPANSIZE from taking effect. SETSYS TAPEUTILIZATION(PERCENTFULL(97)) is a good value.

4.3.15 Verifying the installation

In this section, we discuss the software areas for you to consider testing as part of your library and system-managed tape implementation project. Table 4-11 lists the testing tasks.

Table 4-11 System-managed tape testing

Task	Comment
Vary library drives online and offline.	N/A
Allocate a standard SMS dataset in the 3494.	N/A
Allocate an SMS multivolume dataset in the 3494.	N/A
Allocate several SMS datasets as multifile (LABEL=) in the IBM 3494.	N/A
Allocate an SMS dataset and reuse it with DISP=MOD.	N/A
Allocate an SMS dataset 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 the library.	N/A
Allocate non-SMS multivolume datasets outside the library.	N/A
Reuse with DISP=MOD one of the first datasets of a multifile tape.	This is impossible.
Allocate non-SMS datasets in the IBM 3494.	This is impossible.
Allocate an SMS dataset outside of the IBM 3494.	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 192.
Watch for whether automatic relabeling processing occurs.	This is only applicable at migration time.
Test-drive sharing for drives in the IBM 3494.	This 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) occurs correctly in a multiple systems environment.	RESERVE if no GRS is introduced, or if the enqueue is not converted. This is only applicable in new environments.

Task	Comment
Test the stand-alone procedure with the IBM 3494.	This is inapplicable for cartridge VTS/TS7700.
Test the vaulting procedures.	N/A

4.3.16 Testing ACS logic with NaviQuest

When you select ISMF Option 7.4, you see the ACS TEST SELECTION panel (Figure 4-40). The input from the test cases is saved in a dataset. For an example, see Figure 4-43 on page 235.

```

                                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 4-40 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. A special function that NaviQuest delivers is to set 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, see the *NaviQuest Demonstration and Hands-On Usage Guide*, SG24-4720.

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 4-41 on page 234).

```
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 4-41 NaviQuest Primary Option Menu panel

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 shown in Figure 4-42 on page 235 appears, where you can choose:

- ▶ Number of test cases to create
- ▶ Member name prefix for the resulting members
- ▶ Selection filter to apply against the input data

Note: The input to this process is not raw SMF data but VMA-extracted SMF data. See “Volume mount analyzer (VMA) reporting for tape utilization” on page 482 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 4-42 Test case generation from VMA

The output written to the specified dataset has the same format as output 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 for DFSMSHsm data (Figure 4-43) and one for DFSMSDss data (Figure 4-44 on page 236).

```
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 4-43 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 4-44 NaviQuest-generated test case: DFSMSdss

The result of checking the specified input against the SCDS that you are about to test looks similar to the panel shown in Figure 4-45. DSS0017 and HSM0001 are the member names created by NaviQuest. You see the specified classes, which are to be assigned to the dataset names, and you can check if this assignment is what you intend.

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 4-45 ACS TESTING RESULTS panel

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 4-46 on page 237).

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 4-46 NaviQuest-generated ACS CROSS REFERENCE REPORT panel

The input is the ACS test output listing dataset, and the output is a new listing dataset as shown in Figure 4-47. 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.SCDS0

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	ADRSSU
	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 4-47 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.



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. We discuss Tape Drive Encryption in the System z and Open Systems environments.

We also outline the hardware and microcode firmware that you need to upgrade in order to implement tape drive Encryption.

For more information about the IBM Tape Drive Encryption solution, see the *IBM System Storage Tape Encryption Solutions: Planning, Implementation, and Usage Guide*, SG24-7320.

5.1 Tape Encryption concepts

IBM has enhanced the IBM System Storage TS1120 Tape Drive to provide you with the option to use drive-based data Encryption, which is now standard on TS1130 tape drives. A chargeable upgrade feature to enable your drives for Encryption is available for installed TS1120 tape drives manufactured prior to 8 September 2006. 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 TS1120 Tape Drive or TS1130 Tape Drive offers a cost-effective solution for tape data Encryption by offloading 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 little impact to the performance of the IBM System Storage Tape Drive TS1130.

5.1.1 Introduction to Encryption

The TS1120 and TS1130-based Encryption and associated Encryption Key Manager (EKM) component are supported in a wide variety of operating system environments, including z/OS, i5/OS, AIX, Hewlett-Packard, Sun, Linux, and Windows. The three methods of Encryption are:

- ▶ *Application-Managed:* The TS1120 Tape Drive and TS1130 Tape Drive support Application-Managed Encryption for Open Systems environments. The application controls the Encryption process and generates and provides keys to the TS1130 Tape Drive through the Atape device driver. 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, the Encryption policy is passed between the server and the drives, which is the way that System z encrypts data. It requires the Encryption Key Manager program. DFSMS supports the Encryption Key Manager component. System-Managed Encryption is also available for AIX servers. This support requires a new AIX Atape device driver, as well as the Encryption Key Manager program. Sun Solaris is also supported through the IBMTape device driver.
- ▶ *Library-Managed:* Encryption by tape library-based policy is supported with the TS1120 Tape Drive and TS1130 Tape Drive. The user sets up and controls the Encryption process through the library interface. This method of Encryption is supported for the IBM TS3500 Tape Library and the 3494 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, Sun, 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 being written to and decrypt information being read from 3592 tape media. The Encryption Key Manager 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. You must install this software on a supported server and interface with the tape drive to support Tape Encryption in a System-Managed Encryption or Library-Managed Encryption implementation.

Encryption Key management

During Encryption, you use a single data key 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 Encryption and Library-Managed Encryption, the drive communicates with the key manager, which provides the key to encrypt the data. When data is appended, it must be encrypted with the same key used by 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 Encryption Key Manager and are referenced by key labels that you define. You can share these labels with authorized external users of the data cartridge.

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 Encryption Key Manager, and it is provided in an encrypted form to make the Tape Encryption solution secure. See Figure 5-1.

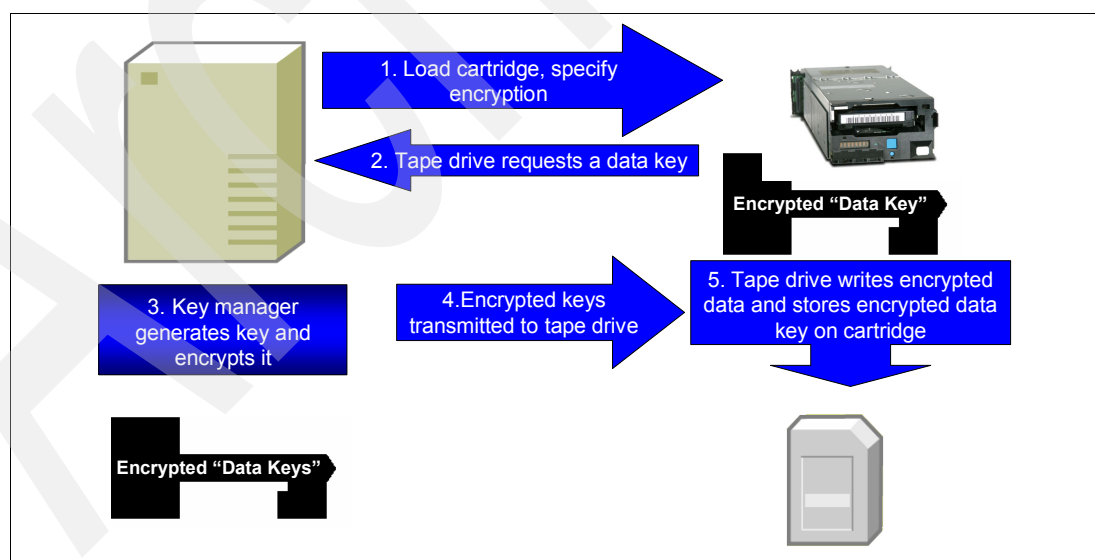


Figure 5-1 Process flow summary for Tape Encryption

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, 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 TS1120 Tape Drive and TS1130 Tape Drive can also process unencrypted 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 Encryption Key Manager when decrypting data on the cartridge. A mix of data written in encrypted and unencrypted 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 TS1120 drives, which means it is effectively in the clear.

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, 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 identifying information 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. You enable this process 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, yours and the other organization's. 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 keystore to allow you to exchange encrypted data with them. The other organization must have the associated private key in the keystore used by the other organization's EKM to decrypt the data key. This method gives you the flexibility to make a specific tape readable by both your organization and another organization.

5.1.2 Encryption on z/OS

In a System z environment, you implement Encryption through TS1120 and TS1130 Tape Drive hardware, microcode additions and changes to the Library Manager and tape controller, and a 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 TS1120 and TS1130 tape drives. This full support is required when encryption-enabled TS1120 and TS1130 tape drives are installed in an IBM tape library environment. Encryption-enabled TS1120 tape drives can coexist in the same library with TS1130 drives that are not encryption-enabled, as well as 3590 Model B1x, 3590 Model E1x, 3590 Model H1x, and 3592 Model J1A drives.

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-capable TS1120 or TS1130 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

the Encryption Key Manager. 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. One other consideration is that with out-of-band, any z/OS image using a drive also has to 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 EKM pointing to a different keystore. This approach allows images sharing drives to use different keystores. You might find this approach useful if you need to support a client or application where each client requires its own keystore for security or regulatory needs.

For z/OS tape Encryption, both methods allow you to configure whether to encrypt the data based on Data Class definitions. You can specify the key labels through the Data Class or through the DD statement (JCL, dynamic allocation, or TSO ALLOCATE). You can also use the Encryption Key Manager-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 that you use. DFSMSrmm also tracks the key labels that were used for a given cartridge.

5.1.3 Encryption with TS7700 on z/OS

When the TS1120 Tape Drive is used for stacked volumes on an IBM Virtualization Engine, Encryption is done outboard from the host and not based on Data Class as described for native TS1120. Encryption concepts on the TS7700 are described in “Tape Encryption” on page 15.

5.2 Encryption Key Manager

The IBM Encryption Key Manager component for the Java Platform (Encryption Key Manager) is a software program designed to generate, protect, store, and maintain Encryption Keys that are used to encrypt information being written to and decrypt information being 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. You must install this software on a supported server and interface with the tape drive to support Tape Encryption in a System-Managed Encryption or Library-Managed Encryption implementation.

5.2.1 Tivoli Key Lifecycle Manager

In addition to the Encryption Key Manager, there is also a new Tivoli Key Lifecycle Manager (TKLM) that 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 user 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 can easily 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, see the *IBM Tivoli Key Lifecycle Manager Information Center*.

5.2.2 Overview

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 you can achieve this security 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 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 (JCECCA KS) 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 (System i) software-based keystores or the PKCS11IMPLKS hardware-based keystore.

System-Managed and Library-Managed Encryption processes

Figure 5-3 on page 246 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 that is used to encrypt the data key. The business partner has the corresponding private key needed to decrypt the data key.

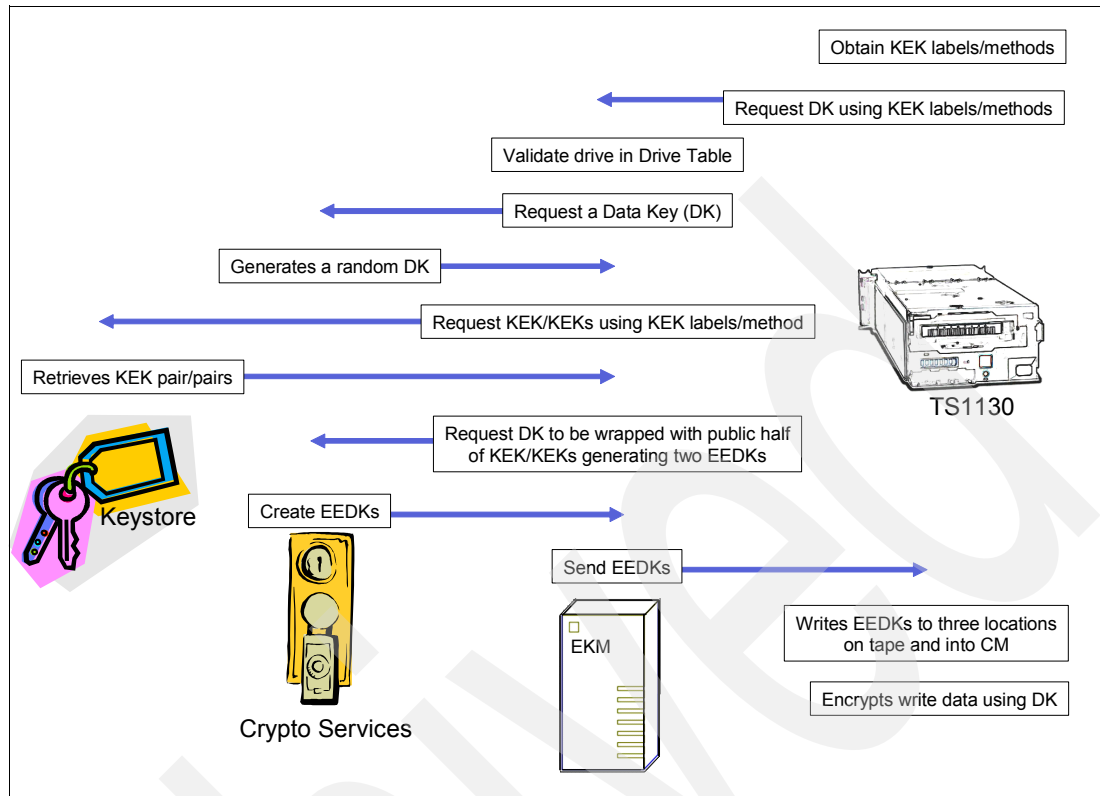


Figure 5-3 Data and Encryption Key flow

The server sends a write request to the drive. The drive is encryption-capable, 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-capable tape drive needs a key to perform an encrypted write, the EKM generates a data key. The data key (DK) that is used to encrypt the data on a tape cartridge is itself encrypted (using the public key of the public/private key pair) with either one or two key encrypting keys (KEK) 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 to encrypt the DK using the public KEKs aliased by the two KEK labels.

The EKM can reside on that same host system, on another host system, or even on another platform server.

For z/OS, the drive request for the data key and the passing of key management-related information can be in-band between the drive and the Encryption Key Manager (through the control unit and host across ESCON/FICON), or it can be out-of-band (through the control unit across TCP/IP). 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, we recommend that the communication path to the EKM is in-band across ESCON/FICON under the same system that initiated the read or write request.

For Open Systems, the drive to EKM conversation travels through the tape device driver on the host for System-Managed Encryption (SME) or through the tape library for Library Managed-Encryption (LME).

The EKM validates that the drive is in its list of valid drives. After validation, the EKM obtains a random DK from crypto services. 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 uses 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 you export tape cartridges to another location, especially if that location might use a different key label (than the originating site) to refer to the same key.

When sharing business partner KEKs, we recommend using the HASH mode, which lets each party use any KEK label when importing a certificate into that party's 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. 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 SMS Data Class policy and the specification of EEFM2 for the recording format). OPEN processing also passes 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 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 are used that can be specified on both a global and a drive level. See "Defining Data Classes" on page 201 for more information about how to specify which Data Classes contain information to encrypt.

For Open Systems SME, Encryption occurs based on which drive is selected. The tape device driver (Atape or IBMTape) is configured with which drives will encrypt and which drives will not encrypt. The key label defaults in the EKM, either the global EKM defaults or the per drive defaults, are used to indicate which KEKs to use to encrypt the data key.

For Open Systems LME, the library policies are used to determine which volumes are to be encrypted. These same policies define which KEKs to use to encrypt the data. The policy can

either the Barcode Encryption Policy (BEP) or, if Veritas NetBackup is the application, Internal Label Encryption Policy (ILEP) can be used.

Decrypting System-Managed and Library-Managed Encryption

Figure 5-4 illustrates how the keys are retrieved from the media and communicated to the EKM, the data key is sent from the EKM to the drive, and the data is decrypted. In this example, we decrypt data that was encrypted at another site, as outlined in Figure 5-3 on page 246. The tape has two EEDKs stored in its cartridge memory. We call these EEDK1 and EEDK2. EEDK1 was stored with the CLEAR (or LABEL) mode selected, and EEDK2 was stored with the HASH mode selected.

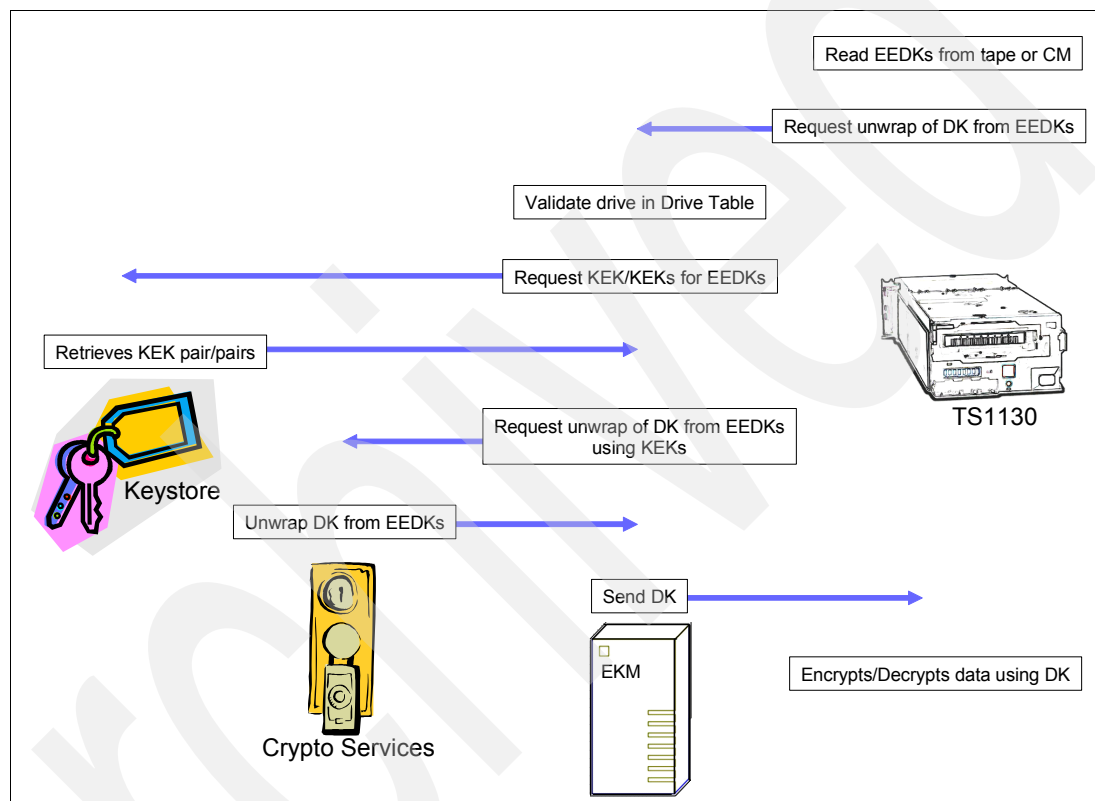


Figure 5-4 Data and decryption key flow

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 that was 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 it uses the DK to encrypt data for a write-append.

For additional information about the Encryption Key Manager, see the *IBM System Storage Encryption Key Manager Introduction, Planning, and User's Guide*, GA76-0418, and the *IBM System Storage TS1120 Tape Encryption Planning, Implementation, and Usage Guide*, SG24-7320.

5.2.3 Management interfaces

You need to configure the TCP/IP connection between the storage devices and the Encryption Key Manager.

Under z/OS, you define the in-band proxy by using the IECIOSxx PARMLIB member (or the SETIOS EKM command). For z/OS tapes, you can configure whether to encrypt based on Data Class definitions. Also 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, you can also use Encryption Key Manager-assigned defaults if the key labels are not provided through z/OS. For tape cartridges that will be encrypted or decrypted, you must define and track the key information that you use.

For z/OS out-of-band encryption, the IP addresses of up to two EKM are defined for the Control Unit (CU) using a configuration panel at the 3494 Library Manager or Web Specialist as shown in Figure 5-5. The lower portion of the panel is used to enter the IP addresses or Domain Names and port numbers of the EKMs. If a Domain Name is specified, you must also enter one or two Domain Name Server (DNS) IP addresses. For more information, refer to the *IBM TotalStorage Tape Library 3494 Operator Guide*, GA32-0449.

IBM TotalStorage® Enterprise Automated Tape Library Specialist

Control Unit Encryption Information

This page displays current setup for each Control Unit that is Encryption-Capable. To modify any CU configuration: Select it on the list, change the parameters and then press the 'Modify this CU only' button. You can also modify ALL the Control Units by clicking the 'Modify ALL CUs' button.

Encryption-Enabled Control Unit List
Select a Control Unit from the list and modify its configuration

Select	Frame	Primary			Secondary		
		DN/IP Address	IP Address	Port	DN/IP Address	IP Address	Port
<input type="radio"/>	2	9.7.141.33	192.168.251.20	03801	9.7.141.34	192.168.250.20	03801
<input type="radio"/>	3			00000			00000

Control Unit Encryption Configuration

Frame: Primary NS IP Address: Secondary NS IP Address:

Primary Key Manager Data

Address Type: ☒ IP Address / Domain Name Port:
☐ Domain Name

Secondary Key Manager Data

Address Type: ☐ IP Address ☒ Domain Name Port:

Status

Figure 5-5 SME out-of-band EKM IP address entry

For Open Systems SME, the EKM addresses are specified in the Atape or IBMTape EKM Proxy Configuration File. Up to 16 EKM addresses can be specified. For more information, refer to the *IBM System Storage TS1120 Tape Encryption: Planning, Implementation, and Usage Guide*, GA24-7320.

For Open Systems LME, the EKM addresses are specified at the Library Manager interface or Web Specialist as shown in Figure 5-6 on page 250. Up to two EKM IP addresses can be specified. For more information, refer to the *IBM TotalStorage Tape Library 3494 Operator Guide*, GA32-0449.

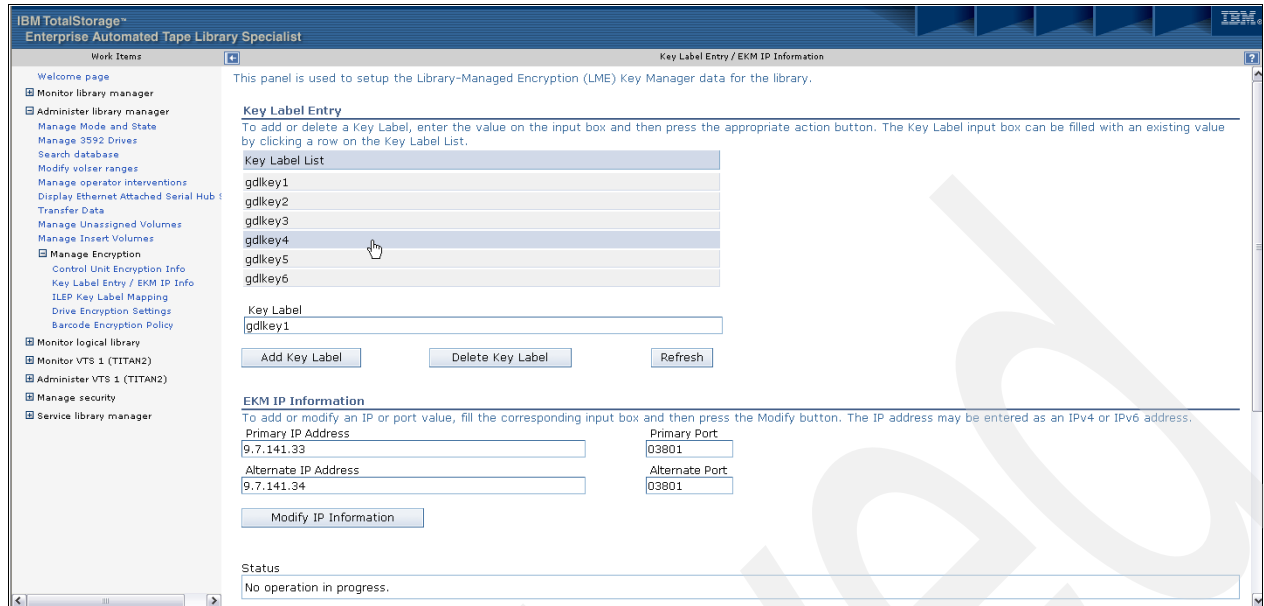


Figure 5-6 LME EKM IP address entry and key label entry

For information about key management and the role of the Encryption Key Manager (EKM), refer to *IBM System Storage Tape Encryption Key Manager, Introduction, Planning, and User Guide*, GA76-0418.

5.2.4 Key label specifications

When you write the first file sequence on a tape and request encryption, you can specify up to two Key Encrypting Key (KEK) labels, enabling the data key to be encrypted with two keys. You can use one of the keys for local (on-site) usage, and you can use the second key for export (off-site) purposes.

For z/OS SME, you can indicate key label specifications by:

- ▶ Data Class (using the new integrated storage management facility (ISMF) panel fields)
- ▶ DD statement (JCL or dynamic allocation, using new keywords: KEYLABL1, KEYENCD1 and KEYLABL2, KEYENCD2)
- ▶ TSO ALLOCATE command (using new keywords: KEYLABL1, KEYENCD1 and KEYLABL2, KEYENCD2)

For Open Systems SME, the key labels used are the EKM defaults, either the global EKM default or the per drive EKM defaults.

For Open Systems LME, the key labels used are defined by the Barcode Encryption Policy (BEP) or, in the case of Veritas NetBackup, by the Internal Label Encryption Policy (ILEP).

5.2.5 EKM configuration planning checklist

When planning your EKM configuration, you need to:

- ▶ 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 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 drives=true` function, this 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 and create keys and certificates into the keystore.

- Determine the keystore type that will be employed.

The keystore holds 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 run on separate systems, you likely will use separate keystores.

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. This design allows any of the EKM servers that are contacted to have access to the necessary information to support the requests that the server receives from the tape drives for EKM server keystore information.

5.2.6 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 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 have lost your data.

Acting on the advice

Maintenance, backup, and restoration of key and certificate information depend on the key ring and keystore implementation that you use. Here are suggestions to be sure that you can access 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 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. See *IBM System Storage TS1120 Tape Encryption, Planning, Implementation, and Usage Guide*, SG24-7320, for more information about key management.

5.3 Encryption planning and implementation

In a System z environment, you implement Encryption capability through TS1120 Tape Drive and TS1130 Tape Drive hardware, microcode additions and changes to the Tape Library Manager and Tape Controller, and a software component called the Encryption Key Manager (EKM).

In an Open Systems SME environment, you implement Encryption capability through TS1120 Tape Drive and TS1130 Tape Drive hardware, the tape device driver, and the EKM.

In an Open Systems LME environment, you implement Encryption capability through TS1120 Tape Drive and TS1130 Tape Drive hardware, the 3494 Library Manager, and the EKM.

5.3.1 Ordering information

The main drive hardware and microcode additions and changes for TS1130 Tape Drive Encryption are:

- ▶ A no-charge encryption-enabled feature number for TS1120 tape drives
- ▶ An optional chargeable Encryption feature number upgrade, which can contain refurbished parts, for installed TS1130 tape drives
- ▶ Microcode firmware upgrades to your TS1130 Tape Controller or 3592-J70 Enterprise Tape Controller
- ▶ Library Manager microcode firmware upgrade
- ▶ A router for Control Unit out-of-band key management support and EKM connectivity for tape controllers, tape frames, and the tape subsystem
- ▶ The appropriate host operating system level
- ▶ The Encryption Key Manager component

5.3.2 General hardware requirements

In addition to encryption-capable TS1130 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. New drive microcode levels are available for models J1A and E05, enabling recognition of the E06 format and allowing reuse of the media in the old formats.

IBM 3592 Model E Tape Drive Encryption support

Encryption capability is standard on all IBM System Storage TS1120 and TS1130 tape drives (Machine Type 3592, Model E).

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

Under z/OS, with system-managed tape support, 3592 model E tape drives that are encryption-enabled are not supported under the same 3592-J70 or 3592-C06 controller. By attaching the drives to different tape controllers, a mix of 3592 model E tape drives that are encryption-enabled and not encryption-enabled along with 3592-J1A and 3590 drives can exist in the same tape library. Additionally, an 3592 model E tape drive that is

encryption-enabled can write, on separate media, either Encryption or non-Encryption format based on your needs.

Note: Tape drives attached to the same tape control unit are not supported. Tape drives must all write in the same format. For example, if you attach both TS1130 tape drives and 3592-J1A tape drives to the same controller, the TS1130 Tape Drive operates in TS1120 (3592-A05) emulation mode.

With encryption-enabled tape drives, the access time to data on the tape drive increases. This increase is due to the time needed to retrieve, read, and write the Encryption key.

IBM tape controller Encryption support

In a System z environment, you can attach your TS1120 and TS1130 encryption-enabled drives to either an IBM 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 (CU) and attached tape drives, you need to order CU Encryption Configuration/Plant or Field (FC9595 or FC5595 respectively) for your Tape Controller Model J70 or C06. 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 regardless of whether you implement in-band or out-of-band support.

Note: When you install the CU Encryption Configuration features, it is not necessary to order the Encryption Configuration/Plant or Field (FC9592 or FC5592 respectively) on the 3592 model E tape drives attached to the controller. Unless you install the 3592 model E tape drives in a client rack, the minimum level of Library Manager microcode also ships when you order FC9595 or the first time that you order FC5595 for the control unit.

Support for the 3592 model E tape drives Encryption function 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:

- ▶ Level 1.19.5.x for any IBM 3592-J70 Enterprise Tape Controller
- ▶ Level 1.21.x.x for any IBM TS1120 Tape Controller (3592-C06)

Note: The 3590-A60 Enterprise Tape Controller does not support the attachment of an IBM TS1130 Tape Drive. 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.

3494 Tape Library Manager Encryption support

SME TS1130 Encryption support for tape drives in an Enterprise Tape Library 3494 requires a minimum level of microcode firmware in the Library Manager of LM534.xx. LME support for the 3494 is delivered in the LM535.xx level of code. The required level of microcode firmware ships the first time that you order FC5595 or FC9595 and if the 3592 Tape Controller is not located in a client-owned rack (FC4641).

Router for out-of-band support

If you are using CU out-of-band support, you must install one of FC5593 on the 3494 Library Manager (Model L10, L12, L14, and L22) to support up to seven 3592 tape controllers. FC5246, Dual Path Concentrator, is required on the Library Manager before you can install FC5593. You can install a second Router for EKM Attach feature on the 3494 Library Manager to support up to fourteen 3592 tape controllers.

Note: The 3494 Tape Library supports up to fifteen tape controllers. However, the maximum quantity of two FC5593s in the 3494 Library Manager supports up to fourteen 3592 controllers.

5.3.3 General software requirements

Tape Encryption for the TS1130 Tape Drive is supported by z/OS V1R7 and later. You also need IBM Software Developer Kit (SDK) for Java 2.

z/OS support for Tape Encryption

The IBM TS1130 Tape Drive with Encryption enabled is supported for attachment to ESCON and FICON channels on System z servers.

z/OS support of System-Managed Encryption requires:

- ▶ z/OS V1R7 or later
- ▶ An Encryption Key Manager component available to the z/OS system

For z/OS V1R7, refer to enabling APAR OA22119. For z/OS V1R8, refer to enabling APAR OA17562. For additional information about the support that is provided, refer to the 3592 preventive service planning (PSP) bucket.

For details about supported software versions and release levels for the IBM TS1130 Tape Drive and 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>

Other mainframe platform support for Tape Encryption

Currently, Tape Encryption on System z servers is supported in z/OS environments only. IBM supports System-Managed Encryption with the TS1120 on the following platforms:

- ▶ z/VM® V5.1 and V5.2 support the IBM TS1120 Tape Drive with Encryption, which includes transparent support for VM guests. The z/VM support requires the Encryption Key Manager component running on an operating system other than z/VM using an out-of-band connection.
- ▶ z/TPF V1.1 supports the TS1120 Tape Drive with Encryption. The z/TPF support requires the Encryption Key Manager component running on an operating system other than z/TPF using an out-of-band connection.
- ▶ z/VSE™ V3.1 and later support the TS1120 Tape Drive with Encryption. The z/VSE support requires the Encryption Key Manager component running on an operating system other than z/VSE using an out-of-band connection.

Note: z/VSE 4.2 provides native support for TS1130. z/VM and z/TPF will provide support in 2009.

5.3.4 Encryption on Open Systems platforms

The TS1130 Tape Drive can be installed in and is supported in the 3494 Tape Library models L22, D22, and D24. Support for the TS1130 Encryption function requires a minimum level of microcode firmware.

Encryption Key Manager on z/OS

If you run the Encryption Key Manager on the z/OS system, you must install one of the following IBM SDKs for Java 2:

- ▶ 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-N98 (at the SDK5 SR3 or later level)

For details about supported software versions and release levels for the IBM 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>

Linux on System z

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 or Fibre Channel Protocol (FCP) protocols, Linux on System z 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 all drives are usually contained in a library in the mainframe environment. This approach 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, you need a method to manage the library. Tivoli Storage Manager or iRMM can be used to manage the library. These products are 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.

Library-Managed Encryption is available for System z servers connected to the 3494 through FCP, running 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 3494
- ▶ An IBM 3494 Tape Library

If the Encryption Key Manager is run on a Linux on System z partition, you need to 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>

5.3.5 Media support for encryption-enabled TS1130 tape drives

The IBM System Storage TS1130 and TS1120 tape drives record in two recording formats supporting both Encryption and non-encryption. TS1130 Enterprise format 3 (EFMT3) is used to denote the new non-encrypted recording format, and enterprise-encrypted format 3 (EEFMT3) is used to denote the new encrypted recording format. The TS1130 also provides write compatibility for the Enterprise format 2 (EFMT2 and EEFMT) used by the TS1120 Tape Drive. An MES upgrade is also available to upgrade a 3592 Model E05 drive to a 3592 Model EU6. As with the 3592 Model E05, this MES upgrade will take both hardware and microcode changes to an existing 3592 Model E05 drive.

The 3592 Model E06 uses the existing cartridge media (MEDIA5, MEDIA6, MEDIA7, MEDIA8, MEDIA9, and MEDIA10). The 3592 Model E06 is downward-read compatible ($n-2$) to the 3592 Model J1A format (EFMT1) and is downward write ($n-1$) compatible 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, this default can be changed at the drive.

Support for the encryption-enabled IBM TS1130 Tape Drive is provided at z/OS V1R7 or later.

5.4 Configuring Library-Managed Encryption

This section describes how to configure the 3494 Tape Library for Library-Managed Encryption. We describe the various Web specialist panels. For more details, refer to the *IBM TotalStorage Tape Library 3494 Operator Guide*, GA32-0449.

5.4.1 EKM IP addresses

For Library-Managed Encryption, the 3494 Tape Library is the proxy between the IBM TS1130 Tape Drive and the EKM. As the proxy, it translates the serial conversation between the drive and the 3494 to a fibre protocol to the EKM. It also handles automatic failover to the secondary EKM when necessary. You must specify one or two IP addresses or domain names for the EKMs. We highly recommend that you set up two EKMs to allow for automatic failover in the event that one of the EKMs cannot be accessed. As shown in Figure 5-6 on page 250, the 3494 Web Specialist allows you to enter up to two EKM IP addresses or domain names and a port ID. If you specify a domain name, you must also specify at least one DNS IP address.

5.4.2 Key label entry

The 3592 model E tape drive with SME and LME solutions encrypts data with a data key and then stores the data key on the tape cartridge in an encrypted form. The data key is encrypted using Key Encrypting Keys (KEK), also known as public/private key pairs. These KEKs are stored in a keystore and are referred to by a key label or KEK label. Encryption policies allow you to specify what KEKs to use to encrypt the data key by referencing the KEK labels. The 3494 provides an operator panel or Web Specialist panel to enter the KEK labels that will be accessed on other panels. This panel is shown in Figure 5-6 on page 250. When a new KEK label needs to be introduced to the 3494, it must be entered on this panel first, and then accessed on the other panels needing to specify the label.

5.4.3 Drive Encryption settings

The 3494 Tape Library Specialist can be used to set the Encryption mode of the TS1120 and TS1130 tape drives. Figure 5-7 shows the Tape Library Specialist page. From this page, you can change the Encryption settings for one or more encryption-capable drives. Any of the Encryption methods, AME, SME, or LME, can be selected for encryption-capable TS1120 tape drives. You select the drives that you want to set, select **Set VPD**, and click **Go**. This action displays the Drive Encryption Settings panel where you select the method.

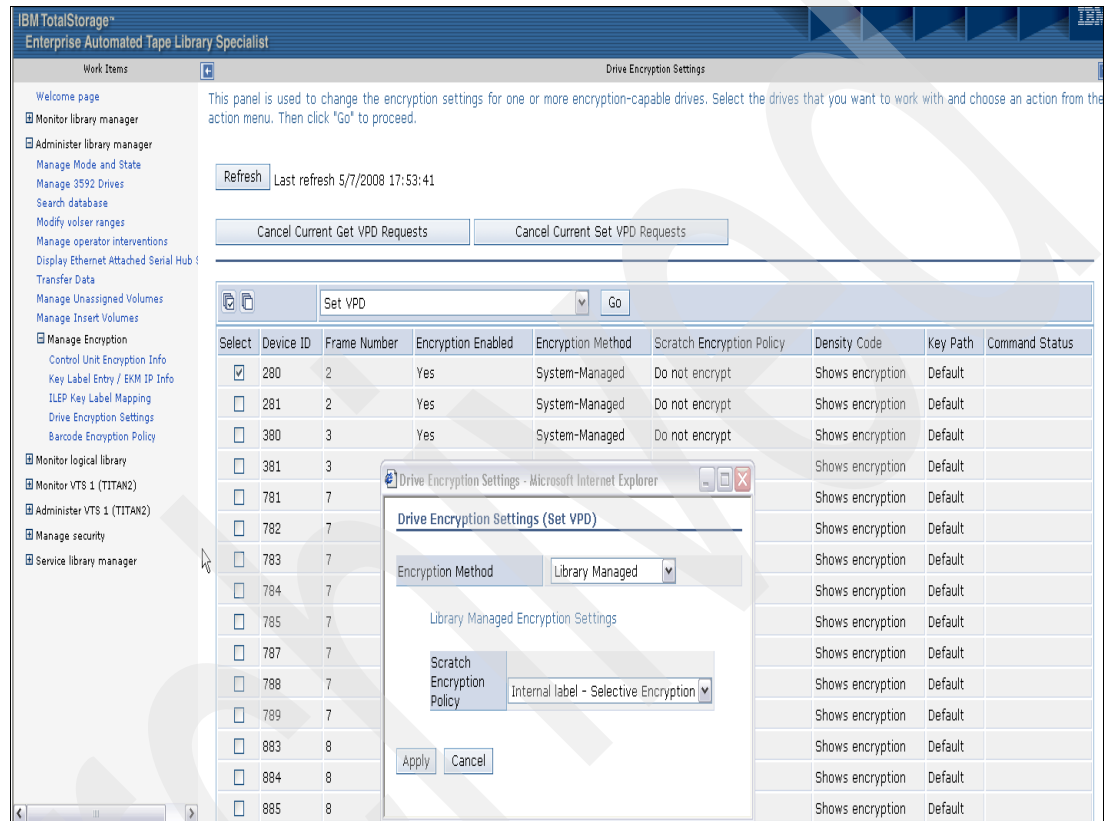


Figure 5-7 Drive Encryption Settings

5.4.4 Barcode Encryption Policy

One of the Encryption policies for LME is the Barcode Encryption Policy (BEP). When a drive is set to this form of LME, the VOLSER of the tape cartridge is used to determine whether it is to be encrypted and which KEKs to use to encrypt the data key. Figure 5-8 on page 258 shows the 3494 Tape Library Specialist panel. To create a new range, select **Add** from the drop-down list and then click **Go**. The Add panel is displayed. From here, you can enter a VOLSER range and one or two KEK labels to associate with the range. The KEK labels, which you entered on the KEK label entry panel as described in 5.4.2, "Key label entry" on page 256, appear for selection in the KEK label drop-down lists. You cannot create a new KEK label from this panel. You must enter new KEK labels on the Key Label Entry panel.

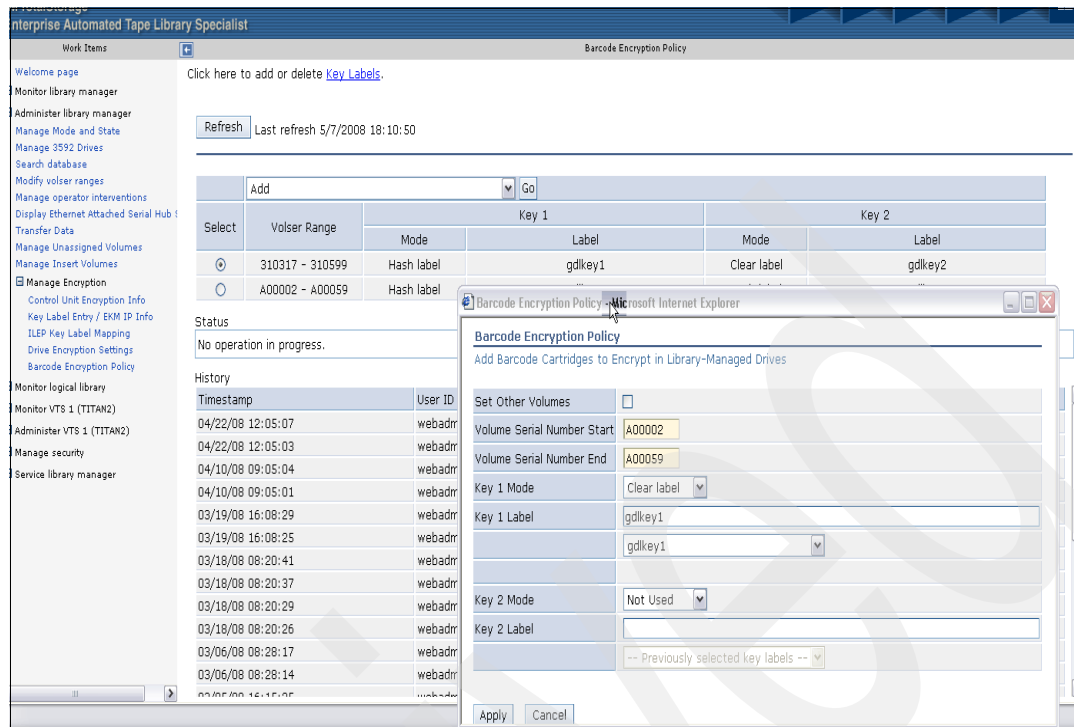


Figure 5-8 3494 Barcode Encryption Policy

5.4.5 Internal Label Encryption Policy key mapping

Internal Label Encryption Policy (ILEP) is another LME policy. It can only be used for drives that are exclusively used by Veritas NetBackup. There are two versions of ILEP available: Selective and Encrypt All. Refer to the ILEP white paper available on Techdocs for a detailed explanation of ILEP.

ILEP will cause the tape drive to generate a KEK label in a predetermined format based on the NetBackup pool ID. These labels are not descriptive. This panel allows you to provide an alias for the drive-generated KEK label. If an ILEP-generated KEK label has a match in this mapping panel, the EKM will use the remapped KEK label to find the KEK. Figure 5-9 on page 259 shows the mapping panel. To create a new mapping, click **Add/Modify**. The Add/Modify panel is displayed. From this panel, select the from and to KEK labels from the drop-down lists. Also, select the encoding method. The KEK labels, which you entered on the KEK label entry panel as described in 5.4.2, "Key label entry" on page 256, appear for selection in the KEK label drop-down lists. You cannot create a new KEK label from this panel. You must enter new KEK labels on the Key Label Entry panel.

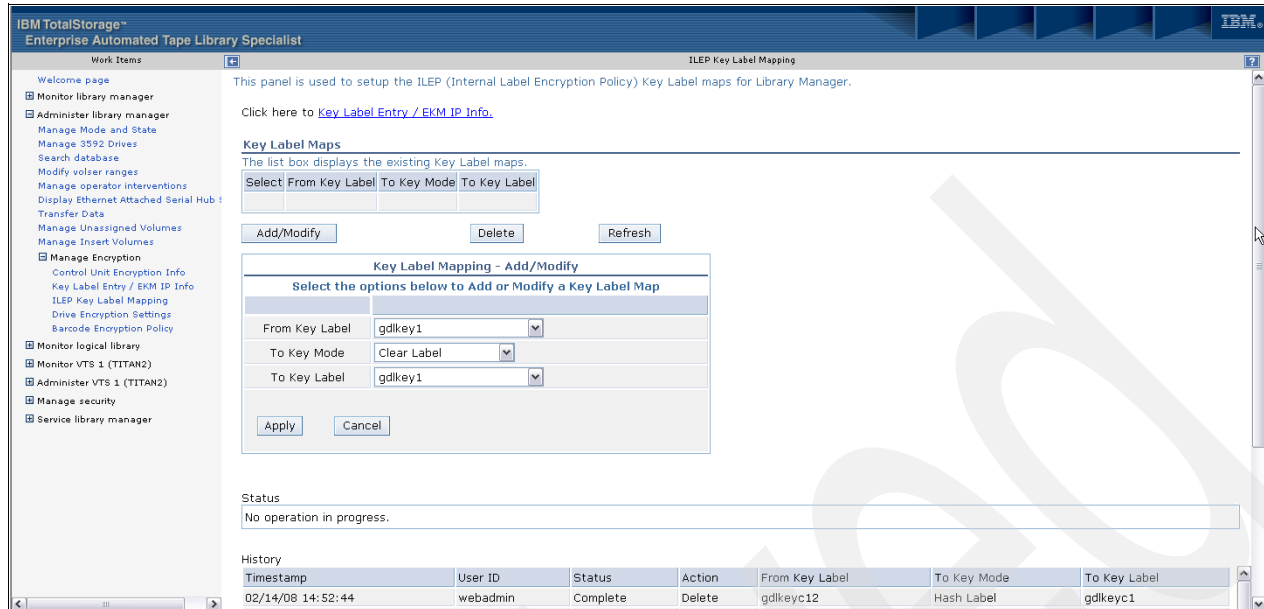


Figure 5-9 Internal Label Encryption Policy Key Label Mapping

5.5 Other considerations

This section provides additional topics to consider when implementing Tape Encryption.

5.5.1 Disaster recovery considerations

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

- Create a duplicate EKM at the DR site with the same information as your local EKM (configuration file, tape drive table, and keystore). Then, this EKM is 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 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 than your primary site uses, the configuration file and tape drive table must contain the correct information for the DR site.

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

- Use the second Externally Encrypted Data Key (EEDK) on each tape cartridge to encrypt tape cartridges so 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, which 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 method 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 than 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. See *IBM System Storage TS1120 Tape Encryption Planning, Implementation, and Usage Guide*, SG24-7320, for more information about this variable.

5.5.2 Performance considerations 3592 Model E Tape Drive

Unlike software Encryption or Encryption appliances, the 3592 Model E Tape Drive 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 will increase 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, which can delay processing across your enterprise.

Using Virtual IP Addressing (VIPA) in your z/OS setup can contribute to both better performance and redundancy when 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 might appear stopped.

Before cancelling a job, ensure that you allow enough time for the retry attempts that might occur on the primary and also the secondary key manager. Typically, each attempt might 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 will always attempt 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 joblog and in the system log alerting you to a potential problem with the primary key manager.

Running z/OS production systems

Running and improving a tape environment in z/OS is an ongoing task. This chapter provides a collection of useful tasks and information. These tasks include:

- ▶ Data migration considerations
- ▶ Partitioning tape libraries among multiple z/OS users
- ▶ Managing different device models in a z/OS environment
- ▶ Tape device selection criteria
- ▶ Cartridge processing and interaction with object access method (OAM) exits
- ▶ Integrated storage management facility (ISMF) ALTER command
- ▶ Tape configuration database (TCDB) considerations and resynchronization of RMM-CDS
- ▶ Exploitation of new capabilities

This chapter has been updated with the considerations that apply when using IBM TotalStorage Enterprise Tape Model 3592 drives and WORM media.

6.1 Data migration

The following sections discuss the necessary steps to plan and perform data migration. There are several strategies to migrate the data from one hardware platform to another hardware platform and to introduce new drives or media. Plan the migration phases carefully in advance and allow time for side steps regarding education, disaster recovery adjustments, and documentation (refer to 6.9, “Exploitation of new capabilities” on page 299).

This section assumes that before you install your new hardware, you have analyzed your data in general. This knowledge of your environment (how much data, the type of data, how many business hours, and so forth) is essential to the input for the data migration steps.

Note: We do not include migration considerations to a Virtual Tape Server (VTS) or Peer-to-Peer (PtP) VTS in this chapter. 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. These books were updated recently and contain all of the necessary and detailed information.

We also do not include migration considerations to a TS7700 Virtualization Engine. Refer to *IBM Virtualization Engine TS7700: Tape Virtualization for System z Servers*, SG24-7312.

6.1.1 Scenarios for planning a data migration

Data migration is necessary when you introduce new hardware or media. Depending on the change in your environment, you must perform different migration tasks. Table 6-1 lists migration scenarios. Each scenario considers the following factors:

- ▶ **Redirection of new data:** Do I have to review and change my automatic class selection (ACS) routines?
- ▶ **Movement of physical cartridge:** Do I have to carry my cartridge to a new location to place it into new hardware?
- ▶ **Copy existing data:** Do I have to copy all of my existing data on this media or in this library to a different media or library?
- ▶ **Time aspects:** Consider time aspects if you must meet the end of the lease period. For example, time-consuming tasks (copying data) are sometimes a key aspect in the planning. For physical movement, plan the outage carefully. However, you can finish the actual transition phase on a weekend.

Table 6-1 Migration scenarios

Scenario	Redirecting new data	Movement of physical cartridges	Copy existing data	Time aspects
A) Replacement library without changing the media or 359x models	No	Yes	No	No
B) Replacement library with changing drive models (no old drive models left?)	No	Yes	No/Yes	No
C) Replacement library with changing media	Yes	No/Yes	Yes	Yes

Scenario	Redirecting new data	Movement of physical cartridges	Copy existing data	Time aspects
D) Changing drives or media in existing library	Yes	No	Yes	Yes/No
E) Replacement of hardware not containing 3590	Yes	No	Yes	Yes

The following section offers a detailed explanation for each of the scenarios in Table 6-1.

Scenarios A and B

The physical movement of the cartridge to the new environment is the easiest way. However, physical movement requires special considerations (see 6.1.3, “Moving native cartridges to another library” on page 266). After the movement, the old hardware is ready for removal. To redirect the new traffic to the new library, you must add the new library to the appropriate Storage Class. You do not need to perform any data migration.

In scenario B, you must follow the instructions in “Special migration considerations for applications and products” on page 270 for applications, such as Hierarchical Storage Manager (HSM) or OAM, to avoid problems.

Scenario C

Introducing new media (regardless of whether you are also upgrading the drive models) depends on your new library to determine whether you want to move the old cartridges to the new library. If there are enough free slots, you can move them, which frees the old hardware quickly. This approach is helpful if you must migrate before the end of the lease for the old hardware. If this situation is not the case, it is best to put the new media in the new library and change the ACS routines to direct to the new hardware. Follow this action with data migration. Refer to 6.1.2, “Planning data migration details” on page 263.

Scenarios D and E

Moving physical cartridges is unnecessary or inapplicable. Redirection of the new datasets through ACS routines is the first step. Data migration needs the most attention. Refer to the following sections for more information.

6.1.2 Planning data migration details

Depending on the structure of your company, data migration can be a task outside of your department. Involve all parties early in the installation planning process, so they can plan their migration part in advance.

Discuss and review the following details:

- ▶ How do you plan to redirect new data? Change ACS routines, change Job Control Language (JCL), and so forth?
- ▶ How fast must you redirect the new data? Which data must you redirect first?
- ▶ Are there special migration considerations for applications or products?
- ▶ How much existing data must you move? How will you move it (moving cartridges or copying data)?
- ▶ What is the time schedule for migration? Is there a lease end for old hardware?
- ▶ Is additional software required for migration?

The following sections look closely at these steps.

Redirecting new datasets

You redirect a new dataset through changes in the ACS routines. Introducing new hardware or hardware attachments might create a case for you not to redirect your whole workload in one big step. Instead, you might want to change specific parts of the workload in phases.

The advantage of redirecting smaller parts of the workload at a time are:

- ▶ Less risk
- ▶ Time for education and the learning phase
- ▶ Opportunity to check the installation regarding performance and automation

Do *not* move user-specific data first. In a z/OS environment, dumps and traces, SMF data, and syslogs are good examples of the data to move first. Even if they are critical for the z/OS operations, they contain no user data.

You might want to use NaviQuest for creating SMS test cases for the new environment. Refer to 4.3.16, “Testing ACS logic with NaviQuest” on page 233.

Special products

There are products from third-party vendors that do not use the tape standard support of tape labels or tape marks. Several of them do not support multivolume processing. If you use these products, migration to a different media type is only possible if the media has more capacity than the old one. Migration from a 3590 or 3592 media to a VTS or TS7700 reduces the capacity of a single volume. Multivolume processing and correct tape mark processing are necessary in this case. Therefore, copying data from the original source might be impossible. Make a list of the software that writes datasets on tape, and check whether certain data needs special treatment.

Compressed data

Volume mount analyzer (VMA), the tape tools, or other monitoring and sizing tools cannot distinguish between compressed and uncompressed data. In a z/OS environment, you can use compression tools or use compression components in applications, such as DB2® compression, DFDSS, or HSM-ML2 compression.

The information regarding MB or GB traffic shows you the amount of compressed data. The calculation of the tape utilization might be wrong, because the assumption of three to one (3:1) is incorrect. Instead, use one to one (1:1).

Consider using compressed data if you monitor or size your environment in regard to:

- ▶ Throughput
- ▶ Necessary cartridges and slots
- ▶ Necessary cache in VTS or TS7700
- ▶ Necessary stacked volumes in VTS or TS7700

Existing data: Moving, copying, and expiring

Copying existing data is a difficult task and consumes significant personnel resources. Therefore, investigate how much of the data you really need to copy. Use EXPDIST (see “Tape tools” on page 485) to obtain detailed information about your expiration dates. Check the hardware removal dates (the lease end date and the amount of time required for hardware removal and shipping) and review the number of VOLSERS already expiring on that date. Find out whether there is any issue in moving cartridges that do not expire until this date and keeping in them in the new library.

Make a list of the volumes and data that you must copy and the copy mechanism that you intend to use for the process. Using a copy tool can make the migration easier (refer to “Additional software for data migration: Copy tool” on page 265) and provides a lot of additional functionality (for example, keeping the original tape management system entries). There are still many time-consuming migration tasks left. Do not underestimate the necessary effort for this task.

Time schedules and staffing requirements

Even if migration is not a project, using a project plan schedule can help you to finish the migration in time. Allow at least two weeks (depending on your environment and equipment) before the end of the lease for the complete deinstallation of the drives, controllers, and frames of a 3494 and for packaging for shipment. You need this time to empty the frames, disconnect from the host attachments, deinstall the hardware, and prepare it for shipping.

Preparing the copy tasks and checking the results of the copy jobs are time-consuming. Checking the results is essential because of a possible data loss.

Remember that the migration tasks run in addition to your daily business or the daily business of your storage administrator. Consider carefully how much time you can spend each day for this task.

Additional software for data migration: Copy tool

You might want to consider using a product designed to copy data from one media type to another media type. These products are designed to do much of the work for you. Here are reasons why you might want to choose a copy tool:

- ▶ Interaction with the tape management system can keep the original creation date, the original owner, and the original expiration date. Standard z/OS software does not keep this information in a copy process. You must manually intervene to keep the expiration date.
- ▶ Bulk processing is possible. You can copy similar data, such as SMF, from one job or all the datasets from one tape, regardless of the names on it.
- ▶ The copy tool might support multilabel, multivolume, and multilabel-multivolume files.
- ▶ The copy tool might support automatic cleanup (expiration of the source volumes).

Table 6-2 shows the tape copy products of which we are aware. You can choose one of these products, or perhaps you have your own tool, which performs a similar function. However, you must take your own environment into consideration when evaluating these products. Options to consider when evaluating a tape copy product are:

- ▶ Interaction with your tape management system
- ▶ Automation level of the process
- ▶ The speed and efficiency of the copy operation
- ▶ Flexibility in using the product for other functions, such as duplicate tape creation
- ▶ Ease of use
- ▶ Ability to create a pull list for any manual tape mounts
- ▶ Ability to handle multivolume datasets
- ▶ Ability to handle volume size changes, whether from smaller to larger or larger to smaller
- ▶ Functionality to review the list of datasets before submission
- ▶ Audit trail of datasets already copied

- Flexibility in filtering the datasets by wildcards or other criteria, such as the expiration date or the creation date
- Failure management, such as input volume media failures, during the copy operation

Table 6-2 Tape copy product examples

Product name	Vendor name	Web address for more information
Tape copy Tool/DFSMSrmm	International Business Machines	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

6.1.3 Moving native cartridges to another library

To move an existing cartridge to another library, you must install the second library as explained in Chapter 4, “Software implementation in z/OS” on page 157. Because you have the library in SMS online and can bring the drives online to the system, you can start moving the cartridges.

You can use the procedures that the system provides, such as Eject and Enter controlled, through the tape management systems (TMS), ISMF and OAM, or you can choose manual operations. The procedure that you choose depends on your environment and the service level agreements that you have. Consider the following points:

- Library length and productive workload influence eject times. In a busy 14-frame-wide library, ejecting 30 cartridges takes approximately 20 to 25 minutes.
- Your business and service level agreements: Outage for an application can be a problem.
- Convenience I/O station is installed.
- High/capacity I/O facility is available.
- Whether the new library is already in production.
- The library stand is in the same building or in different data centers.
- For a manual move, you need to manipulate the TMS database and TCDB. Careful preparation is necessary.

Depending on these conditions, you must evaluate the best choice for your environment. Table 6-3 summarizes the advantages and disadvantages of system-controlled and manual methods of moving cartridges.

Table 6-3 Comparison between system-controlled and manual methods of moving cartridges

Consideration	System-controlled moving	Manual moving
Outage time	Middle to long	Short to middle
Need manipulation on tape management and TCDB	None	High (home location Storage Class)
Risk of data loss	None, only if you drop a cartridge	Middle risk, manipulation of TMS is always a risk.
Risk of losing cartridge	No difference	No difference
Risk of forgetting cartridges	None, ejects can be created by procedures or TMS.	High risk if cartridges must be selected manually from the frame. Middle risk if all cartridges are transferred.

6.2 Partitioning tape libraries among multiple z/OS systems

Partitioning a tape library gives you the chance to use the library resources with different users. Each attached partition can be either an MVS platform or a non-MVS platform. There can be single MVS platforms or MVS platforms that consist of one or more systems or sysplexes, or both, connected to a shared TCDB. If systems share the TCDB, they are referred to as a *TCDBplex*. Each TCDB can contain configuration information about the library and a subset of the volumes in the library. Therefore, you can view partitioning as dividing a physical library into multiple logical libraries, with each logical library (TCDBplex) represented by one TCDB.

Inside a sysplex, the tape devices can be shared through ATS STAR (or previously through IEFAUTOS) without manual intervention. If you have a TCDBplex containing more than one sysplex or single systems, the common use of tape devices is not possible without additional tools or manual intervention. The same is also true if multiple users (multiple TCDBplex or single MVS platforms) want to use the same devices.

Inside a TCDBplex, the cartridges are shared. Partitioning a library among multiple TCDBplexes requires separation of the scratch pools. That is, each TCDBplex must have a separate Library Manager category for each scratch media type (CST, ECCST, high performance cartridge tape, and extended high performance cartridge tape). For logical completeness, make the error and private volume categories also unique to each TCDBplex.

To change the default category assignments, you can specify the categories in PARMLIB member DEVSUPxx. DEVSUPxx eliminates the need for a user modification that was used in earlier releases of DFSMSdfp to assign volume categories. The category specification parameters enable the installation to change the default category assignments associated with a system or sysplex, or both. The installation must ensure that all systems, sysplexes, or both that are associated with the same TCDB (TCDBplex) use the same category assignments. For a discussion of the partitioning-related DEVSUPxx parameters, see 4.3.2, "Updating SYS1.PARMLIB" on page 174.

6.2.1 Setting volume categories

In a partitioned library, we recommend that the installation use DEVSUPxx to change the default categories associated with each TCDBplex. Therefore, no TCDBplex uses the default categories, so there are no volumes in those categories. If the DEVSUPxx parameters are inadvertently removed from one system, scratch mount requests are directed to the empty default categories, and the mount requests fail.

If there is a TCDBplex that uses the default categories, volumes can be mounted by the system where the DEVSUPxx parameters were removed. If a scratch volume from a default category is mounted on the system where the parameters were removed, it is not used, because there is no tape volume record in the TCDB. The volume is assigned to the error category, with resultant disruption in library operations in the TCDBplex that owns the default categories.

6.2.2 Volume categories and DFSMSrmm

In DFSMSrmm, the REJECT ANYUSE command in PARMLIB member EDGRMMxx allows an installation to specify volume serial numbers that are not to be used in this TCDBplex. When you enter a volume into a system-managed tape library, all connected systems get this information and if the volume matches a specified REJECT ANYUSE(*prefix*), EDGLCSUX sets a return code of 12 to pass to OAM. OAM passes the return code to the Library Manager. It does not create a volume entry in the TCDB or an entry in DFSMSrmm. If no connected system passes a return code of 0, the volume is left in the INSERT category in the Library Manager database.

Important: The REJECT ANYUSE command is mandatory for volumes that are not allowed. Even if you predefine the volumes in one of the connected z/OS systems with the DFSMSrmm ADDVOLUME subcommand, it does not prevent other systems from taking the inserted volumes to the TCDB if a REJECT ANYUSE is not coded.

Refer also to 4.3.7, “Updating and customizing your tape management system” on page 190.

If you have another tape management system and need to partition your tape library, ask your vendor for the exit code of module CBRUXENT to approve or disapprove entry of cartridges into the TCDB.

Assume that you have two TCDBplexes: PLEX1 and PLEX2. PLEX1 includes systems SYS1A and SYS1B. PLEX2 includes systems SYS2A, SYS2B, and SYS2C. All five systems are attached to the same IBM 3494 Tape Libraries (see Figure 6-1 on page 269).

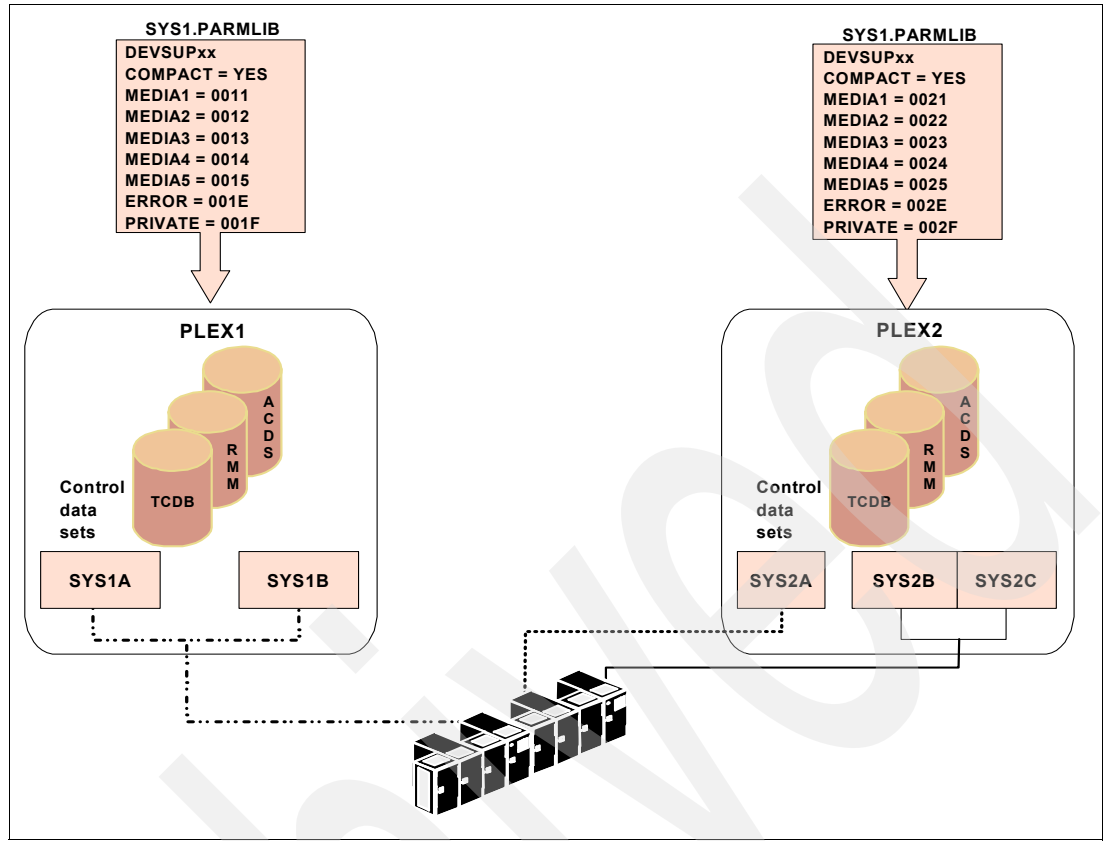


Figure 6-1 Partitioning and volume categories

Note the following points:

- ▶ Scratch mounts from systems in PLEX1 get volumes from Library Manager categories X'0011', X'0012', X'0013', X'0014', or X'0015' assigned as specified in the DEVSUPxx members of SYS1.PARMLIB, depending on the requested media type in the Data Class.
- ▶ Scratch mounts from systems in PLEX2 get volumes from Library Manager categories X'0021', X'0022', X'0023', X'0024', or X'0025' assigned as specified in the DEVSUPxx members of SYS1.PARMLIB, depending on the requested media type in the Data Class.

The setting for the private category is optional, because specific mount requests use the TCDB volume entry information. The Library Manager private category is not used for specific mount requests. To reflect the host category assignment on the Library Manager, we recommend that you always specify a category for private volumes on all hosts.

For details regarding partitioning and sharing, refer to the *Guide to Sharing and Partitioning IBM Tape Library Data*, SG24-4409.

6.3 Managing different 359x models in a 3494 Tape Library

Sometimes, new drive models are installed for migration purposes. After the migration, only the new drive model is left in a library. However, a mix of different drive models can exist for a longer period of time. Depending on your purpose, you need to consider your options.

6.3.1 Migration to TS1130

TS1130 support exists only on z/OS V1R7 and above. Software PTFs are available through normal software distribution channels. An IPL will be required to enable this support once installed.

You must perform the following implementation steps in an SMS-managed tape library:

- ▶ Define or alter existing Data Class constructs to utilize the new recording technologies.
- ▶ Update ACS routines to reference the appropriate Data Class.

With the 3590 Model E and H, there were read-compatibility considerations that required you to indicate on a volume or job basis that the request for a volume was for read-only purposes. This indication enabled a higher technology device that was downward read-compatible to be considered eligible for the request. This capability was particularly important, because if you had upgraded all of the drives in their library to the new recording technology, this 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, the DD statement of JCL was not required for the EFMT1 recording format. The same holds true 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) on the DD statement of the JCL is needed to enable the 3592 Model E06 drive to be considered eligible for an EFMT1 request.

Special migration considerations for applications and products

If you change the device type or the media size, certain applications need specific attention to avoid problems. The following list contains information regarding whether the application can exploit the new capacity of tape drives and media. It also offers considerations for migration time:

- ▶ **DB2 or IMS™ logs:** These logs do not change their behavior. However, if you need to write them directly to tape, you do not benefit from their higher capacity.

You can copy existing datasets with standard z/OS procedures, which does not exploit their capacity, unless you introduce multilabel volumes. We do not recommend this approach for DB2 or IMS.

- ▶ **HSM/TSM/OAM:** All of these products exploit the full capacity of a tape. No extra tasks are required in HSM and OAM. For TSM, you need to adjust the MAX or Estimated capacity to exploit the full capacity for the storage pool. The introduction of XL cartridges increases the recall times in all of these systems (doubled media length).

You must set all existing tapes in filling status to full before you introduce the new drives. If not, the programs try to fill the tapes and receive a label error due to different recording technologies, which results in discontinued processing (refer to 6.3, “Managing different 359x models in a 3494 Tape Library” on page 269). Recycle for HSM and Movevol for OAM transfer the data from full cartridges to new media tapes or the new scratch tapes, which are labeled on the higher capacity. Converting to an XL cartridge is possible if you set **Return to scratch** to NO in DFSMSrmm for the old cartridges before you start the migration.

- ▶ **Output directly from jobs, DFDSS backups:** You can change these backups and the DFDSS backups to use multilabel processing. If you migrate to a VTS or TS7700 later, multilabel processing restricts the possibilities of serializing your jobs. Then, you cannot exploit the full benefits of the virtual drives, which can impact your batch window. However, if you want to fill your cartridge with an acceptable amount of data, multilabel is the only way to do so.

You can copy existing datasets using standard z/OS software. If you do not use multilabel processing, the same number of volume serial numbers (VOLSERs) is needed. You cannot exploit capacity.

- **Output management systems:** Typically, these systems have the capability to exploit higher capacity. Refer to your specific software customization.

Most output management systems have their own databases that keep track of which output resides on which cartridge and where. Therefore, you cannot copy the data with standard z/OS software. Most vendor systems provide utilities to upgrade to a higher device.

If you have different 359x models installed (for example, 3590, 3590E, or 3590H, or 3592-J1A, 3592-E05, and 3592-E06), one of the following implementation steps applies:

- To direct new tape allocations to a specific drive model, you need to define a Data Class. Specify Recording Technology with the appropriate value for each model. Also, update the ACS routines for new tape allocations accordingly to assign the new Data Class.

Refer to the Data Class definition (shown in Example 4-2 on page 216) 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 DEVSUPxx. Refer to “DEVSUPxx member of SYS1.PARMLIB” on page 176 for a detailed description of DEVSUPxx.
- To allow a *private cartridge* written with 128 or 256 tracks to be mounted for a read operation on a drive with higher track capability, set the TCDB volume entry definition of SPECIALATTRIBUTE(READCOMPATIBLE). You can verify the TCDB Special Attribute field using the ISMF MOUNTABLE TAPE VOLUME LIST shown in Figure 6-2.

Panel List Utilities Scroll Help						

MOUNTABLE TAPE VOLUME LIST						
Command ==>			Scroll ==> HALF			
			Entries 1-14 of 157			
Enter Line Operators below:			Data Columns 9-12 of 20			
LINE	VOLUME	RECORDING		SPECIAL	LAST	
OPERATOR	SERIAL	TECHNOLOGY	COMPACTION	ATTRIBUTE	WRITTEN DATE	
---(1)----	-(2)--	---(9)----	---(10)---	--(11)---	----(12)----	
	DA0018	EEFMT3	YES	-----	2008/04/17	
	DA0019	EEFMT2	YES	-----	-----	
	JA1054	EFMT2	YES	-----	2008/04/17	
	JBZ085	EFMT3	NO	-----	2008/04/17	
	JBZ086	EFMT3	NO	-----	2008/04/17	
	JBZ087	EFMT3	NO	-----	2008/04/22	
	JBZ088	EEFMT3	YES	-----	2008/04/22	
	JBZ089	EEFMT3	YES	-----	2008/04/21	
	JJH960	EFMT3	NO	-----	2008/04/03	
	JJH961	EFMT2	NO	-----	2008/02/27	
	JJH962	EEFMT3	NO	-----	2008/05/02	
	JJH963	EFMT3	NO	-----	2008/05/02	
	JJH964	EEFMT3	NO	-----	2008/04/30	
	JJH965	EEFMT3	NO	-----	2008/03/12	

Figure 6-2 ISMF MOUNTABLE TAPE VOLUME LIST panel

In addition to browsing through ISMF panels, you can list the information in the TCDB by using the LISTC command. To verify volume entries, specify the VOLUMEENTRIES parameter as shown in the LISTC command in Figure 6-3. This example lists all tape volume entries whose names begin with the letters D* and J* in the CASH02 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-----VJBZ085
  DATA-VOLUME
    LIBRARY-----CASH02      LOCATION-----LIBRARY
    RECORDING-----EFMT3     MEDIATYPE-----MEDIA9
    STORAGE-GROUP---*SCRTCH*  USE-ATTRIBUTE-----PRIVATE
    CHECKPOINT-----N        ERROR-STATUS-----NOERROR
    SHELF-LOCATION-----      (NULL)
    OWNER-----            (NULL)

  CREATION-DATE---2008-02-29 ENT-EJ-DATE---2008-02-29

  COMPACTION-----NONE      SPEC-ATTRIBUTE -----NONE
  EXPIRATION-----2008-05-05 LAST-MOUNTED--2008-04-17
  WRITE-PROTECTED-----N    LAST-WRITTEN--2008-04-17

```

Figure 6-3 LISTC command for library entry

The default of this parameter is SPECIALATTRIBUTE(NONE), (SPEC-ATTRIBUTE -----NONE in Figure 6-3). There is a high probability that you need to update it in your system. You can update this parameter either through IDCAMS ALTER VOLENTRY or by using DFSMSrmm if this is your tape management system. The IDCAMS command for volume VJBZ085 looks like this example:

```
ALTER VJBZ085 VOLUMEENTRY SPECIALATTRIBUTE(READCOMPATIBLE)
```

HSM and OAM with OAM Storage Management Component (OSMC)

If you want to use the new drives with HSM or OAM with OSMC, 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, you need to perform the following steps for HSM and OAM:

- **For HSM:**
 - a. Find out the volumes that are in filling status. Enter:


```
LIST TT0C SELECT(ML2 NOTFULL) ODS(SMS.LIST.TT0C2)
```

 You can also specify BACKUP or BOTH instead of ML2.
 - b. Set the volumes to 100% full. Enter:


```
HSEND DELVOL VOLSER MIGRATION(MARKFULL)
```

 You receive a message, ARC0260I Migration Volume VOLSER entry marked FULL.

Clients, who currently use MEDIA5 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 the installation uses MEDIA5 60 GB for ML2 and MEDIA5 300 GB for backup and dump. ML2 migration and recycle output can be redirected to MEDIA7 and all of the MEDIA5 ML2 tapes can be either specifically recycled by VOLSER, or marked full and recycled generically. The released MEDIA5 tapes can then be used to their full capacity for backup and dump processing. All HSMs in an HSMplex must 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 prevents accidentally mounting WORM tapes for DFSMSHsm functions and avoids including MEDIA10 or MEDIA7 tapes with MEDIA5 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 can give you a volume table, extracted from DB2, which 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/OSMC traffic to the new drive models.

6.4 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. It is not mandatory that you catalog 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.

6.4.1 Reading a dataset

The procedure that z/OS allocation uses to locate and read a dataset is shown in Figure 6-4 on page 274 and explained in the following steps (the numbers correspond to the numbers in Figure 6-4 on page 274):

1. Find the VOLSER:
 - If a dataset is cataloged, the dataset name is found in the z/OS dataset catalog. The VOLSER is extracted from the catalog entry, which is shown in Figure 6-4 on page 274.

- When the dataset is not cataloged, its VOLSER must be indicated through JCL or parameters in a dynamic allocation request. Searching the z/OS dataset catalog is bypassed.
2. The 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 (128, 256, 384, E1, E2, EE2, or EE3), and device type are extracted from the TCDB entry. They are used to allocate a tape unit for reading the dataset.

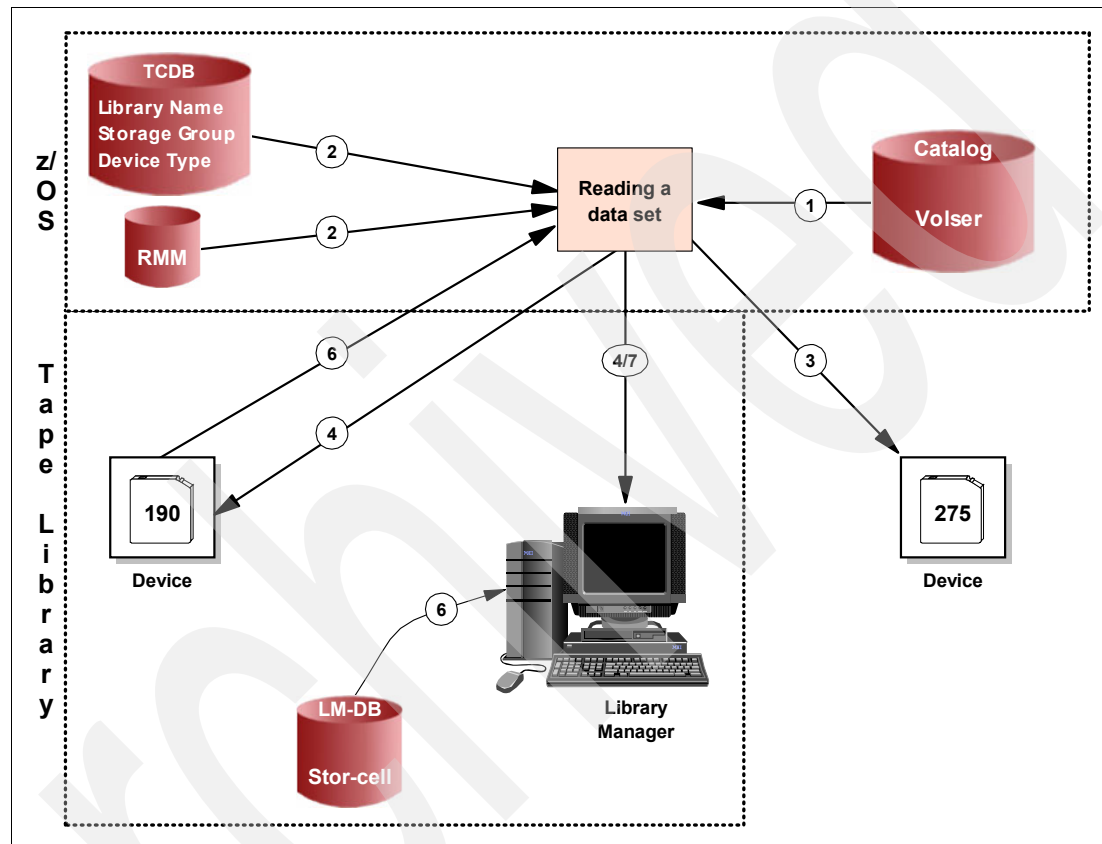


Figure 6-4 Process flow to read a dataset

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 this way to read it on a tape device outside of the library:

STORCLAS=DUPT@SMS, DISP=OLD, VOL=SER=xxxxxx (specific mount) UNIT=uuuu
(nonsystem-managed tape devices)

SMS checks against the TCDB are bypassed and the UNIT parameter is honored, which drives the allocation to a nonsystem-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 of the library.
4. Allocation or OPEN requests that the volume is mounted on the selected unit. For a discussion of device selection, refer to 6.4.3, “Device and library selection in a 3494 environment” on page 276. In the case of a library, this request is transformed into a channel command, which requests the Library Manager to mount the volume.
5. The Library Manager searches its database to find the storage cell ID where the cartridge is stored. 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 System Authorization Facility (SAF). The volume and the dataset usage are reflected in the TCDB and DFSMSrmm database by updating the relevant records there.
7. When the dataset is closed after it is used and the volume is demounted, the Library Manager receives a request to move the volume from the tape unit to a storage cell in a library.

6.4.2 Writing a new dataset

We show the procedure to write a new dataset in Figure 6-5 on page 276 and explain the procedure in the following steps (the numbers correspond to the numbers in Figure 6-5 on page 276):

1. From the dataset name and other information given in JCL or a dynamic allocation request and the Data Class, the SMS ACS routines derive a Storage Class and a Storage Group for the dataset (which 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 6.4.3, “Device and library selection in a 3494 environment” on page 276.
3. OPEN requests that the Library Manager mount a scratch volume.
4. The Library Manager selects a volume from the scratch category and mounts it on the tape unit.

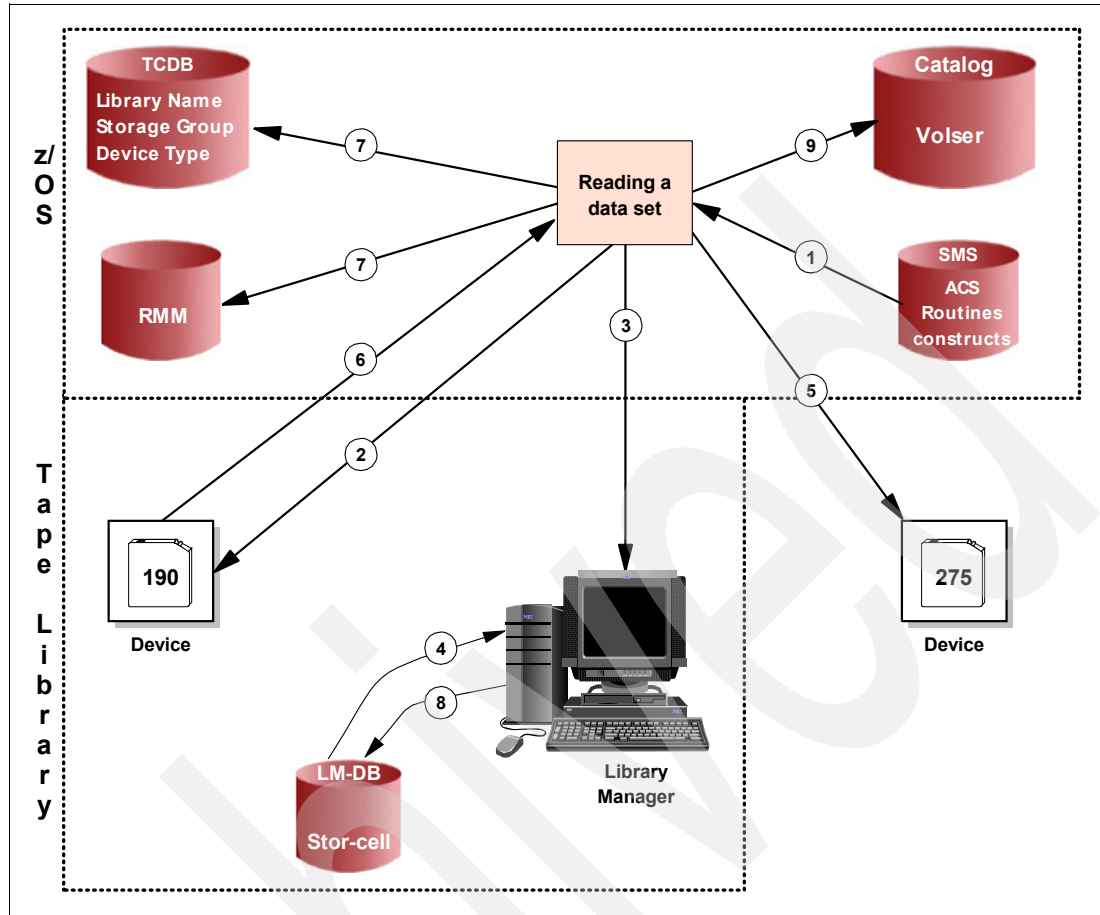


Figure 6-5 Process flow to write a dataset

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 volume serial number, 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 volume serial.

6.4.3 Device and library selection in a 3494 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 being 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: Device selection does not consider the following conditions:

- ▶ Number of available drives
- ▶ Busy condition of control unit or library accessor

6.5 Cartridge processing

In the following sections, we describe the interaction between z/OS OAM exits and actions regarding the cartridge:

- ▶ Insert
- ▶ Eject
- ▶ Return to scratch

For additional information about the OAM exits, refer to 4.3.6, “Customizing OAM” on page 187.

6.5.1 Cartridge entry processing

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 a volume record for the entered MEDIA5 - MEDIA8 volume does not exist in the TCDB and the volume is being entered as a private volume, EFMT1 is passed to the exit. If the exit returns with a recording technology for a MEDIA5 - MEDIA8 volume and the recording technology is not EFMT1, EFMT2, EEFMT2, EFMT3, or EEFMT3, the specification is considered invalid and the exit is disabled.

If a volume record for the entered MEDIA9 or MEDIA10 volume does not exist in the TCDB and the volume is being entered as a private volume, EFMT2 will be passed to the exit. If the exit returns with a recording technology for a MEDIA9 or MEDIA10 volume and the recording technology is not EFMT2, EEFMT2, EFMT3, or EEFMT3, the specification is considered invalid and the exit is disabled.

If a TCDB volume record exists and the volume's recording technology or media type is not supported on the system processing the volume, in an ATLDS, the volume is left in the library manager insert category to be processed by a system with appropriate support.

The volume is left in the Library Manager insert category to be processed by a system with appropriate support. The cartridge entry installation exit (CBRUXENT) is passed through register 1, the pointer to a parameter list mapped by CBRUXEPL. If CBRXLCS FUNC=MCE is used to enter a volume into a manual tape library (MTL) and its existing TCDB record has EEFMT3 recording technology or an unsupported media type (MEDIA9 or MEDIA10, V1R7 system) and the software does not support the recording technology or the media type, the request fails with existing return code LCSFAIL (12) and existing reason code LCSFNSUP (310). If the CBRUXENT exit returns a unsupported recording technology or media type, the entry of the volume also fails. Table 6-4 shows the CBRUXENT return codes.

Table 6-4 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 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 a VTS/TS7700 installation, the parameter list has extended significantly. For a detailed list of 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 in an environment where a library is shared among multiple hosts is 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 an 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, ignore their volumes. 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.

6.5.2 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. This action is controlled by the EJECT DEFAULT on the ISMF LIBRARY DEFINE panel or on the parameter used when ejecting the volume.

The installation-wide exit CBRUXEJC approves or disapproves of a cartridge being ejected from the library.

6.5.3 Cartridge return to SCRATCH

Cartridges are returned to SCRATCH status in the library by having their Library Manager category changed from specific to one of the scratch media categories. 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 change requested.

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 use care in 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.

6.6 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 (see Figure 6-22 on page 295).

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 the volumes in a single Storage Group. Use the ALTER command against the subset list to change information for all of the volumes in 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, the use attribute, Storage Group, Shelf Location, and Owner Information values are altered for all volumes in the list (see Figure 6-6 on page 280).

```
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 6-6 ALTER command from the MOUNTABLE TAPE VOLUME ALTER ENTRY panel

When you enter the ALTER line operator from the MOUNTABLE TAPE VOLUME LIST panel, the next MOUNTABLE TAPE VOLUME ALTER ENTRY panel (Figure 6-7) displays to enable you to enter the new values for the specific volume requested. The panel examples in Figure 6-7 through Figure 6-10 on page 284 provide more information regarding the ALTER function for a specific tape volume.

Panel Utilities Help		

MOUNTABLE TAPE VOLUME ALTER ENTRY PANEL		
Command ==>		
Tape Volume : DA0018		
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 6-7 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 is displayed, the new information appears in the Old Value fields. The New Value fields are primed with the same information (see Figure 6-8).

```
Panel  Utilities  Help
-----
                                MOUNTABLE TAPE VOLUME ALTER ENTRY PANEL

Command ==>

Tape Volume: DA0018

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: ST6T25B
    New Value . . ST6T25B

Use ENTER to Perform ALTER;
Use HELP Command for Help; Use END Command to Exit.
```

Figure 6-8 Both old value fields and new value fields 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 blank the next time that you display the record (see Figure 6-9).

```
Panel  Utilities  Help
-----
                                MOUNTABLE TAPE VOLUME ALTER ENTRY PANEL
Command ==>

Tape Volume: DA0018

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: ST6T25B
    New Value . . ST6T25B

Use ENTER to Perform ALTER;
Use HELP Command for Help; Use END Command to Exit.
```

Figure 6-9 New Value blanked out for Storage Group

Note that both the Old Value and 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 (see Figure 6-10).

```

Panel  Utilities  Help
-----
                                MOUNTABLE TAPE VOLUME ALTER ENTRY PANEL

Command ==>

Tape Volume: DA0018

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: ST6T25B
    New Value . . ST6T25B

Use ENTER to Perform ALTER;
Use HELP Command for Help; Use END Command to Exit.

```

Figure 6-10 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:

- ▶ The volume's Storage Group is defined in the current 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 is made.

If OAM detects an error in any of these conditions, neither the use attribute nor the Storage Group is changed. 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 6-11) displays. 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 6-11 CONFIRM ALTER REQUEST panel

6.6.1 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 in the list are private with an expiration date that has not yet passed. When you specify scratch, the PRIVATE TO SCRATCH CONFIRMATION panel (Figure 6-12 on page 286) displays for *each* volume whose expiration date has not yet passed.

Note: When you install DFSMSrmm, 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 4.3.6, “Customizing OAM” on page 187 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: DA0018

                                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 6-12 PRIVATE TO SCRATCH CONFIRMATION panel

If the response is the forward slash (/) on either confirmation panel, OAM changes the following items:

- ▶ The use attribute is changed to S in the TCDB.
- ▶ The Storage Group name is set to *SCRATCH* in the TCDB.
- ▶ The expiration date in the TCDB is blanked out.
- ▶ The volume error status is reset to NO ERROR in the TCDB.
- ▶ The Library Manager category of the cartridge is changed from private to scratch.

6.6.2 Changing the use attribute from scratch to private

When you use the ALTER line operator or the ALTER command to change the use attribute for tape volumes to private, the following fields in the TCDB are updated:

- ▶ The use attribute is changed to P in the TCDB.
- ▶ The volume error status is reset to NO ERROR in the TCDB.
- ▶ The category of the cartridge or cartridges is changed from scratch to private.

The changes to the TCDB volume record occur immediately. When the line operator or command is complete, you return to the MOUNTABLE TAPE VOLUME LIST panel with the appropriate success or failure message. If the volume or volumes are successfully changed, use the ISMF REFRESH command to display the new values in the tape volume record.

Note: When you install DFSMSrmm, its CDS is updated to reflect these changes.

6.6.3 Using ISMF ALTER to change the volume category

Sometimes (especially in consolidation phases, outsourcing, or migration tasks), it is necessary to change the MEDIA categories in DEVSUPxx to support new numbering conventions or to consolidate systems. If you must change the MEDIAx value, there must be no movement from the cartridge. We explain the easiest way to make this change in the following steps:

1. Change DEVSUPxx MEDIAx 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 the volumes that you influenced through the MEDIA change. Choose by volume prefix and Storage Class *SCRATCH*.
4. Enter ALTER on the command line. 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. Therefore, the process can take several minutes, depending on the number of volumes. No information is really altered in the z/OS, but the new scratch category is transferred to the Library Manager. After the ALTER is processed, you have the same number of scratch cartridges that you had before the IPL.

For more detailed information about the panels, see *DFSMS/MVS V1R4 DFSMSdss Storage Administration Guide*, SC26-4930.

6.7 TCDB considerations

Your IBM 3494 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 3494 cannot be retrieved without access to the TCDB. TCDB tasks as outlined in Table 6-5 include functions to detect and correct out-of-sync conditions.

Table 6-5 TCDB tasks

Task	Comment
Schedule job to save TCDB.	See 6.7.1, "TCDB backup" on page 288.
Restore or rebuild TCDB after destruction.	See 6.7.2, "TCDB recovery using ICFRU" on page 288.
Move TCDB to a different volume.	See 6.7.4, "Moving a TCDB to a different volume" on page 292.
List information in the TCDB.	See 6.7.5, "Listing information in the TCDB" on page 293.
Verify consistency among TCDB and tape management system.	See 6.8, "Resynchronizing RMM CDS" on page 298.
Verify the location of the tape volumes in your tape libraries.	See 6.7.6, "Library Manager database and TCDB synchronization" on page 294.
Perform manual updates against the TCDB.	See 6.7.7, "TCDB manual update" on page 297.

6.7.1 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 volcat and use DFSMSdss for backup, the backup of all of the volcats at the same time is required for consistency reasons. If you use IDCAMS EXPORT, this backup is not required but 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 right 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 and VTS/TS7700), you must perform partial manual reconstruction to access the library with the backup tape. Performing a backup on DASD is the easiest way to avoid this manual intervention.

6.7.2 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 you record all SMF type 61, 65, and 66 records. Ensure that SMF parameters specify recording for these record types for all jobs. Check the SMFPRMxx 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. Cause the TCDB to be closed in the recovery system.
5. Record the date and time when it is confirmed that the TCDB is closed on all systems, which is the stop date and time that are needed 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 needed for forward recovery of the TCDB.
7. Identify an EXPORT backup copy of the TCDB (This copy is the EXPIN dataset for ICFRRAP).
8. Establish a start date and time for forward recovery, which are needed as input for the ICFRRSV program. You can obtain the date and time from message IDC0594I in the export job creating your backup copy of the TCDB.
9. Identify the SMF data needed 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 determined in the previous steps. 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 produced by ICFRRAP.
15. Back up the TCDB to start a new recovery cycle.
16. Vary the tape library online.

The procedure shown in Figure 6-13 on page 290 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.

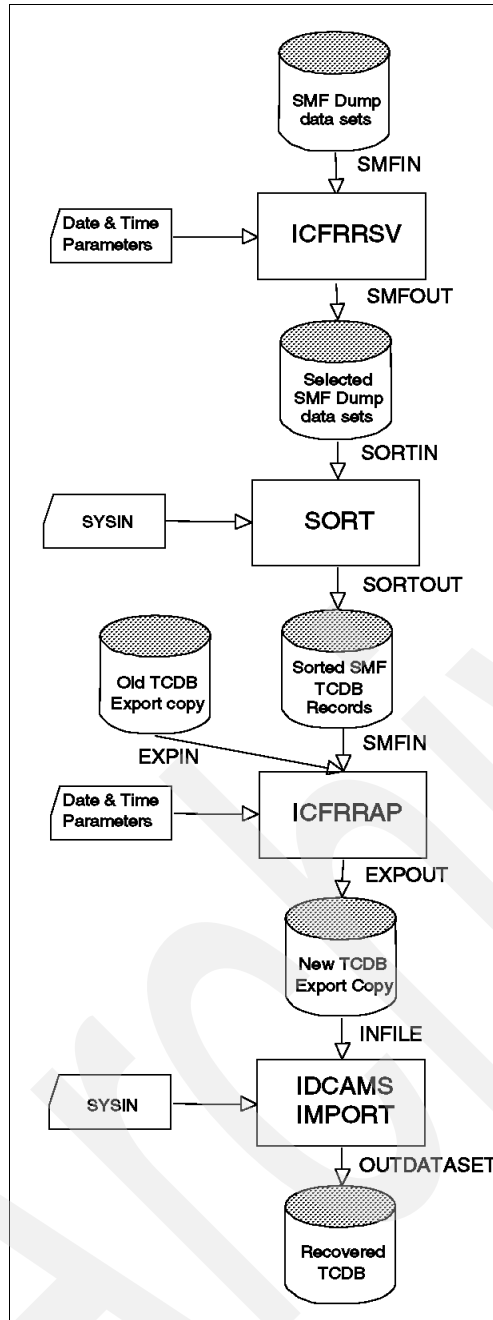


Figure 6-13 Using ICFRU to recover a TCDB

6.7.3 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 3494 Library Manager database list. See Appendix F, “REXX utility to recover TCDB” on page 551.

Recover your TCDB using the REXX utility as we describe in the following steps:

1. Obtain the 3494 Library Manager database list:
 - a. On the 3494 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: (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 on MVS. In addition to these changes, you must enter your tape category code, which is defined in DEVSUPxx PARMLIB member and library name. This program reads the 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.
5. Allocate a new VOLUME CATALOG (TCDB) as shown in Figure 6-14.

```
//TCDBALLOC EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=A
//SYSIN DD *
  DEFINE UCAT(NAME(TEST.VOLCAT.VGENERAL) -
              VOLCATALOG -
              VOLUME(VOL001) -
              CYLINDER(10 1))
/*
```

Figure 6-14 Allocating a new volume catalog

6. Create the library entry.

Creating a library definition outside of ISMF is *only* for recovery purposes. Therefore, Figure 6-15 shows only certain parameters. However, in several 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.

```
//STEP2 EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSIN DD *
  CREATE LIBRARYENTRY -
    (NAME(LIBATL1) LIBID(F4001)

  CREATE LIBRARYENTRY -
    (NAME(LIBVTS1) LIBID(22051) -
  SCRATCHTHRESHOLD(MEDIA2(10))
```

Figure 6-15 TCDB recovery with REXX: Creating a library entry

7. Create the volume entries as shown in Figure 6-16.

```
//STEP3 EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSIN DD DISP=SHR,DSN=DBLIST <= THE OUTPUT OF REXX PROGRAM/*
```

Figure 6-16 TCDB recovery with REXX: Creating volume entries

6.7.4 Moving a TCDB to a different volume

Follow these steps to move the TCDB (SYS1.VOLCAT.VGENERAL) to a different volume:

1. Stop all tape activity and vary the IBM 3494 Tape Library 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 the systems that share the TCDB that you want to move.

2. Restrict access to a catalog when you perform maintenance procedures that involve redefining the catalog (Figure 6-17). 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.

```
//LOCKCAT EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=A
//SYSIN DD *
ALTER SYS1.VOLCAT.VGENERAL LOCK
/*
```

Figure 6-17 Moving the TCDB: Locking the TCDB

3. Verify whether the integrity and structure of the volcat help you to determine and solve problems in the actual TCDB before you move it. See Figure 6-18.

```
//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)
```

Figure 6-18 Moving the TCDB: Verifying the structure of the TCDB

4. Export the TCDB with the EXPORT command (see Figure 6-19 on page 293).

```
//IDCAMS EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSIN DD *
EXPORT 'SYS1.VOLCAT.VGENERAL' DISCONNECT
/*
```

Figure 6-19 Moving the TCDB: Exporting the TCDB

You must disconnect the catalog from all systems in an SMSplex.

5. Import the TCDB to the different volume (see Figure 6-20). If you want the attributes of the catalog to change, define the catalog with the desired attributes on `newvol`. Then, import the original catalog into the newly defined catalog. If the import is successful, the old, exported catalog is deleted.

```
//IDCAMS EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//EXPORTDS DD DSN=h1q.VOLCATMV.EXPORT,DISP=SHR
//SYSIN DD *
IMPORT INFILE(EXPORTDS) -
OUTDATASET('SYS1.VOLCAT.VGENERAL') -
OBJECTS(('SYS1.VOLCAT.VGENERAL' VOLUMES(NEWVOL))) -
UNLOCK
/*
```

Figure 6-20 Moving the TCDB: Importing the TCDB

You connect the catalog again to all master catalogs. The import connects only automatically to one master catalog (where the import was executed).

6. Vary the IBM 3494 Tape Library online. You must vary the library online again to all systems in the SMSplex. Enter the following command:

```
V SMS,LIB(libname),ONLINE
```

6.7.5 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 volume entries, specify the VOLUMEENTRIES parameter as shown in Figure 6-21 on page 294. This example lists all tape volume entries whose names begin with the letters VJ in the CASH02 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-----VJJH978
  DATA-VOLUME
    LIBRARY-----CASH02          LOCATION-----LIBRARY
    RECORDING-----EFMT2         MEDIATYPE-----MEDIA7
    STORAGE-GROUP----- (NULL)   USE-ATTRIBUTE-----PRIVATE
    CHECKPOINT-----Y           ERROR-STATUS-----NOERROR
    SHELF-LOCATION----- (NULL)
    OWNER----- (NULL)

    CREATION-DATE-----2008-02-27  ENT-EJ-DATE-----2004-01-01
    COMPACTION-----NONE          SPEC-ATTRIBUTE -----NONE
    EXPIRATION-----2008-05-05     LAST-MOUNTED-----2008-04-02
    WRITE-PROTECTED-----N        LAST-WRITTEN-----2008-04-02

```

Figure 6-21 LISTC command for library entry

6.7.6 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 need to use the AUDIT command to search for misplaced volumes without stopping auto mode.

The AUDIT command helps you 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 you perform an audit, you must correct the TCDB records, the inventory, or both.

The AUDIT function does not perform any corrective actions. Messages are issued, and the volume error status field in each tape volume record is updated. 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 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 that uses 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 suspected VOLSER on the MOUNTABLE TAPE VOLUME LIST panel as shown in Figure 6-22.

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	*SCRATCH*
	VOL101	SCRATCH	NO ERROR	NO	SHELF	*SCRATCH*
	VOL102	SCRATCH	PASSWORD CONFLICT	NO	LIB1	*SCRATCH*
	VOL103	SCRATCH	SECURITY CONFLICT	NO	LIB2	*SCRATCH*
	VOL104	PRIVATE	SCRATCH IN USE	---	LIB2	TAPE1
	VOL105	PRIVATE	VOLSER MISMATCH	NO	LIB1	TAPE1
	VOL106	SCRATCH	CHKPOINT CONFLICT	YES	LIB2	*SCRATCH*
	VOL107	SCRATCH	WRITE CONFLICT	YES	LIB1	*SCRATCH*
AUDIT	VOL108	PRIVATE	VOLUME MISPLACED	NO	LIB1	TAPE1
	VOL109	PRIVATE	NO ERROR	NO	LIB1	TAPE1
-----	-----	-----	BOTTOM OF DATA	----	----	-----

Figure 6-22 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. Only the external label is verified.

The following actions are performed when an audit is requested against volumes in a library:

1. The system verifies that the tape volume has an entry in the Library Manager.
2. The vision system verifies that the tape volume is in its assigned location in the library.

3. The vision system verifies that the external cartridge label of the tape volume is present and readable.
4. 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, all VOLSERS assigned to that library by the host are audited.

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. See Figure 6-23 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 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 6-23 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, consider workload and time factors.

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 need to run the inventory process.

6.7.7 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.

LIBRARYENTRIES can be changed as well to recover from catalog errors. The LIBRARYENTRY record entry is contained 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 for the library name
- ▶ **ALTER VOLUMEENTRY:** Alters all tape volume entry fields, except for 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 6-24 shows how to alter the LIBRARYNAME of the tape volume entry for VOLSER GRKB01.

```
//ALTEVOL JOB ...
//STEP1 EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=A
//SYSIN DD *
        ALTER VGRKB01 -
            VOLUMEENTRY -
            LIBRARYNAME(ATL01)
```

Figure 6-24 TCDB alter volume entry

Figure 6-25 on page 298 shows an example of how to create a volume entry.

```
//ALTEVOL JOB ...
//STEP01 EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//SYSIN DD *
  CREATE VOLUMEENTRY -
    (NAME(VUK0000) -
     LIBRARYNAME(LIIBMETB) -
     STORAGEGROUP(*SCRATCH*) -
     USEATTRIBUTE(SCRATCH) -
     MEDIATYPE(MEDIA5) -
     RECORDING(EFMT1) -
     COMPACTION(YES) -
     NOWRITEPROTECT -
     LOCATION(LIBRARY))
```

Figure 6-25 TCDB creating a volume entry example for a scratch volume

Refer to *z/OS DFSMS Access Method Services for Catalogs*, SC26-7394, for the syntax of the IDCAMS command.

6.8 Resynchronizing RMM CDS

You might need to use the TCDB and Library Manager entries to update the RMM database. You update the RMM database by using an EDGUTIL RMM utility.

You can use EDGUTIL with a VERIFY option to find out whether there are differences between the information sources. Or you can use it with the MEND option, which processes the same way as the VERIFY option but 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).

With the introduction of Release 2.10, there is an enhancement in that process. Before Release 2.10, only the TCDB was used (see Figure 6-26). Now, you can ask the Library Manager as an additional source (see Figure 6-27). 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 6-26 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 6-27 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 that are provided with the system-managed tape support.

6.9 Exploitation of new capabilities

Installing new hardware with new functionality or implementing system-managed tape for the first time are major changes to your actual production environment. To facilitate the migration process and avoid typical beginner problems, consider the following points of interest in education and readiness.

6.9.1 Education and learning phase

New hardware (the first 3494, VTS, PtP VTS, or TS7700) or new software (first system-managed tape solution, ETL Specialist, VMA reports, and so forth) impacts your data, production jobs, and the people who handle the new environment. Plan operator training sessions and hands-on training sessions for the 3494 and ETL Specialist. Offer SMS base knowledge, VTS/TS7700 knowledge, or even PtP VTS basics 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 to conduct education in an adequate time frame *prior to* the production date. Do not educate the staff 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 vary online or offline units, ejecting cartridges, and so forth), place the changed information together 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.

6.9.2 Achieving production readiness

As a result of 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. Consider these topics:

- ▶ 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 find new capabilities to establish the same level of quality (or even better) in a short time frame for your new environment.

Messaging alerting and automation procedures

Even if a 3494 and a VTS/TS7700 do not need much automation (normally a message also needs manual intervention), you must perform alarm and escalation planning. Decide whether and which messages you want to see on operator consoles, alarming boards, or pagers. Maybe 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 make trend analyses. For specific VMA reports, refer to “Volume mount analyzer (VMA) reporting for tape utilization” on page 482. Watch out for instruments and products that you already use and if the new technology supports them. 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 interval between microcode releases becomes 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 it improves and stabilizes your environment.

Disaster recovery considerations

Every change in your environment can affect your disaster recovery location site (if you have one) 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 3590E to 3590H drives. You might need additional hardware at your second location or trucks to bring cartridges from one place to the other place. If you have a contract with a provider for a disaster recovery location, talk to them during the decision process about the 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. You need to have the documentation (handling, explanations, short introduction, and so forth) ready at the start of your production period.

Software implementation: Other System z platforms

This chapter explains how to implement and run the IBM TotalStorage Tape Environment in System z server environments other than z/OS. It discusses software requirements, implementation, customization, and platform-specific considerations about operations and monitoring.

This chapter examines the following platforms:

- ▶ z/VM native support
- ▶ VSE/ESA™ 2.7 native support
- ▶ z/VSE 3.1 native support
- ▶ z/VSE as a guest under z/VM
- ▶ Linux on System z

7.1 General support information

Not all operating systems support all IBM Tape Libraries and Virtual Tape Server (VTS) solutions. Table 7-1 show a summary of supported tape solutions for non-z/OS environments.

Table 7-1 Supported tape solutions for non-z/OS platforms in System z environments

Platform/ Tape system	TS1130 tape drives	IBM 3494 Tape Library	IBM 3494 VTS	IBM 3494 PtP VTS	TS7700	3592-JA1 and TS1120
z/VM native	No	Yes	Yes	Yes ¹	Yes	Yes
z/VSE 4.2 native	Yes	Yes	Yes	No	Yes	Yes
z/VSE 3.1 native and z/VSE 4.1 native	No ²	Yes	Yes	No	Yes	Yes
z/VSE 3.1 or z/VSE 4.1 under z/VM	No	Yes	Yes	Yes ¹	Yes	Yes
Linux on System z native	Yes	No	No	No	No	Yes
Linux on System z under z/VM	No ²	No	No	No	No	Yes

1. With restrictions, see 7.1.1, "Other System z platforms and VTS support" on page 302.

2. Support will be available post GA of the TS1130.

7.1.1 Other System z platforms and VTS support

Even if z/VM and z/VSE can use the VTS or Point-to-Point (PtP) VTS, there are restrictions that you must consider.

Restrictions in all VTS environments

Neither z/VM nor z/VSE are able to provide SMS constructs to the Library Manager. Therefore, the functions provided by Advanced Policy Management (APM) for VTS or PtP VTS cannot be used in these platforms. However, there is a way to use dedicated physical pools in a VTS environment. During 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 it is the only solution to provide physical pooling for non-z/OS platforms. Refer also 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.

Restriction: APM functions are not supported by non-z/OS platforms.

In the following sections, we describe the implementations for these platforms.

Restrictions in a PtP VTS environment

As you can see from 7-1, PtP VTS is supported in a z/VM or in a z/VSE under z/VM environment. In both operating systems, there is no difference from the host point of view between a PtP VTS and a stand-alone VTS. Neither z/VM or z/VSE under z/VM knows about the Composite Library nor can monitor the total environment. Also, both systems are unable to handle unsolicited messages and actions, for example, requirements for intervention and hardware messages. To run a PtP VTS, you must have a z/OS system connected to the same PtP VTS that is connected to your z/VM or z/VSE under z/VM.

Remember that the PtP VTS is unsupported in native z/VSE environments.

Important: You must have a z/OS system connected to the same PtP VTS.

7.1.2 Linux on System z and tape libraries

Linux on System z does not provide any tape library support. All backup and restore activities must be provided by a different host system with either z/VM or z/OS.

7.2 Considerations for partitioning or sharing

If you want to use your library for different hosts or different platforms, you must introduce logical partitioning. Each host has its own cartridges or logical volumes and shared or dedicated tape drives but uses common components, such as the Library Manager and Accessor.

7.2.1 Basic information about partitioning

Each host needs a dedicated scratch volume category, which ensures that volumes are only used by a specific host and not by other hosts using the same library. Each time that a volume is used, the assigned category in the Library Manager database is set to PRIVATE, and with the “return to scratch” process from the tape management system, the volume will be assigned to the dedicated scratch category again.

Volume categories for z/VM

For z/VM, you can specify 16 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 or are assigned to a specific user Library Manager volume category are X'FFFF'.

The default scratch pool is defined in DFSMS/VM™ in DGTVCNTL DATA. If you do not specify a scratch category, z/VM uses X'0080'.

Defining Volume Categories in z/VSE

For z/VSE, you can specify 32 scratch volume categories: SCRTCH00 to SCRTCH31. They result in the Library Manager volume categories, X'00A0' to X'00BF', for example:

SCRTCH00 = X'00A0'

Private volumes that contain data or are assigned to a specific user Library Manager volume category are X'FFFF'.

The default scratch pool is defined in the Library Control Device Driver (LCDD) with an LCDD control statement or in Tape Library Support (TLS) in the define library procedure. If there is no scratch category specified, z/VSE uses scratch category X'00A0'.

7.2.2 Basic information about sharing in a z/VM environment

You share volumes in a DFSMS/VM environment by using an installation exit and a control file that lists the volumes that are accessible by a single system and by all systems.

Sharing drives with different z/VM hosts or guests

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.

7.2.3 Basic information about sharing volumes in a z/VSE environment

You can only share volumes in a z/VSE environment if the tape management system's volume catalog is shared among the attached hosts. You can only share volumes if you use a shared DASD environment and if the tape management system allows the usage of different hosts. IBM does not provide a tape management system product for z/VSE.

Considerations for drive sharing in a z/VSE under z/VM environment

When z/VSE is running as a guest system under z/VM, you can share tape drives and volumes using the DFSMS/VM Removable Media Services (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, which establishes assignment.

If you use the new Tape Library Support (TLS) for a z/VSE system running under z/VM, drive sharing is no longer possible. The TLS support is unable to provide the detachment and attachment functions for the drive.

Considerations for drive sharing in a native z/VSE environment

The TLS support in z/VSE does not allow drive sharing among multiple z/VSE systems running in native mode.

7.2.4 Sharing cross-platform hosts

Sharing means using a common set of volumes, and therefore, a common tape control database. Different System z operating systems are unable to share a common tape control database or tape management system. Therefore, there is no sharing between z/OS systems and other System z hosts.

7.3 z/VM native support

In this section, we briefly describe the support for the IBM 3494 in a z/VM native environment. We give you a basic introduction to the support provided for the library. We explain how to customize the DFSMS/VM Removable Media Services (RMS) service machine and introduce general considerations for using a 3494 with native VM.

In this section, we also provide information about third-party vendor tape management systems. We include test cases for verifying your installation and considerations for data migration. Additionally, we discuss information about drive allocation and how hardware errors are reported.

7.3.1 Software requirements for z/VM

Support is provided for z/VM 3.1.0, 4.4.0, and 5.1.0 with DFSMS/VM Function Level (FL) 221.

Support for IBM 3592 tape drives is provided with CP APAR VM63325 and DFSMS/VM APAR VM63353. Support of the IBM 3592 enhanced media support, including WORM media and the economy length cartridge, is provided with CP APAR VM63461 and DFSMS/VM APAR VM63460.

Support for the VTS is provided with z/VM Version 3 Release 1 or later. APAR VM62710 is required for native z/VM support with Fibre Channel Connection (FICON).

7.3.2 Basic functionality

DFSMS/VM FL221 is the only means for a z/VM system to communicate with an IBM 3494 Tape Library. DFSMS/VM FL221 is part of z/VM.

The RMS function of DFSMS/VM FL221 provides IBM 3494 Tape Library support in VM/ESA® 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 IBM 3494 Tape Library 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, using a volume inside the tape library requires the sequence of steps shown in Figure 7-1 on page 306.

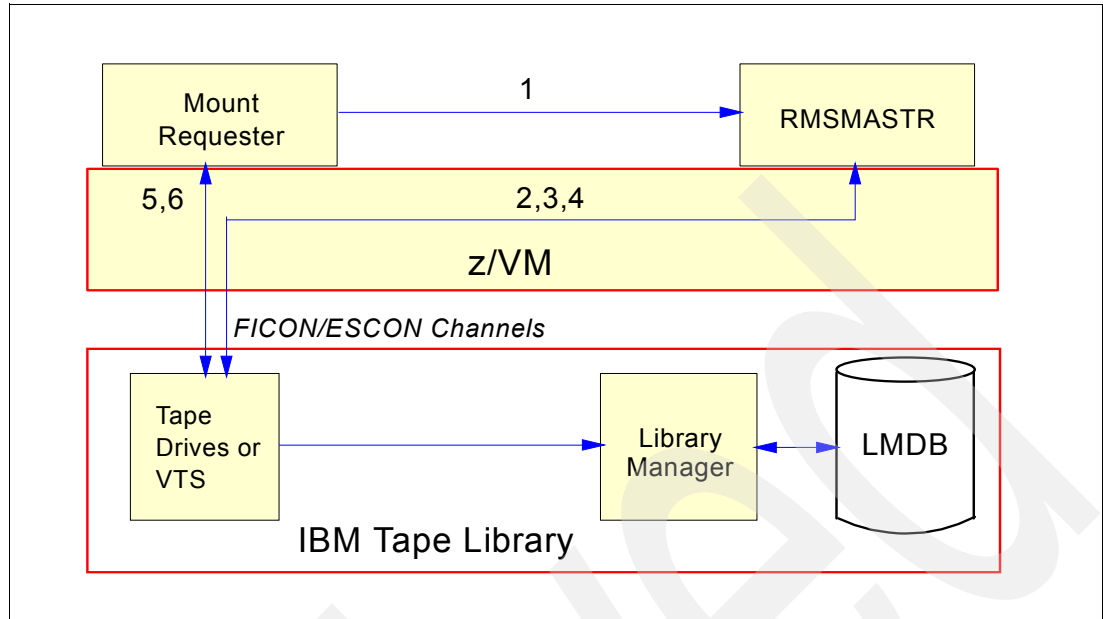


Figure 7-1 z/VM using DFSMS/VM

The process shown in Figure 7-1 (the numbers correspond to the numbers in Figure 7-1) 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 no device is 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 a 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 IBM 3494 Tape Library 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 (FSMRMxxx) 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-type functions by tailoring installation-wide exits.

7.3.3 Library Manager interface

The interface to the IBM 3494 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.

The available functions and RMS commands are:

- ▶ Assign volumes (either one volume or a list of volumes) to categories by using DFSMSRM SET VOLCAT.
- ▶ Assign a particular category of volumes to a tape drive by using 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. In an IBM 3494, 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 command (potentially, this inventory can be all volumes in a library).
- ▶ Assign a volume to a category.
- ▶ Perform security checking using a supplied exit.

For more information about RMS, see the *DFSMS/VM Function Level 221 Removable Media Services User's Guide and Reference*, SC35-0141.

7.3.4 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.

DFSMS/VM can use RMS bulk processing files to define the category in which to place volumes when they are entered into the IBM 3494 Tape Library. There is one bulk processing file for every IBM 3494 Tape Library known to the RMS machine.

You can use the files for either automatic-insert or on-request bulk processing. An *automatic-insert file name* is of the form RMBnnnnn DATA, where nnnnn is a number unique to the installed IBM 3494 Tape Library. The name is placed in the Shared File System VMSYS:DFSMS.CONTROL directory for access by RMSMASTR. An *on-request bulk processing file* can have any name and be in any directory accessible to RMSMASTR and the requesting user.

RMS does not keep a record of the volumes in the IBM 3494 Tape Library. RMS is provided as an interface to an IBM 3494 Tape Library and not for the management of volumes within a library. The Library Manager stores the information for the volumes in the IBM 3494 Tape Library. A tape management system provides management of volumes for VM/ESA users. It

keeps an inventory of volumes and their location (for example, the library name or off-site location where a volume is stored).

7.3.5 Customizing the DFSMS/VM RMS service machine

In this section, we provide the steps that are required to customize RMS to provide support for an IBM 3494 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 (see Figure 7-2). The user ID of RMSMASTR must be the same as the ID defined in DFSMS_MASTER_VM. See “DGTVCNTL DATA” on page 309.

```
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 OOC 2540 READER *
SPOOL OOD 2540 PUNCH A
SPOOL OOE 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 7-2 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
- ▶ RMBnnnnn DATA

These files are all in the shared file system VMSYS:DFSMS.CONTROL directory. The use of the RMBnnnnn DATA file is optional.

DGTVCNTL DATA

The DGTVCNTL DATA file is where you define:

- ▶ DFSMS RMS machine name
- ▶ IBM 3494 Tape 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 written to the RMS console
- ▶ Severity level of messages written to the RMS machine log file
- ▶ Whether library requests are queued in the Library Manager
- ▶ Whether write protection is enabled 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 provided is RMSMASTR.

```
DFSMS_MASTER_VM RMSMASTR
```

The RM_AUTO_LIBRARY parameter defines the name and sequence number (the five digits of the IBM 3494 Tape Library's serial number) of every IBM 3494 Tape Library that you use.

In the following example, the “friendly” name of the IBM 3494 Tape Library is MARVIN, the library sequence number is 12345, and messages relating to RMS processing will be sent to the user ID OPER:

```
RM_AUTO_LIBRARY MARVIN 12345 OPER
```

To find the library sequence number on the Library Manager, refer to 9.4.1, “Discovering the LIBRARY-ID given during the teach process” on page 402.

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, 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 use for the scratch category.

```
RM_DEFAULT_SCRATCH_POOL SCRATCH0
```

The RM_ACCOUNTING parameter, shown in the following example, is optional. It defines whether RMS provides accounting information. The default is that accounting is turned off (N).

```
RM_ACCOUNTING N
```

You can find 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 the messages to send 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. We recommend that you code 4 at least one time 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 write 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, you use XEDIT with the NOLOCK option in order to browse it. The message severity levels are the same as they are 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_QUEUEING` 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_QUEUEING 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 7-3 on page 311 shows an example of an RMCONFIG DATA file.


```

* +-----+
*  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 can not 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 7-3 Sample RMSCONFIG DATA file

RMBnnnnn DATA

DFSMS/VM can use RMS bulk processing files to define the category in which to place volumes when they are entered into the IBM 3494 Tape Library. There is one bulk processing file for every IBM 3494 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 RMBnnnnn 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 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 7-4 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 RMBnnnnn to the defined category. Volumes that are not defined in the RMBnnnnn DATA file are ignored, and insert processing can be completed on other hosts. In this example, we set cartridges with volume serial numbers (VOLSERs) in ranges 000001 through 000849 and VM0000 through VM0099 to the VOLUME SPECIFIC or private category. We also set cartridges with VOLSERs in the UN0000 to UN0099 range to the EJECT category, which enables you to stop cartridges from being entered into the IBM 3494 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 7-4 Sample RMBnnnnn DATA file

RMS does not keep a record of the volumes in the IBM 3494 Tape Library. RMS is provided as an interface to an IBM 3494 Tape Library and not for the management of volumes within a library. The Library Manager stores the information for the volumes in the IBM 3494 Tape Library. A tape management system provides management of volumes for VM/ESA 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

RMS functions can be protected by using RACF/VM. Simply set up RMS so that it uses the RACROUTE interface. You authorize users through the use of the STGADMIN or a user-defined group.

7.3.6 Considerations for using a 3494 Tape Library in a VM/ESA environment

Consider these points when you use the IBM 3494 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 an attached tape drive. 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 RMBnnnnn DATA. You might want to disable automatic insert processing on a particular VM/ESA system when you share your IBM 3494 Tape Library with multiple VM/ESA systems.

- ▶ It is impossible to create an SMSplex between a VM/ESA system and a z/OS system.
- ▶ RMS does not provide tape management functions. Several software vendor products provide VM tape management functions. However, it is possible to 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.

7.3.7 Tape management systems

Table 7-2 shows the third-party tape management systems (of which we are aware) that provide support for the IBM 3494 in the z/VM environment. Other products might exist, or new products might have been announced since the publication of this book.

Table 7-2 z/VM tape management software support

Product name	Vendor name	Web address 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, and VM:RESTORE	Computer Associates International, Inc.	http://www.ca.com

7.3.8 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:

- ▶ Insert
- ▶ Eject
- ▶ 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 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 instruction 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.

7.3.9 Testing procedures

Table 7-3 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 need to complete before the library is used for production work.

Table 7-3 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.	Check by using either a command or a batch job.
Check the tape management system vaulting procedures. They eject the 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 IBM 3494.	N/A
Allocate a multivolume dataset in the IBM 3494.	N/A
Allocate several datasets as multifile on one cartridge in the 3494.	N/A
Modify a previously written dataset.	N/A
Initialize a new cartridge (if using new media).	N/A
Re-initialize an already initialized cartridge (if the drive model changed).	N/A

7.3.10 Data migration considerations

In a z/VM environment, the tape management system controls tape allocation. Therefore, the details of a migration project differ, depending on which tape management system you installed. When migrating to a library, you must consider:

- ▶ 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?

7.3.11 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 model 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 must influence the selection of an appropriate tape drive.

Note: The operating system does not manage device allocation.

7.3.12 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.

7.3.13 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*, which you can find at this Web site:

<http://www-1.ibm.com/support/docview.wss?uid=ssg1S7000247>

SIMs and MIMs are reported as HCP6359I and HCP6357I messages and appear in the EREP reports.

7.3.14 Related documentation

Before you install an IBM 3494 Tape Library, we recommend that you refer to the following documents:

- ▶ *DFSMS/VM Function Level 221 Removable Media Services User's Guide and Reference*, SC35-0141

- ▶ *IBM TotalStorage Enterprise Tape System 3590 Introduction and Planning Guide*, GA32-0329
- ▶ *IBM TotalStorage 3592 Tape System Introduction and Planning Guide*, GA32-0464
- ▶ *IBM TotalStorage Enterprise Automated Tape Library (3494) Introduction and Planning Guide*, GA32-0448

7.4 VSE/ESA native support (VSE 2.7.x)

In this section, we briefly describe the support for the IBM 3494 in a native VSE/ESA environment using the library control device driver (LCDD) for VSE/ESA. We give you a basic introduction about providing library support.

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.

Restriction: VSE/ESA 2.7 does not support the 3592 drives or the PtP VTS.

For all information that is not release dependent, such as information about third-party vendor tape management systems, test cases, or data migration, refer to 7.5, “z/VSE native environments with Tape Library Support” on page 319.

7.4.1 Software requirements for VSE/ESA

We strongly recommend that you review the following Preventive Software Planning (PSP) Bucket: *Upgrade 3494DEVICE, Subset 3494VSE/ESA*.

You can find PSP Buckets using this Web site:

<https://techsupport.services.ibm.com/server/390.psp390>

Inside the PSP Bucket, you see all of the necessary APARs and PTFs to exploit the full functionality of the new environment. The PSP Bucket also lists the latest fixes.

7.4.2 Basic functionality

Unlike the IBM 3494 Tape Library support of VSE/ESA as a VM/ESA guest machine, VSE/ESA native support requires the LAN attachment feature of the IBM 3494 to communicate with the Library Manager. A token ring or Ethernet is used for the LAN. In this environment, the VSE/ESA host uses tape drives inside the tape library in the usual way through ESCON or parallel channels. The VSE/ESA program uses this channel path for normal tape device operations.

For library control, the LCDD for VSE/ESA is required. LCDD runs an application program in a VSE/ESA partition and communicates with the Library Manager by using VTAM APPC (LU6.2) through a LAN. The LBSERV macro application programming interface (API) is provided in VSE/ESA to communicate with the Library Manager through the LCDD. See Figure 7-5 on page 317 for an overview.

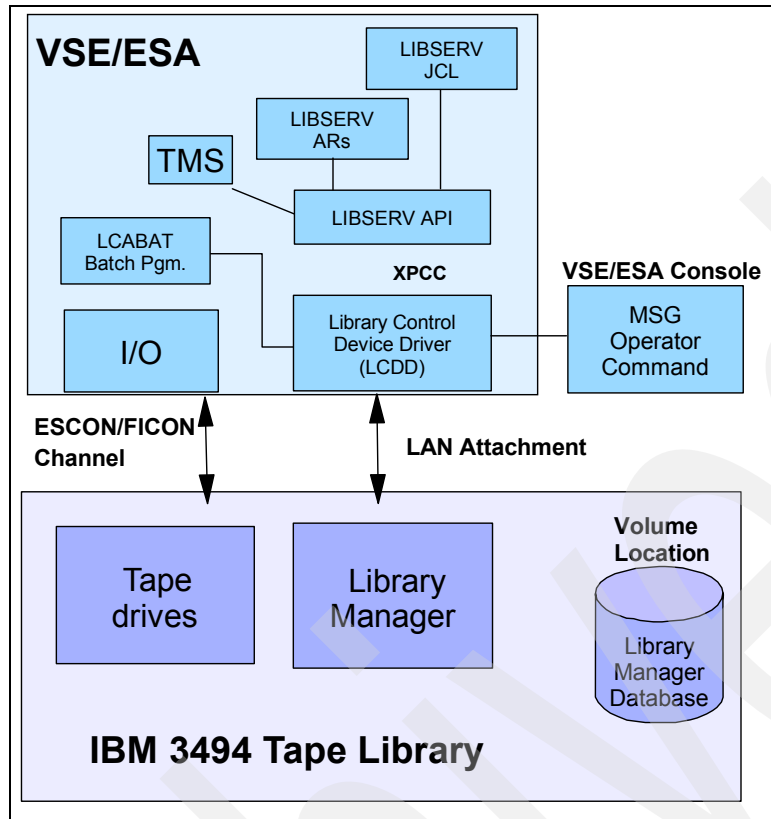


Figure 7-5 VSE/ESA and the library control device driver

There are five interfaces to the LCDD:

- ▶ LIBSERV attention routines (ARs)
- ▶ LIBSERV JCL statements
- ▶ LBSEVR application programming interface (API)
- ▶ MSG operator command
- ▶ Batch program LCABAT

The LCDD interfaces enable mounting cartridges, managing the inventory, and retrieving IBM 3494 information. For mount services, specific volume (private) mounts and 32 scratch pools (SCRCH00 to SCRCH31) are supported. Users can set a default scratch pool by specifying an LCDD control statement.

Automatic insert processing is optional and can be specified by an LCDD control statement with a target category. Users can also dynamically change the automatic insert processing through an MSG operator command. In addition, disposition of inserted volumes is handled by the tape management system product through the LBSEVR API or by LCABAT batch jobs that specify a list of volumes.

You can handle ejecting or changing the category of cartridges on an individual volume basis or by specifying the file name of a list of volumes to process.

Query functions return status information about IBM 3494 tape units, cartridges, and the IBM 3494 Library Manager. Library member files of a VSE/ESA Librarian facility are created when inventory lists are requested. The library member files can be used, in turn, as volume lists for other processing requests. An inventory list for the entire IBM 3494 serves as a point-in-time host backup of the IBM 3494 status of tape processing. This list is potentially useful for

recovery purposes, because VSE/ESA does not have a permanent tape inventory dataset like DFSMS/MVS and BTLS systems have.

When jobs running on VSE/ESA use the 3494, typically the tape management system product gets control at dataset OPEN time and requests the tape mount through the LBSERV API.

A tape management system might help this operation, but IBM does not provide a tape management system for VSE/ESA. Ask the software vendors, who offer tape management systems, which systems support VSE/ESA products.

Note: With VSE/ESA 2.7 and APAR DY45905, an LCDD enhancement is provided. It introduces the support and the usage of more than one subsystem with non-unique subsystem serial numbers.

7.4.3 Library Manager interface

Communication between the host and the Library Manager is through a different physical path (LAN) from the path used for the data (ESCON or parallel channel). The LBSERV API handles interaction between the user application and the LCDD. Commands can be sent to the LCDD through the VSE/ESA operator command, MSG.

A batch interface that uses the LCABAT batch program is provided.

LIBSERV ARs provide an additional interactive interface for library control. LIBSERV JCL statements allow library control functions in job steps.

7.4.4 Control datasets

The VSE/ESA librarian facility is used. Volume lists for the complete IBM 3494 inventory or specified categories can be maintained in VSE/ESA librarian files. The volume lists are created only by user request. However, they are not updated automatically by the LCDD.

The tape units and library names are held in the LCDD initialization deck.

7.4.5 Considerations

Consider these points when you use the LCDD for VSE/ESA:

- ▶ LCDD for VSE/ESA is included in the VSE base code. One of the LAN adapter features is required for the IBM 3494. The choice is Ethernet (FC5220) or token ring (FC5219).
- ▶ LCDD requires the following network hardware (or equivalent) and software to attach a native VSE/ESA system to a 3494:
 - ACF/VTAM
 - IBM 3174 establishment controller
 - IBM 3745, 3720, or 3725 communication controller
 - IBM 9221 with a token-ring communications subsystem
- ▶ Volumes can be mounted in any of the scratch categories.
- ▶ All of the volumes in a library are potentially accessible by VSE/ESA. In a shared environment, the tape management system on the VSE system must provide protection to prevent erroneous access of another system's volumes.
- ▶ IBM does not provide a tape management system for VSE/ESA.

- ▶ Any other vendor's tape management system must be able to use the LBSERV API of the LCDD.
- ▶ Do not use the batch program interface, LCABAT, to mount a volume.

7.5 z/VSE native environments with Tape Library Support

z/VSE supports the IBM 3494 natively through its Tape Library Support (TLS). The LCDD support is still available; however, new functionality, such as the 3592 drive support, is only implemented in TLS.

7.5.1 Software requirements for z/VSE

We strongly recommend that you review the following Preventive Software Planning (PSP) Bucket: Upgrade 3494DEVICE, Subset 3584VSE/ESA.

You can find PSP Buckets at this Web site:

<https://techsupport.services.ibm.com/server/390.psp390>

Inside the PSP Bucket are all of the necessary APARs and PTFs to exploit the full functionality of the new environment. The PSP Bucket lists the latest fixes also.

Native z/VSE 3.1 and later releases support the attachment of 3592 tape drives. Also, a stand-alone VTS environment is supported, but there is no support for PtP VTS.

z/VSE provides support for PtP VTS only as a guest under VM.

7.5.2 Basic functionality

TLS allows support for the tape library through the /390 channel command interface commands; therefore, you no longer need the cross-partition communication capability (XPCC)/APPC communication protocol that was required with the old interface. The external interfaces (LBSERV JCL and LBSERV 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 LIB59 to tailor and submit.

Define tape libraries

You must define your tape library or libraries. Use a batch job as shown in Example 7-1.

Example 7-1 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 the macro interface. Example 7-2 shows a sample job using LIBSERV to mount volume 123456 for write on device address 480 and, in a second step, to release the drive again.

Example 7-2 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	LIBSERV 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.

7.5.3 Migration from LCDD to TLS

Because all macros and commands remain unchanged, the migration is extremely 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, so far the migrations that we have performed were without problems.

After the migration, you can eliminate the no longer necessary XPPC/APPC statement in a second step.

7.5.4 Tape management systems

Table 7-4 shows the third-party tape management systems (of which we are aware) that provide support for the IBM 3494 in the VSE environment. Other products might exist, or new products might have been announced since the publication of this book.

Table 7-4 VSE/ESA native and tape management software support

Product name	Vendor name	Web address for more information
BIM-EPIC	CSI International	http://bimoyle.com/
BVS VSE/ESA	Pfeilschifter GmbH (Germany)	http://www.pfeilschifter-gmbh.de/english/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

7.5.5 Cartridge processing

In the following sections, we describe the interaction among VSE/ESA, the tape management system that you installed, and the actions regarding cartridges:

- ▶ Insert
- ▶ Eject
- ▶ Return to scratch

Cartridge insert processing

If you work in a native VSE/ESA environment, it is the responsibility of the tape management system to complete insert processing after new cartridges are 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, which is 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 instruction 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.

7.5.6 Testing procedures

7-5 lists the testing tasks to prove that the tape management system and the library communicate 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 you detailed information about how to perform these tests. Also, use these tests to develop operational procedures that you need to complete before the library is used for production work.

Table 7-5 VSE/ESA 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.	Check by using either a command or a batch job.
Check the tape management system vaulting procedures. They need to eject the 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 IBM 3494.	N/A
Allocate a multivolume dataset in the IBM 3494.	N/A
Allocate several datasets as multifile on one cartridge in the 3494.	N/A
Modify a previously written dataset.	N/A
Initialize a new cartridge (if using new media).	N/A
Re-initialize an already initialized cartridge (if the drive model changed).	N/A

7.5.7 Data migration considerations

In a VSE/ESA 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, consider:

- ▶ 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?

7.5.8 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 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). Application software maintains the relationships between pieces of media and the subset of drives on which they can be mounted. In turn, the software must influence the selection of an appropriate tape drive.

Use of the generic device type, in the ASSGN JCL statement, eliminates distinction between an emulated and actual 3490E and a 3590. If 3590 Model H, Model E, and Model B are added in 3490E emulation mode, the ASSGN JCL statements specify that the 3490 H or E cannot work properly. The same applies if either Model H, Model E, or Model B is added when actual 3490E drives are present. If Model H, Model E, and Model B are added in 3590 mode, then ASSGN JCL statements specify that the 3590 cannot work properly.

The same considerations are true for 3592 tape drives defined in HCD as model 3590.

7.5.9 Media capacity exploitation

Typically, applications use the physical end-of-volume to determine that a tape is full. Applications fully use the capacity of media, regardless of emulation mode or track density.

7.5.10 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 download from this Web site:

<http://www-1.ibm.com/support/docview.wss?uid=ssg1S7000247>

SIMs and MIMs are presented in VSE/ESA through OP64I, OP65I, and OP20 messages, as well as EREP reports.

7.5.11 Related documentation

Refer to the IBM VSE/ESA home pages on the Internet for general information:

<http://www-1.ibm.com/servers/eserver/zseries/os/vse/>

Refer also to:

- ▶ *IBM TotalStorage Enterprise Tape System 3590 Introduction and Planning Guide*, GA32-0329
- ▶ *IBM TotalStorage 3592 Tape System Introduction and Planning Guide*, GA32-0464
- ▶ *IBM TotalStorage Enterprise Automated Tape Library (3494) Introduction and Planning Guide*, GA32-0448

7.6 General information about VSE/ESA or z/VSE under z/VM

You can implement tape library support for VSE under z/VM in different ways. Also, the choice of tape management has an impact on the implementation. Therefore, we describe several options.

Table 7-6 shows an overview of which interfaces are needed for different releases and which restrictions you must consider.

Table 7-6 Supported solutions for VSE/ESA or z/VSE under z/VM

Platform	Needed software interfaces	Restriction
VSE/ESA 2.7	VSE Guest Server (VGS) and RMSMASTR	None
z/VSE 3.1	VGS and RMSMASTR	None
z/VSE 3.1	TLS	Devices must be defined static to the VSE and cannot be shared with other hosts. ^a
z/VSE or VSE/ESA with Dynam/T	None ^b	None

a. See section 7.5, “z/VSE native environments with Tape Library Support” on page 319.

b. See section 7.6.4, “VSE/ESA and z/VSE under z/VM using Dynam/T” on page 324.

7.6.1 Software requirements for z/VSE and z/VM

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 all of these products:

- ▶ z/VSE V3.1
- ▶ DFSMS/VM Function Level 221 with PTFs
- ▶ EREP Version 3.5 with PTFs

We strongly recommend that you review the following Preventive Software Planning (PSP) Buckets. See 7.3.1, “Software requirements for z/VM” on page 305 and 7.5.1, “Software requirements for z/VSE” on page 319.

7.6.2 Tape management systems for all implementations

Table 7-7 shows the third-party tape management systems (of which we are aware) that provide support for the IBM 3494 in the VSE environment under VM. Other products might exist or new products might have been announced since the publication of this book.

Table 7-7 z/VSE tape management software support

Product name	Vendor name	Web address for more information
BIM-EPIC	CSI International	http://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

7.6.3 z/VSE under z/VM using TLS

With z/VSE 3.1, 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.

7.6.4 VSE/ESA and z/VSE under z/VM using Dynam/T

Dynam/T uses its own interface, instead of VGS or TLS. Therefore, it uses none of these interfaces. Figure 7-6 on page 325 show the information flow with Dynam/T.

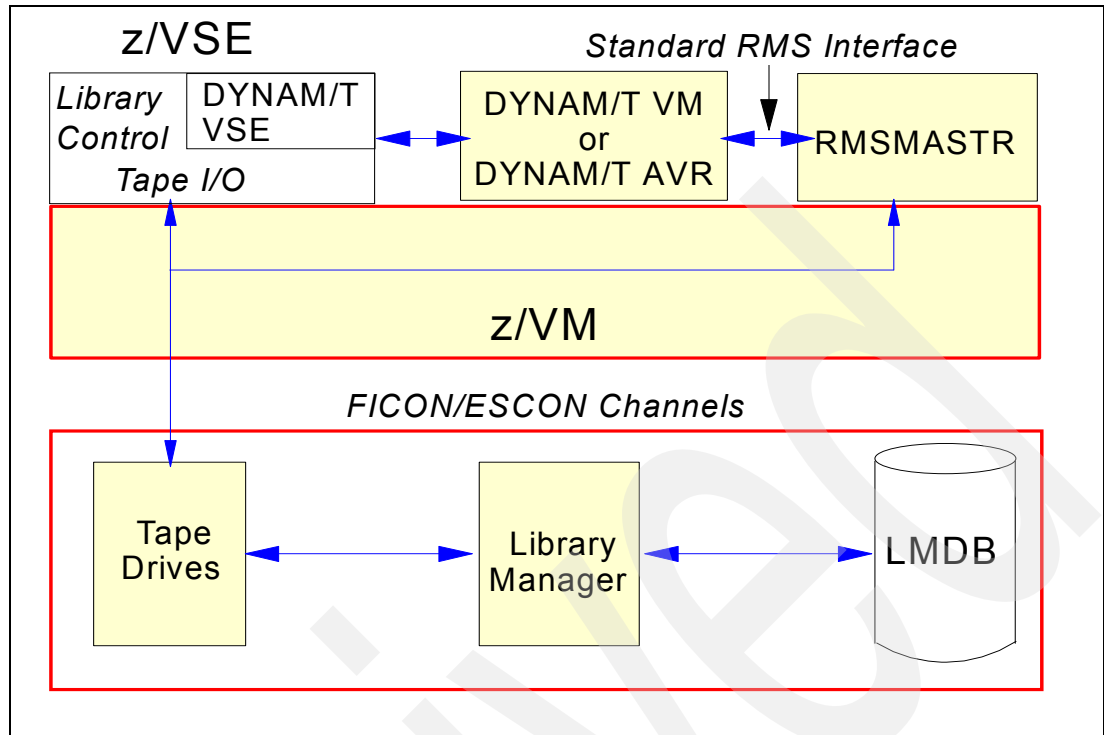


Figure 7-6 z/VSE and z/VM using Dynam/T

7.7 VSE/ESA as a VM/ESA guest using VGS

In this section, we describe VSE/ESA support of the IBM 3494 Tape Library when VSE/ESA or z/VSE runs as a guest of z/VM. We introduce 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 7.5.6, “Testing procedures” on page 321 and 7.5.7, “Data migration considerations” on page 322 in the z/VSE native section.

For information about the needed software support, refer to Chapter 4, “Software implementation in z/OS” on page 157.

7.7.1 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 to communicate with RMSMASTR. Certain vendor tape management support scenarios do not use the VGS but communicate directly with RMSMASTR through CSL calls.

z/VSE communicates with the VGS through an API provided by the LBSERV macro of VSE/ESA. The library control API uses VSE’s 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 operation 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 VSE/ESA guest machine. There is no direct interface from the VGS to the IBM 3494 Tape Library and the tape drive inside the library.

Figure 7-7 shows the z/VSE guest support for the IBM 3494 Tape Library. Although we show only a single z/VSE guest machine here, multiple z/VSE guests can share one VGS machine.

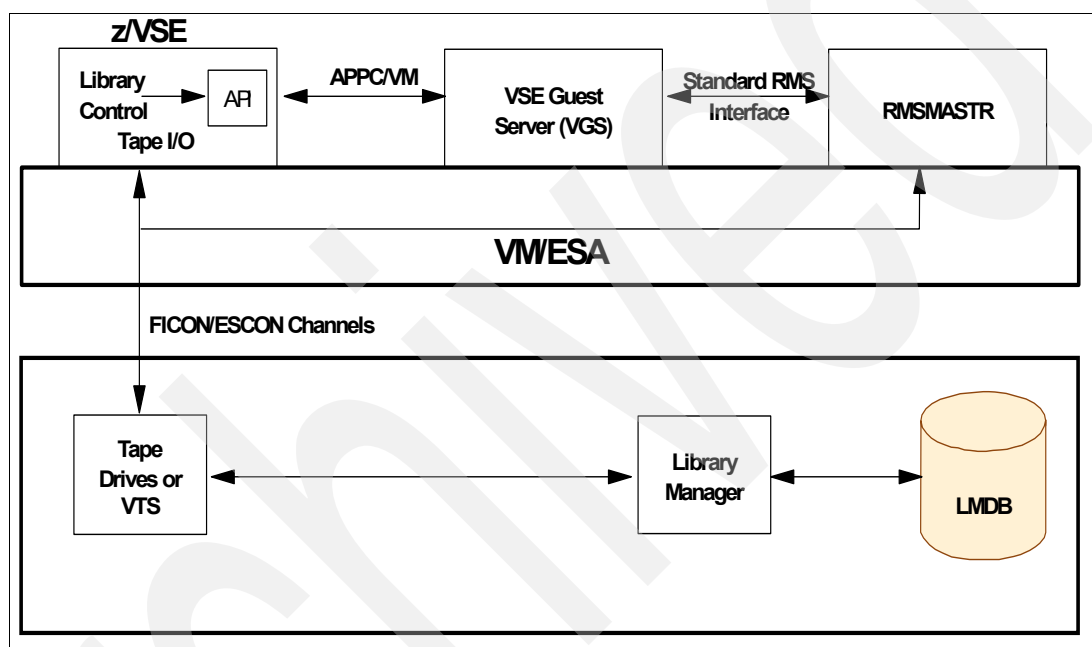


Figure 7-7 z/VSE as a z/VM guest using the VSE Guest Server

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 VSE/ESA partition. Figure 7-8 on page 327 shows the flow of an inventory request as follows (the numbers correspond to the numbers in Figure 7-8 on page 327):

1. The inventory request is sent using 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 that the librarian server on VSE/ESA read a librarian-managed file in the VSE/ESA librarian files and 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 and result for changing volume category) to the inventory support server.

7. The inventory support server sends the result to the librarian server on VSE/ESA, 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.

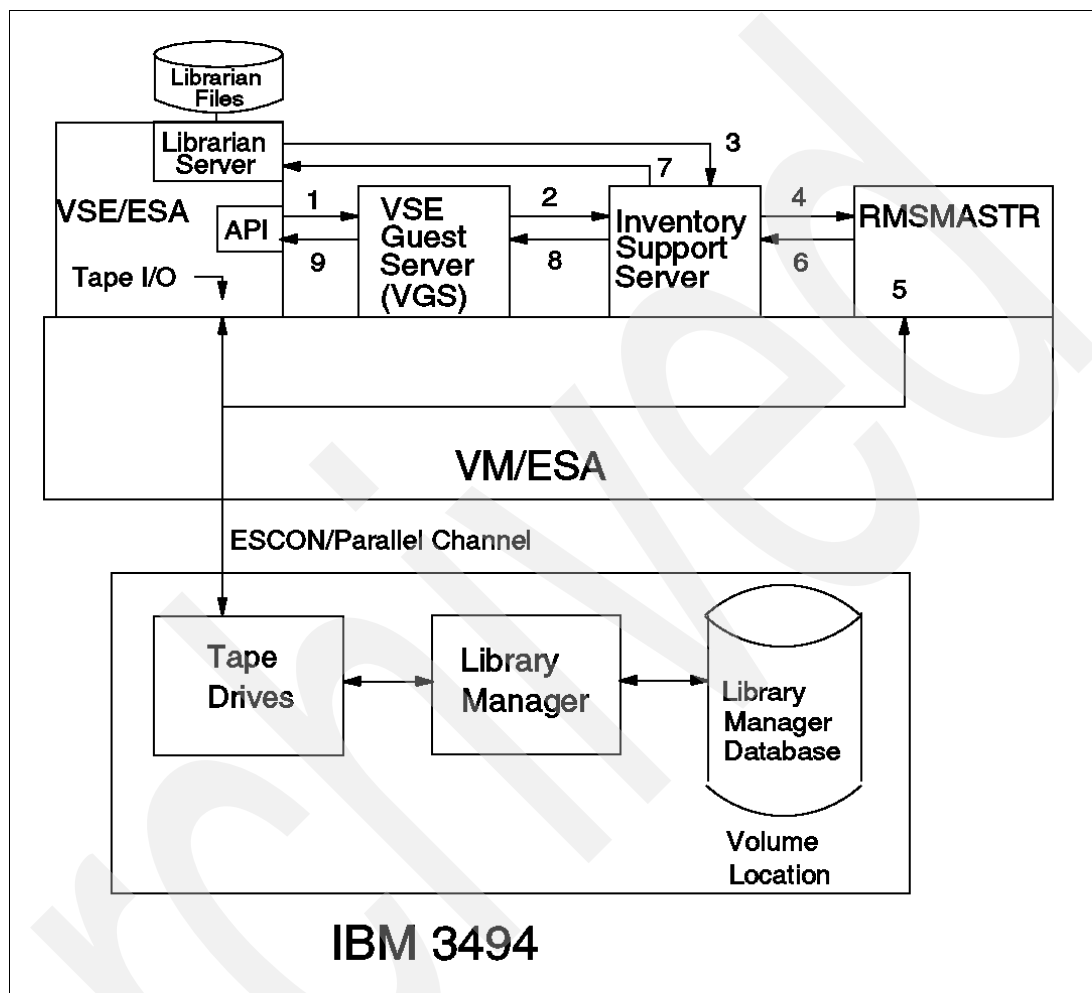


Figure 7-8 VSE Guest Server: Flow of an inventory request

7.7.2 Library Manager interface

You use the VSE/ESA LBSERV macro to access volumes in an IBM 3494 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 IBM 3494 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. The VGS, in turn, passes them on to the IBM 3494 Tape Library 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 IBM 3494 Tape 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 the above query and managing inventory requests.

An interface for explicit demount is intentionally not provided. The IBM 3494 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 VSE/ESA.

7.7.3 Control datasets

The VGS keeps a file (on a CMS minidisk) of in-process and completed work. The VGS keeps a file, LIBCONFIG LIST, that contains the VSE/ESA library names and the corresponding DFSMS/VM library names. This file is optional when you only install one IBM 3494 Tape Library.

The inventory support server (as a secondary VGS) uses a LIBRCMS SRV NAMES file in its 191 minidisks to handle library control for multiple VSE/ESA guests.

The librarian server on VSE/ESA uses the VSE/ESA librarian files for inventory processing, such as query and manage.

As with the VM/ESA native environment (see 7.4, “VSE/ESA native support (VSE 2.7.x)” on page 316), the tape management system is responsible for keeping an inventory of volumes in the IBM 3494 Tape Library belonging to VSE/ESA.

Note: The VGS customization exit, FSMRMVGC, is highly important and just as critical to the system as these control datasets.

7.7.4 Considerations

Consider these points when you introduce z/VSE as a guest under VM:

- ▶ Multiple VSE/ESA guests can share one VGS machine.
- ▶ A VGS machine can manage more than one IBM 3494 Tape Library.
- ▶ VSE/ESA guests have access to the same set of scratch pools that RMS uses.
- ▶ VSE/ESA 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, there is no IBM-provided mechanism to check whether new volumes are inserted.

- ▶ IBM-supplied tape management system products are not available for VSE/ESA.
- ▶ z/VSE with the LCDD can run as a guest of VM/ESA. DFSMS/VM is not required in this environment.

Archived

Archived

Software implementation: Open Systems environments

This chapter discusses the implementation of the IBM 3590 and IBM 3592 tape drives, as well as the implementation of the IBM 3494 Tape Library.

This chapter describes the installation requirements and implementation considerations for the following environments:

- ▶ IBM System i and iSeries servers
- ▶ IBM System p and pSeries servers running AIX
- ▶ Sun Servers running Solaris
- ▶ Hewlett-Packard servers running HP-UX
- ▶ Intel servers running Microsoft Windows NT, Windows 2000 Server, and Windows Server 2003
- ▶ Linux servers

This chapter also discusses specific considerations for implementing and using IBM Tivoli Storage Manager (TSM) with the IBM 3494 Tape Library.

8.1 Operating system and ISV support

Prior to the installation, we recommend that you check for the most recent tape support information regarding the Open Systems environment that you plan to implement, as well as for any independent software vendor (ISV) applications that you plan to implement. Check the following Web sites for support information:

- ▶ IBM 3494 Tape Library
<http://www.storage.ibm.com/tape/conntrix/pdf/isv3494112.pdf>
- ▶ IBM 3590 tape drive and controller:
 - Operating system support
<http://www.storage.ibm.com/tape/drives/3590/3590opn.pdf>
 - Host bus adapter (HBA) support
<http://knowledge.storage.ibm.com/HBA/HBASearchTool>
 - Independent Software Vendor (ISV) applications support
http://www.storage.ibm.com/tape/conntrix/pdf/3590_isv_matrix.pdf
- ▶ IBM 3592 Tape Drive and Controller:
 - Operating system support
<http://www.storage.ibm.com/tape/drives/3592/3592opn.pdf>
 - HBA support
<http://knowledge.storage.ibm.com/HBA/HBASearchTool>
 - ISV support
http://www.storage.ibm.com/tape/conntrix/pdf/3592_isv_matrix.pdf

IBM tape products are supported in general with IBM (OEM Brocade), Cisco, Inrange/CNT, and McData switches. For detailed information, check the support matrix at:

<http://www-1.ibm.com/servers/storage/support/san/index.html>

8.2 General installation information

Installing an IBM 3494 Tape Library or either the 3590 or 3592 tape drives requires the appropriate host adapters and device drivers. The IBM 3590 Tape Drive provides Ultra SCSI and Fibre Channel (FC) attachment for Open Systems hosts. The IBM 3592 Tape Drive provides FC attachment only. The IBM 3494 Tape Library provides LAN or serial connection.

In this chapter, we discuss how to install the necessary device drivers for the IBM tape drives, as well as for the IBM 3494 Tape Library. For additional detailed information for the device drivers' installation, you can refer to the publication *IBM TotalStorage Tape Device Drivers Installation and User's Guide*, GC35-0154, which you can download from:

ftp://ftp.software.ibm.com/storage/devdrv/Doc/IBM_TotalStorage_tape_IUG.pdf

For the latest levels of device and library drivers, refer to:

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

There are differences in the installation of an IBM 3590 compared to an IBM 3592 tape drive; still, there is one device driver that supports both tape drives. However, you must install two different drivers when using these tape drives and the IBM 3494 Tape Library.

In the IBM 3494 Tape Library, the communication between the tape drives and the attached servers goes over SCSI or FC (the IBM 3592 only supports FC). On the other side, the communication between the servers and the library goes over LAN (Ethernet or token-ring) or over serial connections (RS-232) (refer to Figure 8-1). The current state of the art is using FC connections to attach the tape drives and the servers while using LAN (Ethernet) connections between the servers and the library (as illustrated in Figure 8-1).

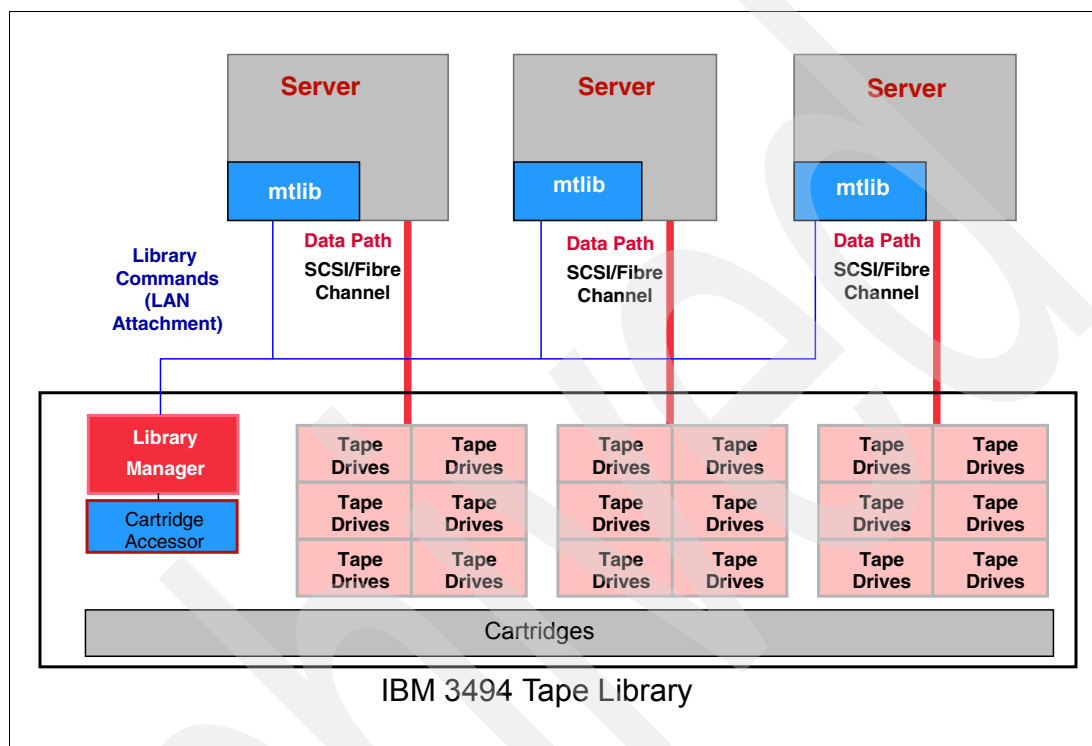


Figure 8-1 IBM 3494 Enterprise Tape Library connections

For detailed discussion when installing the IBM 3494 in a SAN environment, as well as additional detailed considerations about FC host bus adapter (HBA) installation, refer to the following books:

- ▶ *Implementing IBM Tape in Linux and Windows*, SG24-6268
- ▶ *Implementing IBM Tape with UNIX Systems*, SG24-6502

The device drivers allow the operating system and the application software to manage the tape devices and the library medium changers. The tape devices and medium changers are managed using a special device file name used to address each tape operation (mount, demount, write, and read).

This special device file name is specific for each Open Systems platform. Table 8-1 on page 344 shows the most commonly used names for AIX, Sun Solaris, and HP-UX.

Example 8-1 Special device file names used with UNIX operating systems

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

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

b. A *b* stands for Berkeley Software Distribution (BSD) compatibility. The BSD device special file modifies close behavior for non-rewind devices. If the device is opened for no rewind on close, in non-BSD mode, and if the last command before closing the device was a read, the tape is positioned after the file mark immediately following the last block read. If the device is opened for no rewind on close, in BSD mode, and if the last command before closing the device was a read, the tape is left positioned exactly where it was following the last block read. If the device is opened for rewind on close, the BSD mode is irrelevant.

c. A *c* stands for Compression: the compression device special file determines whether the tape device will use built-in hardware compression while storing data on the tape.

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

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

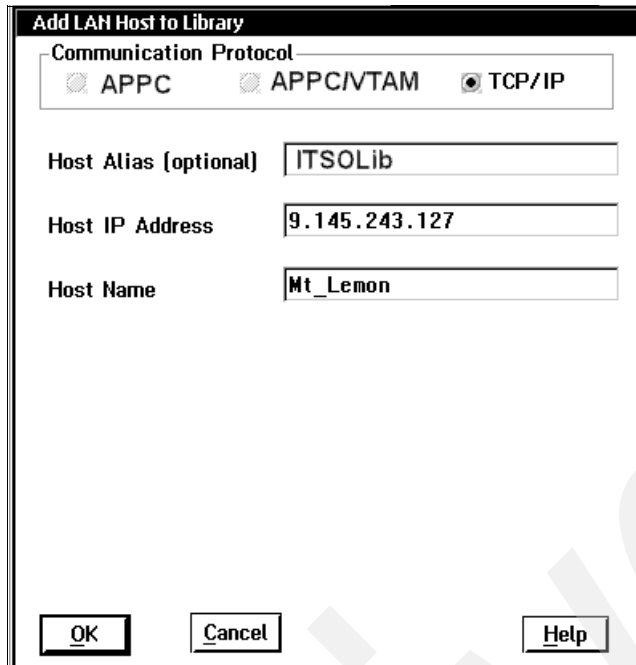
In the following sections, we give detailed examples of installing the drivers in AIX, SUN Solaris, and HP-UX environments.

8.3 IBM 3494 Tape Library preparation

Before installing the drivers, you need to configure the servers to properly communicate with the tape library.

The steps are:

1. For security reasons, the IBM 3494 Tape Library can only communicate with the configured servers, which you configure on the 3494 Library Manager Operator panel. Go to **Commands** → **LAN Options** → **Add LAN Host**. Type the Host IP Address and the Host Name (see Figure 8-2 on page 335) of the server that you want to configure so that it can send commands to the Library Manager. The Host Alias is optional, but we recommend the use of the host alias, which is also used later on the library device driver. Click **OK**.



Add LAN Host to Library

Communication Protocol
☐ APPC ☐ APPC/VTAM ☒ TCP/IP

Host Alias (optional) ITSOLib

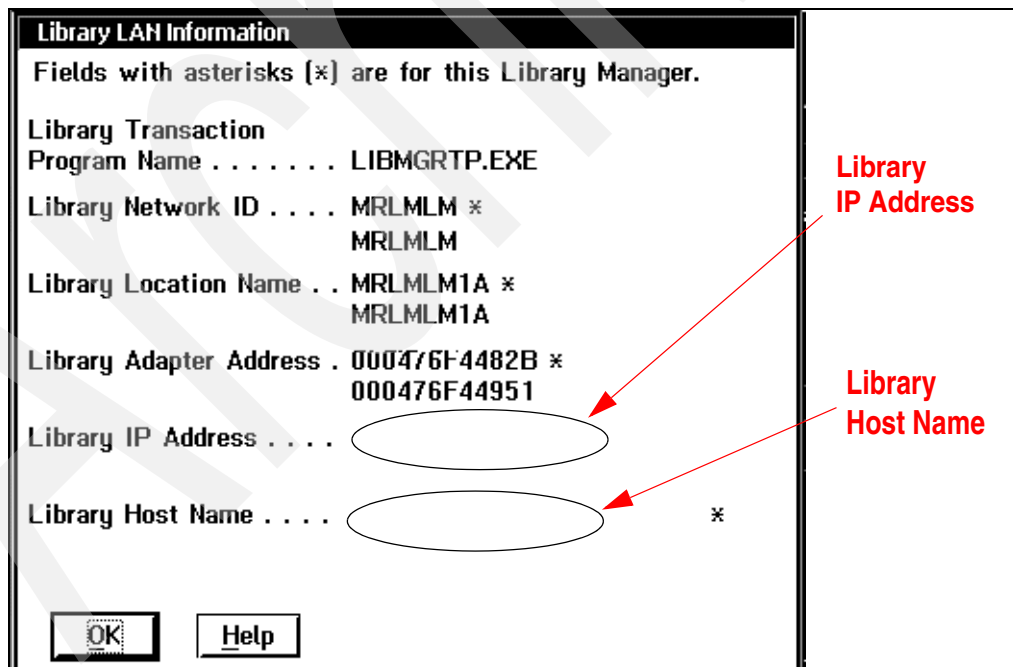
Host IP Address 9.145.243.127

Host Name Mt_Lemon

OK Cancel Help

Figure 8-2 Add LAN host

- Next, you also need to provide the library LAN information (IP address of the library). Go to **Commands** → **LAN Options** → **LM LAN** information and type the Library IP Address (see Figure 8-3), which you will need later. Click **OK**.



Library LAN Information

Fields with asterisks (*) are for this Library Manager.

Library Transaction
Program Name LIBMGRTPEX

Library Network ID MRLMLM *
MRLMLM

Library Location Name . . MRLMLM1A *
MRLMLM1A

Library Adapter Address . 000476F4482B *
000476F44951

Library IP Address

Library Host Name *

OK Help

Library IP Address

Library Host Name

Figure 8-3 Library LAN Information

After physically installing and connecting the tape drives, the library (FC cables, LAN connections, and so forth), and the servers, the next step is the installation of the device drivers.

The following sections provide examples of how to install the drivers for the AIX, SUN Solaris, and HP-UX environments.

8.4 AIX

In this section, we discuss how to install the drivers when you work with AIX servers. The first step is to download the latest tape device driver (called *Atape*) and the latest library device driver (*Automated Tape Library Device Driver (atlld)*) from the FTP server:

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

8.4.1 Tape device driver installation

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

The steps are:

1. Use **ls1pp** to determine if the *Atape.driver* is installed and to determine the version as shown in Example 8-2.

Example 8-2 Checking if Atape.driver is installed on AIX

```
# lspp -l Atape.driver
```

Fileset	Level	State	Description

Path: /usr/lib/objrepos Atape.driver	6.1.8.0	COMMITTED	IBM AIX Enhanced Tape and Medium Changer Device Driver

2. If you have downloaded the driver to your local system, use this command:

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

For other methods of installing, refer to *IBM TotalStorage Tape Device Drivers Installation and User's Guide*, GC35-0154.

3. Assuming that you have downloaded the file `Atape.8.1.9.0` to the directory `/home/itso/`, use this command string:

```
installp -acXd /home/itso/Atape.8.1.9.0 Atape.driver
```

This command installs and commits the Atape driver in your system. Example 8-3 is an example of the **installp** command output.

Example 8-3 AIX Atape installation output

```
# installp -acXd /tmp/Atape.8.4.1.0.bin Atape.driver
+-----+
Pre-installation Verification...
+-----+
Verifying selections...done
Verifying requisites...done
Results...

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

Selected Filesets
```

```

-----
Atape.driver 8.4.1.0                                # IBM AIX Enhanced Tape and Me...

<< End of Success Section >>

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

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

installp: APPLYING software for:
        Atape.driver 8.4.1.0

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

IBM AIX Enhanced Tape and Medium Changer Device Driver

(C) COPYRIGHT International Business Machines Corp. 1993 1997
All Rights Reserved
Licensed Materials - Property of IBM

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

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

Checking for existing Atape devices...
Installing AIX Version 5.2 Atape.driver...
Adding device prototype...
Adding odm and smit entries...
Adding catalogs...
Adding trace template...
Adding error template...
5 entries added.
0 entries deleted.
0 entries updated.
Adding utility programs...
Finished processing all filesets. (Total time: 11 secs).

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

bosboot: Boot image is 18316 512 byte blocks.
0503-292 This update will not fully take effect until after a
        system reboot.

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

```

```
installp: bosboot process completed.
```

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

Configuring the tape devices

After the driver software is installed and the tape drives are connected to the server, you can configure the device and make it available for use. You cannot access the devices until this step is complete.

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

- ▶ Enter the following command without parameters:

```
cfgmgr
```

This command configures all devices automatically (including any new tape or media changer device).
- ▶ Power off your system and reboot to configure all devices automatically during the startup, and make available any new tape or medium changer in the system.

Verifying the Atape driver installation

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

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

Figure 8-4 on page 339 (for the `lsattr` command) and Example 8-4 on page 339 (for the `lscfg` command) illustrate the various outputs from these commands.

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

Figure 8-4 Details of 3592-E drive

Figure 8-4 shows that *scsi_id* is the port ID of the SAN switch, because this tape drive is a FC-attached tape drive. Also, *ww_name* shows the worldwide name (WWN) of the FC tape drive.

Example 8-4 The *lscfg* command output of the 3592 drive

```

lscfg -vl rmt3
rmt3          P1-I1/Q1-W5005076300410811-L0  IBM 3592 Tape Drive (FCP)

Manufacturer.....IBM
Machine Type and Model.....03592E05
Serial Number.....000001300280
Device Specific.(FW).....04B8
Loadable Microcode Level....A1700D5C

```

Example 8-4 (*lscfg*) shows:

- ▶ The serial number and firmware level of the drive
- ▶ The number 3592E05 under Machine Type and Model indicates that this is a 3592 drive.

Configuring the IBM tape device parameters

You can change the default operating parameters for the tape drive and device drivers using System Management Interface Tool (SMIT).

From the SMIT menu, select **Devices** → **Tape Drive** → **Change/Show Characteristics of a Tape Drive**. Select the **device(rmtx)** that you want to change from the list, which displays output similar to Example 8-5.

Example 8-5 SMIT characteristics of a 3592 tape drive

Change / Show Characteristics of a Tape Drive		
Type or select values in entry fields. Press Enter AFTER making all desired changes.		
	[Entry Fields]	
Tape Drive	rmt3	
Tape Drive type	3592	
Tape Drive interface	fc	
Description	IBM 3592 Tape Drive (>	
Status	Available	
Location	20-58-01-PRI	
Parent adapter	fscsi0	
Connection address	2	
SCSI ID	0x10db1	
Logical Unit ID	0x0	
World Wide Name	0x5005076300410811	
New Logical Name	[]	
Enable Alternate Pathing Support	yes	+
Block Size (0=Variable Length)	[0]	+#
Use DEVICE BUFFERS during writes	yes	+
Use Hardware Compression on Tape	yes	+
Activate volume information logging	no	+
Maximum size of log file (in # of entries)	[500]	+#
Backward Space/Forward Space Record Mode	SCSI	+
Use Immediate Bit in Rewind Commands	no	+
Trailer Label Processing	no	+

Change any updateable device options required and press Enter. Check for the output message `rmtx Changed`. The default for hardware compression on the tape is yes for every Linear Tape-Open (LTO) Ultrium and 3592 device, which is the normal recommended setting for performance reasons (however, this setting might vary with particular applications). `Blocksize=0` means that the device uses variable block size; certain application software might override this value.

8.4.2 SAN failover

In this section, we discuss how to configure alternate paths to address the failover and load balancing requirements of the installation. For more information about dynamic load balancing, you can also refer to Chapter 5, “Alternate Pathing Support” in the *IBM TotalStorage Tape Device Drivers Installation and User’s Guide*, GC35-0154.

Path failover and load balancing

The Atape device driver for AIX supports alternate drive pathing that configures multiple physical paths to the same device within the device driver and provides two basic functions:

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

Automatic failover

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

For example, consider a simple multipath connection consisting of two HBAs in an AIX host, connected over a SAN to a 3590 or 3592 drive. The IBM TS1120 has two fibre ports available on the back of each drive for increased redundancy. The IBM TS1120 can achieve complete redundancy of the SAN components (see Figure 8-5). This simple configuration provides two physical paths to the same drive providing redundancy if one path from an HBA to the drive fails. When you boot the AIX server or run `cfgmgr`, each HBA detects the drive and two logical devices will be configured (for example, `rmt0` and `rmt1`). Each logical device is a physical path to the one tape drive. An application can open and use only one logical device at a time, either `rmt0` or `rmt1`.

When the alternate pathing support is enabled on both `rmt0` and `rmt1`, the device driver configures them internally as a single device with multiple paths. The application can still open and use only one logical device at a time (either `rmt0` or `rmt1`). If an application opens `rmt0` and a permanent path error occurs, the driver initiates failover error recovery automatically on the alternate path (`rmt1`), and the current operations continue on the alternate path without interrupting the application.

Without the Atape alternate pathing support, if an application opens `rmt0` and a permanent path error occurs (for example, because of an HBA or cable failure), the application fails. It is possible to initiate manual failover by changing the device path to the alternate path (`rmt1`), but this change is a manual operation and you must resubmit the last failing job. Sometimes, manual failover can require operator intervention to reset the drive, because a SCSI reservation can still exist on the failing HBA path.

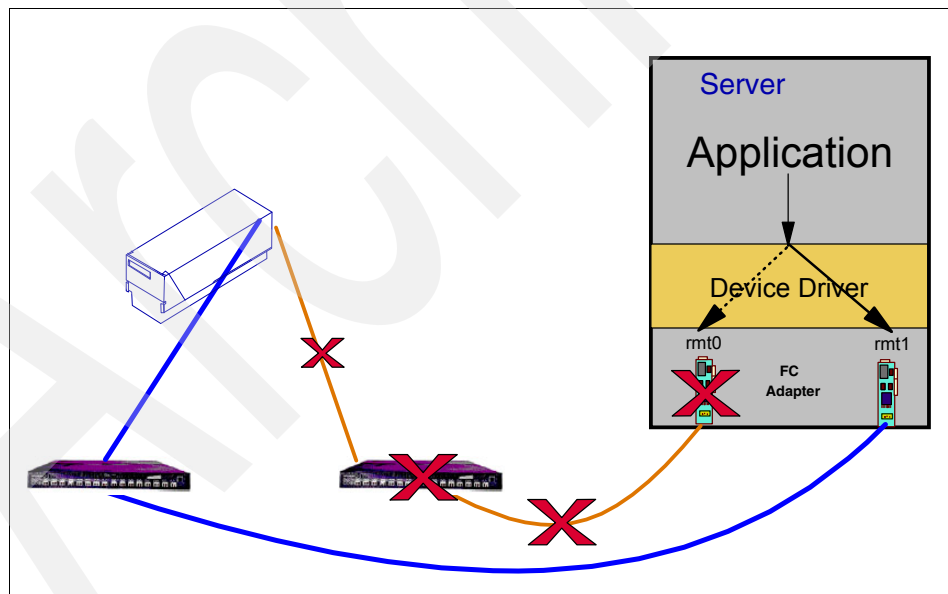


Figure 8-5 Datapath failover

Dynamic load balancing

The *dynamic load balancing support* optimizes resources for devices that have physical connections to multiple HBAs in the same machine. When an application or job opens a device that has multiple HBA paths configured, the device driver determines which path has the HBA with the lowest usage and assigns that path to the application or job. When another

application or job opens a different device with multiple HBA paths, the device driver again determines the path with the lowest HBA usage and assigns that path to the second application or job. The device driver will update the usage on the HBA assigned to the application when the device is closed. Dynamic load balancing will use all HBAs whenever possible and balance the load among them to optimize the resources in the machine.

For example (refer to Figure 8-6), consider a server with two HBAs, HBA1 and HBA2, and with four tape drives attached. Each tape drive is connected to both HBA1 and HBA2. The server sees rmt0 to rmt3 through HBA1 and rmt4 to rmt7 through HBA2. The device files rmt0 and rmt4 point to the same physical tape drive (similarly, for rmt1 and rmt5, rmt2 and rmt6, rmt3 and rmt7). Initially, there are no tape drives in use. The application is assigned the first four tape drives (rmt0 - rmt3). When the first job (Job 1) opens a tape drive (rmt0), the device driver will use HBA1. When the application starts a second job, which opens rmt1, the device driver will use HBA2. A third job is assigned to HBA1 (with rmt2), and a fourth job is assigned to HBA2 (with rmt7). There are two jobs using HBA1 and two jobs using HBA2. If the first job finishes and closes the device, there is now one job using HBA1, and two jobs using HBA2. When the next job opens a tape drive (rmt0), it is assigned to HBA1, so again there are two jobs using HBA1 and two jobs using HBA2. Likewise, if the second job finishes and closes the device, HBA2 has one job using it, and the next job that opens a tape drive (rmt1) is assigned to HBA2.

The dynamic load balancing support is independent from the automatic failover support. Regardless of the path assigned initially for load balancing, if that path fails, the automatic failover support will attempt recovery on the next available path.

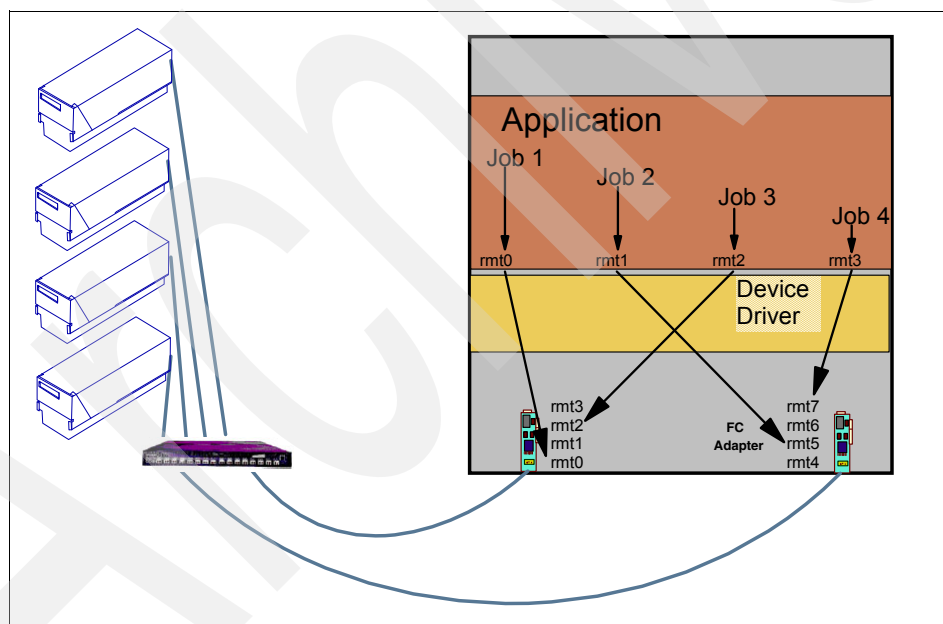


Figure 8-6 Dynamic load balancing

Note that dynamic load balancing works on opened tape drives and not on the load of the tape drive. The device driver tries to balance the usage of drives opened over several HBAs, but it is not possible to balance the workload or throughput of the HBAs. Therefore, the throughput of one HBA can be significantly different than the throughput of the other HBAs.

Also, if a failover happens, all open devices are switched to the next available HBA regardless of the dynamic load balancing. The next time that the driver opens the devices, it will then try to balance, because failover is more critical than load balancing, and failover must be resolved quickly to avoid application impacts.

Configuring and unconfiguring alternate data pathing support

Alternate path support is not enabled automatically when you install the device driver. You must configure it initially on *each logical device* after installation. When alternate pathing support is enabled for a logical device, it remains set until the device is deleted or the support is unconfigured. The alternate pathing setting is retained even if the system is rebooted.

To enable or disable the support on a single logical device, use **SMIT Devices → Tape Drive → Change/Show Characteristics of a Tape Drive**. Select the logical device to change, such as **rmt0**, **rmt1**, and so on, and then select **Yes** for **Enable Alternate Pathing Support** (see Example 8-6).

Example 8-6 Enable alternate pathing support with SMIT

Change / Show Characteristics of a Tape Drive

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

[TOP]	[Entry Fields]
Tape Drive	rmt13
Tape Drive type	3592
Tape Drive interface	fc
Description	IBM 3592 (FCP)
Status	Available
Location	30-68-01
Parent adapter	fscsi0
Connection address	15
SCSI ID	0x21700
Logical Unit ID	0x0
World Wide Name	0x5005076300410802
New Logical Name	<input type="checkbox"/>
Enable Alternate Pathing Support	yes +

[MORE...9]

F1=Help	F2=Refresh	F3=Cancel	F4=List
F5=Reset	F6=Command	F7=Edit	F8=Image
F9=Shell	F10=Exit	Enter=Do	

You can also enable or disable the support using the **chdev** command:

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

Example 8-7 shows you output of the **chdev** command.

Example 8-7 Enable alternate pathing support on command line

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

When the device driver configures a logical device with alternate pathing support enabled, the first device configured always becomes the primary path. On FC-attached devices, **-PRI** is appended to the location field of the device. When a second logical device is configured with alternate pathing support enabled for the same physical device, it configures as an alternate path. The device driver supports up to 16 physical paths for a single device.

On FC-attached devices, **-ALT** is appended to the location field of the device. A third logical device is also configured as an alternate path with **-ALT** appended, and so on. For example, if an **rmt0** is configured first, then an **rmt1**, and an **rmt2**, the **lsdev -Cc tape** command output will look as shown in Example 8-8 (assuming the function has been enabled for each **rmt** device).

Example 8-8 Alternate data path: Configured FC tape devices

```
# lsdev -Cc tape
rmt0 Available 30-68-01-PRI IBM 3592 (FCP)
rmt1 Available 20-58-01-ALT IBM 3592 (FCP)
rmt2 Available 10-70-01-ALT IBM 3592 (FCP)
```

You can see by the location code which HBA connection is associated with the primary and alternate paths. In Example 8-8, `rmt0` is the primary device, which is connected to the HBA in location 30-68-01. You also see that the three HBAs are on three separate Peripheral Component Interconnect (PCI) buses to distribute the I/O workload among them, therefore improving the performance.

Different types of PCI buses have different performance specifications (see Table 8-1). It does make sense to put one 2 Gbps HBA in a 32/33 PCI bus; however, it does not make sense to put more than one 2 Gbps HBA in a 64/33 PCI bus, because the throughput will be saturated.

Table 8-1 PCI bus performance specifications

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

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

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

8.4.3 IBM 3494 Tape Library device driver installation

The 3494 device driver consists of an Automated Tape Library Device Driver (*atlld*), an application daemon (*lmcpd*) that communicates with the 3494 Library Manager, and a utility program (*mtlib*), which provides a command-line interface to the library.

You can start by executing the command:

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

This command installs and commits the 3494 Enterprise Library Driver (**at1dd**) on your system.

After the software is installed, you must edit the `/etc/ibmatl.conf` file to define the tape libraries to the `lmcpld`. The format of the file is:

Symbolic name Connection type Identifier Alternate LAN Connection

Symbolic name Used to identify each library.

Connection type Used to define the IP address of the Library Manager.

Identifier Used to specify a name by which the Library Manager identifies the host machine. We suggest that you use the same identifier name that you used on the Library Manager (the host alias as illustrated in Figure 8-2 on page 335).

Alternate LAN Connection

Used to specify an alternate IP address for a 3494 High Availability LAN-attached configuration.

The following example shows how to define the library name:

```
lib3494 9.xxx.xx.177 itsolib 9.xxx.xx.178
```

This stanza defines the `lib3494` High Availability library connected through TCP/IP to the workstation. The IP addresses of the dual Library Managers are `9.xxx.xx.177` and `9.xxx.xx.178` (see discussion related to Figure 8-3 on page 335).

MTLIB command-line interface

You can issue the `MTLIB` command from either the AIX prompt or within a shell script. The `MTLIB` command is easy to use. It enables you to obtain status information about the library, drives, and cartridges. Using `MTLIB`, you can mount and demount cartridges, and you can perform insert and eject functions by changing the cartridge's Library Manager category.

The structure of the `MTLIB` command is simplistic, so you must code every action that the library must perform to complete a task.

You can use the `MTLIB` command to quickly automate existing backup procedures if you do not use an application, such as Tivoli Storage Manager, RTAPI, or LibrarySmart. Before you can mount a cartridge, you must first change its Library Manager category to an AIX scratch or specific category. Native AIX can use any category, but be careful when you share the library.

The example in Figure 8-7 on page 346 assumes that volume AIX001 was already in the library, so we just inserted volume AIX002. Then, we made two tar backups and we ejected AIX001 so that it can be kept in an off-site vault.

```
mtlib -l /dev/lmcp0 -C -VAIX001 -t1000
mtlib -l /dev/lmcp0 -m -f /dev/rmt0 -VAIX001
mtlib -l /dev/lmcp0 -m -f /dev/rmt1 -VAIX002
tar -cvf /dev/rmt0 ./
tar -cvf /dev/rmt1 ./
mtlib -l /dev/lmcp0 -d -f /dev/rmt0 -VAIX001
mtlib -l /dev/lmcp0 -d -f /dev/rmt1 -VAIX002
mtlib -l /dev/lmcp0 -C -VAIX001 -tFF10
mtlib -l /dev/lmcp0 -qL
mtlib -l /dev/lmcp0 -m -f /dev/rmt0 -VAIX002
tar -tvf /dev/rmt1
mtlib -l /dev/lmcp0 -d -f /dev/rmt0 -VAIX002
```

Figure 8-7 Using MTLIB to automate tar backup

The following list explains the commands shown in Figure 8-7:

- ▶ `mtlib -l /dev/lmcp0 -C -VAIX001 -t1000`
This command changes the cartridge AIX001 Library Manager category to x'1000', which is not reserved by any other hosts or for any Library Manager function.
- ▶ `mtlib -l /dev/lmcp0 -m -f /dev/rmt0 -VAIX001`
This command mounts cartridge AIX001 onto device rmt0.
- ▶ `mtlib -l /dev/lmcp0 -m -f /dev/rmt1 -VAIX002`
This command mounts cartridge AIX002 onto device rmt1.
- ▶ `tar -cvf /dev/rmt0 * tar -cvf /dev/rmt0`
This is the **tar** command used to perform normal backup. You normally use this command to back up the whole file system from which you run the MTLIB command.
- ▶ `mtlib -l /dev/lmcp0 -d -f /dev/rmt0 -VAIX001`
This command demounts cartridge AIX001 from device rmt0. In a script, this command is not issued until the **tar** command completes.
- ▶ `mtlib -l /dev/lmcp0 -d -f /dev/rmt1 -VAIX002`
This command demounts cartridge AIX002 from device rmt1. In a script, this command is not issued until the **tar** command completes.
- ▶ `mtlib -l /dev/lmcp0 -C -VAIX001 -tFF10`
This command changes the Library Manager category of cartridge AIX001 to FF10. Setting the Library Manager category instructs the Library Manager to eject the cartridge from the library through the convenience I/O station (see Appendix C, "Library Manager volume categories" on page 499 for a full list of Library Manager volume categories).
- ▶ `mtlib -l /dev/lmcp0 -qL`
This command requests status information about the library from the Library Manager (see Figure 8-8 on page 347 for the response to this command).
- ▶ `mtlib -l /dev/lmcp0 -m -f /dev/rmt0 -VAIX002`
This command remounts cartridge AIX002 to device rmt0.
- ▶ `tar -tvf /dev/rmt0`
This is the **tar** command to list the files on the cartridge. Use this command to ensure that all files are backed up as needed.

► `mtlib -l /dev/lmcp0 -d -f /dev/rmt0 -VAIX002`

This command demounts the cartridge from `rmt0`.

The example in Figure 8-8 shows the response to an MTLIB query library command.

```
Performing Query Library Data using /dev/lmcp0
Library Data:
state.....Automated Operational State
              Dual Write Disabled
input stations.....1
output stations.....1
input/output status..All input stations empty
                  All output stations empty
machine type.....3494
sequence number.....12345
number of cells.....207
available cells.....0
subsystems.....1
convenience capacity.20
accessor config.....01
accessor 0 status....Accessor available
                  Gripper 0 available
                  Gripper 0 vision operational
                  Gripper 1 not installed
                  Gripper 1 vision not operational
accessor 1 status....00
accessor 2 status....00
accessor 3 status....00
accessor 4 status....00
accessor 5 status....00
accessor 6 status....00
accessor 7 status....00
comp avail status....Primary Library Manager installed.
                  Primary Library Manager available.
                  Primary hard drive installed.
                  Primary hard drive available.
                  Secondary hard drive installed.
                  Secondary hard drive available.
                  Convenience input station installed.
                  Convenience input station available.
                  Convenience output station installed.
                  Convenience output station available.
```

Figure 8-8 Response to MTLIB query library command

For more detailed information about the installation procedures for the required drivers, refer to the publication *IBM TotalStorage Tape Device Drivers Installation and User's Guide*, GC35-0154.

Operational considerations

The MTLIB command is supplied with the tape library device driver as described earlier. It provides the operational interface in an AIX environment.

Return to scratch

Use the MTLIB command to change cartridges in the Library Manager category back to a scratch category:

```
mtlib -l /dev/lmcp0 -C -VAIX001 -txxxx
```

Here, *xxxx* is the scratch category that you have chosen.

You can add insert processing support to applications. For example, the IBM Tivoli Storage Manager CHECKIN processing changes the Library Manager category of a cartridge from INSERT to the Tivoli Storage Manager scratch category.

Cartridge insert processing

After cartridges are entered into the tape library, use the MTLIB command to change the Library Manager category from INSERT to your chosen AIX scratch and private categories:

```
mtlib -l /dev/lmcp0 -C -VAIX001 -t0090
```

Here, 0090 is the Library Manager category that you chose for your AIX scratch cartridges.

Tivoli Storage Manager CHECKIN processing changes the Library Manager category from INSERT to an Tivoli Storage Manager category.

Cartridge eject processing

Use the MTLIB command to change a cartridge's Library Manager category to an I/O station category:

```
mtlib -l /dev/lmcp0 -C -VAIX001 -tFF10
```

Here, FF10 is the Library Manager category for the convenience I/O station.

You can add eject processing support to applications. For example, Tivoli Storage Manager CHECKOUT processing changes the Library Manager category of a cartridge to an I/O station's Library Manager category.

8.5 SUN Solaris

In this section, we explain how the drivers are installed when working in a Sun Solaris environment. The first step is to download the latest tape device driver (called *IBMtape*) and the latest library device driver (called *lmcpd*) from the FTP server at:

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

8.5.1 Tape device driver installation

This section explains the tape device driver installation. For more information about the tape device driver installation, you can refer to the *IBM TotalStorage Tape Device Drivers Installation and User's Guide*, GC35-0154.

Important: A reboot of the host system is required to complete the installation, so you need to schedule this operation accordingly.

The *IBMtape* device driver attempts to claim and operate only the supported IBM tape devices. However, Solaris includes its own SCSI tape device driver, named *st*, which will automatically claim any SCSI-compliant tape drive that it detects, including devices that *IBMtape* also recognizes.

In order to avoid conflicts between *IBMtape* and *st*, you must prevent the *st* driver from claiming and attempting to operate *IBMtape*-owned devices. Similarly, you must prevent

other suppliers' SCSI tape device drivers that you have installed from claiming IBMtape-owned devices.

Use the following steps to perform the installation. In our example, we detail the installation for a Solaris system without any previous tape subsystem configured.

This example assumes that we have downloaded a package file named `IBMtape.4.0.9.0.bin` into the `/export/home/pkgadd/IBMtape` directory:

1. Log on to the target system as root.
2. Ensure that all user and tape drive activity on the system has halted.
3. Use **pkgadd** to install the driver:
`pkgadd -d /export/home/pkgadd/IBMtape/IBMtape.4.0.9.0.bin`
4. You see the output shown in Example 8-9.

Example 8-9 IBMtape install output on Solaris

The following packages are available:

```
1  IBMtape      IBM 32-bit and 64-bit Tape & Medium Changer Device Driver 4.0.9.0
                (sparc) 4.0.9.0
```

Select package(s) you wish to process (or 'all' to process all packages). (default: all) [?,??,q]: y

ERROR: Entry does not match available menu selection. Enter the number of the menu item you wish to select, or the token which is associated with the menu item, or a partial string which uniquely identifies the token for the menu item. Enter ?? to reprint the menu.

Select package(s) you wish to process (or 'all' to process all packages). (default: all) [?,??,q]:

Processing package instance <IBMtape> from </export/home/pkgadd/IBMtape/IBMtape.4.0.9.0>

IBM 32-bit and 64-bit Tape & Medium Changer Device Driver 4.0.9.0
(sparc) 4.0.9.0

IBM Tape & Medium Changer Device Driver for Sun Solaris 7, 8 and 9
Version 4.0.9.0

Contains Licensed Internal Code
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Using </opt> as the package base directory.

```
## Processing package information.
## Processing system information.
## Verifying disk space requirements.
## Checking for conflicts with packages already installed.
## Checking for setuid/setgid programs.
```

This package contains scripts which will be executed with super-user permission during the process of installing this package.

Do you want to continue with the installation of <IBMtape> [y,n,?] y

Installing IBM 32-bit and 64-bit Tape & Medium Changer Device Driver 4.0.9.0 as <IBMtape>

```
## Installing part 1 of 1.
/opt/IBMtape/IBMtape.conf
/opt/IBMtape/diags_info
/opt/IBMtape/tapelists
/opt/IBMtape/tapeutil
/opt/IBMtape/tapeutil.c
/opt/IBMtape/tmd
/opt/IBMtape/tmd.conf
/usr/include/sys/oldtape.h
/usr/include/sys/smc.h
/usr/include/sys/st.h
/usr/include/sys/svc.h
/usr/kernel/drv/IBMtape
/usr/kernel/drv/sparcv9/IBMtape
[ verifying class <none> ]
## Executing postinstall script.
## The /usr/kernel/drv/IBMtape.conf file already exists.
## It will be preserved as the current configuration file
## for the IBM Tape & Medium Changer Device Driver.

## Stopping any running instances of tape monitor daemon...

## Installing the /etc/tmd.conf file.

## Creating the directory of /var/opt/IBMtape.

## Adding control node entry to /usr/kernel/drv/IBMtape.conf.

## Adding new tmd entry to /etc/inittab...
## Loading IBM Tape & Medium Changer Device Driver.
## Starting IBMtape Monitor Daemon (tmd)...

Installation of <IBMtape> was successful.
```

*** IMPORTANT NOTICE ***

This machine must now be rebooted in order to ensure
sane operation. Execute
 shutdown -y -i6 -g0
and wait for the "Console Login:" prompt.

Before using the tape devices and the library, configure the device driver parameters that we describe in the following section.

Configuring tape devices

Edit the file /usr/kernel/drv/IBMtape.conf and make sure that all the required target and logical unit number (LUN) definitions for the drives and medium changer are in place. Also, edit the file /kernel/drv/st.conf to make sure that all of the required target and LUN definitions used for IBMtape are commented for the Solaris standard tape device driver.

We recommend that you use persistent binding, which is described in *Implementing IBM Tape with Unix Systems*, SG24-6502, so that you can identify or nominate the SCSI ID to use. Identifying the SCSI ID to use can help you to create the IBMtape.conf file, because you simply add stanzas for every SCSI (target) ID.

Example 8-10 shows three Fibre Channel tape drives with persistent binding.

Example 8-10 Persistent binding of three native FC drives

```
#Binding
hba1-SCSI-target-id-8-fibre-channel-name="5005076300410801";
hba1-SCSI-target-id-9-fibre-channel-name="5005076300410802";
hba1-SCSI-target-id-10-fibre-channel-name="5005076300410803";
```

Because of persistent binding, we know that the tape drives will use SCSI IDs 8 to 10. Therefore, IBMtape.conf needs entries for target IDs 8 to 10 (see Example 8-11).

Example 8-11 IBMtape.conf for three FC drives

```
name="IBMtape" class="scsi"
target=8 lun=0
.....
name="IBMtape" class="scsi"
target=9 lun=0
.....
name="IBMtape" class="scsi"
target=10 lun=0
.....
```

Tip: The persistent binding and the IBMtape.conf entries must be sequential and contiguous so that the tape special file names will also be in sequence.

To prevent the Solaris standard tape driver from claiming the devices, comment out the target ID and LUN for the IBM tape devices from the file /kernel/drv/st.conf.

Example 8-12 File /kernel/drv/st.conf example with three native FC drives

```
.....
#name="st" class="scsi"
#       target=8 lun=0;
#name="st" class="scsi"
#       target=9 lun=0;
#name="st" class="scsi"
#       target=10 lun=0;
.....
```

After editing these files, reboot the system to enable the changes. We show one common method to perform a reboot here, but use your normal installation procedures:

```
reboot -- -r
```

Verifying the IBMtape driver installation

To verify the installation and configuration of the IBMtape device driver, use the command in Example 8-13 on page 352. This example relates to native Fibre Channel drives using the persistent binding setting used in Example 8-10.

Example 8-13 Verifying Solaris device configuration

```
ls -l /dev/rmt/*stbn
lrwxrwxrwx 1 root root      58 Mar 24 17:33 /dev/rmt/0stbn ->
../../../../devices/pci@1f,4000/fibre-channel@2/IBMtape@8,0:stbn
lrwxrwxrwx 1 root root      57 Mar 29 13:22 /dev/rmt/1smc ->
../../../../devices/pci@1f,4000/fibre-channel@2/IBMtape@8,1:smc
lrwxrwxrwx 1 root root      58 Mar 24 17:33 /dev/rmt/2stbn ->
../../../../devices/pci@1f,4000/fibre-channel@2/IBMtape@9,0:stbn
lrwxrwxrwx 1 root root      57 Mar 29 13:22 /dev/rmt/3smc ->
../../../../devices/pci@1f,4000/fibre-channel@2/IBMtape@9,1:smc
lrwxrwxrwx 1 root root      58 Mar 24 17:33 /dev/rmt/4stbn ->
../../../../devices/pci@1f,4000/fibre-channel@2/IBMtape@a,0:stbn
lrwxrwxrwx 1 root root      57 Mar 29 13:22 /dev/rmt/5smc ->
../../../../devices/pci@1f,4000/fibre-channel@2/IBMtape@a,1:smc
```

Example 8-13 shows:

- 0stbn** Because this device has a SCSI ID of 8 and a LUN of 0 (8,0), it is most likely that this device special file represents the device with a WWN of 5005076300410801 from the persistent binding setting in Example 8-10 on page 351, which is the first tape drive.
- 2stbn** Similarly, 2stbn is the device special file name for the second tape drive.
- 4stbn** And, 4stbn is the device special file name for the third tape drive.

In the newer versions of IBMtape device drivers, there is a useful tool called *tapelist* for identifying the relationship between the device special file and the physical device that it represents. Example 8-14 uses the *tapelist* tool.

Example 8-14 Tape entries in the server using the *tapelist* tool

Inst #	Special File	Device	Serial No	TGT/LUN	Ucode	World Wide NN	World
Wide PN	Device	Physical Path			Path Type		
3682	/dev/rmt/10st	03592J1A	000001300280	8/0	04B8	5005076300010811	
	5005076300410811	/devices/pci@1f,4000/fibre-channel@2/IBMtape@8,0:st				N/A	
3683	/dev/rmt/13smc	03584L22	000001310008	8/1	404e	N/A	N/A
	/devices/pci@1f,4000/fibre-channel@2/IBMtape@8,1:smc					N/A	
3715	/dev/rmt/12st	03592J1A	000001300178	9/0	04B8	5005076300010812	
	5005076300410812	/devices/pci@1f,4000/fibre-channel@2/IBMtape@9,0:st				N/A	

Example 8-14 shows that device special file /dev/rmt/10st represents a 3592J1A tape drive with a serial number of 1300280, an assigned SCSI target ID of 8, a LUN of 0, and the worldwide node name (WWNN) is 5005076300010811.

Note: The plan is for the *tapelist* tool to be available with the IBMtape device driver.

IBMtape is listed correctly as the owner of these devices. For performance reasons, we recommend that you use a special device file name that has compression turned on.

8.5.2 IBM 3494 Tape Library device driver installation

The Sun Solaris Tape Library Driver (*lmcpd*) is the software for attaching the IBM TotalStorage 3494 Enterprise Automated Tape Library to a Sun server. The software consists

of a daemon that communicates directly with the Library Manager of the IBM 3494 through RS-232 or LAN, a utility program that provides a command-line interface to the daemon, and a C object module that can be linked with user applications to provide a communication interface with the daemon. This software is known as a driver throughout this document, because it provides the necessary software and interfaces for the library. However, the product does not consist of a device driver in the true sense of the term. That is, it is not an extension of the operating system kernel, such as a SCSI tape device driver.

The Library Manager control point daemon (*lmcpd*) is provided in the package. The *lmcpd* is a process that always runs on the system. It provides direct communication with the 3494 Library Manager.

You start by executing the following command:

```
/usr/sbin/pkgadd -d //directory/filename lmcpd-acXd
```

This command installs and commits the 3494 Enterprise Library Driver on your system.

After the software is installed, you must edit the `/etc/ibmatl.conf` file to define the tape libraries to the *lmcpd*. The format of the file is:

Symbolic name Connection type Identifier Alternate LAN Connection

Symbolic name Used to identify each library.

Connection type Used to define the IP address of the Library Manager.

Identifier Used to specify a name by which the Library Manager identifies the host machine. We suggest that you use the same identifier name that you used on the Library Manager (the host alias as illustrated in Figure 8-2 on page 335).

Alternate LAN Connection Used to specify an alternate IP address for a 3494 High Availability LAN-attached configuration.

The following examples show how to define the library name:

```
lib3494 9.xxx.xx.177 itsolib 9.xxx.xx.178
```

This stanza defines the `lib3494` High Availability library connected through TCP/IP to the workstation. The IP addresses of the dual Library Managers are `9.xxx.xx.177` and `9.xxx.xx.178` (see discussion related to Figure 8-3 on page 335).

MTLIB command-line interface

You can issue the *MTLIB* command from either the Solaris prompt or within a shell script. The *MTLIB* command is easy to use. It enables you to obtain status information about the library, drives, and cartridges. Using *MTLIB*, you can mount and demount cartridges and perform insert and eject functions by changing the cartridge's Library Manager category. For more information, see "MTLIB command-line interface" on page 345.

Operational considerations

The Sun Solaris operational interfaces and return-to-scratch, insert, and eject processing are similar to those of AIX. See "Operational considerations" on page 347.

8.6 HP-UX

In this section, we explain how the drivers are installed when working in an HP-UX environment. The first step is to download the latest tape device driver (called *Atape*) and the latest library device driver (called *atlld*) from the FTP server from:

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

To find the right driver, go to the subdirectory that matches your HP-UX OS level and system architecture (either Precision or PCI). In our example, we have an HP PCI bus system with HP-UX V11.0, therefore, we need to go to the 11.0_PCI directory. The IBM tape device driver has the format atdd.1.x.x.x.bin.

We recommend that you also download the *tapeutil* utility from the same location. This file is called *tapeutil.hpux.x.x.x.x.bin* and is packaged separately, unlike for Solaris or AIX. You use *tapeutil* for tape and medium changer commands, such as **mount**, **dismount**, **move media**, **write** and **read** (files).

Be sure to check the readme file for updated information about fixes and prerequisites.

8.6.1 Tape device driver installation

This section explains the tape device driver installation. For more information about the tape device driver installation, you can refer to the publications *IBM Ultrium Device Drivers: Installation and User's Guide*, GA32-0430, for LTO tape drives and libraries and *IBM TotalStorage Tape Device Drivers Installation and User's Guide*, GC35-0154, for 3592 tapes.

Note: You must reboot the host system to complete the installation, so you must schedule this operation accordingly.

By default, the *atdd* device driver automatically configures all supported IBM tape drives that are attached and powered on when the system starts.

You must have *root* authority to proceed with the installation of the driver. We assume the driver *atdd.1.9.0.1.bin* has been downloaded to the directory */bavaria/atdd*. This is the procedure:

1. Copy the installation file to the software depot using the command:

```
swcopy -p -s /bavaria/atdd.1.9.0.1.bin atdd
swcopy -s /bavaria/atdd.1.9.0.1.bin atdd
```

The first command performs a preview copy only. Repeat without the **-p** option to actually execute the copy. Example 8-15 shows the output that you will see from **swcopy**.

Example 8-15 Output of swcopy

```
# swcopy -s /bavaria/atdd.1.9.0.1.bin atdd

===== 03/26/03 13:47:51 PST BEGIN swcopy SESSION (non-interactive)

* Session started for user "root@easter".

* Beginning Selection
* Target connection succeeded for "easter:/var/spool/sw".
* Source: /bavaria/atdd.1.9.0.1.bin
* Targets: easter:/var/spool/sw
* Software selections:
    atdd.driver,r=1.9.0.1
```

* Selection succeeded.

* Beginning Analysis

* Session selections have been saved in the file
"/.sw/sessions/swcopy.last".

* "easter:/var/spool/sw": 1 filesets have the selected revision
already installed.

* Analysis succeeded.

NOTE: More information may be found in the agent logfile (location
is easter:/var/spool/sw/swagent.log).

===== 03/26/03 13:47:52 PST END swcopy SESSION (non-interactive)

Verify that the atdd software has been copied in the depot:

swlist -d atdd

You see these messages:

atdd	1.9.0.1	GES IBM Magstar and Ultrium tape device driver
atdd.driver		Advanced Tape Device Driver

2. Use the **swlist** command to view the product's readme file:

swlist -d -a readme atdd | more

3. The following command installs atdd from the depot to the default root file system:

swinstall atdd

The output is shown in Example 8-16.

Example 8-16 Output of the swinstall atdd command

swinstall atdd

===== 03/26/03 13:53:23 PST BEGIN swinstall SESSION
(non-interactive)

* Session started for user "root@easter".

* Beginning Selection

* Target connection succeeded for "easter:/".

* Source connection succeeded for "easter:/var/spool/sw".

ERROR: Installation of software requiring a reboot is, by default,
not allowed from the command line. You must specify "-x
autoreboot=true" on the command line to change the default for
this session.

ERROR: Cannot continue the "swinstall" task.

* Selection had errors.

===== 03/26/03 13:53:29 PST END swinstall SESSION (non-interactive)

If you receive an error message saying that a reboot of the system is needed (as shown in
Example 8-16), reissue the **swinstall** command with the **autoreboot** option:

swinstall -x autoreboot=true atdd

Note: If an earlier version of atdd is installed, the existing version is replaced. This is
true even if the version installed is more recent than the version that you install.

During the installation, you see the messages shown in Example 8-17 on page 356.

Example 8-17 Installing atdd on HP-UX

```
# swinstall -x autoreboot=true atdd
===== 03/26/03 13:56:30 PST BEGIN swinstall SESSION
(non-interactive)
* Session started for user "root@easter".
* Beginning Selection
* Target connection succeeded for "easter:/".
  * Source connection succeeded for "easter:/var/spool/sw".
WARNING: The software specified contains a kernel fileset. It will be
         necessary to reconfigure and reboot the system to make the
         kernel software functional.
  * Source:                /var/spool/sw
  * Targets:               easter:/
  * Software selections:
    atdd.driver,r=1.9.0.1
  * Selection succeeded.

  * Beginning Analysis
  * Session selections have been saved in the file
    "/.sw/sessions/swinstall.last".
  * The analysis phase succeeded for "easter:/".
  * Analysis succeeded.

  * Beginning Execution
  * The execution phase succeeded for "easter:/".
  * Execution succeeded.

NOTE:    More information may be found in the agent logfile (location
         is easter:/var/adm/sw/swagent.log).

*** FINAL System shutdown message (easter) ***

System going down IMMEDIATELY
===== 03/26/03 13:57:30 PST END swinstall SESSION (non-interactive)

# logout root
```

4. To verify the installation, use the command:

```
swverify atdd
```

Example 8-18 shows the output.

Example 8-18 Verifying the correct installation with swlist atdd

```
# swlist atdd
# Initializing...
# Contacting target "easter"...
#
# Target:  easter:/
#

# atdd          1.9.0.1          GES IBM Magstar and Ultrium tape device driver
atdd.driver    Advanced Tape Device Driver
```

8.6.2 Verifying the atdd driver installation

To verify that you have installed the atdd device driver correctly, you can use the following commands:

- ▶ The command **ioscan -fnkC tape** shows detected (claimed) tape drives.
- ▶ The command **ls -la /dev/rmt** shows the special file name.

Example 8-19 shows the device special files (/dev/rmt/1m and /dev/rmt/2m) for each tape drive. Both tape drives are connected to the same FC HBA with the location code 0/0/12/0/0.121.

Example 8-19 The ioscan -fnkC tape command output

ioscan -fnkC tape pg							
Class	I	H/W Path	Driver	S/W State	H/W Type	Description	
=====							
tape	1	0/0/12/0/0.121.8.255.0.0.0	atdd	CLAIMED	DEVICE	IBM 3592	
		/dev/rmt/1m			/dev/rmt/1mnb	/dev/rmt/c27t0d0BESTn	
		/dev/rmt/1mb			/dev/rmt/c27t0d0BESTb	/dev/rmt/c27t0d0BESTnb	
		/dev/rmt/1mn			/dev/rmt/c27t0d0BESTb		
tape	2	0/0/12/0/0.121.9.255.0.0.0	atdd	CLAIMED	DEVICE	IBM 3592	
		/dev/rmt/2m			/dev/rmt/2mnb	/dev/rmt/c29t0d0BESTn	
		/dev/rmt/2mb			/dev/rmt/c29t0d0BESTb	/dev/rmt/c29t0d0BESTnb	
		/dev/rmt/2mn			/dev/rmt/c29t0d0BESTb		

You can now use the *tapeutil* utility to test the library. If you downloaded the tapeutil installation file as described in 8.6, “HP-UX” on page 354, you can then install the package with the following commands:

```
swcopy /bavaria/tapeutil.hpux.4.0.0.0.bin tapeutil
swinstall tapeutil
```

Then, go to 8.7, “Testing the tapes with tapeutil” on page 359 to learn how to use tapeutil.

Open the device, issue inquiry commands **read** and **write**, and move media across the library to check the driver functionality.

8.6.3 Configuring tape devices

This section describes the procedure that you can follow to change the default configuration parameters for the tape devices, such as compression, block size, or buffering.

You can examine the current configuration using the atdd_cfg program located in the /opt/OMImag/bin directory. Every tape device is associated with a specific instance. To get the instances used in your environment, you first need to know the H/W Path (SCSI path) to the device. Use the H/W Path column of the **ioscan** command shown in Example 8-19 to determine the SCSI path of your device. In our case, the two drives are configured at addresses 0/0.0.0 and 0/0.1.0. Issue the command shown in Example 8-20.

Example 8-20 The atdd_cfg command to get the instance number

```
/opt/OMImag/bin/atdd_cfg -g INSTANCE 0/0.0.0
INSTANCE: 1
/opt/OMImag/bin/atdd_cfg -g INSTANCE 0/0.1.0
INSTANCE: 2
```

Our devices correspond to instance number 1 and instance number 2. With the instance number of the device, you can query the device parameters (see Example 8-21 on page 358).

Example 8-21 Querying the device parameters

```
/opt/OMImag/bin/atdd_cfg -g DENSITY <instance>
/opt/OMImag/bin/atdd_cfg -g SILI <instance>
/opt/OMImag/bin/atdd_cfg -g DEVICES
/opt/OMImag/bin/atdd_cfg -g BLOCKSIZE <instance>
/opt/OMImag/bin/atdd_cfg -g COMPRESSION <instance>
/opt/OMImag/bin/atdd_cfg -g BUFFERING <instance>
/opt/OMImag/bin/atdd_cfg -g IMMEDIATE <instance>
/opt/OMImag/bin/atdd_cfg -g TRAILER <instance>
/opt/OMImag/bin/atdd_cfg -g ERRNO_LEOT <instance>
```

If needed, change the device parameters as in Example 8-22.

Example 8-22 Changing the device parameters

```
/opt/OMImag/bin/atdd_cfg -s DENSITY <density> <instance>
/opt/OMImag/bin/atdd_cfg -s SILI <sili> <instance>
/opt/OMImag/bin/atdd_cfg -s BLOCKSIZE <block size> <instance>
/opt/OMImag/bin/atdd_cfg -s COMPRESSION <compression> <instance>
/opt/OMImag/bin/atdd_cfg -s BUFFERING <buffering> <instance>
/opt/OMImag/bin/atdd_cfg -s IMMEDIATE <immediate> <instance>
/opt/OMImag/bin/atdd_cfg -s TRAILER <trailer> <instance>
/opt/OMImag/bin/atdd_cfg -s ERRNO_LEOT <errno_leot> <instance>
```

Any changes made here are lost when you reboot the server. To make the changes permanent, modify the appropriate entries in the file `/etc/rc.config.d/atdd.cfg`.

A sample file named `atdd.cfg.ex` is provided. Modify it as desired and then copy it to `atdd.cfg`. In Example 8-23, we change the compression by changing it from off (0) to on (1) for the device `ATDD_HWPATH[0]`.

Example 8-23 Example of the atdd.cfg device configuration file

```
# HW Path for Tape drive 1
ATDD_HWPATH[0]=0/7/0/0.0.0
ATDD_COMPRESSION[0]=1
# HW Path for Tape drive 2
ATDD_HWPATH[1]=0/7/0/0.1.0
# HW Path for Medium Changer
ATDD_HWPATH[2]=0/7/0/0.6.0
```

For performance reasons, we generally recommend that you enable compression unless otherwise instructed by your software application provider.

8.6.4 IBM 3494 library device driver installation

The HP-UX Tape Library Driver (*lmcpd*) is the software for attaching the IBM TotalStorage 3494 Enterprise Automated Tape Library to an HP server. The software consists of a daemon that communicates directly with the Library Manager of the IBM 3494 Tape Library through RS-232 or LAN connections, a utility program that provides a command-line interface to the daemon, and a C object module that can be linked with user applications to provide a communication interface with the daemon.

This software is known as a driver throughout this document, because it provides the necessary software and interface for the tape library. However, the product does not consist of a device driver in the true sense of the term. That is, it is not an extension of the operating system kernel, such as a SCSI tape device driver.

The Library Manager control point daemon (*lmcpd*) is provided in the package. The *lmcpd* is a process that always runs on the system. It provides direct communication with the 3494 Library Manager.

You start downloading the *lmcpd* from:

<ftp://ftp.software.ibm.com/storage/devdrv/HPUX/lmcpd/>

Issue the command to copy the downloaded file to the software copy:

```
swcopy -s /directory/filename lmcpd
```

Then, you execute the command:

```
swinstall lmcpd
```

This command installs and commits the 3494 Enterprise Library Driver on your system.

After the software is installed, you must edit the */etc/ibmatl.conf* file to define the tape libraries to the *lmcpd*. The format of the file is:

Symbolic name Connection type Identifier Alternate LAN Connection

Symbolic name Used to identify each library.

Connection type Used to define the IP address of the Library Manager.

Identifier Used to specify a name by which the Library Manager identifies the host machine. We suggest that you use the same identifier name that you used on the Library Manager (the host alias as illustrated in Figure 8-2 on page 335).

Alternate LAN connection
Used to specify an alternate IP address for a 3494 High Availability LAN-attached configuration.

The following example shows how to define the library name:

```
lib3494 9.xxx.xx.177 itsolib 9.xxx.xx.178
```

This stanza defines the *lib3494* High Availability library connected through TCP/IP to the workstation. The IP addresses of the dual Library Managers are *9.xxx.xx.177* and *9.xxx.xx.178* (see the discussion related to Figure 8-3 on page 335).

MTLIB command-line interface

The *MTLIB* command is easy to use. It enables you to obtain status information about the library, drives, and cartridges. Using *MTLIB*, you can mount and demount cartridges, and you can perform insert and eject functions by changing the cartridge's Library Manager category. For more information about *MTLIB*, see "MTLIB command-line interface" on page 345.

Operational considerations

The HP-UX operational interfaces and return-to-scratch, insert, and eject processing are similar to those of AIX. See "Operational considerations" on page 347.

8.7 Testing the tapes with tapeutil

The *tapeutil* tape utility is installed with the IBM tape device drivers on Solaris and AIX or as a separate package for HP-UX. This utility tests the functions of the tape device and the

device driver. It also performs basic tape and medium changer operations. The tape utility program provides two versions: one version with an interactive menu and another version for UNIX command line entry.

Start the `tapeutil` interactive menu by typing `tapeutil` without any parameters. On AIX, you then see the menu shown in Figure 8-9. For Solaris and HP-UX, the menu has a slightly different format.

General Commands:		
1. Open a Device	5. Inquiry	9. Log Sense Page
2. Close a Device	6. Test Unit Ready	10. Mode Sense Page
3. Device Info	7. Reserve Device	11. Release Device
4. Tape Drive Service Aids	8. Request Sense	Q. Quit Program
Medium Changer Commands:		
12. Element Information	16. Move Medium	
13. Position To Element	17. Load/Unload Medium	
14. Element Inventory	18. Initialize Element Status	
15. Exchange Medium	19. Prevent/Allow Medium Removal	
Tape Commands:		
20. Query/Set Parameters	30. Read and Write Tests	
21. Prevent/Allow Medium Removal	31. Unload Tape	
22. Rewind	32. Erase	
23. Erase Gap	33. Write Filemarks	
24. Forward Space Filemarks	34. Backward Space Filemarks	
25. Forward Space Records	35. Backward Space Records	
26. Space to End of Data	36. Query/Set Tape Position	
27. Log Sense	37. Read or Write Files	
28. Display Message	38. Query/Create/Change Partition	
29. Synchronize Buffers	39. Report Density Support	
Enter Selection:		

Figure 8-9 *Tapeutil main menu*

A list of general subcommands, medium changer subcommands, and tape subcommands displays. You must open a device before using these commands and operations. To open a device:

1. Select option **1:Open a Device** from General Commands.
2. Enter the name of the device special file. Use any special file that exists for the device using your OS conventions, for example, `/dev/rmt0`, `/dev/rmt0.1`, `/dev/rmt1.smc`, or `/dev/smc0`. See Example 8-1 on page 334 for the device special file names.
3. Enter the Read/Write, Read-Only, Write Only, or Append mode to open a device. These modes apply to the tape devices only, not for the medium changer.

After you open a device, select a command by using the appropriate number for the command from the menu. Certain commands require additional information after they are selected from the menu.

You can also use the `tapeutil` command-line interface by entering commands in the format:
`tapeutil -f DeviceName Subcommand [Subcommand ...]`

You can obtain detailed `tapeutil` reference information in the *IBM Ultrium Device Drivers Installation and User's Guide*, GA32-0430.

8.8 Linux

In this section, we explain how the drivers are installed when working in a Linux environment. The first step is to download the latest tape device driver (called *IBMtape*) and the latest library device driver (called *IBMatl*) from the FTP server:

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

8.8.1 Tape device driver installation

Move to the directory for your corresponding Linux distribution and version. The driver comes in an RPM package in the form *IBMtape-x.x.x-y.y.y.i386.rpm.bin* where *x.x.x* is the version of the driver and *y.y.y* is the version of the Linux kernel that it supports.

You also need to download from the same directory the *tapeutil* program, which includes the *IBMtapeconfig* tool, to access the Ultrium devices through the IBM tape device driver. The package is called *IBMtapeutil.x.x.x.i386.tar.bin*.

Example 8-24 shows the installation of the IBM tape device driver and tapeutil program. You can obtain more information about the installation procedure in the *IBM Ultrium Device Drivers: Installation and User's Guide*, GA32-0430.

Example 8-24 Installing IBM tape driver and library utilities on Linux

```
[root@saab tmp]# ls -l
...
-rw-r--r-- 1 root root 283839 Apr 16 08:42 IBMtape-1.4.11-2.4.21-9.0.1.EL.i386.rpm.bin
-rw-r--r-- 1 root root 307200 Apr 16 08:42 IBMtapeutil.1.2.2.i386.tar.bin
...
[root@saab tmp]# rpm -i IBMtape-1.4.11-2.4.21-9.0.1.EL.i386.rpm.bin
Installing IBMtape
Warning: loading /lib/modules/2.4.21-9.0.1.ELsmp/kernel/drivers/scsi/IBMtape.o will taint
the kernel:

non-GPL license - USE
R LICENSE AGREEMENT FOR IBM DEVICE DRIVERS
See http://www.tux.org/1kml/#export-tainted for information about tainted modules
Module IBMtape loaded, with warnings
IBMtape loaded
[root@saab tmp]# tar xvf IBMtapeutil.1.2.2.i386.tar.bin
IBMtapeutil.1.2.2/
IBMtapeutil.1.2.2/IBMtapeutil
IBMtapeutil.1.2.2/IBMtapeutil.h
IBMtapeutil.1.2.2/IBMtapeutil.c
IBMtapeutil.1.2.2/IBMtapeconfig
IBMtapeutil.1.2.2/makefile
IBMtapeutil.1.2.2/IBMtapeutil.ReadMe
[root@saab tmp]# cd IBMtapeutil.1.2.2
[root@saab IBMtapeutil.1.2.2]# make
make: `IBMtapeutil' is up to date.
[root@saab IBMtapeutil.1.2.2]# make install
cp -f IBMtapeutil /usr/bin/.
cp -f IBMtapeconfig /usr/bin/.
```

In Example 8-25 on page 362, we execute **IBMtapeconfig** to check if the tape devices are accessible to our system and to create the device files that provide access through the IBM driver.

Example 8-25 Creating Linux device special files with IBMtapeconfig

```
[root@saab tmp]# IBMtapeconfig

Creating IBMtape special files
major number: 254
Attached devices: 0 1
mknod -m 0666 /dev/IBMtape0 c 254 0
mknod -m 0666 /dev/IBMtape0n c 254 64
mknod -m 0666 /dev/IBMtape1 c 254 1
mknod -m 0666 /dev/IBMtape1n c 254 65
```

You can see that **IBMtapeconfig** creates device entries for the tape drives. The drives are represented by `/dev/IBMtapeX` for the rewinding behavior and `/dev/IBMtapeXn` for the non-rewinding behavior.

The IBM tape device drivers are installed in addition to the native Linux device drivers. Only the devices created through **IBMtapeconfig** will use the IBM drivers. The standard Linux devices remain unchanged.

The **mt** command allows you to check if the installation was successful (see Example 8-26).

Example 8-26 Checking the IBM tape driver with mt

```
[root@diomedes IBMtapeutil.1.0.5]# mt -f /dev/IBMtape0 status
SCSI 2 tape drive:
File number=-1, block number=1203, partition=0.
Tape block size 0 bytes. Density code 0x40 (unknown to this mt).
Soft error count since last status=0
General status bits on (10000000):
  ONLINE
```

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

8.8.2 IBMtapeutil

IBMtapeutil provides a comprehensive collection of tape and library commands. The *IBMtapeutil* utilities exist in a separate tar package from the device driver. You need to download and install the package from the IBM Web site:

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

Get the package from the appropriate Linux version subdirectory. The package will have the name `IBMtapeutil.x.x.x.tar.bin`. Unpack the package into a directory, and from that directory, run **make install**. In the following sections, we show examples of the invocation and outputs of *IBMtapeutil*.

Example 8-27 shows the initial invocation display for *IBMtapeutil*.

Example 8-27 Start display of IBMtapeutil

```
[root@saab root]#IBMtapeutil
IBMtapeutil for Linux, Version 1.4.1, Jan. 03, 2007
=====
1. Tape
```

2. Changer
3. Quit

=====

Enter your choice:

Example 8-28 shows the general SCSI commands, as well as the tape-specific commands, that are available through IBMtapeutil.

Example 8-28 Tape command selection display of IBMtapeutil for Linux

```
----- General Commands: -----
  1. Open a Device
  2. Close a Device
  3. Inquiry
  4. Test Unit Ready
  5. Reserve Device
  6. Release Device
  7. Request Sense
  8. Log Sense Page
  9. Mode Sense Page
 10. Switch Tape/Changer Device
 11. Create Special Files
 12. Query Driver Version
 13. Query Device Path
 14. Display All Paths
 15. Enable A Path
 16. Disable A Path
  Q. Quit IBMtapeutil

----- Tape Commands: -----
 20. Rewind
 21. Forward Space Filemarks
 22. Backward Space Filemarks
 23. Forward Space Records
 24. Backward Space Records
 25. FSFM
 26. BSFM
 27. Space to End of Data
 28. Read and Write Tests
 29. Write Filemarks
 30. Read or Write Files
 31. Erase
 32. Reset Drive
 33. Set Block Size
 34. Retension Tape
 35. Query/Set Tape Position
 36. Query Tape Status
 37. Load Tape
 38. Unload Tape
 39. Lock Tape Drive Door
 40. Unlock Tape Drive Door
 41. Take Tape Offline
 42. Enable/Disable Compression
 43. Flush Drive's Buffer
 44. Self Test
 45. Display Message

----- IBMtape Commands: -----
 46. Query Sense
 47. Query Inquiry
 48. Query/Set Tape Parameters
 49. Query/Set Tape Position
 50. Query/Set MT/ST Mode
 51. Report Density Support
 52. Locate Tape Position
 53. Read Tape Position
 54. Query Mtdevice Number
 55. Synchronize Buffers
 56. List Tape Filemarks

----- Service Aid Commands: -----
 70. Dump Device
 71. Force Dump
 72. Load Ucode
 73. Reset Drive

-----
 99. Back To Main Menu
```

Enter Selection:

Example 8-29 is an example of using IBMtapeutil that shows sending a SCSI inquiry command to the tape device.

Example 8-29 Sending a SCSI inquiry command to an LTO tape drive with tapeutil

Enter Selection: 1

Enter device name (<enter> for /dev/IBMTape0): /dev/IBMTape1

Select mode (<enter> or 1=Read/Write, 2=Read Only, 3=Write Only, 4=Append): 1

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

Enter Selection for /dev/IBMtape1: 3

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

Inquiry Data:
 Peripheral Qualifier-----0x00
 Peripheral Device Type-----0x01
 Removal Medium Bit-----1
 Device Type Modifier-----0x00
 ISO version-----0x00
 ECMA version-----0x00
 ANSI version-----0x03
 Asynchronous Event Notification Bit---0
 Terminate I/O Process Message Bit----0
 Response Data Format-----0x02
 Additional Length-----0x33
 Medium Changer Mode-----0x00
 Relative Addressing Bit-----0
 32 Bit Wide Data Transfers Bit-----0
 16 Bit Wide Data Transfers Bit-----0
 Synchronous Data Transfers Bit-----0
 Linked Commands Bit-----0
 Command Queueing Bit-----0
 Soft Reset Bit-----0
 Vendor ID-----IBM
 Product ID-----03592E05
 Product Revision Level-----04B8

vendor1, Length 20b

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	0123456789ABCDEF
0000 -	3133	3030	3030	3031	3330	3036	3337	2030								[13000001300637 0]	
0010 -	0100	4081															[..@.]

vendor2, Length 31

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

Hit <enter> to continue...

(...)

Enter Selection for /dev/IBMtape1: 2

Device closed...

Hit <enter> to continue...

Example 8-30 on page 365 shows that a similar set of commands is available to interact with the tape library (option **2. Changer** from the start display in Example 8-27 on page 362).

Example 8-30 Library command selection display of IBMtapeutil for Linux

```

----- General Commands: -----
    1. Open a Device
    2. Close a Device
    3. Inquiry
    4. Test Unit Ready
    5. Reserve Device
    6. Release Device
    7. Request Sense
    8. Log Sense Page
    Q. Quit IBMtapeutil
    9. Mode Sense Pag
   10. Switch Tape/Changer Devic
   11. Create Special Files
   12. Query Driver Version
   13. Query Device Path
   14. Display All Paths
   15. Enable A Path
   16. Disable A Path

----- Medium Changer Commands: -----
   60. Element Information
   61. Position To Element
   62. Element Inventory
   63. Exchange Medium
   64. Move Medium
   65. Load/Unload Medium
   66. Initialize Element Status
   67. Prevent/Allow Medium Removal
   68. Initialize Element Status Range
   69. Read Device Identifiers

----- Service Aid Commands: -----
   70. Dump Device
   71. Force Dump
   72. Load Ucode
   73. Reset Drive

-----
   99. Back To Main Menu

Enter Selection:

```

8.8.3 Creating a library device table

Operating system device names might not necessarily reflect the order in which the devices are physically installed in the library. Therefore, check your drive configuration carefully. We recommend creating a table, such as Table 8-2.

Table 8-2 Library device table

Device name	Serial number/WWN	Tape drive in the library
IBMtape20	1110067680	Drive 1
IBMtape21	1110068317	Drive 2
IBMtape22	1110067231	Drive 3
IBMtape23	1110059779	Drive 4
IBMtape24	1110067604	Drive 5
IBMtape25	1110064661	Drive 6

See “The tapeutil inqpage command” on page 365 for a way to create this table.

Remember that rebooting the server or executing the **IBMtapeconfig** command refreshes the list. Also, check *Implementing IBM Tape in Unix*, SG24-6502, to understand how the operating system assigns device special file names and the ways to keep them persistent across reboots.

The tapeutil inqpage command

Another method of verifying devices is to issue a **tapeutil** inquiry on log sense page 0x80:

```
tapeutil -f /dev/IBMtape inqpage 80
```

This command will return the serial number of the device represented by the specified device special file. Compare the number to the number written on the drives or to the number returned by the **tapeutil** command (see Example 8-31).

Example 8-31 Verify device by tapeutil inqpage command

```
[root@saab root]# tapeutil -f /dev/IBMtape20 inqpage 80
Issuing inquiry for page 0x80...

Inquiry Page 0x80, Length 14

      0 1  2 3  4 5  6 7  8 9  A B  C D  E F  0123456789ABCDEF
0000 - 0180 000A 3131 3130 3036 3736 3830      [...1110067680  ]
```

Example 8-31 shows that /dev/IBMtape20 is a tape drive with the serial number 1110067680.

8.8.4 Linux on System z

Only Fibre Channel connectivity to 35xx drives and libraries is supported when connecting to Linux in the System z platform. Since 20 February 2003 (in conjunction with the latest SLES 8 Linux distribution from SuSE), the System z platform supports full fabric attachment of SCSI devices to Linux images using the Fibre Channel Protocol (FCP).

In this section, we describe the requirements to enable Fibre Channel connectivity to a native FC tape library only. This section assumes that the correct Fibre Channel Connection (FICON) adapters have been installed and the firmware has been loaded to enable the Fibre Channel Protocol on the FICON device (see Figure 8-10 on page 367 for a typical connectivity setup). For additional FCP connectivity information, refer to:

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

The Fibre Channel topology supported for the System z (z800 and z900) models is fabric only. Point-to-point connection and arbitrated loops are *not* supported by the current System z Fibre Channel Protocol. See *Getting Started with zSeries Fibre Channel Protocol*, REDP-0205, for more details about the supported configurations for Fibre Channel device attachment on System z models.

The Linux Fibre Channel adapter device driver *zfcplib.o* is available in the kernel rpm package from your Linux distributor that supports the System z Fibre Channel Protocol. By default, *zfcplib.o* is not loaded into the running kernel. There are three ways that you can load *zfcplib.o* to see the tape devices on your system:

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

We describe these options in more detail in the following sections.

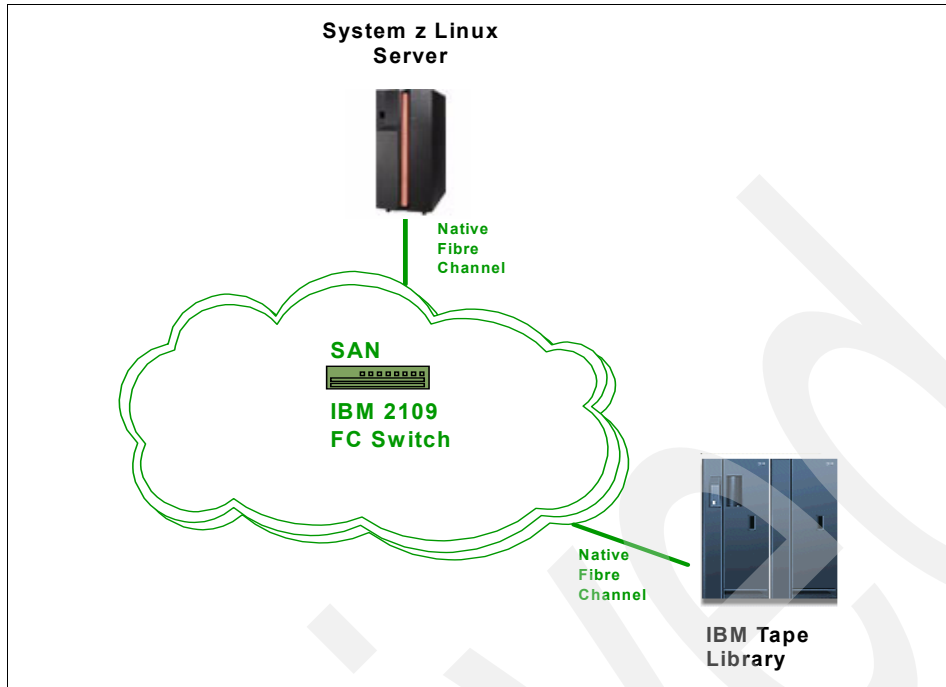


Figure 8-10 Typical System z SAN

Using the `/etc/zfc.conf` file

First, you need add the device map into this file. The following example shows an `zfc.conf`:

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

The `zfc` device driver uses the `map` module parameter to recognize a physically attached tape device. The format of `map` is:

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

Where:

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

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

After you create `/etc/zfc.conf`, run the following commands:

```
>mk_initrd
```

```
>zip1
```

Reboot the system. After it boots up, your tape device shows in the `/proc/scsi/scsi` file.

Modifying the `/etc/modules.conf` file

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

```
options zfc map="\
```

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

```
0xf1c1 0x1:0x5005076300402733 0x0:0x0001000000000000"
```

The map arguments are the same as the ones listed in the `/etc/zfc.conf` file.

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

```
>depmod -A
```

```
>modprobe zfc
```

These commands install the **zfc** device driver and all of its prerequisite kernel modules.

Now, you can check the file `/proc/scsi/scsi` to see if all of the attached tape devices are shown in this file. If not, check the Fibre Channel connections (Fibre cables), if the devices are powered on, and so on.

Finally, run the following commands to install **zfc**:

```
>rmmod zfc
```

```
>modprobe zfc
```

Dynamically attaching a tape device

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

```
>echo "0xf1c0 0x1:0x5005076300402733 0x0:0x0000000000000000;\
```

```
0xf1c1 0x1:0x5005076300402733 0x0:0x0001000000000000">/proc/scsi/zfc/add_map
```

```
>echo "scsi add-single-device 0 0 10">/proc/scsi/scsi
```

```
>echo "scsi add-single-device 1 0 11">/proc/scsi/scsi
```

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

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

After you have done all of the mapping, if you can see all of the attached tape devices in `/proc/scsi/scsi`, you have successfully attached those devices to your system.

8.8.5 IBM 3494 Tape Library device driver installation

The Linux Tape Library Driver (*ibmatl*) is the software for attaching the IBM TotalStorage Enterprise Tape Library 3494 to a Linux server. Use the tape library driver in conjunction with the IBM SCSI Tape and Medium Changer Device Driver for Linux to provide support for 3590 and 3592 tape systems with the Fibre Channel Attachment installed in an IBM 3494.

The software consists of a daemon that communicates directly with the Library Manager of the IBM 3494 Tape Library using Ethernet or token-ring LAN connections, a utility program that provides a command-line interface to the daemon, and a C object module that can be linked with user applications to provide a communication interface with the daemon.

This software is known as a driver throughout this document, because it provides the necessary software and interfaces for the IBM 3494. However, the product does not include a device driver in the true sense of the term. That is, it is not an extension of the operating system kernel, such as a tape device driver.

You start downloading the 3494 device driver package from:

<ftp://ftp.software.ibm.com/storage/devdrv/Linux/IBMatl/>

The IBM Tape Library driver for Linux (*ibmatl*) is supplied in both a tar file and an rpm package. You must have root authority to proceed with the installation of the driver.

Note: In the following explanations, you see file names with *xxxx* or *x.x.x.x* in them. The *xxxx* or *x.x.x.x* refer to the version of the driver, which changes as IBM releases new driver levels. Use the actual driver version numbers as you perform the procedures. Replace the string *os* with *s390* or *i386*, depending on whether you are using an S/390 or an Intel PC client, respectively.

There are two packages available for driver installation. We recommend that you use the rpm package, if possible, rather than the tar file. If you choose the rpm package, use the following command (*os* is either *s390* or *i386*):

```
>rpm -ivv ibmatl.x.x.x.x.os.rpm
```

If you choose the tar file, issue the following commands to extract the files from the archive into the **ibmatl.x.x.x.x.os** directory:

```
tar -xvf ibmatl.x.x.x.x.os.tar
```

Then, execute the following command to change to the new directory:

```
cd ibmatl.x.x.x.x.os
```

And finally, execute:

```
./install
```

This command will install the atldd program.

After the software is installed, edit the /etc/ibmatl.conf file to define the tape libraries to the Imcpd. The format of the file is:

Symbolic name Connection type Identifier Alternate LAN Connection

Symbolic name Used to identify each library.

Connection type Used to define the IP address of the Library Manager.

Identifier Used to specify a name by which the Library Manager identifies the host machine. We suggest that you use the same identifier name that you used on the Library Manager (the host alias as illustrated in Figure 8-2 on page 335).

Alternate LAN connection

Used to specify an alternate IP address for a 3494 High Availability LAN-attached configuration.

The following example shows how to define the library name:

```
lib3494 9.xxx.xx.177 itsolib 9.xxx.xx.178
```

This stanza defines the lib3494 High Availability library connected through TCP/IP to the workstation. The IP addresses of the dual Library Managers are 9.xxx.xx.177 and 9.xxx.xx.178 (see the discussion related to Figure 8-3 on page 335).

MTLIB command-line interface

The MTLIB command is easy to use. It enables you to obtain status information about the library, drives, and cartridges. Using MTLIB, you can mount and demount cartridges and perform insert and eject functions by changing the cartridge's Library Manager category. For more information about MTLIB, see "MTLIB command-line interface" on page 345.

Operational considerations

The Linux operational interfaces and return-to-scratch, insert, and eject processing are similar to those of AIX. See "Operational considerations" on page 347.

8.9 Microsoft Windows NT, Windows 2000 Server, and Windows Server 2003

In this section, we explain how the drivers are installed when working in a Microsoft environment. In our discussion, we describe a Windows Server 2003 example.

The first step is to download the latest tape device driver (called *IBMtape* or *IBMMag*) and the latest library device driver (called *IBMatl*) from the FTP server:

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

8.9.1 Installing the IBM tape device drivers in Windows 2003 Server

If the IBM tape is physically attached, Windows 2003 Server will attempt to automatically install the drivers upon boot. The driver installation wizard appears and requests details regarding the location of the drivers and information files.

If the driver installation wizard does not appear, you can perform a hardware scan from the Device Manager (as shown in Figure 8-11) to detect the added devices and initiate the device driver install wizard.

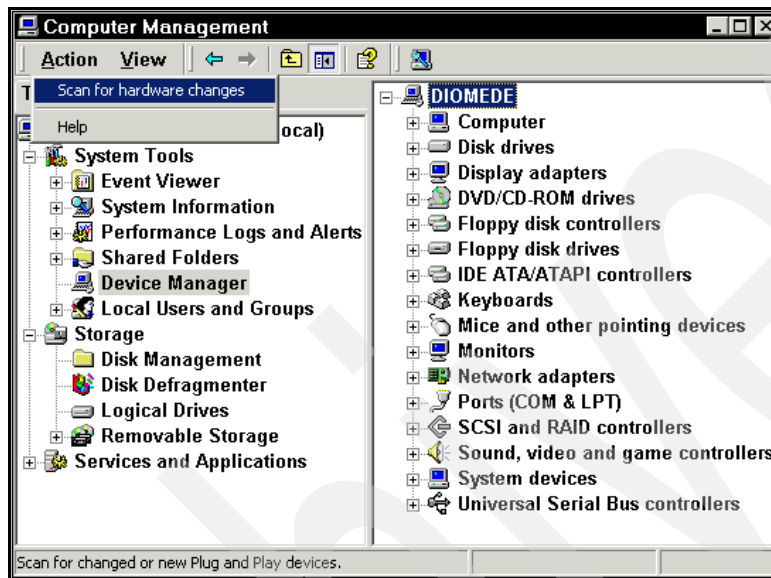


Figure 8-11 Performing a hardware scan

Extracting the drivers

The IBM Tape Device Driver downloads as a zipped package. Unzip the package; in our example, we used the directory D:\IBMdrv\IBMULtrium\5078. The content is shown in Figure 8-12 on page 372.

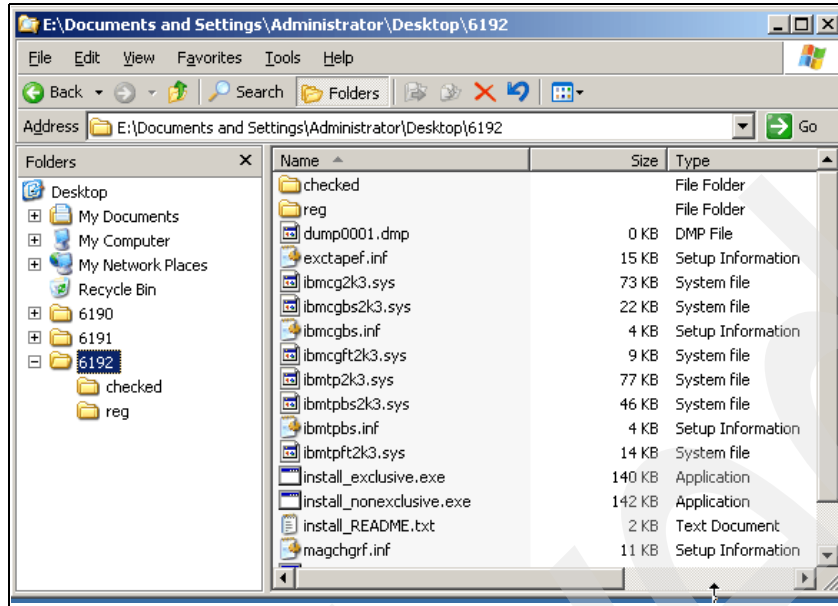


Figure 8-12 Extracted device driver package contents

Installing the tape device driver

You need to install the drivers for each tape device.

The steps are:

1. Right-click **My Computer** on the Windows desktop and select **Manage**. Open **Device Manager** (see Figure 8-13) and expand **Other Devices** to display if you have other devices attached to your computer. After that, select **Tape drives** as in our example and you see the drive.

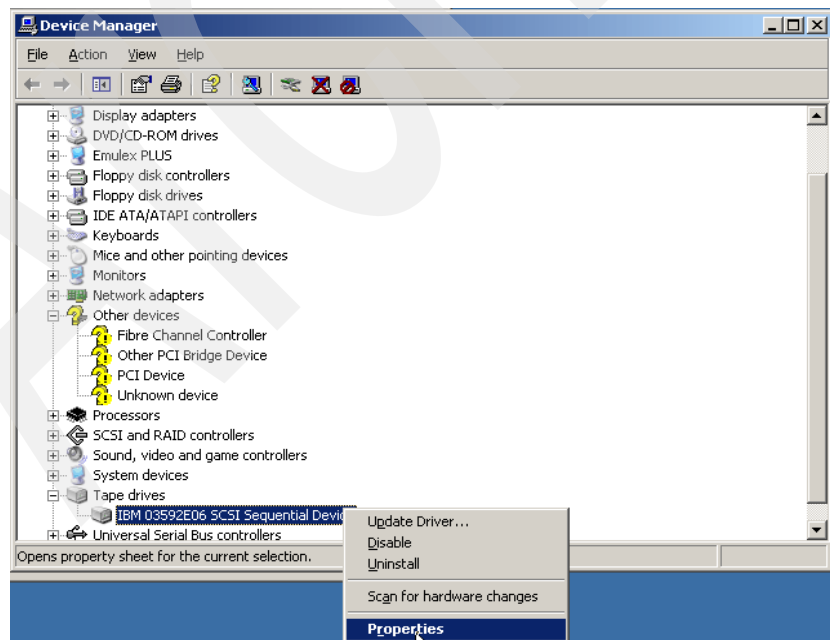


Figure 8-13 Preconfigured tape drives in Device Manager

2. But checking the Device Properties (see Figure 8-14) in fact shows that the drivers are not configured yet. Select **Properties** for the first drive and install the driver using the same process as for the Medium Changer. Click the **Driver** tab, and then click **Update Driver** (see Figure 8-14).

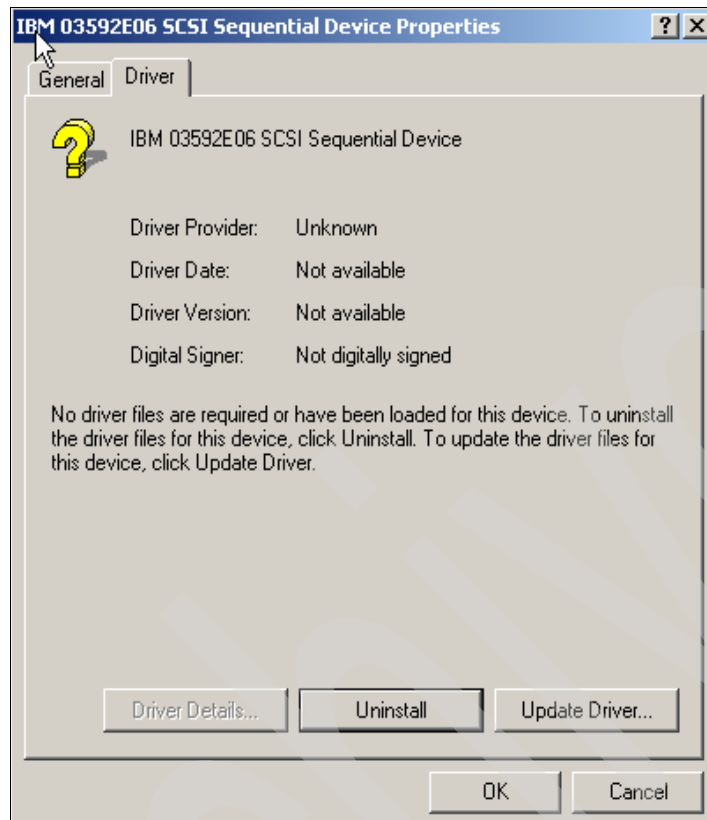


Figure 8-14 The Driver tab of the unconfigured tape drive's properties box

3. You get the Upgrade Device Driver Wizard window (see Figure 8-15 on page 374), prompting you to search for a driver or to display a list of the known drivers for installation. Click **Search for a suitable driver for my device (recommended)**, and then click **Next**.

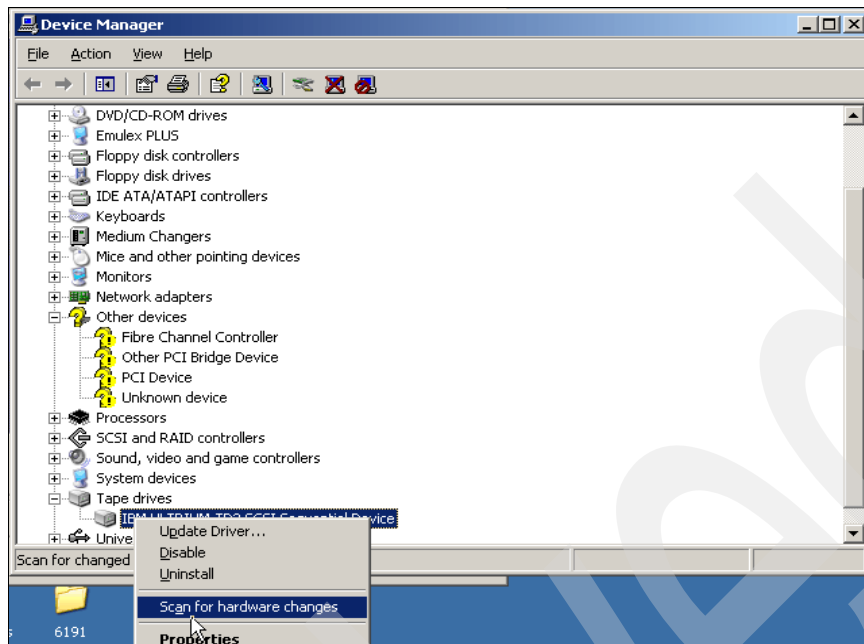


Figure 8-15 Device Driver Wizard install options

4. In the next window for locating the driver files, check the box **Install from a list of specific locations (Advanced)** and then click **Next** (see Figure 8-16).

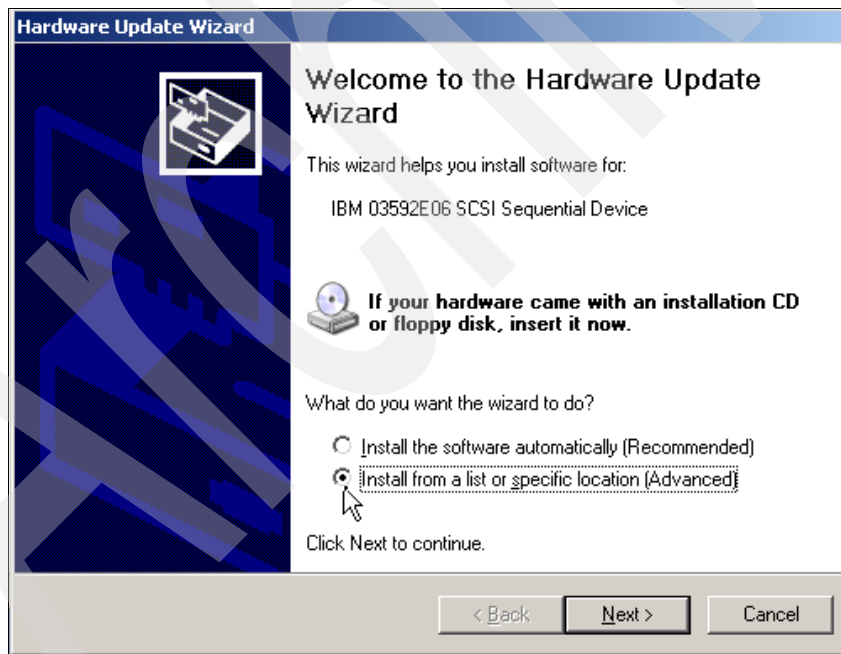


Figure 8-16 Device driver location search options

5. The path to the location of the drivers is presented as in Figure 8-17 on page 375. Specify the directory from where you extracted the downloaded driver zipped file.

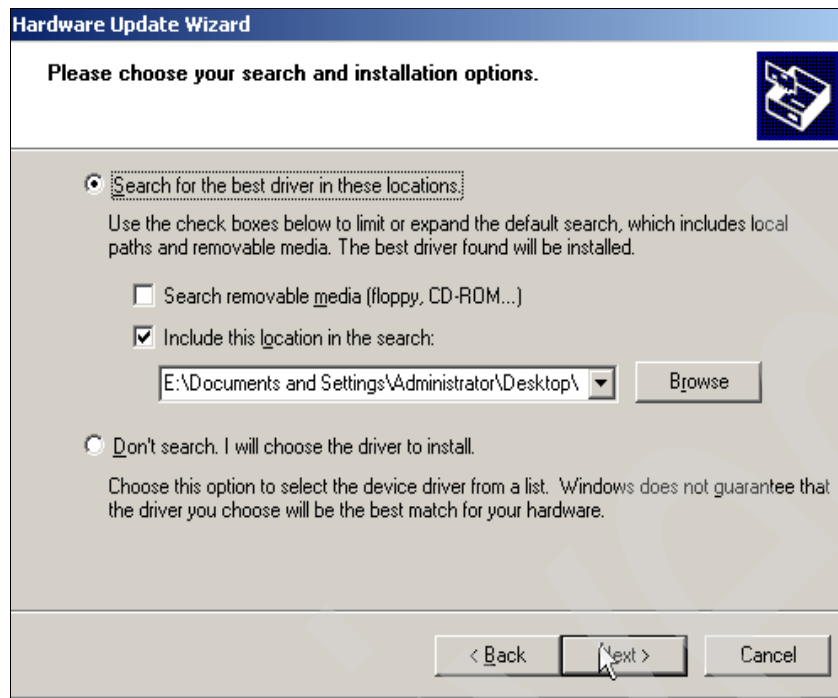


Figure 8-17 Specify a location

6. The wizard locates a device driver as shown in Figure 8-18. If this is the driver version that you want to install, click **Next**; otherwise, select the box labeled **Install one of the other drivers** and click **Next**. Typically, the latest driver version is installed unless there is a specific reason not to do so, such as for independent software vendor (ISV) application support issues.

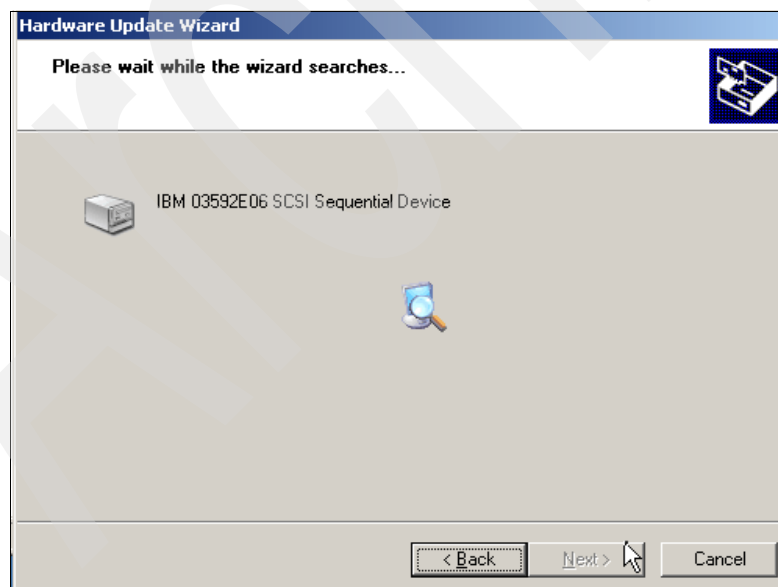


Figure 8-18 Search results

7. The Device Driver Wizard proceeds to install the device driver and informs you when the installation is complete as Figure 8-19 on page 376 shows.



Figure 8-19 Device Driver Wizard completion

8. We recommend that you reboot the system to ensure a clean installation of the drivers.

Removable Storage Manager (RSM) users

Levels of the Windows 2000 Server and Windows Server 2003 Device Driver 5.0.4.9 through 5.0.5.8 permit multiple opens on a single tape drive. This change was made to enable the use of RSM™ on Windows Server 2003. For those levels of the device drivers, system administrators are responsible for ensuring that a single tape drive is never accessed by more than one application at a time in order to prevent potential data loss.

Driver level 5.3.2 and thereafter are necessary whether or not you are a Tivoli user, so that you can prevent a tape drive from being accessed by more than one process and potentially causing data to be corrupted or lost. However, if you use RSM, you need to use the other driver and take steps to ensure that multiple opens to a tape drive do not occur.

To select the driver:

1. If you use driver level 5.0.5.9 or later, the Driver Files Search Results window prompts you to choose between drivers during installation (see Figure 8-20 on page 377). This window presents you with a default driver choice and a check box labeled **Install one of the other drivers**. Select this check box and click **Next**.

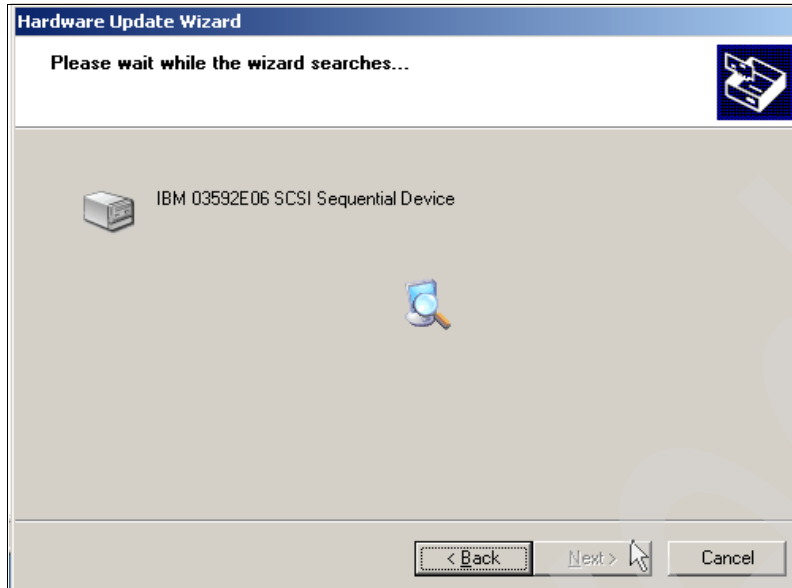


Figure 8-20 Install one of the other drivers if using RSM

2. Then, choose the driver from the list that best suits your needs (Figure 8-21) and click **Next**.

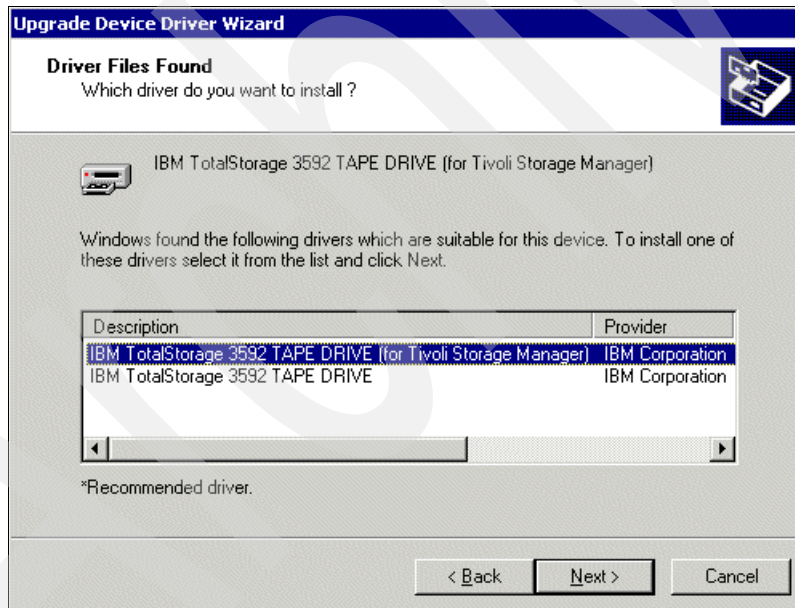


Figure 8-21 Choose the driver that best suits your needs from the list

3. The Device Driver Wizard proceeds to install the device driver and informs you when the installation is complete as Figure 8-22 on page 378 shows.



Figure 8-22 Device Driver Wizard completion for RSM users

8.9.2 Verifying the IBM tape device driver installation

You can initially verify the device driver installation for the medium changer and tape devices through Device Manager. The steps are:

1. To view any installed tape devices and medium changers, right-click **My Computer** on the desktop, then select **Manage** → **Device Manager** (see Figure 8-23).

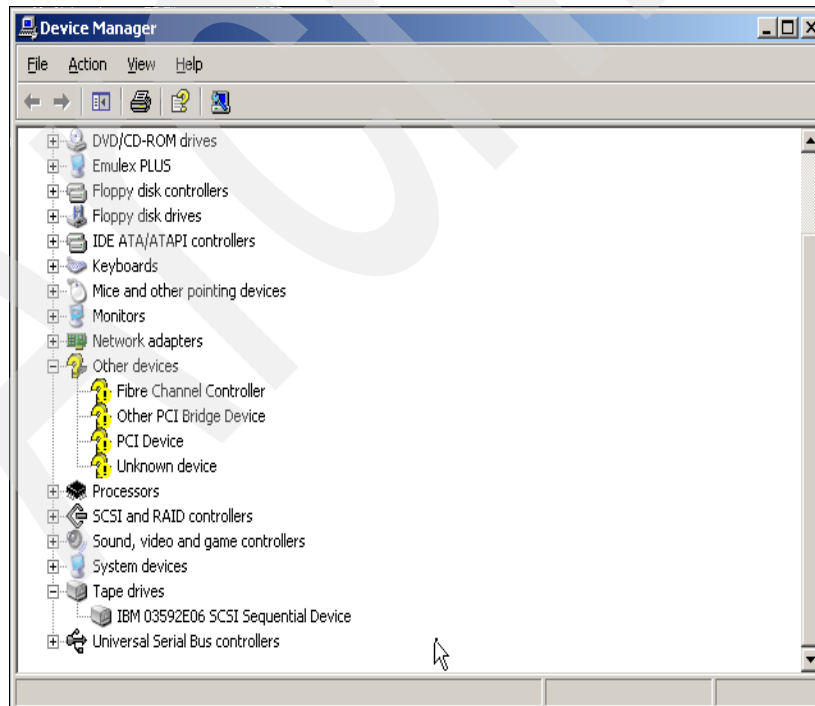


Figure 8-23 Viewing an IBM tape device in Device Manager

- Now, right-click each of the devices and select **Properties**. If properly configured, the windows show **Manufacturer** as IBM Corporation (see Figure 8-24), **Driver provider** as IBM Corporation, and **Driver version** as the version that you have installed (see Figure 8-25).

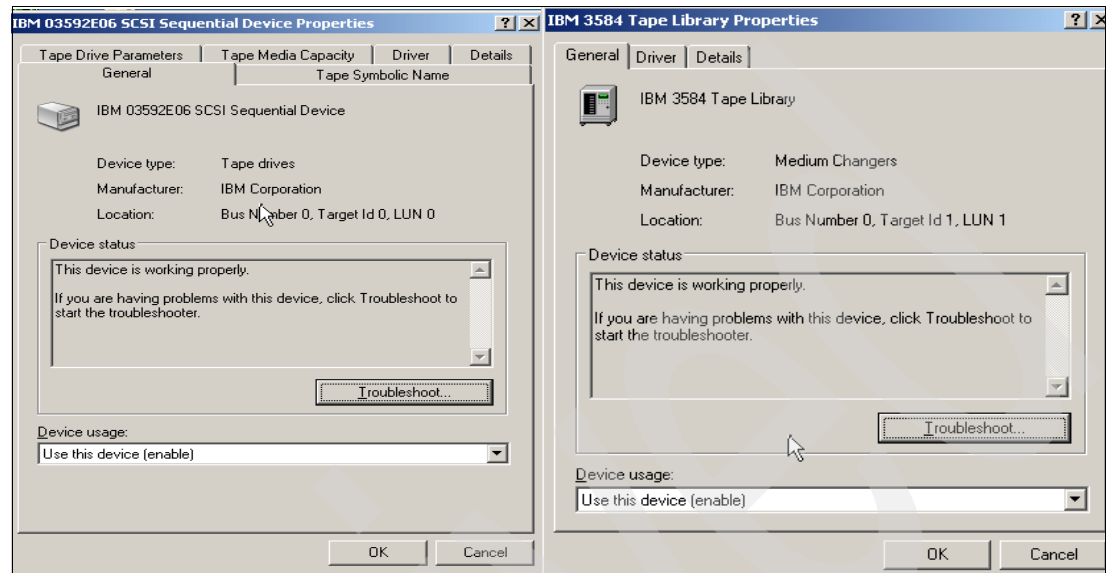


Figure 8-24 Driver details on General tab

- The driver level for the device is shown in the Driver tab in Figure 8-25. Note that the driver is not digitally certified by Microsoft at this time, but is still supported by IBM.

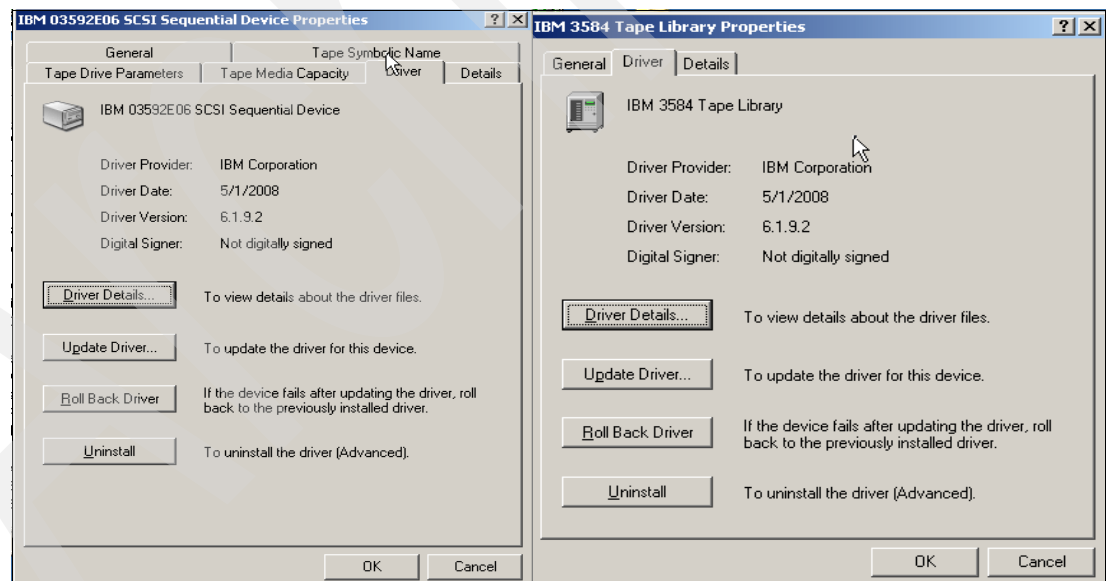


Figure 8-25 Driver tab

- If you click **Driver Details**, you then get the detailed information for the drivers as shown in Figure 8-26 on page 380.

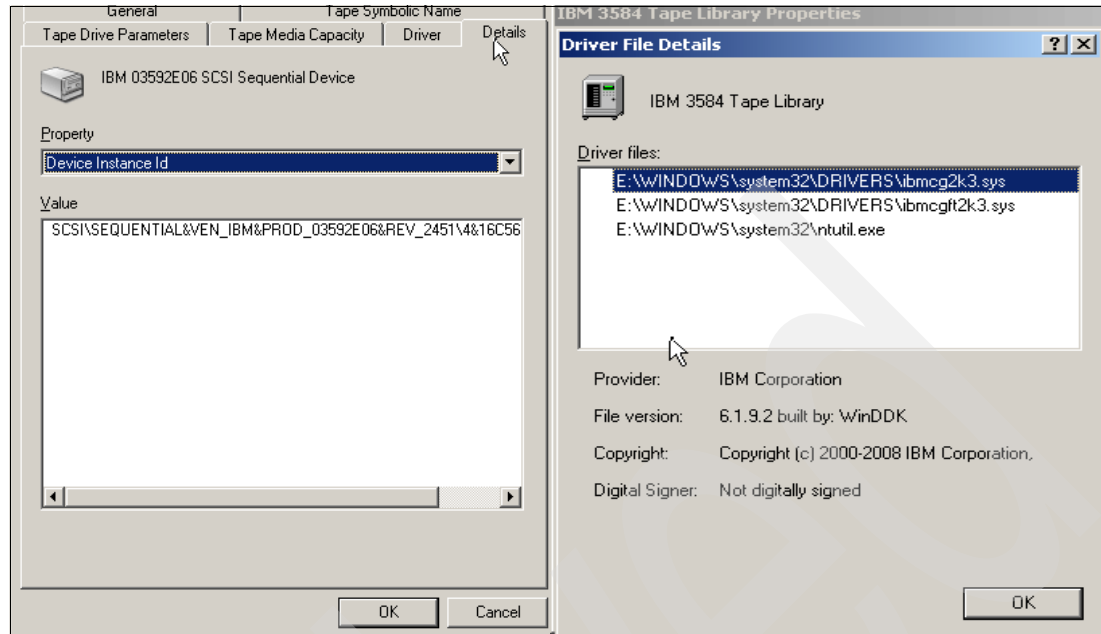


Figure 8-26 Driver File Details

5. You can now use the NTUTIL utility to test the library. This utility allows you to open the device, issue inquiry commands, read and write, and move media within the library to ensure that the devices function and operate correctly with the installed driver.

8.9.3 Testing the library with NTUTIL

NTUTIL is a utility that comes packaged with the tape device drivers. Use it to perform several functions, including:

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

In our example, we used NTUTIL to test basic operations as a way of verifying that we installed the IBM 3494 Tape Library and drives correctly.

Note that you must stop the Removable Storage Manager (RSM) service in Windows before you can use NTUTIL. NTUTIL will not have visibility of the devices until RSM releases them. Alternatively, you can simply disable the IBM 3494 Tape Library in RSM.

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

You have unpacked NTUTIL along with the device drivers. Install it at any location, but you typically install it in the c:\winnt\system32 directory. Because this directory is in the system path, you can run NTUTIL from any command line. When NTUTIL is invoked without arguments, it starts in interactive mode.

There are two modes in which NTUTIL can run: base mode and library mode. The default mode is base mode. The library mode only applies to the SCSI Library and not to the IBM 3494 Tape Library.

Example 8-32 shows the main menu, which presents the option to run the utility in interactive (manual) or batch mode.

Example 8-32 NTUTIL main menu

NTutil - Copyright (c) 1997-2004 IBM Corporation

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

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

Enter selection:

Selecting option **1: Manual test** provides the following menu for interactive commands (see Example 8-33).

Example 8-33 NTUTIL manual test menu (base mode)

Test tool version 5.0.7.5
Variable settings
===== BASE MODE =====

tape-special-file-name: tape0
gp->fd0=FFFFFFFF gp->fd1=FFFFFFFF block size=1024 block count=1
hex block id = 0000000000000000
return_error_when_fail 1 exit_on_unexpected_result 0 trace_flag 0

manual test menu:
=====

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

```

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

```

```

=====
enter selection:

```

Note that option 8 says **Library Mode**, which indicates then that NTUTIL runs in base mode.

To view the installed library and drive, select option **88: List registered devices**. The bus, target ID, and LUN ID for each device are also shown here. Example 8-34 shows a list of the configured devices.

Example 8-34 Registered devices on a SAN

```

=====
enter selection: 88
Device found: Tape0 @"Scsi Port 2\Scsi Bus 0\Target Id 2\Logical Unit Id 0"
Device found: Tape1 @"Scsi Port 2\Scsi Bus 0\Target Id 3\Logical Unit Id 0"
Device found: Tape2 @"Scsi Port 2\Scsi Bus 0\Target Id 4\Logical Unit Id 0"
Device found: Tape3 @"Scsi Port 2\Scsi Bus 0\Target Id 5\Logical Unit Id 0"
Total elapsed time in seconds =      0.00
Return to continue:

```

To perform any operation, you usually need to open the desired device (option **1: set device special file**), then select the appropriate device from the device listing, and open it (option **20: open**). Example 8-35 and Example 8-36 show these selections.

Example 8-35 Selecting a device special file

```

=====
enter selection: 1
Enter device special file (tape path) name or return for no change: tape1
Total elapsed time in seconds =      6.00
Return to continue:

```

Example 8-36 Performing an open call on a selected device special file

```

=====
enter selection: 20
Enter open mode (1) RW (2) RO: 1
special file (\\.\tape1) will be opened
analyze() called with rc 6 err 0 (ERROR_SUCCESS) data 0
Total elapsed time in seconds =      1.00
Return to continue:

```

After the tape is mounted (through **mtlib**), you can perform a Read/Write (R/W) test (option **87: Read/Write Test**) on the cartridge (see Example 8-37 on page 383). Note that this test overwrites any data on the tape (NTUTIL does not interact with any applications, so it is unaware whether the tape has valid data); therefore, be careful about which tape you choose for this operation.

Example 8-37 Read/write test

```
enter selection: 87
This will rewind and write on tape! Are you sure?? Y or N
y
ntutil execute_command_read_write test
rewinding
Rewind OK, set blocksize to 32K
Set Block Size OK, writing 32K
Write 32K OK, rewinding
Rewind after Write OK, reading data
Read after Rewind OK, comparing data
analyze() called with rc 1 err 0 (ERROR_SUCCESS) data 0
Total elapsed time in seconds = 6.00
Return to continue:
```

The tape has been successfully written as shown in Example 8-37. We can now unload the cartridge by selecting option **33: unload** (see Example 8-38).

Example 8-38 Unload

```
enter selection: 33
analyze() called with rc 0 err 0 (ERROR_SUCCESS) data 0
Total elapsed time in seconds = 23.00
Return to continue:
```

To display information about the drive, use option **49: inquiry** (see Example 8-39).

Example 8-39 Inquiry

```
enter selection: 49
Drive = 0, Library = 1: 0
Device Path SCSI data:
PortNumber 2, PathId 0
TargetId 2, Lun 1
INQUIRY data:
devtype(0): 01, rmb(1): 80
ASO/ECMA/ANSI(2): 03, resp_data_fmt(3): 02
additional_length(4): 33, reserved(5): 00
SCSI_3(6): 10, flags(7): 00
vendor_id (8-15): IBM
product_id (16-31): 03592J1A
Microcode Revision Level (32-35): 04C4
vendor specific (bytes 36-55):
31 33 30 30 30 30 31 33 30 30 31 37 38 20 30 01 00 40 81
analyze() called with rc 1 err 0 (ERROR_SUCCESS) data 0
Total elapsed time in seconds = 8.00
Return to continue:
```

You can also run NTUTIL in batch mode. For more information about NTUTIL, refer to the *IBM Ultrium Device Drivers: Installation and User's Guide*, GA32-0430. This guide is installed with the packaged device drivers. *IBM TotalStorage Ultrium Device Drivers Programming Reference*, GC35-0483, has information about issuing commands to tape device drivers and manipulating tape application programming interfaces (APIs).

8.9.4 Configuring tape and medium changer devices

You can alter certain default operating parameters for the medium changer and tape devices using NTUTIL through **Set** commands that allow you to change these parameters:

- ▶ Drive Compression - default: (0=off)
- ▶ Block size - default: (0=variable)
- ▶ Block ID

To activate (on) or deactivate (off) drive compression, open NTUTIL, select option **20: open**, and then select option **44: set dev parms (compression)**. A value of 0 indicates compression is off and any other value indicates compression is on (see Example 8-40).

Example 8-40 Activating compression

```
enter selection: 44
Compression off = 0, on = 1: 1
execute set_device_parameters compression = ON
analyze() called with rc 0 err 0 (ERROR_SUCCESS) data 0
Total elapsed time in seconds = 4.00
Return to continue:
```

You can also alter the drive block size similarly with option **43: set media parms (block size)**. This size is 0 (variable) by default. Certain backup applications can override this value.

8.9.5 IBM 3494 library device driver installation

The Windows Automated Tape Library Service is software that provides attachment for the IBM 3494 Enterprise Tape Library to workstations running Microsoft Windows NT 4.0, Microsoft Windows 2000 Server, or Microsoft Windows Server® 2003. The software consists of a tape library service that communicates directly with the Library Manager of the IBM 3494 through LAN, which is a utility program that provides a command-line interface to the service. This utility program also provides a static library and a dynamic link library (DLL), which you can use to provide a communication interface with the service. The IBM Automated Tape Library service is provided in the installation package.

Download the package from:

<ftp://ftp.software.ibm.com/storage/devdrv/Windows/ibmatl/>

The installation file is named `ibmatl.x.x.x.x.exe` or `ibmatl64.x.x.x.x.exe` (for example, `ibmatl.4.0.3.0.exe`). When you execute this file, you see windows indicating the image is being unpacked. Follow the instructions on the windows.

After you install the software, you must edit the `c:\winnt\ibmatl.conf` file to define the tape libraries to the `lmcpd`. The format of the file is:

Symbolic name Connection type Identifier Alternate LAN connection

Symbolic name	Used to identify each library.
Connection type	Used to define the IP address of the Library Manager.
Identifier	Used to specify a name by which the Library Manager identifies the host machine. We suggest that you use the same identifier name that you used on the Library Manager (the host alias as illustrated in Figure 8-2 on page 335).

Alternate LAN connection

Used to specify an alternate IP address for a 3494 High Availability LAN-attached configuration.

The following example shows how to define the library name:

```
lib3494 9.xxx.xx.177 itsolib 9.xxx.xx.178
```

This stanza defines the lib3494 High Availability library connected through TCP/IP to the workstation. The IP addresses of the dual Library Managers are 9.xxx.xx.177 and 9.xxx.xx.178 (see the discussion related to Figure 8-3 on page 335).

Because this program starts as a Windows service, check that the IBM Automated Tape Library service is started (see Figure 8-27). Set the **Startup type** to **Automatic** to ensure that the service is started after every reboot.

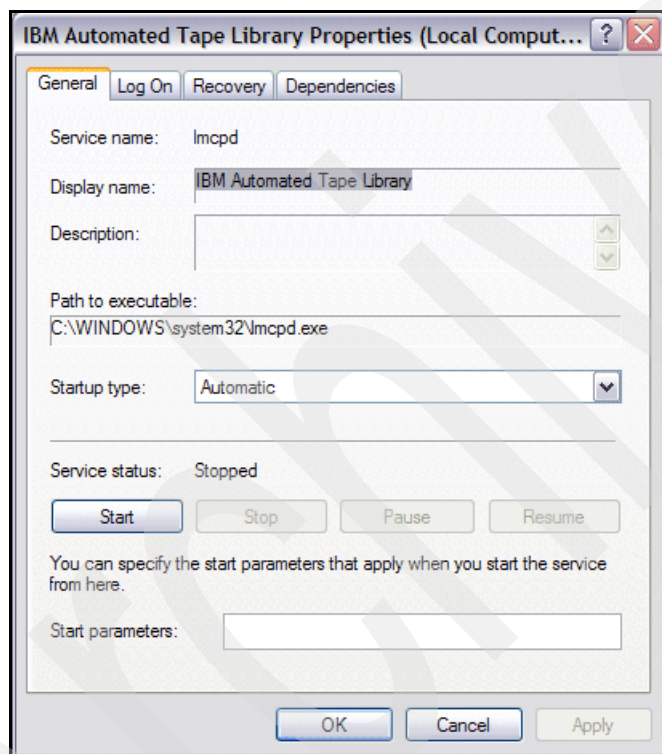


Figure 8-27 IBM Automated Tape Library properties

MTLIB command-line interface

The MTLIB command is easy to use. It enables you to obtain status information about the library, drives, and cartridges. Using MTLIB, you can mount and demount cartridges and perform insert and eject functions by changing the cartridge's Library Manager category. For more information about MTLIB, see "MTLIB command-line interface" on page 345.

8.10 i5/OS

The System i servers support the attachment of both Ultra SCSI and Fibre Channel IBM 3590 and IBM 3592 tape drives, as well as the IBM 3494 Tape Library. For implementation of IBM tape with System i servers, refer to *Implementing IBM in i5/OS*, SG24-7440.

8.11 IBM Tivoli Storage Manager considerations

This section discusses the major implementation steps for IBM Tivoli Storage Manager (TSM). Note that the steps, as well as the TSM commands, are the same across all Open Systems platforms.

For IBM Tivoli Storage Manager to use the IBM 3494 Tape Library, follow these steps:

1. Define the tape library.
2. Define the library-resident drives.
3. Define the storage pool device class.
4. Define the storage pool.
5. Define the tape volumes in the storage pool.
6. Check in the volumes to the storage pool.
7. Change the Management Class to use the new storage pool.

Although the TSM commands are the same for the various platforms, the parameters vary. The example in the following sections refers to an implementation in an AIX environment.

8.11.1 Defining the tape library and tape drives to IBM Tivoli Storage Manager

To define the library and type of library to IBM Tivoli Storage Manager, use the `DEFINE LIBRARY` command as shown here. We used the abbreviated versions of the parameters.

```
DEF LIBR LIB3494 LIBT=349X SCRATCHCAT=301 PRIVATCAT=300 DEVI=/dev/lmcp0
```

LIB3494 is the library name. This name can also be the name used for the LMCP. The IBM Tivoli Storage Manager Library Manager categories are 012d and 012c for scratch and private volumes, respectively. In IBM Tivoli Storage Manager, the category numbers are in decimal, and in the Library Manager, they are in hex. You can change the IBM Tivoli Storage Manager scratch and private default Library Manager categories in the `DEFINE LIBRARY` command (except for those categories reserved for the Library Manager) as shown in the example.

Next, you use the `DEFINE DRIVE` command to define the devices inside the library.

```
DEF DR LIB3494 ATLDR1 DEVI=/dev/rmt1
```

In this example, we define the tape drive that is accessed through the AIX special drive to IBM Tivoli Storage Manager:

```
/dev/rmt1
```

The drive is known to IBM Tivoli Storage Manager as ATLDR1. It resides in the library called LIB3494.

Before you define the storage pool, you must define the type of devices within the storage pool using the `DEFINE DEVCLASS` command. You cannot mix 3592, 3590, and 3490E drives in the same device class or in the same storage pool. We show the command to define a device class for the 3590 tape drives in our IBM 3494 Tape Library in the following example. For other parameters, we use the default values:

```
DEF DEV ATLDEVCL DEVT=3590 LIBR=LIB3494
```

Use the `DEFINE STGPOOL` command to define a storage pool that the IBM 3494 Tape Library uses:

```
DEF STG ATLP00L ATLDEVCL
```

The storage pool is called ATLP00L. The class of device with that pool is defined by the ATLDEVCL device class. For other parameters, we use the defaults.

Using the DEFINE VOLUME command as shown in the following example, you can manually define the volumes that IBM Tivoli Storage Manager will have in a storage pool:

```
DEF V ATLP00L AD5M01 ACC=READW
```

Alternatively, you can use the MAXSCRATCH parameter of STGPOOL to allow IBM Tivoli Storage Manager to get its own scratch volumes from the Library Manager IBM Tivoli Storage Manager scratch category.

We defined the cartridge with a volume serial number (VOLSER) of AD5M01 that belongs to a storage pool called ATLP00L.

Before IBM Tivoli Storage Manager can use the volumes, you must label the volumes. IBM Tivoli Storage Manager provides a program (DSMLABEL) to label the volumes. DSMLABEL with the **-search** parameter labels all cartridges in the INSERT category. Use care so that only the cartridges to be used by IBM Tivoli Storage Manager are in this category. Here is an example of a DSMLABEL command:

```
dsmlabel -drive=/dev/rmt1 -drive=/dev/rmt2  
        -library=/dev/lmcp0 -search -keep
```

If the **-keep** parameter is not specified, the cartridge is placed in the convenience I/O station after it is labeled.

After the cartridges are labeled, the Library Manager category is assigned to them by issuing the CHECKIN LIBVOLUME command to eject volumes from an IBM 3494 Tape Library. Here is an example of a CHECKIN LIBVOLUME command:

```
CHECKI LIBV PAINLESS AD5M01 STAT=SCR CHECKL=N0 DEVT=3590
```

We assign cartridges with a VOLSER number of AD5M01 to the IBM Tivoli Storage Manager Library Manager scratch category. By specifying CHECKL=N0, we tell IBM Tivoli Storage Manager that we do not want the label to be checked. If all of the volumes in the Library Manager insert category are to be in IBM Tivoli Storage Manager, we use the SEARCH=YES parameter and do not specify a VOLSER number. Be careful when using this parameter if you share the IBM 3494 Tape Library with other hosts.

8.11.2 Tivoli Storage Manager using 3592 capacity scaling

The 3592 family of drives supports scaling and segmentation modes on the R/W (JA/JB) cartridges to allow a capacity trade-off for improved access times.

Tivoli Storage Manager can utilize these functions by specifying the SCALECAPACITY parameter with the command define/update devclass. A cartridge is initialized according to the SCALECAPACITY parameter when it is first mounted to the drive. It stays in the SCALECAPACITY setting until it returns to scratch state. Each of the SCALECAPACITY parameter settings (20/90/100) will initialize, for example, a JA Media cartridge on a 3592-J1A as depicted in Figure 8-28 on page 388.

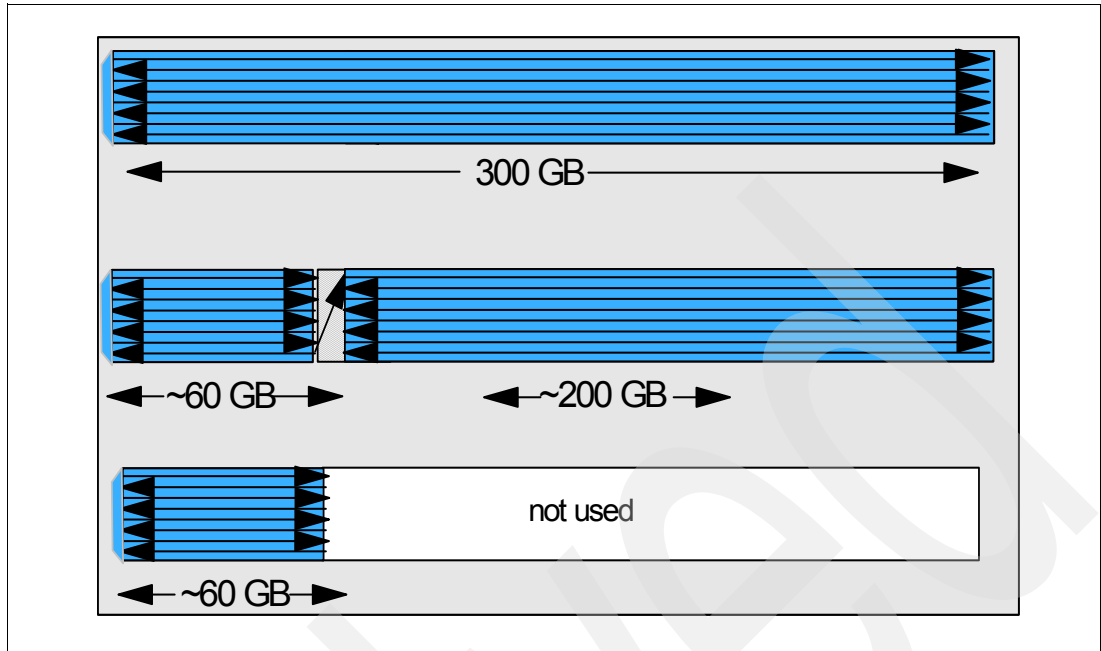


Figure 8-28 Scaled capacities

When SCALECAPACITY is set to 100 (default), Tivoli Storage Manager initializes the cartridge as a 300 GB cartridge. When set to 90, it initializes the cartridge as a segmented tape. When set to 20, it initializes the cartridge to use only the first 60 GB. There is no practical reason for using SCALECAPACITY=90, because you cannot control where the data is written on the tape. After the first 60 GB segment is filled, the drive proceeds to write on the rest of the (slower-access) tape. Each of the segmented parts needs to be defined to a different storage pool to fully utilize the segmented function, but with the current Tivoli Storage Manager architecture, it is not possible to define two storage pools from one volume.

Available 3592 tape formats for the 3592 tape drives are:

- ▶ JA Data cartridge R/W
- ▶ JJ Economy Data R/W
- ▶ JW WORM
- ▶ JR Economy WORM
- ▶ JB Extended Data R/W
- ▶ JX Extended WORM

For JA and JB cartridges, define device class in the following manner; you have the option to specify the SCALECAPACITY parameter:

```
DEFINE DEVCLASS devclass_name DEVTYPE=3592 FORMAT=3592/3592c/drive \
LIBRARY=library_name SCALECAPACITY=20/90/100
```

For JJ cartridges, define device class as:

```
DEFINE DEVCLASS devclass_name DEVTYPE=3592 FORMAT=3592/3592c/drive \
LIBRARY=library_name
```

For JW, JR, and JX cartridges, define device class as:

```
DEFINE DEVCLASS devclass_name DEVTYPE=3592 FORMAT=3592/3592c/drive \
LIBRARY=library_name WORM=yes
```

The SCALECAPACITY parameter with a value other than 100 (default) can be specified only with the standard-length R/W cartridge.

When the short-length cartridges are initially defined to a storage pool, the query volume and query stgpool commands show you 300 GB (or 900 GB for compression) for each of the volumes defined. When the EOVS (end-of-volume) is reached, query commands show you the actual data written for the volume.

WORM data cartridges are designed to provide non-alterable, non-rewritable tape media for long-term records retention. The drive automatically determines if the mounted volume is a WORM or R/W cartridge. To use this function, specify the WORM=yes parameter in the command define/update devclass. TSM Version 5.2.3 or later is required. Because TSM can distinguish between WORM and R/W cartridges (it assigns “media type” of 412 for WORM cartridges and 411 for R/W cartridges at the time of check-in), you can have both WORM and R/W cartridges in a single logical library just by defining one device class with WORM=yes and the other device class with WORM=no.

Archived

Operating the IBM TotalStorage 3494 Tape Library

This chapter discusses the operation of the IBM 3494. It includes information about generic tape library operating procedures and operations in a z/OS environment.

This chapter does not include details about the operation of the tape drives, because the library performs all cartridge mount and demount operations. Operational knowledge of the tape drive is required only for error recovery (see 9.8, “Error handling and recovery summary” on page 442) or manual mode operation (see 9.4.10, “Handling manual mode operation” on page 417).

9.1 Library operation overview

During normal library operation, there is no need for any operator involvement with the exception of adding or removing cartridges from the library enclosure. The library attempts to recover from errors without operator intervention. The library requires operator intervention only if it is unable to recover. The cleaning of the tape drives is carried out automatically on the basis of the rules that you defined through the Library Manager.

The Library Manager application has detailed help. You can access the help by pressing the F1 key or using the Help menu. For ease of use, we recommend that you use the operator panel on the IBM 3494 (rather than the Library Manager) to change the operational mode and power status.

The Library Manager application provides two menus: the operator menu and the service menu. The service menu provides additional options under the operator menus, such as the service menu that the IBM service support representative (SSR) uses to maintain and repair the library. The service menu can be password-protected if that option is chosen during the library teaching process.

You can make selections from the action bar of the operator or service menu with choices from the menus, or by using active radio buttons, check boxes, and buttons. Although you can use either the keyboard or the pointing device to make your choices, the pointing device is the preferred method for ease of use.

You can obtain more operating information in the *IBM TotalStorage Automated Tape Library (3494) Operators Guide*, GA32-0449.

9.2 Operational modes and states

At any point in time, the current operational status of the tape library is defined by a combination of:

- ▶ An operational mode
- ▶ An operational state
- ▶ One or more informational states

Operational modes describe accessor movement. *Operational states* describe the status of the Library Manager or library power. *Informational states* describe any error or abnormal library condition. The following sections provide detailed information about operational modes, operational states, and informational states.

9.2.1 Operational modes

The IBM 3494 can be in any of three operational modes, but only one mode at a time. The library must complete mode transition before the mode can be changed again. The three operational modes are:

- ▶ Auto
- ▶ Pause
- ▶ Manual

The operational mode of the library is changed through the Mode menu on the Library Manager or the auto and pause buttons on the IBM 3494 operator panel.

Auto mode

In auto mode, the library is under the control of the Library Manager. The accessor moves under the control of the Library Manager to carry out mount, demount, and cartridge movement requests. To be in auto mode, all safety circuits must be complete. From auto mode, you can go to pause or manual mode. If you select manual mode, the library goes into pause mode before it enters manual mode.

Pause mode

Pause mode is intended to allow the operator to access the interior of the IBM 3494. While the library is in pause mode, the mount and demount commands that require accessor movement are queued until the library returns to auto mode. The Library Manager responds to host requests for status information. From pause mode, you can change the library operational mode to either auto or manual.

Manual mode

Manual mode is intended to allow 100% library availability. It enables the library to be operated manually under the control of the Library Manager in the event of an accessor failure or during preventive maintenance. From manual mode, you can go to pause or auto mode. If you select auto mode, the library goes into pause mode before it enters auto mode. During manual mode operation, the Library Manager receives requests from the attached host and displays the action (mount or demount), volume serial number (VOLSER), storage cell location, and drive address on the Library Manager console and tape drive message panels.

Home-cell mode

The 3494 Tape Library operates in either fixed home-cell or floating home-cell mode. The service representative makes the home-cell mode selection during the teach process:

- ▶ Fixed home-cell
Fixed home-cell mode assigns each physical cartridge to a fixed storage cell location when it enters the 3494 Tape Library. It is always returned to the same location after it is used.
- ▶ Floating home-cell
A physical cartridge is put into a cartridge cell location that optimizes performance.

When in manual mode, the 3494 Tape Library operates in fixed home-cell mode regardless of the home-cell mode specified during installation.

9.2.2 Operational states

The operational states are:

- ▶ Library Manager initialization
- ▶ Initialization complete
- ▶ Offline
- ▶ Online
- ▶ Shutdown pending
- ▶ Library Manager switchover in progress (only the IBM 3494 with Model HA1 installed)
- ▶ Accessor switchover in progress (only the IBM 3494 with Model HA1 installed)

- ▶ Dual Active Accessor enabled/disabled (only the IBM 3494 with Dual Active Accessor feature)
- ▶ Dual Active Accessor transitioning (only the IBM 3494 with Dual Active Accessor feature)

Library Manager initialization

Library Manager initialization loads the Library Manager application, powers on and tests the interfaces to the tape subsystems and hosts, and verifies the Library Manager database.

Initialization complete

After the Library Manager successfully completes initialization, the library becomes operational. You can set the operational mode and state (online or offline) through the Library Manager after the initialization is complete. If they are not set, a timeout occurs, and the library enters the default mode and state. If any library components are not available after the initialization is complete, the operation mode and state are set to match the current component availability. The library does not exit or complete the initialization if it has not been taught or inventoried.

Offline

The Library Manager is offline. It does not respond to any host requests, although it accepts commands entered through the Library Manager.

Online

The Library Manager is online and accepts commands from host requests. This state is the normal operational state of the Library Manager.

Shutdown pending

The Library Manager is in the process of terminating the Library Manager application, after power is removed from the library. After shutdown is complete, you can initialize the Library Manager application by pressing Ctrl+Alt+Delete on the Library Manager keyboard. If you press the Power Off button on the IBM 3494 operator panel, the Library Manager enters shutdown pending before the power is removed. When you select shutdown by using the Mode menu, the Library Manager enters into this state.

Library Manager switchover in progress

This operational state is available only on an IBM 3494 with the High Availability (HA) unit installed. In the dual Library Manager configuration, this state occurs when the active and standby Library Managers switch roles on a failure or on request by the operator. The Library Manager is in this state until the switchover completes. The switchover can take several minutes to complete.

Accessor switchover in progress

This operational state is available only on an IBM 3494 with the High Availability unit installed. In the dual accessor environment, this state occurs when the active and standby accessors switch roles on a failure or on request by the operator. This switchover can take several minutes to complete.

Dual Active Accessor enabled or disabled

These operational states are possible only on an IBM 3494 with the High Availability unit and Dual Active Accessor feature installed. The Dual Active Accessor environment can be enabled by the operator and disabled by a failure of one accessor or on request by the operator.

Dual Active Accessor transitioning

This operational state is possible only on an IBM 3494 with the High Availability unit and Dual Active Accessor feature installed. In the dual accessor environment, this state is initiated by failure of one accessor or on request by the operator. Transitioning can take several minutes to complete.

9.2.3 Informational states

The informational states are:

- ▶ Degraded operation
- ▶ Safety enclosure interlock open
- ▶ Barcode reader or vision system nonoperational
- ▶ Intervention required
- ▶ Library Manager Check 1 condition
- ▶ All storage cells full
- ▶ Out of cleaner volumes
- ▶ Dual write disabled
- ▶ Dual Library Manager status (only the IBM 3494 with Model HA1 installed)
- ▶ Accessor status (only the IBM 3494 with Model HA1 installed)

Degraded operation

The library is degraded when any component (with the exception of tape subsystems) fails and is unavailable. Some level of library operation is available even in the degraded state. To resolve the degraded state, an IBM SSR has to repair the failing component and make it available.

With the IBM 3494, the following components can be marked unavailable. The library continues operation but indicates to the hosts that it is in a degraded mode:

- ▶ One gripper in a dual gripper, single accessor configuration
- ▶ Up to three grippers in a dual gripper, dual accessor configuration (when the High Availability unit is installed)
- ▶ Second disk drive in a dual disk drive configuration
- ▶ Barcode scanner
- ▶ One accessor in a dual accessor configuration (when the High Availability unit is installed)
- ▶ Components of the dual Library Manager configuration (when the High Availability unit is installed)
- ▶ Convenience input/output (I/O) station

Safety enclosure interlock open

This state indicates that one or more of the door interlocks are open. If all doors are fully closed, it is likely that a component within the safety circuit has failed. The library does not enter auto mode while in this state.

This state does not apply to an IBM 3494 when a service bay door of the High Availability unit is open in service mode.

Barcode reader or vision system nonoperational

On the IBM 3494, this state is entered if the barcode reader fails. During this time, the library continues to operate, but you cannot enter or remove cartridges from the library.

Intervention required

This state occurs when the library requires an operator to take action. On the IBM 3494, the attention light on the operator panel blinks to signal the operator. After the operator clears the intervention and, if required, confirms that they have done so, this state ends.

Refer to 9.4.7, “Handling an intervention-required condition” on page 412 for details about operator responses and console message automation possibilities.

Library Manager Check 1 condition

The library enters this state if it is unable to continue because of an unrecoverable error. In this state, all host commands and requests are lost. The Library Manager attempts to restart the Library Manager after a Check 1 condition. However, this restart does not occur if the number of Check 1 conditions exceeds three Check 1 conditions in 10 minutes.

All storage cells full

This state is entered when cartridges are present in the convenience I/O station and no empty storage cells are available in the library.

Out of cleaner volumes

This state indicates that cleaner volumes are not present in the library and a clean operation was requested by the Library Manager. In a mixed tape drive system (3490E/3590), either type of cleaner cartridge can be missing.

Dual write disabled

This state indicates that a secondary copy of the Library Manager database is not available. Either the dual write option was not selected, or the second Library Manager hard disk failed (or was not installed) in an IBM 3494.

Dual Library Manager status

This informational state is available only on an IBM 3494 with the High Availability unit installed. It includes the status of the connection links between the two Library Managers, the state of the secondary database, and whether the standby Library Manager is capable of taking control.

Accessor status

This informational state is available only on an IBM 3494 with the High Availability unit installed. In a dual accessor environment, this state indicates the status of the accessors, which accessor is active, and whether the standby accessor is capable of taking control.

9.3 Library Manager

The following sections explain how a Library Manager startup works. They examine the various possibilities of library inventories and the basics about cartridge labels and barcodes. They also include information about drive cleaning and cleaner volumes.

9.3.1 Library Manager startup

The Library Manager is automatically started when the library is powered on by way of the operator panel on the IBM 3494. While the Library Manager is starting, it is in Library Manager initialization status. At this time, the Library Manager database is initialized, and a validity check is carried out on the primary and backup databases. If any errors are found with

the secondary database, Library Manager initialization continues. Then, the library enters the dual write disabled informational state. If errors exist with the primary database, the library enters the Check 1 informational state.

On an IBM 3494 with the High Availability unit installed, the two Library Managers must decide which of four possible databases to choose as the primary database and which database to choose as the secondary database. Many combinations are possible. Each combination depends on the status of the Library Managers, the databases, and the communication links between the Library Managers.

A comparison of the databases is performed by the Library Managers. Under normal conditions (Library Managers, communication links, and databases all available after a normal termination of both Library Managers), one Library Manager is the active Library Manager. Its primary disk contains the primary database. The second Library Manager is the standby Library Manager. Its primary disk contains the secondary database.

Other conditions (such as Library Managers unable to communicate, desynchronized databases, and Library Manager failure) are handled so that one Library Manager starts with the correct database. If this situation is not possible, the library enters the Check 1 state.

9.3.2 Library inventory

An inventory of the library is performed during the installation of the IBM 3494. After the IBM 3494 is installed, you can choose to re-inventory the library. The IBM 3494 also has the option to inventory only parts of the library.

Installation inventory

When the library is first installed, an inventory of the library is performed after the teach process has completed. At this time, the Library Manager database is initialized. If volumes are present in the library, the records are added to the Library Manager database. This initial inventory is started by selecting *Inventory new storage* from the Library Manager Commands menu. Until the inventory is complete, the Library Manager is offline, and all attached hosts are unable to use the library.

The IBM 3494 takes approximately four minutes to inventory one frame. After the inventory of the hardware is complete, the Library Manager can be put online. Before any host can use the library, the host and Library Manager databases must be synchronized. At this point, all cartridges within the library are in the Library Manager INSERT category (see Appendix C, “Library Manager volume categories” on page 499). This synchronization (referred to as *insert processing*) causes the Library Manager database to be updated to match the host tape management system database. Each volume has a volume category assigned, indicating which host owns the volume, and whether the volume is a specific or nonspecific cartridge. Insert processing varies among the different platforms. Refer to the following appropriate platform chapters for more detailed information:

- ▶ Chapter 6, “Running z/OS production systems” on page 261
- ▶ Chapter 7, “Software implementation: Other System z platforms” on page 301
- ▶ Chapter 8, “Software implementation: Open Systems environments” on page 331

Re-inventory complete system

By selecting Re-inventory storage from the Library Manager Commands menu, you can re-inventory the contents of the library. To select this option, you need the administrator password if password protection is enabled. The re-inventory processes cause the existing Library Manager volume database to be deleted, a new database initialized, and records added for all the cartridges within the library. All cartridges are placed in the Library Manager

INSERT category (see Appendix C, “Library Manager volume categories” on page 499). Therefore, the Library Manager database must be resynchronized with the host tape library databases. Insert processing differs among the various platforms. Refer to the following appropriate platform chapters for more detailed information:

- ▶ Chapter 6, “Running z/OS production systems” on page 261
- ▶ Chapter 7, “Software implementation: Other System z platforms” on page 301
- ▶ Chapter 8, “Software implementation: Open Systems environments” on page 331

During the re-inventory of a complete system, all other library actions (mounts, demounts, and so forth) are queued until re-inventory has finished.

We recommend that you do not re-inventory a library on a regular basis. Perform re-inventory only if problems exist with the Library Manager database that cannot be rectified by host software commands.

IBM 3494 inventory update

Inventory update is available on the IBM 3494 only. It is enabled from the Library Manager Commands menu. If enabled, the IBM 3494 inventories a single frame or adjacent frames after the door is opened.

Note: With the High Availability unit, the IBM 3494 does not inventory a service bay frame when the door of a service bay is opened in service mode.

The choice of a single frame or adjacent frames is selected as part of the teach process. Inventory update has two major purposes. If a cartridge is lost within the library, performing an inventory update identifies the cartridge’s location and updates the Library Manager database to reflect its new location. If you insert large numbers of cartridges into the library, you can place them in empty storage cells throughout the library. When the doors are closed and the library is placed in auto mode, the Library Manager database is updated with the new cartridges. These new cartridges are now in the Library Manager INSERT category. The Library Manager and host databases must be synchronized to ensure that the cartridge is placed in the correct Library Manager category.

After an inventory update, if the IBM 3494 finds that cartridges are removed from the library since the last update, it places those cartridges in a category called “Manually Ejected” (X’FFFA’). The host system can upload that category and use the “Purge Volume” category (X’FFFB’) to delete the database entries in the Library Manager.

See Appendix C, “Library Manager volume categories” on page 499 for more information about the Library Manager categories.

During an inventory update, certain operations are held until the update has completed. Operations that are held are:

- ▶ Audit
- ▶ Eject
- ▶ Mounts involving volumes in the rack or racks to be inventoried

9.3.3 Cartridge labels and barcodes

The tape library uses the external label to identify cartridges in the tape library during the inventory process. It uses the media type label to determine the type of the cartridge. Any cartridges without a media type label are added to the Library Manager database as the default media type that is specified in the teach process.

An IBM 3590 drive cannot read from, or write to, a 3592 tape cartridge. Similarly, IBM TotalStorage Enterprise 3590 cartridges cannot be used on IBM 3592-J1A or IBM 3592 model E tape drives. IBM tape cartridges are designed with different cartridge casing color schemes to avoid the situation where an operator might mount an incompatible cartridge in an IBM tape drive.

To ensure that the operator can identify the correct tape volume and mount it on an IBM tape drive, a human-readable label is used. You must label all cartridges with a six-character VOLSER on the external label. A VOLSER can be from one to six characters, with blanks padded on the right for a VOLSER with fewer than six characters. The character set supported for the external labels is:

- ▶ Uppercase alphabet: A to Z
- ▶ Numerics: 0 to 9
- ▶ Blank (or space), trailing only

If you automate your tape operations, the same considerations apply. However, in this case, the library must ensure that:

- ▶ The correct type of cartridge is mounted on a compatible IBM tape drive.
- ▶ The correct type of cleaning cartridge is mounted in the drive when a cleaning operation is needed.
- ▶ The correct tape volume is mounted when requested.

Therefore, a machine-readable label, a *barcode*, is required in addition to the human-readable external volume identification label.

To enable the IBM 3494 to recognize different cartridge types, an additional, single-character, media-type label is used. When a cartridge is inserted in a tape library, its media type is recorded from the label, which ensures that the correct cartridge types are mounted on compatible IBM tape drives within the library. Also, when using IBM system-managed tape, scratch thresholds can be set according to media type.

The five types of IBM tape cartridges are:

- ▶ The CST cartridge has a monotone gray casing.
- ▶ The ECCST cartridge has a two-tone gray and white casing.
- ▶ The 3590 tape cartridge has a monotone black casing with blue inserts and a blue leader block.
- ▶ The 3590 XL tape cartridge has a monotone black casing with green inserts and a green leader block.
- ▶ Each 3592 data cartridge is identified by a unique label consisting of eight digits; the normal six-digit Volume Serial Number (VOLSER), followed by a two-digit media type identifier ("Jx" for 3592 Tape Cartridges).

With the exception of CSTs, we recommend strongly that you place media type E, J, K, and Jx labels on all cartridges within the 3494 Tape Library. This recommendation applies to all environments and all platforms. This type of labeling minimizes the possibility of mounting incompatible cartridge types in the tape drives.

Currently, barcode labels supplied by two label manufacturers conform to the common standard of IBM tape libraries and StorageTek (STK) Silos:

- ▶ Engineered Data Products (EDP) Tri-Optic
- ▶ Wright Line Tri-Code

The barcode used by the external labels is Automation Identification Manufacturers Uniform Symbol Description Version 3, which is also known as *Code 39*. The barcode area contains the same characters as the human-readable area surrounded by start and stop characters. The start and stop characters of the external labels are:

- ▶ Wright Line Tri-Code uses an asterisk (*).
- ▶ EDP Tri-Optic uses a dollar sign (\$).

If an external label contains the asterisk (*) character or the dollar sign (\$) character as part of the VOLSER, the barcode reader might or might not recognize it correctly, which can potentially result in an incorrectly read number.

A request for price quotation (RPQ) for the vision system is available upon request to handle other barcode labels, such as Comparex or GRAU.

We recommend that you order new, initialized cartridges with the specified barcode labels attached. Most suppliers deliver them to your specifications within about six weeks. However, you must confirm when the supplier can deliver them before you order them. You can intermix these labels (and cartridges) in your tape library.

We recommend that you do *not* print your own labels. It is unlikely that you can achieve the same quality as the labels available for purchase.

The IBM TotalStorage Enterprise Tape Drive 3592 uses six media cartridge types: JA, JB, JJ, JR, JW, and JX. All media cartridge types contain the same dual-coat, advanced-particle media. The media is housed in a 3592 cartridge shell, which is designed for automation with a form factor (shape) similar to the 3590 tape cartridges that allow it to be used in the IBM TotalStorage Enterprise Tape Library 3494 and StorageTek Automated Cartridge System (ACS) solutions. The only externally visible difference among the four cartridge types is the color combination of the housing, leader pin door (gate), and write-protect switch.

Service volume label definition

Service volumes (CE cartridges) are shipped with the tape library. Service volumes have a unique external VOLSER label that distinguishes them from any other type of volumes. The pattern of a CE cartridge VOLSER is shown in Table 9-1.

Table 9-1 CE cartridge VOLSER pattern

Character position	Description
1-2	Must be CE
3	Must be a blank
4-6	A three-digit number

For example, CE_001 is a valid VOLSER for a service volume.

Normally, an embedded blank in a VOLSER is illegal. It results in the volume being flagged as having an unreadable external label. The blank is used for the service volume labels to ensure that they are unique and do not conflict with other client volume labels. Service volumes are restricted to certain reserved storage cell locations, which are predetermined.

Cleaner volume

The tape drives need to be cleaned on a regular basis, and cleaning requires special cleaning cartridges. To ensure that the operator can identify a cleaning cartridge, external labels are placed on these cartridges by the manufacturer. The IBM 3480 and 3490 models use a single

type of cleaning cartridge. However, the 3590 tape drive requires a 3590 cleaning cartridge, and the 3592 tape drive requires a 3592 cleaning cartridge.

Within a library, cleaning cartridges are identified by a particular set of volume serial masks, typically, CLN***. The 3590 cleaning cartridges must be further identified by the media type label (J after the VOLSER). In response to a cleaning request, they can be mounted in an IBM 3490 drive.

The cleaner volumes in the tape library also need an external label. From the Library Manager console, you must define one or more masks that identify the VOLSERS of cleaning volumes. The cleaner volume masks can be defined whenever you make one of the following selections from the Library Manager console:

- ▶ Inventory New Storage, and none of the components in the tape library configuration has been inventoried
- ▶ Re-inventory Complete System
- ▶ Cleaner Masks

A dialog box is displayed on the Library Manager console with 10 cleaner masks. When the masks are presented for the first time, the first mask is set to a default value of CLN***. The other nine masks are set to blanks. The asterisk (*) character can be used in the mask and is interpreted as a wildcard character. After the cleaner volume masks are set, any VOLSER labels that match any of the masks are considered to represent cleaner volumes.

Note: Check the cleaner mask after the described inventory process to see if you need to make changes.

You can eject cleaner volumes by using a Library Manager command (see 9.4.3, “Ejecting cartridges” on page 405). This action causes the use count to be reset to zero. If the cartridges are not completely used, the statistics on the cleaner cartridge are inaccurate when the cleaner cartridges are reinserted.

9.3.4 Tape device cleaning

The accessor performs all drive cleaning operations under the control of the Library Manager. Drive cleaning is scheduled by either time or drive mount. These options are mutually exclusive. You can select them through the Cleaning Schedule option of the Library Manager Commands menu.

We recommend that you base drive cleaning on a drive request. Use time-based cleaning only if drive usage is extremely low. For 3590 tape drives, use a value of 999 mounts to perform cleaning based on a drive request rather than a library-initiated request.

9.4 Operations on Library Manager Console

The following sections describe the operational procedures for the IBM 3494. For each of the following topics, you can obtain additional information in the *IBM TotalStorage Automated Tape Library (3494) Operators Guide*, GA32-0449.

With the introduction of the Enterprise Tape Library (ETL) Specialist, most of the information and action tasks are now available without direct access to the Library Manager Console. Refer to “TotalStorage Enterprise Tape Library Specialist” on page 28. You might want to use the Library Manager Console if you are unable to use the ETL Specialist for any reason. The

ETL Specialist might not be available if you are already on the Library Manager and inserting cartridges into the 3494. Therefore, we still keep the Library Manager information in this book.

The following sections focus on the Library Manager Console for the most frequent actions. They do not discuss customization activities in Advanced Policy Management (APM) for a Virtual Tape Server (VTS) or TS7700. For a detailed description of the implementation and handling of APM, see *IBM TotalStorage Virtual Tape Server Planning, Implementing and Monitoring*, SG24-2229, or *IBM Virtualization Engine TS7700 Series Introduction and Planning Guide*, GA32-0567.

9.4.1 Discovering the LIBRARY-ID given during the teach process

During the installation, a five-digit LIBRARY-ID is given to any IBM 3494. Also, each VTS or Peer-to-Peer (PtP) VTS or TS7700 has its own LIBRARY-ID. The LIBRARY-IDs are also coded in the hardware configuration definition (HCD) and in the z/OS system (if a System z is attached). To discover which LIBRARY-ID is given to a specific library, use the Library Manager or the ETL Specialist.

On the Library Manager, you can view the LIBRARY-ID by following these steps:

1. Select the Status menu on the main menu.
2. Select **Operational status**.
3. Scroll until you see Library sequence numbers as shown in Figure 9-1.

Operational Status		
Refresh Help		
Pending Operations		
Mounts.....	3	Inserts..... 0
Demounts....	0	Audits..... 0
Ejects.....	0	Cleans..... 0
Exports.....	0	Imports..... 0
Sequence numbers Partition Names		
Native:	00000	Not Defined
VTS 1:	00001	Not Defined
VTS 2:	BA91A	Not Defined
Subsys IDs: 1-1A		
Capacity		
	Storage	High-Capacity
Total cells....	1045	---
Empty cells....	331	---
Home Cell Mode		
Current mode.... Fixed		

Figure 9-1 Library Manager Operational Status menu

Note: Using the Enterprise Tape Library Specialist is another way to determine the Library-ID. Refer to “TotalStorage Enterprise Tape Library Specialist” on page 28 for more information about the ETL Specialist.

9.4.2 Inserting cartridges

The following section explains ways to insert cartridges into a library:

- ▶ Convenience I/O station insert
- ▶ High capacity I/O facility insert
- ▶ Empty cell insert
- ▶ VTS logical volume insert
- ▶ TS7700 logical volume insert

When the cartridges are inserted into the library, if the barcode is readable and the VOLSER is unique, a record of the volume is added to the Library Manager database. The cartridge is placed in the Library Manager INSERT category. All attached hosts are notified.

In the IBM 3494, a VOLSER range function is used to help determine a VOLSER's media type when a physical cartridge is inserted into the tape library. For more information about the VOLSER range, refer to 9.4.5, "Setting VOLSER ranges for media types" on page 410.

Consider the case when a cartridge is placed in the convenience I/O station, high capacity I/O facility, or an empty cell within the IBM 3494, and the VOLSER already exists within the Library Manager database. In this case, the cell that the volume currently occupies within the library is checked. If the cell is empty, the new cartridge is placed in the cell. If the cartridge is placed in an empty cell within an IBM 3494, the database record is updated. If a cartridge with the same VOLSER is in the cell, the new cartridge is left in the input station and an operator intervention is flagged. If the cartridge is placed in an empty 3494 cell, it is then placed in the convenience I/O station, and an operator intervention is flagged.

Convenience I/O station insert

A cartridge is placed in the convenience I/O station for insertion into the IBM 3494. When the door is closed, the Library Manager senses the presence of a cartridge and locks the door. The Library Manager then instructs the accessor to remove a cartridge from the convenience I/O station and place it in a storage cell. At this time, the barcode is read, and the VOLSER and media type are checked. If the barcode is unreadable or a cartridge with a duplicate VOLSER is in the library, the cartridge is returned to the convenience I/O station and an operator intervention is flagged.

If the barcode is readable and the VOLSER is unique, a record of the volume is added to the Library Manager database. The cartridge is placed in the Library Manager INSERT category. All attached hosts are notified.

If the IBM 3494 unlabeled tape facility is used to enter unlabeled cartridges into the tape library through the convenience I/O station, it is impossible to verify the VOLSER or media type. If a duplicate VOLSER is specified, the cartridge is left in the convenience I/O station, and operator intervention is flagged. For more information about unlabeled tape support, refer to 9.4.8, "Handling unlabeled tapes" on page 413.

High capacity I/O facility insert

To insert a large number of cartridges into the IBM 3494, you can use the high capacity I/O facility. This facility must be predefined in the teach operation. The VOLSER and media type are verified. If a problem exists with the barcode, the cartridge is left in the high capacity I/O facility cells or external high capacity I/O station. Then, operator intervention is flagged.

Empty cell insert

The inventory update function enables you to insert large numbers of cartridges into the library. Inserting cartridges this way is disruptive to library operations. Therefore, it is usually performed at the same time as a high capacity output operation.

To insert the cartridges, you:

1. Enable inventory update
2. Place the library in pause mode
3. Open one or more doors

Place the cartridges in any empty storage cells, close the doors, and put the library into auto mode. When the High Availability unit is installed, do not place a cartridge into a cell of the service bays.

The Library Manager then performs an inventory update. The accessor scans all storage cells in the frames and selected adjacent frames, wherever the doors were opened. Any new cartridges have their barcodes validated. Unlabeled cartridges cannot be added to the library in this way. If the VOLSER and media type are valid, the Library Manager database is updated, and the cartridge is placed in the INSERT category. The inventory of each frame takes a maximum of four minutes.

For detailed information about inventory update, see “IBM 3494 inventory update” on page 398.

Inserting native cartridges in a 3494 with an attached VTS/TS7700

If you have a 3494 with a VTS/TS7700 installed, the 3494 takes a new physical cartridge and updates the Library Manager database with the position of the cartridge. However, the process to notify attached hosts or to introduce the cartridge to a physical stacked pool does not start immediately. The operator must select **Commands** → **System Management** → **Manage Insert Volumes** → **Select volumes** → **Take Action** on the MANAGE INSERT VOLUMES panel to start this process.

Important: If you enter stacked volumes, the volume range must be predefined in *VOLSER Ranges for Media Types* (see 9.4.5, “Setting VOLSER ranges for media types” on page 410) as a stacked volume for a VTS/TS7700. If you do not predefine the volume range, and you select **Manage Insert Volumes** → **Take Action**, the volumes are presented to each attached host for insert processing in the tape configuration database (TCDB) and tape management system. Depending on your tape management system and your customization (EDGRMMxx - REJECT statements), the volumes might be introduced into your system and used as scratch cartridges.

Inserting VTS/TS7700 stacked cartridges

The cartridges are added to the appropriate stacked pool when you perform the following actions:

1. Define the correct VOLSER ranges for media types.
2. Insert the cartridges.
3. Select **Commands** → **System Management** → **Manage Insert Volumes** → **Select Volumes** → **Take Action**.

Inserting VTS logical volumes

This window allows the insertion of logical volumes into a VTS. You can insert up to a total of 500,000 virtual volumes into a 3494. VOLSERS must be unique within a physical library. A logical volume's VOLSER cannot match another logical or physical volume's VOLSER. If it does match another logical or physical volume's VOLSER, the volume is not inserted. Select **Commands** → **System Management** → **Insert VTS Logical Volumes**.

For more information, see *IBM TotalStorage Virtual Tape Server Planning, Implementing, and Monitoring*, SG24-2229.

In a z/OS environment, each logical volume inserted by this panel creates a TCDB and an RMM-CDS entry. Make sure that your TCDB, RMM-CDS, and especially your RMM-journal are big enough to hold these new entries. If not, RMM collapses and the entries cannot be handled. To avoid this problem, enter only a specific number of virtual volumes (for example, 3,000 volumes for each insert processing) and then run the EDGBKUP utility. It is also possible to allocate a bigger RMM-journal.

Important: If you run an environment with a VTS, but without an HA1 feature or a second Library Manager disk, the manual recording (you must keep the insert requests of your storage administrator) of inserting VTS logical volumes is the only source in case of a disaster to recreate your environment. In this scenario, make sure that you store these documents.

Inserting TS7700 logical volumes

Logical volumes are inserted into a TS7700 from the TS7700 Management Interface. They cannot be inserted from the Library Manager. Refer to *IBM Virtualization Engine TS7700: Tape Virtualization for System z Servers*, SG24-7312, for details about inserting logical volumes from the TS7700 Management Interface.

9.4.3 Ejecting cartridges

To eject cartridges from the IBM 3494, enter the appropriate eject commands from the host system that owns the cartridges. You can eject a specified cartridge to either the convenience I/O station or the high capacity I/O facility.

For more information about the specific task on the host system, see 9.7, “z/OS with system-managed tape” on page 438 and Appendix D, “Basic tape library environment” on page 509.

You can eject only two types of cartridges using the Library Manager Console:

- ▶ A cleaning cartridge
- ▶ A VTS or TS7700 stacked volume in an IBM 3494

Ejecting a cleaner cartridge

A cleaner cartridge is automatically ejected if the end-of-life (depends on the clean mode) is reached. Ejecting a cleaner cartridge is, therefore, typically unnecessary. If it is necessary (for example, due to an error), refer to the *IBM TotalStorage Automated Tape Library (3494) Operators Guide*, GA32-0449.

Ejecting a VTS/TS7700 stacked volume

You can allow a stacked volume to be ejected from the library. When a stacked volume eject is initiated, the VTS/TS7700 copies any active data off of the stacked volume onto other stacked volumes. When all data is removed, the VTS/TS7700 initiates the eject of the now empty stacked volume. This process can take a long time. Select **Commands** → **System Management** → **Eject a VTS/VE Stacked Volume**.

For more information, see *IBM TotalStorage Virtual Tape Server Planning, Implementing, and Monitoring*, SG24-2229, or *IBM Virtualization Engine TS7700: Tape Virtualization for System z Servers*, SG24-7312.

Cartridge import

The VTS import operation allows logical volumes to be moved to a VTS from another VTS. The source VTS can be in the same tape library or in a different tape library. The import process allows you to copy logical volumes back from exported stacked volumes.

The basic steps of the import process are:

1. An operator inserts import cartridges (cartridges containing data to be imported) into the IBM TotalStorage Enterprise Automated Tape Library.
2. The host designates the stacked volumes or specific logical volumes to be imported into the VTS.
3. The VTS determines the logical volumes involved and copies them from the set of import cartridges onto cartridges that are already in the VTS. The VTS creates internal references to each imported logical volume.
4. The VTS informs the host of the results of the import process.

For more information about the import function, refer to *IBM TotalStorage Virtual Tape Server Planning, Implementing, and Monitoring*, SG24-2229.

9.4.4 Searching the Library Manager database

You can use the Library Manager database to gather information about the cartridges in the tape library from **Database** → **Search database** menu. Figure 9-2 shows the **Search database** menu from the Library Manage console.

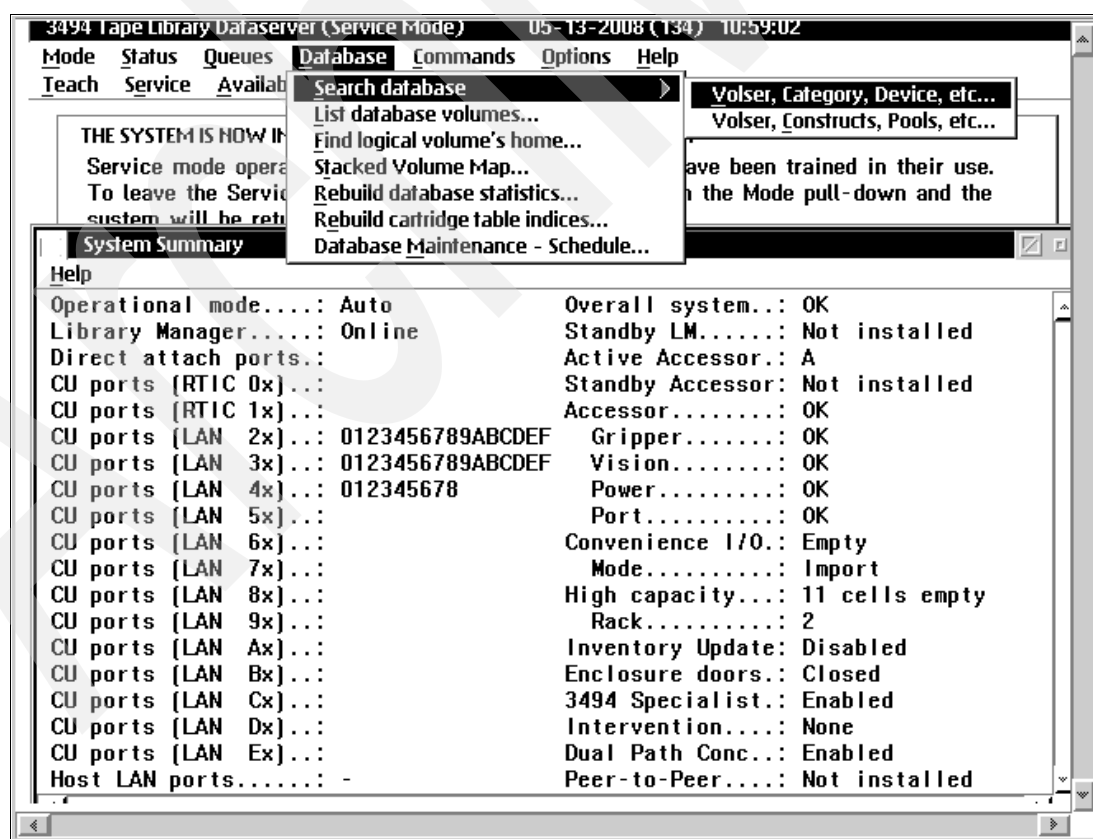


Figure 9-2 Search database menu

Searching the database options

You can obtain the volume category, storage cell location, exception condition, encryption, and other cartridge information. Select the **Database** → **Search Database** → **Volser, Category, Device, etc...** menu from the Library Manager console to view selected volumes in the tape library.

On the Search Database for Volumes window (see Figure 9-3), you can search the volume database for specific volumes on the basis of search criteria. The more search criteria you use, the more restrictive the search is.

Figure 9-3 IBM 3494 Library Manager Search Database for Volumes window

You can include the following options in the search criteria:

- ▶ **VOLSER:** Enter the VOLSER used in the search. The identifier consists of one to six alphanumeric characters that match the external label. You can include a wildcard character where a question mark (?) or an underscore (_) indicates one character and an asterisk (*) or a percentage symbol (%) indicates multiple characters.
- ▶ **Category:** Enter the category used in the search. A *category* is a logical grouping of volumes for specific use. The categories are 0000 to FFFF. They must contain four hexadecimal characters and cannot contain wildcard characters. All categories beginning with 'FF' are predefined for use or reserved for Library Manager use. See Appendix C, "Library Manager volume categories" on page 499 for a comprehensive list of Library Manager volume categories.
- ▶ **Device:** Either enter or select the tape drive address used in the search to see whether the volume is mounted or being mounted on the drive. You can obtain a valid tape drive address by clicking the drop-down arrow. Single-character and multiple-character wildcards are valid.

- ▶ **Media Type:** Select the correct media types for the types of tape drives installed in the tape library:
 - **1:** CST
 - **E:** ECCST
 - **J:** 3590 Tape Cartridge (HPCT)
 - **K:** 3590 Enhanced Capacity Tape Cartridge (EHPCT)
 - **JA:** 3592 Enterprise Tape Cartridge (ETC)
 - **JJ:** 3592 Enterprise Economy Tape Cartridge (EETC)
 - **JW:** 3592 Enterprise Worm Tape Cartridge (EWTC)
 - **JR:** 3592 Enterprise Economy Worm Tape Cartridge (EEWTC)
 - **JB:** 3592 Enterprise Extended Tape Cartridge (EEETC)
 - **JX:** 3592 Enterprise Extended Worm Tape Cartridge (EEEWTC)
- ▶ **Flags:** You can include the following flag selections in the search criteria:
 - *Misplaced:* The cartridge location is unknown. A volume serial number specified in a library request is not in the tape library where expected.
 - *Unreadable:* The vision system cannot read the barcode of the external cartridge label.
 - *Mounted:* The cartridge is mounted or being mounted on a tape drive.
 - *Inaccessible:* The cartridge accessor cannot access the cartridge. A requested VOLSER is in the tape library but cannot be accessed by the cartridge accessor because of a problem with either the cartridge or the cell that contains the cartridge.
 - *Manual mode:* An operator handles the cartridge during manual mode processing.

These flags are used for problem determination procedures that determine whether the tape library contains volumes for which an action must be taken.

The following options are possible values for each flag:

 - *Yes:* Search for volumes to which this flag applies.
 - *No:* Search for volumes to which this flag does not apply.
 - *Ignore:* Search for volumes without regard for this flag.

The search results are displayed in a list. The list can contain up to 100 records at one time. If more than 100 records are found, click **Next 100** and **Prev 100** to display the additional records. Each record contains the following information:

- ▶ **VOLSER:** The volume serial number of the cartridge
- ▶ **M.T.:** The media type of the cartridge
- ▶ **Cat.:** The category, which is represented by four hexadecimal characters that identify the group of volumes or a predefined category
- ▶ **Cat. Order:** The position of the cartridge in the category
- ▶ **Flags:** The status of the flags
- ▶ **Device:** The tape drive address if the cartridge is mounted
- ▶ **Cell:** The storage cell that contains the cartridge
- ▶ **Home:** The cartridge home cell location
- ▶ **Mounts:** The total number of times that the cartridge was mounted

Search Database from Volser, Constructs, pools, etc....

You can obtain the volume category, storage group, management class, storage class, and other cartridge information. Select the **Database → Search Database → Volser, Constructs, Pools, etc...** menu from the Library Manager console to view selected volumes in the tape library.

On the Search Database for Volumes window (see Figure 9-4), you can search the volume database for specific volumes on the basis of search criteria. The more search criteria you use, the more restrictive the search is.

Figure 9-4 Search Database for Volsers, Constructs, Pools panel

You can include the following options in the search criteria:

- ▶ **Volser:** Enter the volser used in the search. The volser consists of one to six alphanumeric characters that match the cartridge label. A wild card (pattern-matching) character can be included, where ? or _ indicates one character and * or % indicates multiple characters.
- ▶ **Category:** Enter the category used in the search. A *category* is a logical grouping of volumes for specific use. The categories are 0000 to FFFF. They must contain four hexadecimal characters and cannot contain wildcard characters. All categories beginning with 'FF' are predefined for use or reserved for Library Manager use. See Appendix C, "Library Manager volume categories" on page 499 for a comprehensive list of Library Manager volume categories.
- ▶ **Storage Group:** Select a Storage Group to be used in the search. Storage Groups are defined by a one to eight alphanumeric character name. Select "Don't Care" if there is no preference.
- ▶ **Management Class:** Select a Management Class to be used in the search. Management Classes are defined by a one to eight alphanumeric character name. Select "Don't Care" if there is no preference.
- ▶ **Storage Class:** Select a Storage Class to be used in the search. Storage Classes are defined by a one to eight alphanumeric character name. Select "Don't Care" if there is no preference.

- ▶ **Data Class:** Select a Data Class used in the search. Data Classes are defined by a one to eight alphanumeric character name. Select “Don’t Care” if there is no preference.
- ▶ **Current Pool:** Select a current Storage Pool to be used in the search. The current pool name can be between 0 and 32. This field is only used for stacked volumes.
- ▶ **Home Pool:** Select a home Storage Pool to be used in the search. The home Storage Pool name can be between 0 and 32. This field is only used for stacked volumes.
- ▶ **Media Type:** Select the correct media types for the types of tape drives installed in the tape library:
 - **1:** CST
 - **E:** ECCST
 - **J:** 3590 Tape Cartridge (HPCT)
 - **K:** 3590 Enhanced Capacity Tape Cartridge (EHPCT)
 - **JA:** 3592 Enterprise Tape Cartridge (ETC)
 - **JJ:** 3592 Enterprise Economy Tape Cartridge (EETC)
 - **JW:** 3592 Enterprise Worm Tape Cartridge (EWTC)
 - **JR:** 3592 Enterprise Economy Worm Tape Cartridge (EEWTC)
 - **JB:** 3592 Enterprise Extended Tape Cartridge (EEETC)
 - **JX:** 3592 Enterprise Extended Worm Tape Cartridge (EEEWTC)

Note: Storage Group, Management Class, Storage Class, Data Class, Current Pool, and Home Pool in the search criteria apply to VTS or TS7700.

The search results are displayed in a list. The list can contain up to 100 records at one time. If more than 100 records are found, click **Next 100** and **Prev 100** to display the additional records. Each record contains the following information:

- ▶ **Category:** The category represented by four digits that identifies the group of volumes or a predefined category.
- ▶ **M.T.:** M.T. represents the media type of the cartridge.
- ▶ **StorGroup:** The Storage Group to which the VOLSER is assigned. The Storage Group is used for volume pooling and to set the primary Storage Pool.
- ▶ **MgmtClass:** The Management Class to which the VOLSER is assigned. The Management Class is used for volume duplexing. The Management Class allows assignment of peer-to-peer copy control parameters and the secondary Storage Pool.
- ▶ **StorClass:** The Storage Class to which the VOLSER is assigned. The Storage Class is used for tape volume cache management.
- ▶ **DataClass:** The Data Class to which the VOLSER is assigned. The Data Class is used for future use.
- ▶ **CurrPool:** The Storage Pool that contains the VOLSER for Stacked Only. This field indicates the Storage Pool that the stacked volume is in currently for Stacked Only.
- ▶ **HomePool:** The VOLSER Home Pool location for Stacked Only. This field indicates the stacked volume’s home pool, which can be the same as the current pool. If it is different, it indicates the volume is borrowed or will be moved to this pool as a result of a pool move operation.

9.4.5 Setting VOLSER ranges for media types

The VOLSER range for the media types function allows the entry of up to 50 or 256 VOLSER ranges and associated media types on the Library Manager. Use it:

- ▶ To determine whether the cartridge is used as a native cartridge or a stacked volume in a VTS/TS7700
- ▶ To determine to which VTS/TS7700 the cartridge belongs when it is used as a stacked volume
- ▶ To help determine a VOLSER's media type when it is inserted into the tape library

VOLSER ranges are used only for physical volumes. The available media types are CST, ECCST, 3590 (HPCT and EHPCT), and 3592 (JA, JW, JJ, JR, JB, and JX).

The VOLSER entry fields can contain up to six alphanumeric characters. The two VOLSERs must be entered in the same format. Corresponding characters in each VOLSER must both be either alphabetic or numeric. For example, AAA998 and AAB004 are of the same form, but AA9998 and AAB004 are not.

Here, we explain how to determine the VOLSERs that fall within a range. The VOLSER's range is increased in increments. The alphabetic characters are increased alphabetically, and the numeric characters are increased in numerical increments. For example, VOLSER range ABC000 through ABD999 might result in a range of 2,000 VOLSERs (ABC000 to ABC999 and ABD000 to ABD999).

When a range is added or modified, the Library Manager automatically combines overlapping ranges with the same media type and checks for range conflicts.

When you modify a VOLSER range, the media type for existing volumes in the tape library is unchanged. Volumes that are inserted subsequently reflect the new set of ranges and associated media type.

The media type of the inserted volume is determined by using the following rules:

- ▶ The media type label read by the vision system is used.
- ▶ The VOLSER ranges are used to determine a media type if the vision system cannot read the media type label. If the VOLSER being inserted appears within one of the VOLSER ranges, the range's associated media types are used.
- ▶ The Library Manager uses the default media type defined during the teach process to determine the media type if the inserted VOLSER does not fall into one of the VOLSER ranges.
- ▶ The VOLSER is ejected if there is no default media type.

Select **Commands** → **System Management** → **Volser Range for Mediatypes**.

For a detailed and full description of all of the fields, refer to the *IBM TotalStorage Automated Tape Library (3494) Operators Guide*, GA32-0449.

The input to this panel comes from the Storage Administrator in your environment. However, we recommend that you:

- ▶ Check whether the range is already defined
- ▶ Check whether the range is modified so that the same media type applies
- ▶ File the original request to keep track of the changes

Important: If you run an environment with a VTS/TS7700, but without an HA1 feature or second Library Manager disk, manual recording of your changes is the only source to recreate your environment in case of a disaster. In this case, be careful with the documents.

9.4.6 Setting Virtual Tape Server and TS7700 management policies

This window allows you to set the *inhibit reclaim schedule* and the *free storage threshold*. The inhibit reclaim schedule defines when the VTS/TS7700 must not perform reclaim operations. The free storage threshold percentage is used to provide a warning when a VTS/TS7700 is running out of available free storage. The reclaim threshold controls the percentage of active data that remains on the stacked volumes before they become eligible for reclaim processing. The default setting is 10%. We recommend that you use caution when executing changes to this value in an established VTS/TS7700. Raising the threshold can cause intense reclaim activity to occur. Use the Library Manager window, Active Data Distribution, to predict the results of a change in this value.

You can obtain information about reclamation through VTSSTATS for a VTS or through VEHSTATS for a TS7700. Select **Commands** → **System Management** → **Set VTS/VE Management Policies**.

Refer to Appendix B, “Monitoring and reporting” on page 481, *IBM TotalStorage Virtual Tape Server Planning, Implementing, and Monitoring*, SG24-2229, or *IBM Virtualization Engine TS7700: Tape Virtualization for System z Servers*, SG24-7312.

9.4.7 Handling an intervention-required condition

Certain conditions in the tape library require short-term operator intervention to resolve them. These conditions do not stop the Library Manager from accepting commands. However, they might delay the execution of certain queued operations.

When one or more intervention-required conditions exist, the tape library is in the intervention required state. Each intervention-required condition is reported to the attached hosts by an unsolicited attention message with an associated unsolicited unit check. The requirement to clear intervention situations can be handled manually by an operator. You can also apply automation software or operational procedures for faster and more efficient management of potential library problems. In a system-managed tape environment, additional information messages are sent to the system console.

For full details about the intervention messages and required responses, see the *IBM TotalStorage Automated Tape Library (3494) Operators Guide*, GA32-0449.

Manual response to library intervention

Library Manager keeps track of the outstanding intervention-required conditions. You can display these conditions on the Library Manager console. An operator can indicate which conditions have been resolved.

Follow these steps to resolve each condition:

1. Using the Commands menu, select **Operator intervention** on the Library Manager console.

The Operator Intervention window displays on the Library Manager console. It shows a list of the intervention-required conditions. If there are no intervention-required conditions, the window is blank.

2. Resolve the intervention-required condition.

Determine which condition to resolve. Perform the necessary action. Reply that the condition was resolved by highlighting the condition and clicking **OK**.

Certain conditions, such as when the convenience I/O station is full, are automatically cleared after you resolve them. However, they cannot be cleared until you resolve the

condition. You can click Help to display the operator actions for the intervention-required conditions.

3. Repeat step 2 until all of the conditions are resolved.

When you reply that all outstanding conditions are resolved, the window closes. You can close the window and resolve certain conditions later by clicking **Cancel**.

Automated responses for intervention conditions

If “Send Interventions to Host Consoles” is enabled on the Operator Intervention display (under the Commands menu), a broadcast message of the operator intervention text is sent to all attached hosts. We recommend this setting for libraries that are managed under DFSMS/MVS system-managed tape. The message includes a portion of the intervention-required text displayed at the Library Manager Console. The information contained in the message enables the capture of these messages for automation procedures to determine the severity of the intervention condition and who needs to handle it.

When an intervention condition is detected in the library, all control unit paths in the affected library send the text message to any attached hosts, which can result in multiple messages received by the same host for the same condition. Although no software support is needed to receive the messages, the DFSMS support software for the Import/Export functions includes a degree of filtering for duplicate messages to the same host. We recommend that you install the program temporary fixes (PTFs).

The host console message has the following format:

```
CBR3750I MESSAGE FROM LIBRARY <library-name>; <70 characters of text>
```

We explain the message format here in more detail:

- ▶ *<library-name>* identifies the library for which the condition is reported
- ▶ *<70 characters of text>* contains two subfields: *identifier* and *intervention text*.
 - *<identifier>*: Six character unique identifier for each intervention, such as OPxxxx where xxxx is the intervention number.
 - *<intervention text>*: The first 63 characters of the Library Manager Console intervention required message. Certain intervention descriptions are longer than 63 characters.

Enough of the description is provided to allow a client to determine:

- ▶ The severity of the intervention
- ▶ Who needs to take action
- ▶ Where to get more information about the intervention

The full message is always available at the Library Manager Console.

There are over one hundred of these messages. You can learn about these messages in the *IBM TotalStorage Automated Tape Library (3494) Operators Guide*, GA32-0449.

9.4.8 Handling unlabeled tapes

Each cartridge in the tape library must have the proper external labels. The vision system identifies the VOLSER and type of cartridge during an inventory operation by reading the external labels. The IBM 3494 provides an unlabeled tape facility to allow occasional insertion of cartridges without proper external labels through the convenience I/O station. After you insert the cartridges through the unlabeled tape facility, you can use them in the same manner as you use regular, properly labeled cartridges. However, there might be operations that require the external label to be read:

- ▶ If the cartridges are moved during manual mode operations to another location, these unlabeled cartridges are ejected because they are not found in their proper locations.
- ▶ If the tape library is re-inventoried, these cartridges are ejected because the Library Manager database is deleted and their external labels cannot be read during re-inventory.
- ▶ If two unlabeled cartridges are swapped during manual or pause mode, the tape library is unaware of the post-inventory exchange. Inventory update is automatically performed after manual or pause mode. It verifies only that all unlabeled cartridges are in cells that previously contained unlabeled cartridges. Therefore, when asked to mount one of the exchanged cartridges, the tape library mounts the wrong one.

We strongly recommend that you leave unlabeled cartridges in the tape library for as short a period of time as necessary to satisfy their requirements.

If you want to use unlabeled tapes, you must have the convenience I/O station.

To insert unlabeled cartridges, follow these steps:

1. Ensure that the convenience I/O station is empty.
2. Enter the VOLSERs and the cartridge types of all cartridges to be inserted in the spaces on the Insert Unlabeled Cartridges window (Figure 9-5 on page 414).

3494 Tape Library Dataserver (Service Mode) - B 12-15-2006 (349) 08:42:52

Mode Status Queues Database Commands Options Help
Teach Service Availability Utilities

Insert Unlabeled Cartridges

I/O Station		Cartridge
Cell	Volser	Type
1		*
2		*
3		*
4		*
5		*
6		*
7		*
8		*
9		*
10		*

Enter the cartridge volsers into the I/O Cell table.

If the cartridge types are not the same as the default shown, enter the new type for each cartridge. An asterisk (*) is displayed if the library was taught with no default type. Valid types are 1, E, J, K, JA, JW, JJ, JR, JB, JX.

Place the cartridges into the corresponding cell positions in the I/O station, close the I/O station door and select the OK button.

OK Cancel Help

Figure 9-5 IBM 3494 Library Manager Insert Unlabeled Cartridges window

3. Place the cartridges in the convenience I/O station in the same sequence that is represented on the window. Close the convenience I/O station door.
4. Click **OK**.

9.4.9 Handling a stand-alone device setup

You can perform stand-alone operations to a tape device inside an IBM 3494 if you use the Setup Stand-alone Device window (Figure 9-6 on page 415). This window allows you to mount or demount cartridges with specific VOLSERs in the Library Manager database.

Dev	Enc	Mnt	Volser	Enc	Location
-----	-----	-----	--------	-----	----------

Enter device: 300

Select operation

☒ Mount a single volume Volser:

☐ Demount a single volume

☐ Mount from Input Station

☐ Assign category to a device

Category to assign to device:

☐ Select volumes in category order

☐ Mount first volume without host interaction

☐ Mount / demount volumes without host interaction

☐ [LME] Re-Key a currently mounted volume

Change volume category

☒ Do not change volume category

☐ Change at mount

☐ Change at demount

Category to change volser to:

OK... Cancel Refresh Help

Figure 9-6 IBM 3494 Library Manager Setup Stand-alone Device window

You can also mount cartridges in the convenience I/O station. This method is known as the *transient mount* or the *mount from input station* function. It allows you to mount cartridges that do not reside in the IBM 3494 and cartridges that do not have proper external labels. These cartridges are chosen directly from the convenience I/O station, loaded into the tape drive by the cartridge accessor, and then returned to the convenience I/O station. You must install the convenience I/O station feature to take advantage of this function.

You can also mount the cartridge of a predefined sequential set of a specified category, which is known as the *automatic cartridge loader mode*. Although the tape drives in the IBM 3494 do not have automated cartridge loaders, the IBM 3494 allows for automatic mounting of the next cartridge of a predefined sequential set in a specified tape drive in the tape library. The IBM 3494 supports the assignment of cartridges to a special category, the assignment of a specified drive for restricted use with the special category, and the removal of the restriction on the usage of a tape drive.

You can also use this panel to rekey an encrypted volume. First, you mount the encrypted volume to be rekeyed using this panel. When it is mounted, you use the Re-key option on this panel.

Selecting **Re-key a currently mounted volume** presents a second panel, "Re-Key Mounted Volume XXXXXX on Device XXXX" as shown in Figure 9-7 on page 416. This panel requires

System Administrator authority and is used to enter the volume rekey data. This operation can only be performed on a volume that is currently mounted by the Stand-Alone Device Setup process.

LME: Re-Key Mounted Volume JA0011 on Device 0100

Select the Key Modes and Key Labels. Then select 'Save/Exit' to continue with the re-Key operation or select 'Cancel' to cancel the operation.

Key Mode 1:

Key Label 1

Key Mode 2:

Key Label 2

Figure 9-7 Re-Key Mounted Volume panel

Except for the rekey operation, the setup stand-alone device function of the IBM 3494 works only when you are running stand-alone utilities or IPL your stand-alone program. For example, in MVS environments, most of these functions are useful only when the MVS operating system is unavailable. Therefore, you cannot use the stand-alone device for MVS jobs.

To set up the stand-alone device function, select **Setup Stand-Alone Device** from the Library Manager Commands menu.

To set up a stand-alone device, follow these steps:

1. Enter a device address in the Enter device field to specify the tape device in the IBM 3494.
2. Enter a VOLSER in the VOLSER field to identify the tape volume to mount.
3. Select **Mount a single volume** to mount a specified volume onto the requested device.

When you select this operation, you must also select either "Do not change volume category" or "Change at mount."

To set up a stand-alone device with transient mount, follow these steps:

1. Enter a device address in the Enter device field to specify the tape device in the IBM 3494.
2. Enter a VOLSER in the VOLSER field to identify the tape volume to mount.
3. Select **Mount from Input Station** to mount transient cartridges located in the convenience I/O station directly onto the requested device and then return them to the convenience I/O station after unloading.

To set up a stand-alone device with automatic cartridge loader mode, follow these steps:

1. Enter a device address in the Enter device field to specify the tape device in the IBM 3494.
2. Enter a VOLSER in the VOLSER field to identify the tape volume to mount.
3. Select **Assign category to a device** to assign a category to a tape device.

When you select this operation, you must select one of the three Change volume category options.

4. Enter a category to assign to a device in the Category to assign to device field.

5. Select **Volumes in category order** to mount volumes in their category order.

To perform the rekey operation, follow these steps:

1. Mount a volume in a device using one of the previous methods.
2. Leave the VOLSER and device ID in their respective fields.
3. Select **Re-key a currently mounted volume**.
4. Press **OK**. The Re-key Mounted Volume panel is displayed.
5. Select one or two Key modes and Key labels from the drop-down lists. If you only select the first Key mode and Label, the same mode and label will be used twice in the rekey operation.
6. Select **Save/Exit**. The rekey operation begins.

See the *IBM TotalStorage Automated Tape Library (3494) Operators Guide*, GA32-0449, for more detailed information.

9.4.10 Handling manual mode operation

If the cartridge accessor is unavailable, library operation can continue with the operator taking the place of the cartridge accessor. With an IBM 3494 with the High Availability unit installed, this condition occurs only when both cartridge accessors are unavailable.

To enter manual mode, select the **Mode** menu from the Library Manager menu. Then, select **Manual mode**. The Library Manager attempts to move the cartridge accessor to its parking position. If a cartridge accessor cannot be moved out of the way automatically, the operator or the IBM SSR might be required to move the failed cartridge accessor into its parking position. When the tape library enters manual mode, the commands for the operator to perform are displayed on the Action List panel of the Library Manager console (Figure 9-8).

Action List				
Select an action. Press Enter to confirm action completion (except Mounts).				
Action	VOLSER	From		To
Mount	WCC007	Rack	12 B 11	Device 3F1
Mount	WSB392	Rack	7 C 5	Device 3F0
Mount	SCR023	Rack	12 E 6	Device 3F1
Mount	WR0112	Rack	3 J 13	Device 201
Mount	FGG641	Rack	11 C 10	Device 200
Eject	ERV399	Rack	13 F 11	
Press the Refresh key (F9) to update the list.				
F1=Help F3=HideScreen F4=Error F5=Insert F6=Review F9=Review F10=Locate				

Figure 9-8 IBM 3494 manual mode terminal Action List

The Library Manager console provides information about the type of command, VOLSER, the cell number of the volume located, and tape drive addresses. The mount commands are also displayed on the tape drive message display.

When the operator opens the frame doors to start performing manual operations, the first task is to remove any cartridge from the gripper and place it in the convenience I/O station.

When volumes are used in manual mode, their Library Manager database indicator is set to *manual mode*. This indicator is also used to direct error recovery when the tape library is returned to the auto mode.

The main operations processed by the operator in manual mode are *mount* and *demount*. To execute a mount operation, the operator reads the information provided on the Library Manager console, locates the volume, and loads it into the specified tape drive. To assist the operator, the VOLSER to be mounted and its location are displayed on the message display of the appropriate tape drive. Therefore, the operator can perform the mount operation without the Library Manager console. If a mount operation is successful, a confirmation is provided by the tape subsystem.

No explicit operator response is required. Unless the operator has a problem performing the mount operation, loading the volume in the tape drive completes the operation. If the operator has a problem during the mount, the operator must specify the action by using cursor keys on the Library Manager console and then press F4. Pressing that key shows the Error Processing display on the Library Manager console (Figure 9-9).

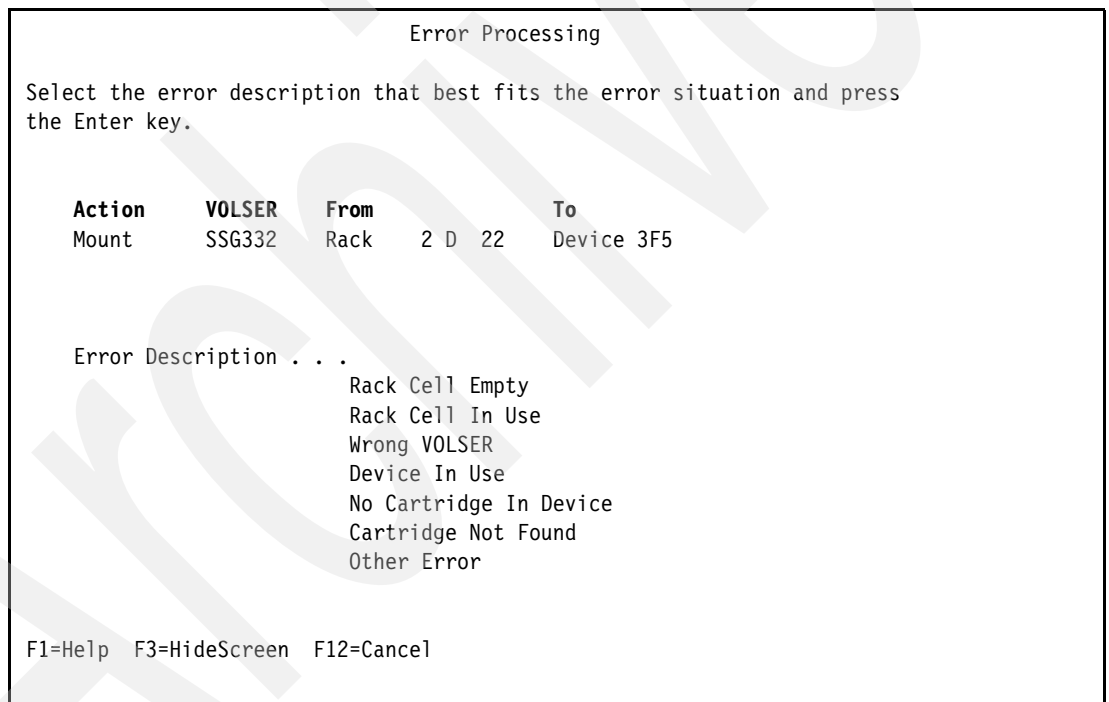


Figure 9-9 IBM 3494 Library Manager manual mode Error Processing display

On the console, the operator selects the error description to report the error.

If a cartridge is loaded into a tape drive that has not requested the mount, the cartridge is unloaded. There is no host attention indicator for the mistaken mount.

To execute a demount operation, the tape drive automatically rewinds and unloads the cartridge volume. The operator then removes the cartridge from that drive. The cartridges demounted from the drives are either placed in the high capacity output cells or removed from the tape library to a client-provided cart.

An audit operation is not allowed in manual mode. Any queued audit operations fail as they are fetched from the operations queue. Any audit commands received after the tape library has entered manual mode fail immediately.

9.4.11 Looking for physical bottlenecks

You might need to gather information about what is happening in the library, regarding both the physical movement in a library, as well as detailed VTS-related or TS7700-related information (where applicable). This information is available on an hourly basis. At the end of the hour, the Library Manager sends the statistics to all attached hosts. z/OS system-managed tape and Basic Tape Library Support (BTLS) provide the support for these statistics. For the VTS, an SMF type 94 record reports the activity of all of the devices in the tape library. For the TS7700, the Bulk Volume Information Retrieval (BVIR) function is used to upload historical statistics and the VEHSTATS tool is used to evaluate them.

You can display information about physical movements directly on the Library Manager Console.

Note: You can also view the performance statistics from the ETL Specialist.

You can view Point-in-Time statistics from the TS7700 Management Interface.

The Performance Statistics window displays the activity involving physical volumes in the library. Commands involving VTS/TS7700 logical volumes are not part of these statistics:

- ▶ 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

If mounts or demounts are not performed in an adequate time, check whether the total number of physical movements (mounts and demounts together) reached the limits of your installed IBM 3494. Refer to 2.5.3, “Performance planning” on page 64.

9.4.12 Handling the Simple Network Management Protocol (SNMP)

The Library Manager contains limited SNMP support. SNMP is a standard TCP/IP protocol that sends alerts (called *SNMP traps*) over a TCP/IP LAN network to one or more SNMP monitoring stations. These monitoring stations can alert operations staff of problems or operator interventions that occur at the library. Monitoring is independent of the host system that controls the IBM 3494 and the location of the IBM 3494.

The Library Manager code offers the ability to monitor the following Library Manager events:

- ▶ **OPINT:** Operator Interventions
- ▶ **UNSOL:** Unsolicited Attention Messages
- ▶ **SERV:** Service Request Messages

- ▶ **CHCK1:** Library Manager Check 1 Conditions
- ▶ **TESTM:** Test SNMP Trap Message

For a detailed description of these events, see the *IBM TotalStorage Automated Tape Library (3494) Operators Guide*, GA32-0449.

Selecting SNMP trap types

To select the types of Library Manager trap events to monitor, follow these steps:

1. Select **Commands** from the main menu.
2. Select **SNMP Options** from the menu.
3. Select **Select SNMP Trap Types** from the submenu.
4. Select the trap types to monitor from the dialog box that lists all of the Library Manager trap types (see Figure 9-10).
5. Click **OK**.



Figure 9-10 Select SNMP Trap Types window

Configuring SNMP trap destinations

When you have selected the Library Manager trap types, you must configure the Library Manager to send SNMP traps to the correct monitoring stations:

1. Select **Commands** from the main menu.
2. Select **SNMP Options** from the menu.
3. Select **Change SNMP Trap Destinations** from the submenu.

You can configure the Library Manager to send SNMP traps to a maximum of five trap destinations. The procedure for configuring the SNMP trap destinations depends on the version of OS/2 (2.11 or 4.0) running on the Library Manager. To determine which version of OS/2 you have, choose **About** from the Help menu. We show the configuration procedures for both versions of OS/2 in the following sections.

OS/2 Version 2.11

Figure 9-11 shows the OS/2 2.11 version of the Change SNMP Trap Destinations window.

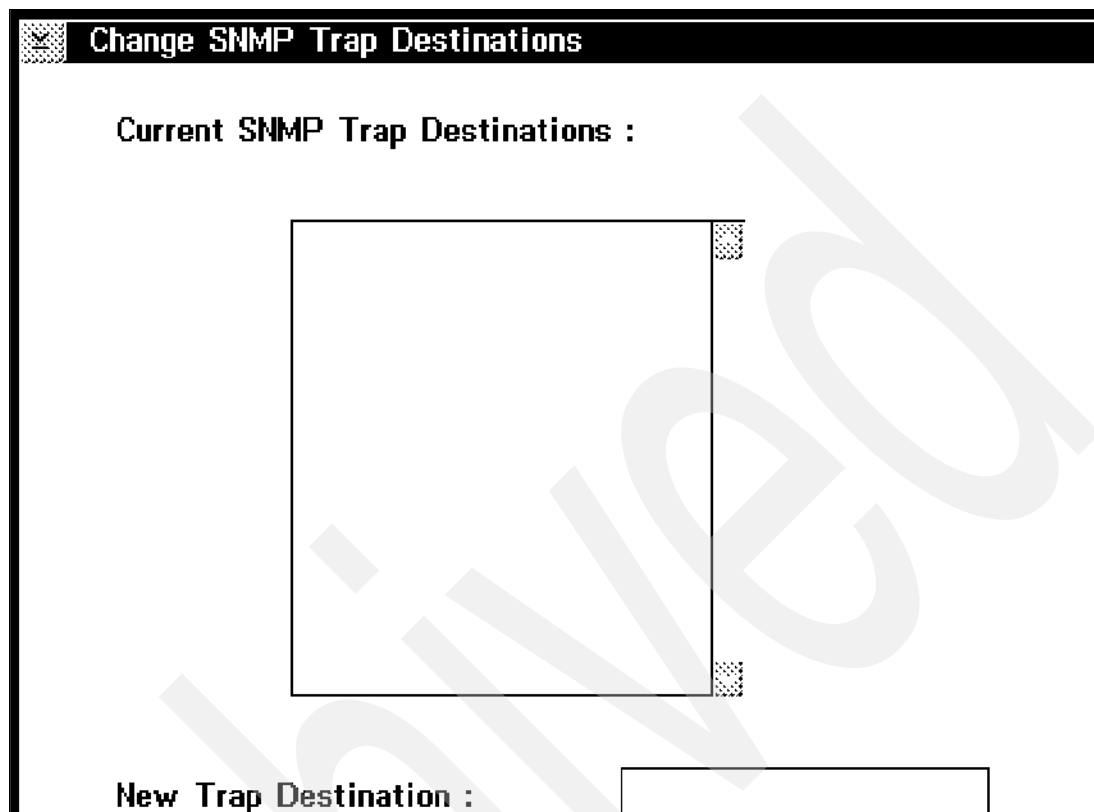


Figure 9-11 Change SNMP Trap Destinations window for OS/2 Version 2.11

To add a destination, follow these steps:

1. Add the SNMP trap destination in the New Trap Destination field.
2. Click **Add**.
3. To activate the changes, select **Activate Changes**.

To delete a destination, complete these tasks:

1. Highlight the SNMP trap destination in the list box that you want to delete.
2. Click **Delete**.
3. To activate the changes, select **Activate Changes**.

If the SNMP daemon is running when you select Activate Changes, the Library Manager ends it and restarts it with the new changes.

OS/2 Version 4.0

For OS/2 Version 4.0, use the SNMP HRMCNFIG program to configure SNMP trap destinations. Select **Change SNMP Trap Destinations** from the SNMP options menu to start this program.

Figure 9-12 shows the SNMP Configuration window.

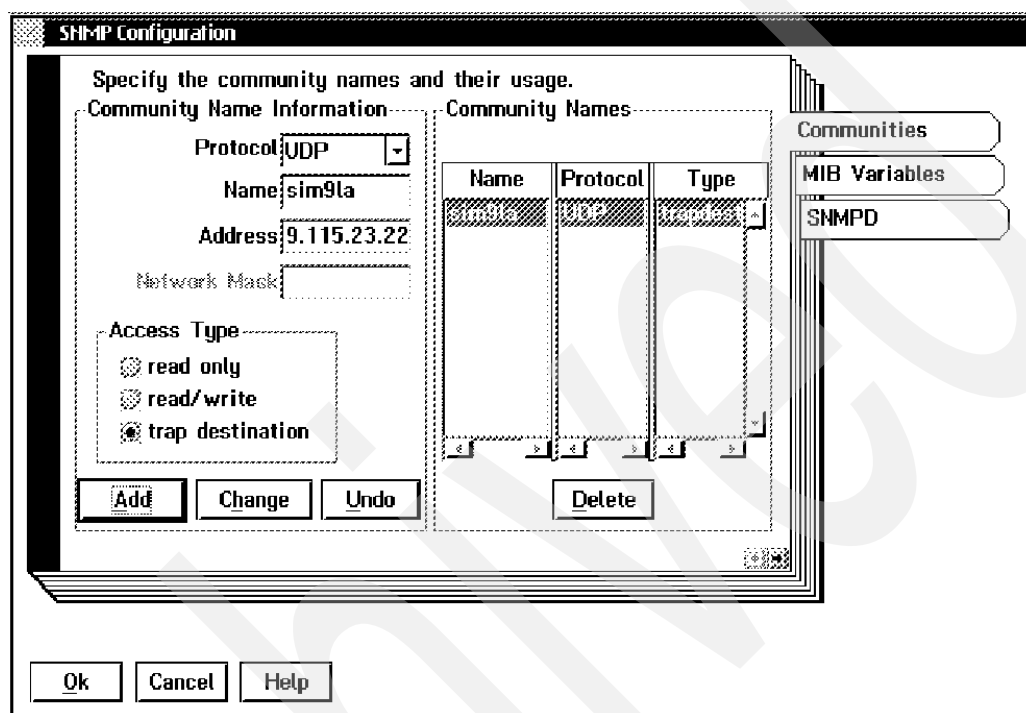


Figure 9-12 SNMP Configuration window for OS/2 Version 4.0

To add a destination, complete these steps:

1. Select **Trap destination**.
2. Select **UDP** in the Protocol field.
3. Enter the monitor station name and IP address in the appropriate fields.
4. Click **Add**.
5. Click **OK**.

To delete a destination, you must:

1. Highlight the SNMP trap destination in the list box that you want to delete.
2. Click **Delete**.
3. Click **OK**.

Note: HRMCNFIG is an external process to the Library Manager. You must wait until that process completes before Library Manager SNMP support is enabled. Wait until the Change SNMP Trap Destinations field becomes selectable again (no shadow). After it becomes selectable, you can use all SNMP features.

Starting SNMP

After you select trap types and configure trap destinations, you can enable Library Manager SNMP support:

1. Select **Commands** from the main menu.
2. Select **SNMP Options** from the menu.
3. Select **Start SNMP** from the submenu.

These actions start the SNMP daemon. To ensure that the daemon is running, press Ctrl+Esc to display a window list and verify that SNMPD is listed.

Stopping SNMP

To stop SNMP, follow these steps:

1. Select **Commands** from the main menu.
2. Select **SNMP Options** from menu.
3. Select **Stop SNMP** from the submenu.

Library Manager SNMP traps are not generated if the SNMP daemon is not running.

Sending TESTM messages

After you configure SNMP, you can send a test SNMP trap to ensure that you configured SNMP correctly. The TESTM trap allows a test message to be sent to the SNMP monitor stations.

To send a TESTM message, follow these steps:

1. Select **Commands** from the main menu.
2. Select **SNMP Options** from the menu.
3. Select **Send TESTM Trap** from the submenu.
4. Enter the test message text in the TESTM SNMP Trap Message window (Figure 9-13).
5. Click **Send**.

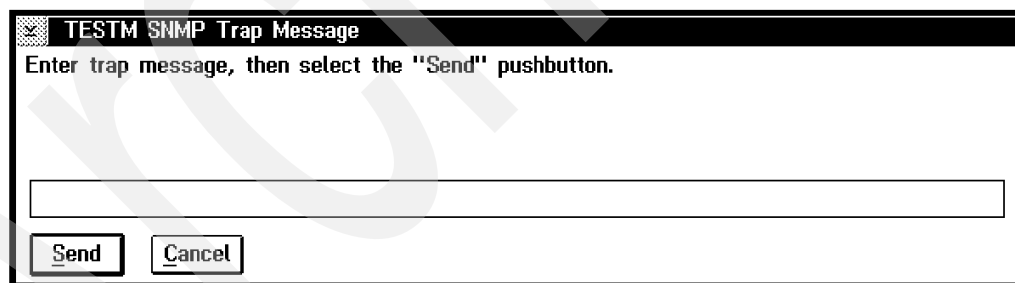


Figure 9-13 TESTM SNMP Trap Message window

SNMP requirements

To use SNMP on the IBM 3494, you must have the following requirements:

- ▶ Either LAN attachment feature code (FC) 5219 or FC5220 must be installed on the 3494 to connect it to the client's LAN.
- ▶ SNMP alert monitoring software must be running on a workstation on the LAN to which the 3494 is connected.
- ▶ The SNMP alert monitoring software must be customized to handle the SNMP traps sent by the 3494 Library Manager.

SNMP troubleshooting

Most problems that you encounter are related to site network configuration. To ensure that SNMP works correctly, follow these steps:

1. Make sure that the SNMPD process is running.
2. Make sure that you can ping the monitor station from a service window. If you cannot ping the monitor station, there is a network configuration problem that you must correct.
3. Generate a TESTM trap message and check the SNMPD window to see whether it was sent. Press Ctrl+Esc to display the window list. Highlight the SNMPD process. You see the TESTM trap message in the window. If there are any errors, the daemon is not starting correctly.

9.5 Enterprise Tape Library (ETL) Specialist operations

The Specialist is the Web-based user interface that can be used to view the current status and configuration of the 3494 Tape Library and the Library Manager. It can also be used to perform limited control functions on the Library Manager. The following are available on the Specialist:

- ▶ A home page
- ▶ A set of Library Manager pages
- ▶ A set of Logical Libraries pages
- ▶ A set of VTS pages (if a VTS is installed)
- ▶ A set of Security pages (functional code level 527 or greater)
- ▶ Links to the Peer-to-Peer VTS Specialist (if a PtP VTS is installed)

Note: If a TS7700 is installed, the Management Interface is the Web-based user interface that can be used to manage TS7700.

Figure 9-14 shows the ETL Specialist Welcome Page.



Figure 9-14 ETL Specialist Welcome Page

The following sections focus on the ETL Specialist for the most frequent actions.

9.5.1 Managing Library Manager mode and state

This panel allows you to view and provides you the ability to control the general system condition. Beside the Mode and State and depending on the hardware configuration, it includes the view and control of the Active Library Manager and the Active Accessor and the Dual Active Accessor conditions.

The actions requested from this panel are more restricted than when the same action is selected from the main console. This restriction is especially true for the Switch Accessor action. For example, if Switch Accessor is selected from this panel and an error condition is detected, the switch will not be allowed. Whereas, from the main console, the user will be prompted with the same error condition and asked whether or not to proceed.

When an action is selected from this panel, the action is initiated on the Library Manager. The History Table will state that the action is *Complete*, but in reality, it was just the initiation of the action that was complete. The final pop-up message received will always state that the initiation of the action has completed. In fact, the action that was initiated can take several minutes. An action will also be classified as *Complete* if an error condition was encountered and the action was not executed. Again, the final pop-up error message explains.

The following functions are *not* supported from the Web interface:

- ▶ Shutdown (Normal or Online).
- ▶ Online Library Manager Switchover: For the Library Manager Switch, only the normal switchover is allowed.

From the ETL Specialist Welcome Page, select **Administer library manager** → **Manage Mode and State** in the panel shown in Figure 9-15 on page 426.

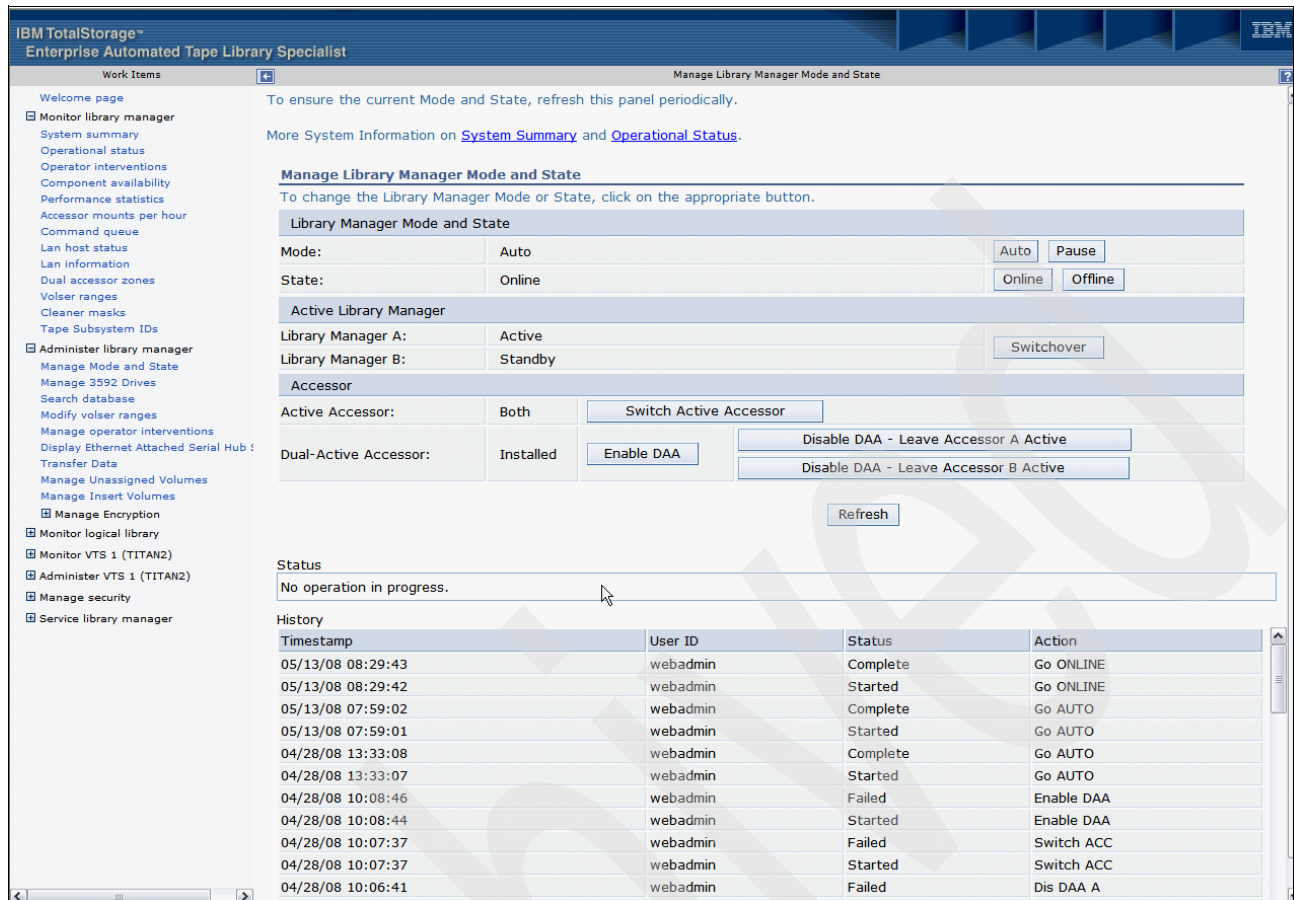


Figure 9-15 Manage Mode and State panel

9.5.2 Managing 3592 drives

This window allows you to retrieve the vital product data (VPD) of 3592 drives. This window also allows you to load and activate 3592 drive code.

Note: We never recommend that you perform a firmware update in a z/OS environment where 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.

From the ETL Specialist Welcome Page, select **Administer library manager** → **Manage 3592 Drives**. These selections display the panel where you can manage the 3592 drives.

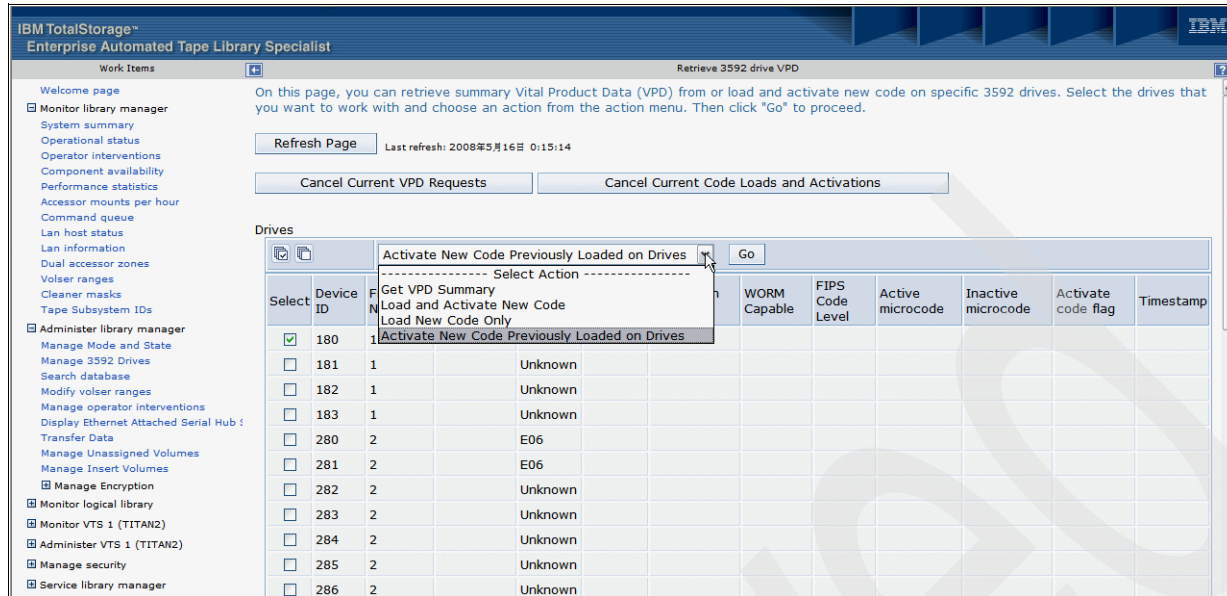


Figure 9-16 Manage 3592 Drives panel

9.5.3 Searching the database

The Search Database Utility allows you to search the volume database. You can start a new search or download the result of a previous search. The last 10 searches are saved to a file on the local Library Manager. This data is not transferred in the event of a switchover to another Library Manager.

From the ETL Specialist Welcome Page, select **Administer library manager** → **Search Database** in the panel shown in Figure 9-17 on page 428.

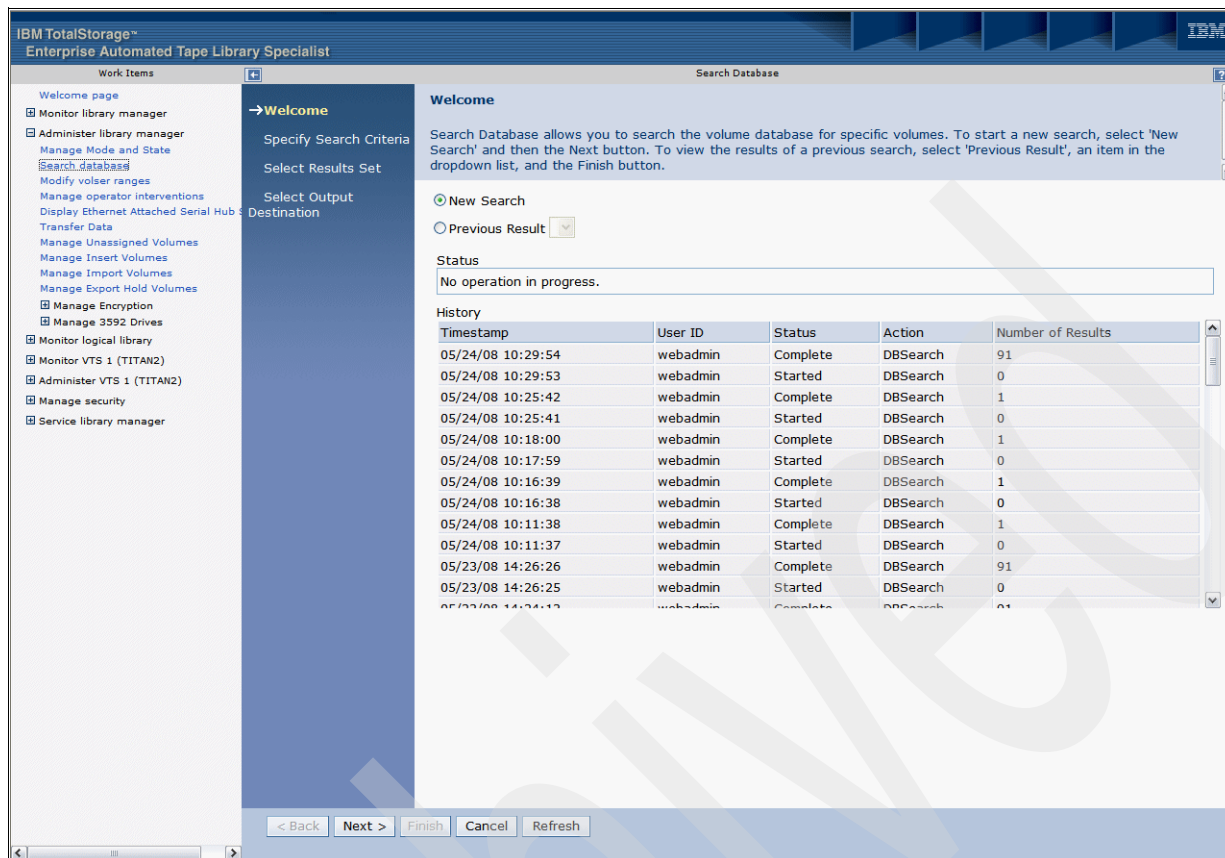


Figure 9-17 Search Database panel

To start a new search, follow these steps:

1. Select **New Search**.
2. Select **Next** at the bottom of the panel.
3. Select the search criteria that is shown in Figure 9-18 on page 429.

IBM TotalStorage™ Enterprise Automated Tape Library Specialist

Work Items

- Welcome page
- Monitor library manager
- Administer library manager
 - Manage Mode and State
 - Search database
 - Modify volser ranges
 - Manage operator interventions
 - Display Ethernet Attached Serial Hub S
 - Transfer Data
 - Manage Unassigned Volumes
 - Manage Insert Volumes
 - Manage Import Volumes
 - Manage Export Hold Volumes
- Manage Encryption
- Manage 3592 Drives
- Monitor logical library
- Monitor VTS 1 (TITAN2)
- Administer VTS 1 (TITAN2)
- Manage security
- Service library manager

Search Database

Specify Search Criteria

Make selections below to define the database search criteria. The more search criteria used, the more restrictive the search.

Volser **Category** **Media Type** **Reserve Time**

Device **Partition** **Expire Time** Days **Encrypt**

Home Rack **Home Row** **Home Column** **Home Pool**

Current Rack **Current Row** **Current Column** **Current Pool**

Storage Group **Management Class** **Storage Class** **Data Class**

Volser Flags

Yes No Ignore

☐ ☐ ☒ **Misplaced**

☐ ☐ ☒ **Unreadable**

☐ ☐ ☒ **Mounted**

☐ ☐ ☒ **Inaccessible**

☐ ☐ ☒ **Manual Mode**

Navigation: < Back Next > Finish Cancel Refresh

Figure 9-18 Specify Search Criteria panel

4. Select **Next** at the bottom of the panel.
5. Select additional fields to be returned in the results set by selecting the check box next to appropriate fields in the panel that is shown in Figure 9-19 on page 430.

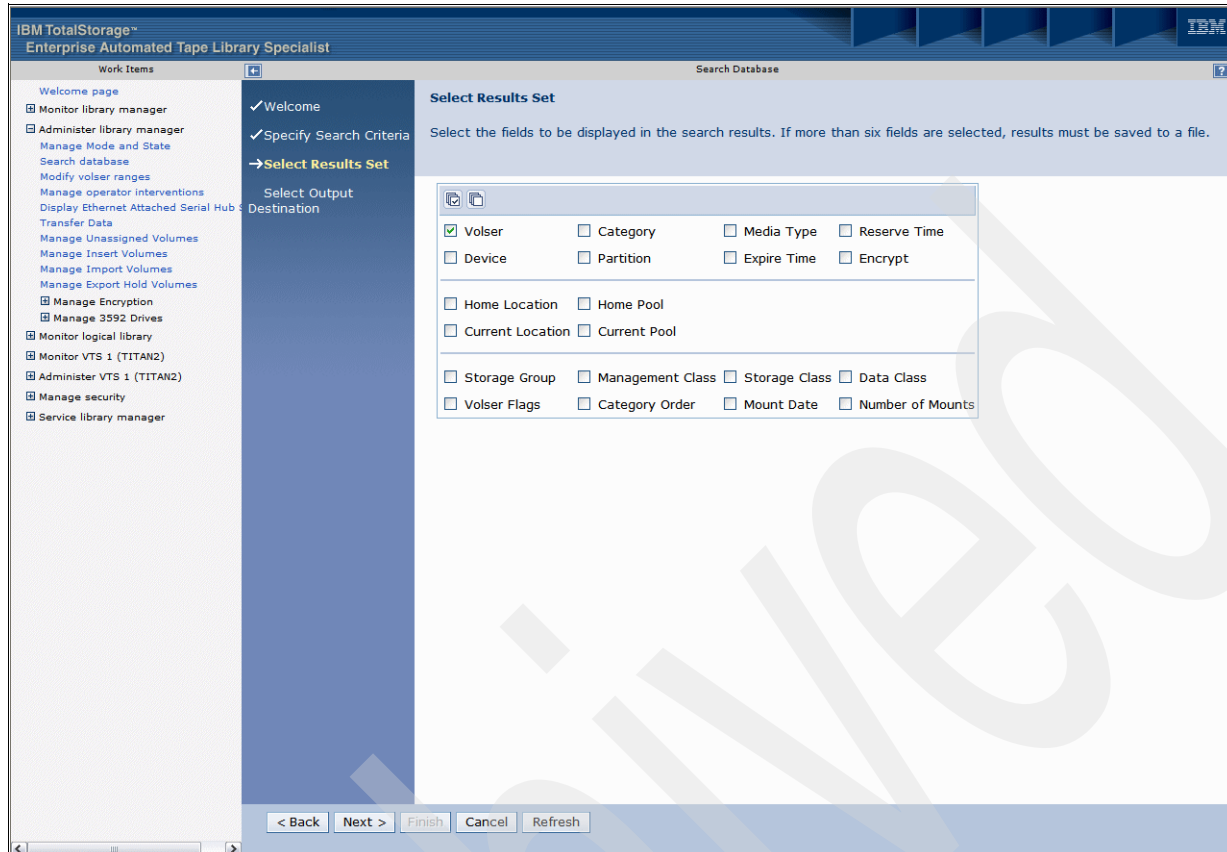


Figure 9-19 Select Results Set panel

6. Select **Next** at the bottom of the panel.
7. Select the format for your search results. You can select from either:
 - i. **Screen:** The search results will be displayed on the panel. This option is available only if six or fewer columns have been selected for output.
 - ii. **File:** The search results will be saved on the hard drive using the filename that you specify. You can view this file by using any text editing software.

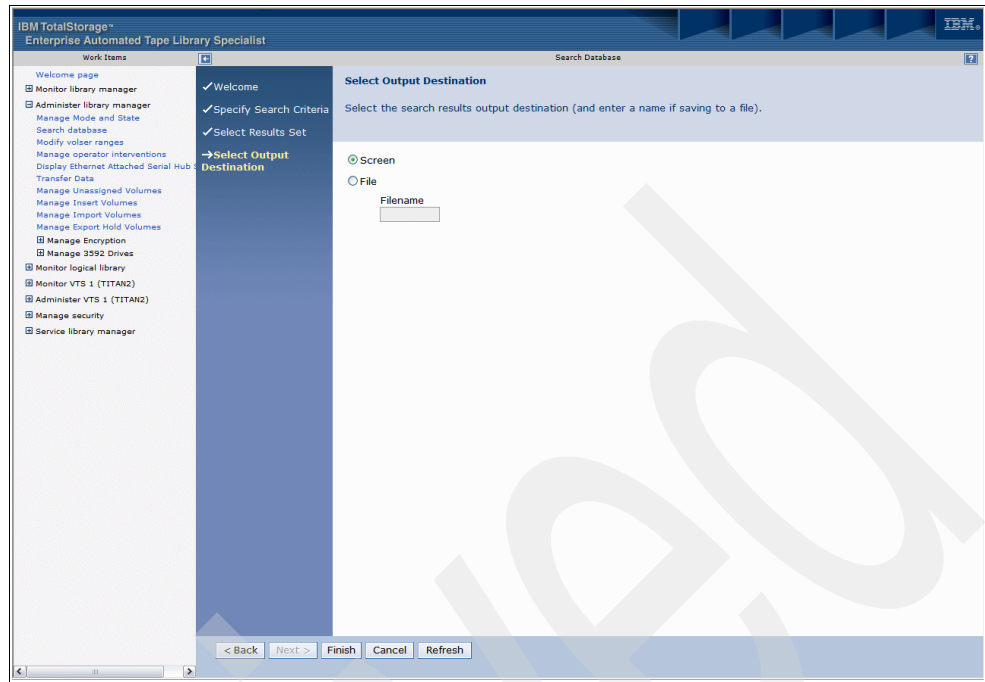


Figure 9-20 Select Output Destination panel

8. Select **Finish**.

Figure 9-21 shows the search database result on the panel.

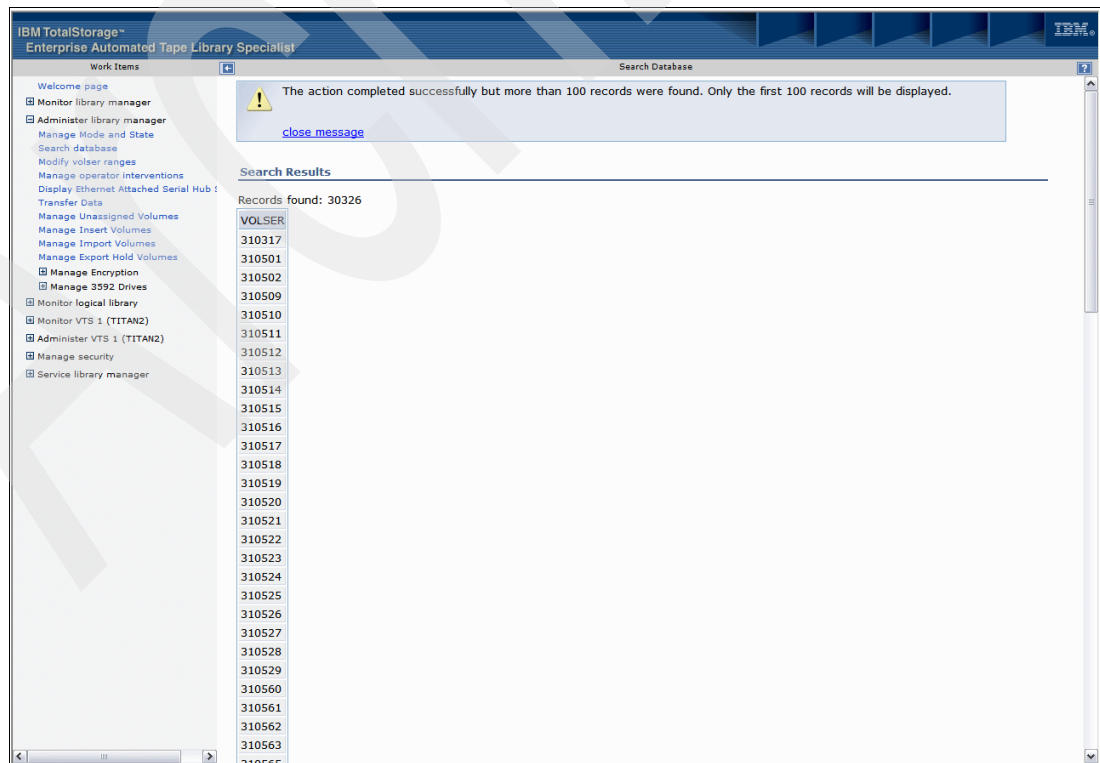


Figure 9-21 Search Results panel

9.5.4 Modifying VOLSER ranges

This panel allows you to add, modify, delete, or view VOLSER ranges. VOLSER ranges are used to help determine a physical volume's media type when it is inserted into the library. When a range is added or modified, the system automatically combines overlapping ranges with the same media type and checks for range conflicts.

From the ETL Specialist Welcome Page, select **Administer library manager** → **Modify volser ranges**. Figure 9-22 displays the panel where you can modify VOLSER ranges.

The screenshot shows the 'Modify Volser Ranges' panel in the IBM TotalStorage Enterprise Automated Tape Library Specialist interface. The left sidebar contains a 'Work Items' section with various links like 'Welcome page', 'Monitor library manager', 'Operational status', etc. The main content area has a header with instructions and a search section with fields for 'From', 'To', 'Library Sequence Number' (set to BA11A), 'Partition' (set to VTS 1), 'Media Type' (set to JJ - EETC), and 'Home Pool' (set to 32). Below the search fields are buttons for 'Add/Modify', 'Delete', 'Total Volsers in Range', 'Find Volser', and 'Refresh'. A table lists the current defined ranges with columns: Select, From, To, Library Sequence Number, Partition, Media Type, and Home Pool. The table contains 20 rows of data. At the bottom, a 'Status' section indicates 'No operation in progress.'

Select	From	To	Library Sequence Number	Partition	Media Type	Home Pool
<input type="radio"/>	310501	310598	CA003	Native	JA - ETC	0
<input type="radio"/>	310600	310609	BA11A	VTS 1	JA - ETC	0
<input type="radio"/>	310660	310660	CA003	Native	JA - ETC	0
<input type="radio"/>	310700	310720	BA11A	VTS 1	JA - ETC	0
<input type="radio"/>	A00000	A00523	CA003	Native	JA - ETC	0
<input type="radio"/>	A02480	A02498	BA11A	VTS 1	JA - ETC	0
<input type="radio"/>	J1A138	J1A548	CA003	Native	JA - ETC	0
<input type="radio"/>	J1G175	J1G176	BA11A	VTS 1	JA - ETC	0
<input type="radio"/>	J1G178	J1G191	BA11A	VTS 1	JA - ETC	0
<input type="radio"/>	J1G192	J1G986	CA003	Native	JA - ETC	0
<input type="radio"/>	J1R070	J1R096	CA003	Native	JA - ETC	0
<input type="radio"/>	J1S242	J1S596	CA003	Native	JA - ETC	0
<input type="radio"/>	J1S828	J1S829	CA003	Native	JA - ETC	0
<input type="radio"/>	J1S843	J1S849	BA11A	VTS 1	JA - ETC	0
<input type="radio"/>	J1S860	J1S879	BA11A	VTS 1	JA - ETC	0
<input type="radio"/>	J2R245	J2R259	BA11A	VTS 1	JA - ETC	0
<input type="radio"/>	JBA004	JBA005	CA003	Native	JB - ETCL	0
<input type="radio"/>	JJG095	JJG109	CA003	Native	JJ - EETC	0
<input type="radio"/>	JJS105	JJS106	CA003	Native	JJ - EETC	0
<input type="radio"/>	JRA004	JRA005	CA003	Native	JR - EEWTC	0
<input type="radio"/>	JWX065	JWX069	CA003	Native	JW - EWTC	0

Figure 9-22 Modify VOLSER ranges panel

9.5.5 Managing operator interventions

This panel allows you to view and clear existing operator and system interventions. It also allows you to enable and disable notification to all hosts of future interventions.

From the ETL Specialist Welcome Page, select **Administer library manager** → **Manage operator interventions** as shown in Figure 9-23 on page 433.

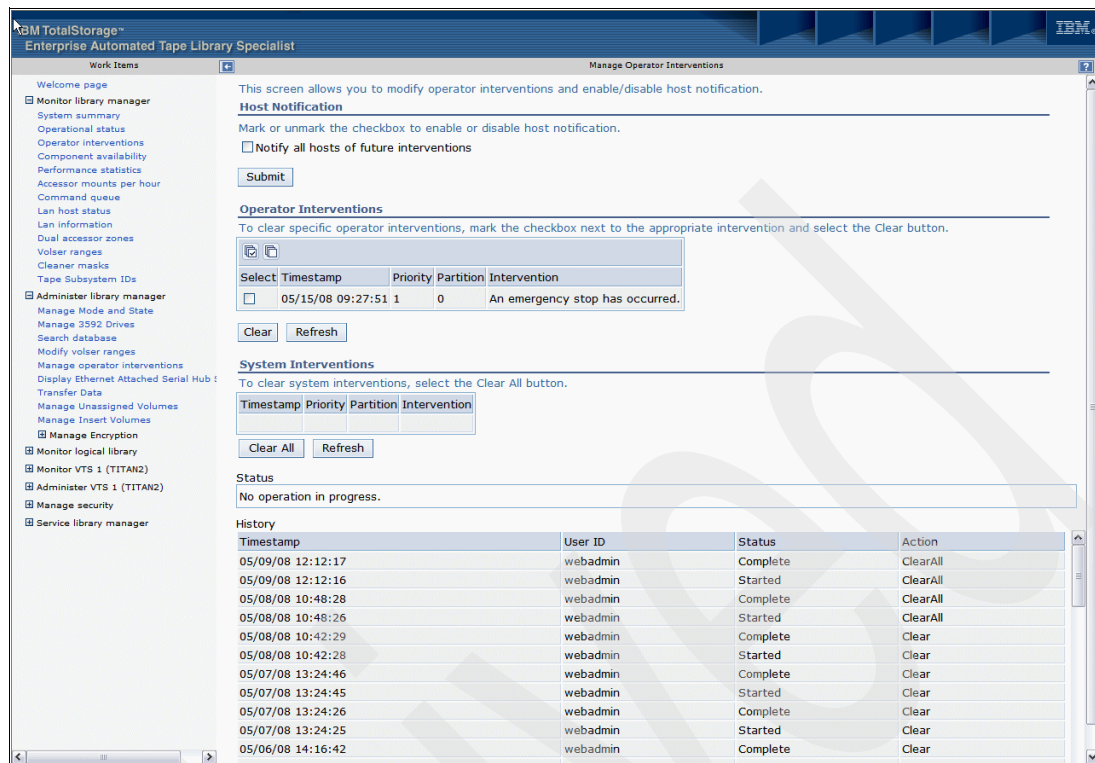


Figure 9-23 Manage Operator Interventions panel

9.5.6 Transferring data

This panel is used to transfer Library Manager system data from one library to another library or from one VTS/VE to another VTS/VE on the same library.

The administrative data can be backed up onto the hard drive. The files are stored in the C:\LM directory. The files have a file extension of *.XFR.

From the ETL Specialist Welcome Page, select **Administer library manager** → **Transfer Data** as shown in Figure 9-24 on page 434.

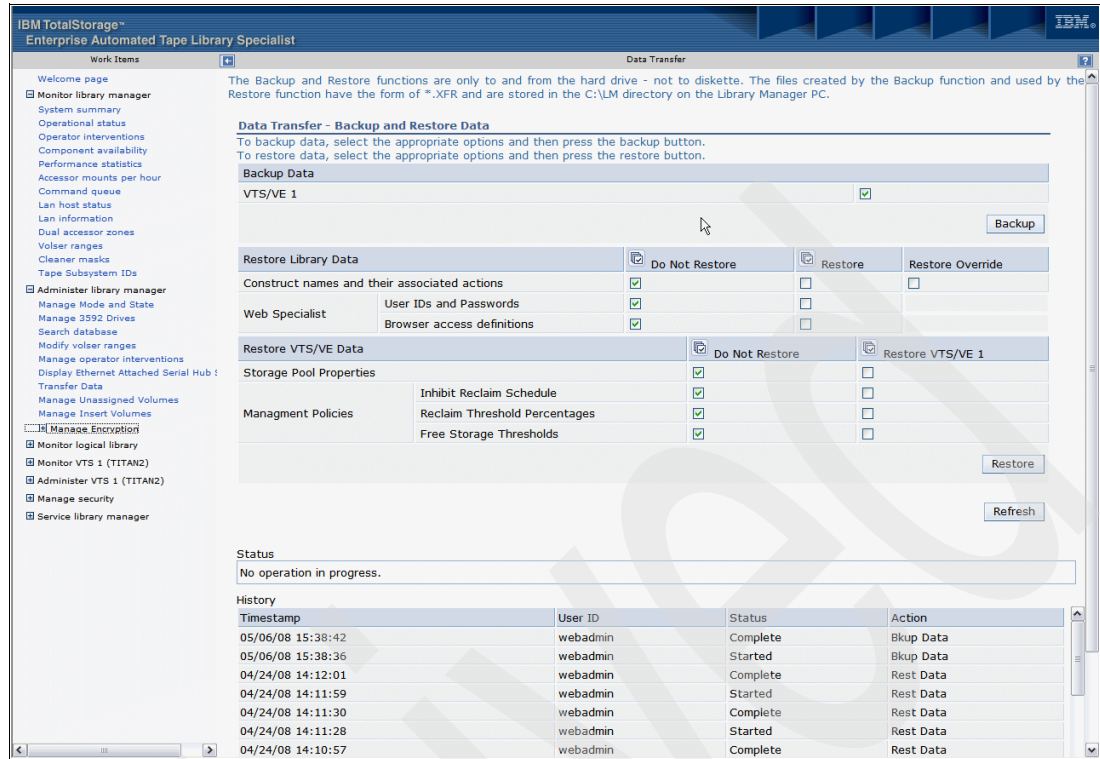


Figure 9-24 Transfer Data panel

9.5.7 Managing unassigned volumes

This 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.

From the ETL Specialist Welcome Page, select **Administer library manager** → **Manage Unassigned Volumes** as shown in Figure 9-25 on page 435.

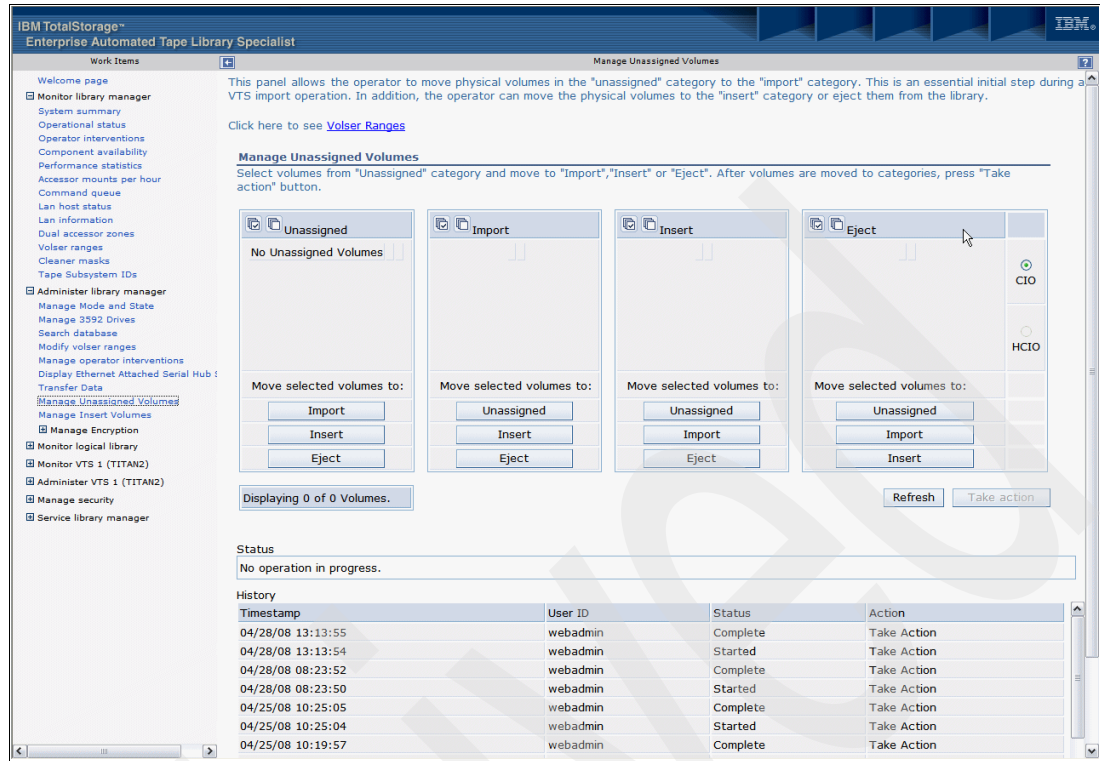


Figure 9-25 Manage Unassigned Volumes

9.5.8 Managing insert volumes

This 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.

From the ETL Specialist Welcome Page, select **Administer library manager** → **Manage Insert Volumes** as shown in Figure 9-26 on page 436.

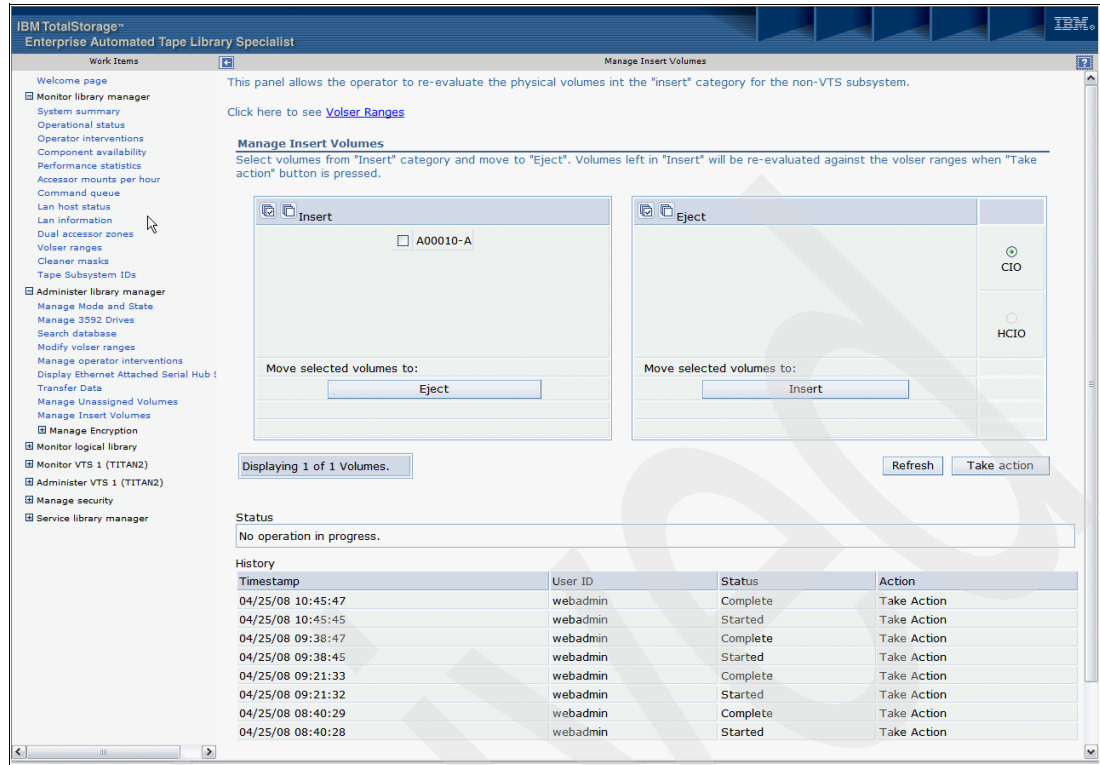


Figure 9-26 Manage Insert Volumes panel

9.6 Stand-alone dump and restore

The following sections describe stand-alone dump and restore procedures using the tape devices within an IBM 3494.

9.6.1 MVS stand-alone dump to IBM 3494

To perform a stand-alone dump to an IBM 3494, use the IBM 3494 stand-alone device support so that normal library operation is unaffected.

To perform a stand-alone dump to an IBM 3494 resident drive, follow these steps:

1. Vary the drive to be used for the stand-alone dump offline to all attached hosts.
2. Set up the stand-alone device support through the Library Manager Commands menu. Select the drive varied offline in step 1. Enter the first of the preformatted stand-alone dump tapes in the convenience I/O station.
3. Start the stand-alone dump procedure on the failed MVS system using the device address of the drive varied offline in step 1.
4. If additional tapes are requested, use the Stand-alone Device panel to mount and demount new tapes.
5. After the stand-alone dump is complete, exit the stand-alone device support and vary the drive back online to the attached hosts.

9.6.2 MVS stand-alone restore from a tape library

The Stand-Alone Services program is available with DFDSS V2.5 and DFSMSdss. The Stand-Alone Services RESTORE command is supported by tape devices within the IBM 3494. The RESTORE command enables you to restore your dump tapes by using tape devices inside the tape library.

The Stand-Alone 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 Stand-Alone 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 Stand-Alone Services program can run on a processor that is in basic mode or logical partition (LPAR) mode. Or, you can run the Stand-Alone Services program in a virtual machine under VM. The drives that you use for Stand-Alone Services must remain offline to other systems.

To restore from the dump tapes, the Stand-Alone Services program uses only tapes inside of the tape library and the TAPEVOLSER parameter of the RESTORE command to mount specified dump tape volumes using the cartridge accessor:

```
RESTORE FRMDV(TAPE) FRMADR(FDD) TOADR(791) -  
NOVERIFY TAPEVOL((BCD101) (BCD102))
```

Device address FDD is a tape drive in an IBM 3494. The tape volumes with VOLSERs BCD101 and BCD102 contain the dump dataset to restore. Volume BCD101 is the first volume in the sequence and BCD102 is the second. 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.

You can use the following devices to IPL the Stand-Alone Services program:

- ▶ DASD:
 - IBM RAMAC® or ESS DASD Family
 - IBM 9345 Storage Subsystem
 - IBM 3390 or 3380
- ▶ Tape:
 - IBM 3590, 3490E, 3490 (including stand-alone VTS/TS7700-emulated drives), and 3480 tape subsystems
 - IBM 3430, 3424, 3422, and 3420 (models 3, 4, 5, 6, 7, and 8)
- ▶ Tape libraries:
 - IBM 3494
 - IBM TotalStorage Virtual Tape Server (stand-alone VTS, because PtP VTS does not support stand-alone RESTORE processing)
 - TS7700 Virtualization Engine
- ▶ Card readers:
 - IBM 3525
 - IBM 3505
 - Virtual card reader under VM

Refer to Chapter 5, “Stand-Alone Services Hardware Requirements” in *z/OS DFSMSdss Storage Administration Reference*, SC35-0424, for more information.

9.7 z/OS with system-managed tape

This section explains the operational aspects of operating 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.

The operational interfaces to system-managed tape are provided by:

- ▶ The Integrated Storage Management Facility (ISMF) library and volume applications
- ▶ The MVS LIBRARY command
- ▶ The DFSMS DISPLAY and VARY commands

These interfaces, in conjunction with the installation tape management system, provide complete operation of the library.

9.7.1 Differences to operator interfaces if units are installed in a 3494

The tape library has operator interfaces that are different from those of other stand-alone tape devices:

- ▶ Two levels of tape unit offline

When the tape unit is part of a tape library, the tape unit online or offline state depends on the Library Manager.

The tape units of a library can individually be taken offline and online. The command to VARY units ONLINE or OFFLINE is the same in a DFSMS and non-DFSMS tape environment, as long as the library is online. Varying a tape unit online can be ineffective if the library is not online.

- ▶ Mount and demount messages

The mount and demount messages no longer appear on the operator console. However, they are issued internally and logged in the hardcopy log.

If there is an error situation where the operator decides to operate the tape library in manual mode, the mount and demount messages are displayed on the Library Manager and on the drive displays.

The mount message also indicates the requested media, displaying MEDIA1, MEDIA2, MEDIA3, MEDIA4, MEDIA5, MEDIA6, MEDIA7, MEDIA8, MEDIA9, or MEDIA10 accordingly.

- ▶ Automated dynamic device reconfiguration (DDR) swap

The DDR swap process, an error retry that is rather complicated, is now automated. If the error is the type that the tape unit can unload the cartridge, a robot moves the cartridge to another tape unit within the same library, if another tape unit is available. The system selects the unit, and the operator cannot change the selection.

9.7.2 MVS operator commands

The following MVS operator commands support the tape library:

- ▶ **LIBRARY EJECT, VOLSER{,PURGE|KEEP|LOCATION}{,BULK}**

Use this command 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 unchanged. If the SHELF location field is empty, the operator must enter information about the new location as a reply to “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 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. You can set this default up 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 will be loaded into the integrated cartridge loader (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 full library. It stops tape library actions and gradually makes all of the tape units within this library unavailable. The units are varied offline for library reasons, which means that they are inaccessible because the whole library is offline.

This simple form is a single-system form. The status of the library remains unaffected in other MVS systems.

Note: The VARY unit command is completely separate from the Library Manager action.

► **VARY SMS,LIBRARY(*libname*),ONLINE**

This command is required to bring the library back to operation after it has been offline.

The library does not necessarily go offline as a result of an error in a component of the library. Therefore, certain message explanations for error situations request the operator to first vary the library offline and then back online, which usually clears all error indications and returns the library back to operation. Of course, this part is only the MVS part of error recovery. You must clear the hardware, software, or operational error within the library before you bring the library back to work with MVS.

► **VARY SMS,LIBRARY(*libname*,*sysname*,...),ONIOFF and
VARY SMS,LIBRARY(*libname*,ALL),ONIOFF**

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, respectively.

► **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 view shows 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 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 library or all of the libraries. The result contains one line of information for each library. This multihost view basically indicates whether the 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 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 of the information that is stored about the volume in the TCDB (the volcat) and certain nonpermanent state information, such as “volume mounted on library-resident drive.”

► **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 an IBM 3494.

Here is the sample output of a DS QT system command:

```
DS QT,1699,1,RDC
IEE459I 12.30.05 DEVSERV QTAPE 970
UNIT DTYPE DSTATUS CUTYPE DEVTYPE CU-SERIAL DEV-SERIAL ACL LIBID
1699 3490L ON-NRD 3490A20 3490B40 0177-10619 0177-10619 I 10007
  READ DEVICE CHARACTERISTIC
3490203490400000 1FF8808000000000 0000000000000000 0000000000000000
0100070100000000 4281000000000000 0000000000000000 0000000000000000
-----
      |  --
      |  |----->          4. Byte = LIBPORT-ID
      |  |----->          1.-3. Byte = LIBRARY-ID (omit first half byte)
LIBRARY-ID=10007
LIBPORT-ID=01
```

► **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 type of 3590 Model (B/E/H) tape volume exist together. The *devnum* parameter is the device address in hexadecimal. The *nnn* parameter is the number of devices to query.

Here is the sample output of a DS QT system command:

```
IEE459I 11.32.31 DEVSERV QMEDIUM 608
UNIT RDTYPE EDTYPE EXVLSR INVLSR RMEDIA EMEDIA
0940 3590-E 3590-1 003700          3
  UNIT, the device address
RDTYPE, the real device type (physical)
EDTYPE, emulated device type
EXVLSR, external volume label
INVLSR, internal volume label
RMEDIA, real media type
EMEDIA, emulated media type
```

► **VARY *unit*,ONLINE|OFFLINE**

The VARY unit command is no different than it was before; however, there are new situations when the affected unit is attached to a library.

When the library is offline, you cannot use the tape units. This condition 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, which 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 unimportant, 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 system might create a situation where it is no longer possible to see from the console response whether a particular tape unit supports 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**

The MOUNT and UNLOAD commands are still available. The processing of MOUNT has been modified to accommodate automated tape libraries and the requirement to verify that the correct volume has been mounted.

9.7.3 System-managed tape automation considerations

The latest versions of this book described error messages and made recommendations about library handling. For most error handling situations, an automatic solution through an automation tool (for example, Tivoli) is impossible, because manual intervention is required.

The previous editions of this book also examined several of the common messages and codes. Due to the new functions and other changes in the latest releases, the number of messages increased rapidly. Therefore, there are too many messages to discuss in this book.

To learn about the latest messages and codes, refer to the following Web site:

http://publibz.boulder.ibm.com/cgi-bin/bookmgr_OS390/Shelves?filter=Z%2Fos

Also, refer to the *IBM TotalStorage Automated Tape Library (3494) Operators Guide*, GA32-0449, which is an excellent source for messages and actions regarding handling the library.

9.8 Error handling and recovery summary

The Library Manager, in conjunction with the built-in hardware error recovery routines, attempts to recover from all library component failures. If the recovery is successful, the operation continues. If the recovery fails, the Library Manager sets the appropriate operational mode, operational status, and information states that reflect the impact of the failure.

Hosts are informed of failures only if a host-requested operation has failed or a library component has become unavailable. How this notification is implemented depends on the way that the host is connected to the library. If the host supports a single data and command path, the error condition is flagged through the channel. If the host requires a second connection to pass library commands (RS-232 or LAN), the error conditions are flagged to the attached host through that connection. The way in which the errors are presented to the operator at the host varies. These messages are accompanied by the operator intervention window on the Library Manager.

The Library Manager logs all errors in an error log. You can access this log through the Library Manager Service menu. Then, contact an IBM SSR to analyze it.

The following sections discuss library hardware failures and suggest recovery actions. For additional information about error recovery, see the *IBM TotalStorage Automated Tape Library (3494) Operators Guide*, GA32-0449.

System Summary window

The System Summary window (Figure 9-27), which appears when the Library Manager is powered on, provides an overview of important information relating to Library Manager status and component availability or failure.

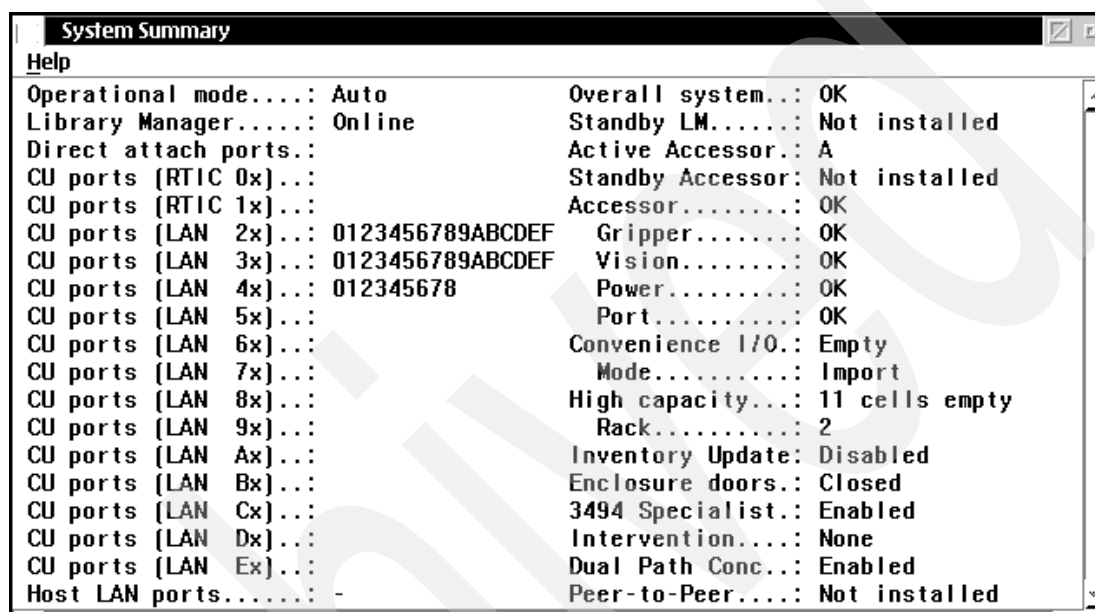


Figure 9-27 System Summary window

The fields on the System Summary window can have the following values:

- ▶ The Library Manager field shows whether the Library Manager is Online Pending, Online, Offline Pending, or Offline to the attached tape control units.
- ▶ The Standby Library Manager field shows the status of the standby Library Manager:
 - *Enabled* indicates that the standby Library Manager is functional.
 - *Disabled* indicates that the standby Library Manager is not functional and causes the overall system to report *Degraded*.
 - *Degraded* indicates that the standby Library Manager has lost one of its communication links with the active Library Manager.
 - *Not Taught* indicates that the accessor has not completed a successful teach, making it unusable.
- ▶ The Active Accessor field shows which accessor is the active accessor:
 - An *A* indicates that accessor A is active.
 - An *B* indicates that accessor B is active.
 - *Both* indicates that the Dual Active Accessor feature is installed. See 9.10.2, “Dual Active Accessor recovery scenarios” on page 453 for more information about the Dual Active Accessor.
 - *None* indicates that there is currently not an active accessor (both accessors are unavailable).

- The Standby Accessor field shows the status of the standby accessor:
 - *Available* indicates that the standby accessor can be used if an accessor switch occurs.
 - *Service Mode* indicates that the accessor is unavailable while it is serviced.
 - *Not Available* indicates that the accessor has components marked unavailable that currently make it unusable.
 - *Not installed* indicates that the second accessor is not installed.

9.9 Failure scenarios without HA1

This section describes the operational impact of failures when you do not install the HA1 feature, the recovery actions initiated by the Library Manager, and the recovery actions the operator must take.

9.9.1 Library Manager failure

In a single Library Manager configuration, if the Library Manager fails, all library operation stops. As long as the Library Manager is unavailable, it is impossible to operate the library in manual mode.

9.9.2 Accessor failure

If an accessor fails in a single-accessor configuration, the library goes into pause mode, and all attached hosts are notified of the error. In the IBM 3494, all mount and demount operations are queued. You can run the library in manual mode while the IBM SSR repairs the accessor. If the accessor inhibits access to any part of the library, operational procedures exist to move it. The accessor can be gently pushed to the end of the library.

9.9.3 Gripper failure

If the gripper in a single accessor single gripper configuration fails, the library enters pause mode, and all attached hosts are notified of the error. During the repair action, you can run the library in manual mode.

If one gripper fails in a dual-gripper, single-accessor configuration, the 3494 continues to function in a *Degraded* state. In this case, if the library was operating in floating home cell mode, it operates in fixed home cell mode. When the failure is corrected, it automatically returns to operating in floating home cell mode.

An IBM 3494 can have up to four grippers installed when the High Availability unit and the dual gripper feature are installed. If all of the grippers of the active accessor fail, a switchover to the standby accessor is initiated. The repair action of a gripper on the standby accessor is nondisruptive.

9.9.4 Barcode reader or vision system failure

The IBM 3494 has a single barcode reader. If the reader fails, all attached hosts are informed. Library operation continues, but all insert, eject, audit, and inventory operations are suspended. If the High Availability unit is installed, there are two barcode readers, one on each accessor. The IBM 3494 continues to run in *degraded* mode. No automatic accessor switchover takes place. Switchover can be done manually by the operator to enable insert, eject, audit, and inventory operations.

9.9.5 Convenience I/O failure

In an IBM 3494, if the convenience I/O station fails, eject operations are redirected to the high capacity output facility. If the high capacity output facility is not defined in the configuration, the eject operations remain queued until the convenience I/O station becomes available.

Insert operations can use any empty cell.

9.9.6 Library Manager secondary hard disk failure

If the Library Manager secondary hard disk fails, normal library operation continues, but all hosts are informed that the library is in a *degraded* mode. After the secondary hard disk is repaired, database dual write can be re-enabled, and the secondary copy of the Library Manager database can be built.

9.9.7 RS-232 or LAN host connection failure

If an RS-232 or LAN path between the library and a host fails, the host cannot use the library until the path is reestablished.

9.9.8 Tape subsystem communication failure

If the communication path between a tape subsystem and the Library Manager fails, the tape subsystem is unavailable.

9.9.9 Tape control unit failure

If a tape control unit fails, the drives supported by that controller are no longer accessible down that path. All hosts are informed of the error. Normal library operation continues while there is at least one available control unit, assuming that the hosts still have access to the tape drives.

9.9.10 Primary Library Manager hard disk failure

A non-HA1 Library Manager comes standard with one primary hard disk and the option to specify a secondary hard disk. The primary hard disk contains the operating system and library database. The purpose of the secondary hard disk is to maintain a copy of the database that is on the primary hard disk. The secondary disk does not have a copy of the operating system.

When the Library Manager has the secondary hard drive feature installed and the primary disk experiences an error, the secondary disk preserves only the database from the primary disk. It does not allow you to continue running. The IBM SSR must replace the failed hard disk and load the operating system, as well as the Library Manager code, on it. Then, the database can be copied from the secondary disk, and normal operations can resume.

In an IBM 3494 configuration without the HA1 and the dual disk drive feature, all library operations cease, and the library is unusable. After the failed hard disk is replaced, the IBM SSR must perform a library teach operation. The IBM 3494 must be inventoried, and the Library Manager database must be synchronized with the host tape databases. See 9.9.11, "Library Manager database recovery" on page 446. Because an extended outage is possible, we recommend that you install at least the dual disk drive feature.

9.9.11 Library Manager database recovery

If the Library Manager database cannot be recovered from a secondary copy, you must perform certain actions before you can restart the automated operations.

Important: This procedure only works if no VTS is installed. Part of the information that is necessary for the VTS (such as Volume Ranges for Media types, the logical volume ranges, reclaim thresholds, and all the necessary information for APM) cannot be restored with a teach or inventory process. Also, you cannot restore security information (users and passwords) for the usage of the ETL Specialist with this procedure. You must provide all of this information again manually.

If no VTS is installed, use the following steps to recreate your library database to a usable level:

1. Perform the library teach process.
2. Perform the library inventory process.
3. Resynchronize the Library Manager database with all attached hosts.

Library teach process

This step recovers information about the tape library system, such as the tape library configuration, default media type, and device cleaning schedule.

Library inventory process

This step recovers information about volumes, such as the VOLSER, media type, volume location, and storage cell status. This step does not recover volume category information or information about the non-external label volumes that were inserted using the unlabeled tape facility. During the inventory process, the Library Manager ejects the non-external label volumes. Therefore, to recover the information about these volumes, use the unlabeled tape facility to insert them again.

After the library inventory, the volume category of each volume in the Library Manager database is assigned to the INSERT category. The Library Manager sends the volume information to all attached hosts.

Resynchronizing the Library Manager database

This step recovers the volume category information. There is no general procedure to recover the volume category information. The recovery procedure depends on the software platform:

► **z/OS with system-managed tape**

In a system-managed tape environment, the TCDB and DFSMSrmm control dataset (if DFSMSrmm is installed) contain the volume category information. It is always synchronized with the Library Manager database. When the library is varied online from a host system, the system receives information about the volumes in the INSERT category. Then, OAM automatically sends commands to the Library Manager to assign the volume category according to the TCDB and DFSMSrmm control dataset.

► **z/OS with BTLS**

In a BTLS environment, BTLS has no volume category information. It records only which volume resides in which tape library.

If you have a procedure or a tape management system to manage tape dataset and volume retention, you can obtain the private or scratch volume category information. Then, use the IDCAMS LIBRARY SETCATEGORY command to assign the Library Manager volume category. Alternatively, your tape management system might support the IDCAMS

LIBRARY SETCEXIT, which automatically resynchronizes the tape management system and the Library Manager database by using the IDCLI04 exit.

BTLS supports eight scratch categories. If you use multiple scratch volume pools, you must also develop a procedure to manage the scratch categories.

► **VM/ESA and VSE/ESA**

In a VM/ESA or VSE/ESA environment, the tape management system is responsible for resynchronizing its database with the Library Manager database. Typically, operational procedures are followed to issue the command or start the job provided by the tape management system to synchronize the two databases. The information in the tape management system database is never changed. Only the Library Manager database is updated.

► **AIX**

The tape management system is responsible for updating the Library Manager database for the volumes that it controls. If you are using IBM Tivoli Storage Manager, use the Tivoli Storage Manager volume history file and CHECKIN the volumes using the appropriate volume category.

If you have cartridges inside of the 3494 Tape Library that you automated through the MTLIB command, set their Library Manager category by using this MTLIB command:

```
mtlib -l /dev/lmcp0 -C -VAIX001 -txxxx
```

Here, xxxx is the Library Manager category that you use.

9.10 Operating and monitoring the High Availability unit

When you install the High Availability unit (HA1), the IBM 3494 configuration has two Library Managers and two cartridge accessors. Each Library Manager controls a cartridge accessor. The addition of the second Library Manager and accessor in the 3494 subsystem improves the subsystem's availability and a client's ability to access its data.

In the event of a cartridge accessor or Library Manager failure, the IBM 3494 can continue operations after a short interruption. The system can continue to operate as the failed component is serviced. This feature also minimizes library downtime for installing Library Manager code patches.

Figure 9-28 on page 448 shows a diagram of the HA1 components.

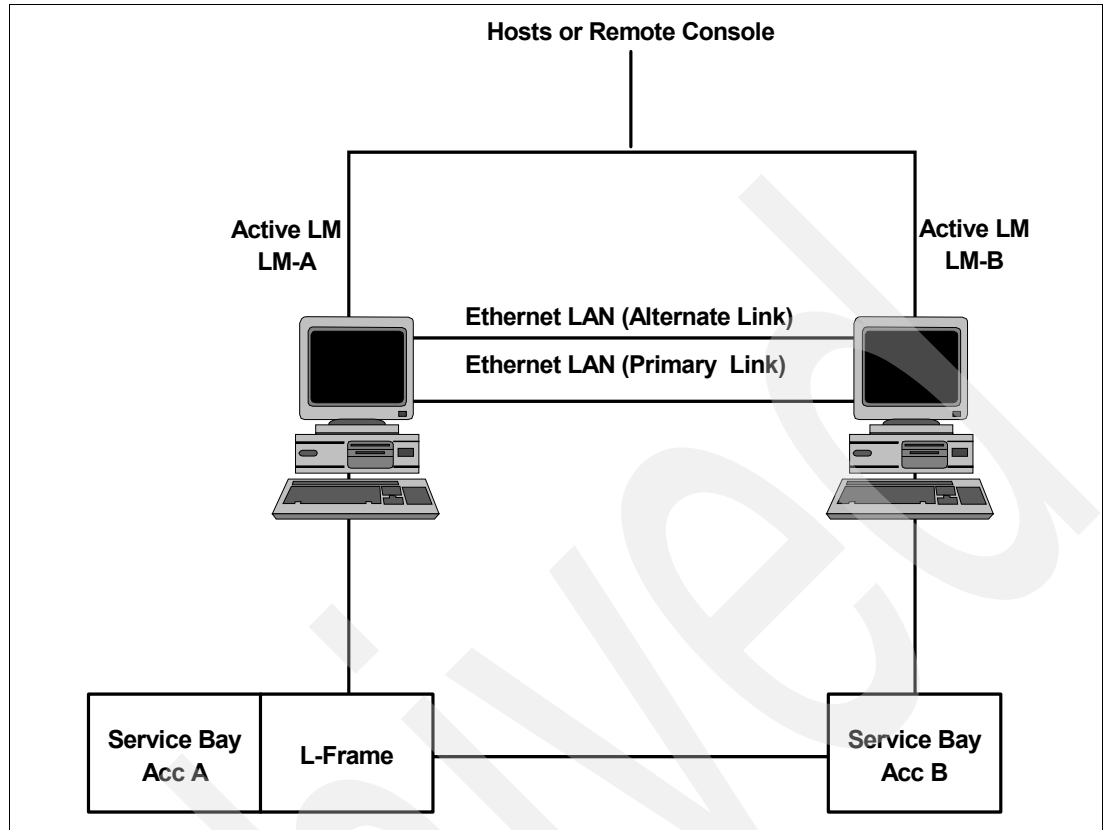


Figure 9-28 HA1 components

Under normal operation, that is, no elements have failed or are degraded, the active Library Manager is Library Manager A (LMA), and the standby Library Manager runs on Library Manager B (LMB). The active accessor, Accessor A, is controlled from LMA. LMA receives host commands over the serial interfaces (RS-422) from direct-attached hosts and serially attached control units. LMA controls the operator panel and convenience I/O station. The accessor manager on LMA knows that the standby accessor, Accessor B, is safely parked in its service bay. The accessor manager in LMA performs move operations using Accessor A. The active database on LMA is continually backed up onto LMB across the primary link.

The Dual Active Accessor (DAA) feature is a performance enhancement follow-on to the HA1 feature. With DAA installed and enabled, both Accessor A and Accessor B are active, and typically, LMA is the active Library Manager and LMB is the standby Library Manager. The accessor manager in LMA performs move operations using Accessor A and passes move operation commands for Accessor B to LMB across the primary link.

The IBM 3494 is designed to operate in degraded mode when a component fails. If a switchover to the standby Library Manager has occurred because of a failure, there is no technical reason to switch back to the original Library Manager. However, the client's policies and needs must dictate this decision. We recommend that you periodically switch between Library Managers to verify that the standby Library Manager is functional.

9.10.1 HA1 recovery scenarios

This section describes the failures that the HA1 recovers and the operational impact of the failure and recovery.

Two conditions cause a Library Manager switchover:

- ▶ Library Manager failure due to a catastrophic failure or unrecoverable code-detected error
- ▶ Switchover on demand

Note: A complete failure of a Library Manager causes its accessor to become unavailable.

Standby Library Manager failure

If a Standby Library Manager failure occurs due to a catastrophic failure, for example, a loss of power or an unrecoverable code-detected error, the Library Manager receives a Library Manager Check 1 condition.

When a standby Library Manager fails, the attached hosts are sent an operational state change message: CBR3758E Library *library-name* operation degraded.

The status of three fields on the System Summary window for the active Library Manager changes:

- ▶ **Overall system:** Degraded
- ▶ **Standby LM:** Disabled
- ▶ **Standby Accessor:** Not Available

When you resolve the failure on the standby Library Manager and you power on the standby Library Manager, the standby accessor becomes *Available* as soon as the base Library Manager code has loaded.

After the standby Library Manager is initialized, the Library Manager database is initialized, and the database is copied from the active Library Manager. You can monitor the progress of the database copy on the active Library Manager by selecting **Operational Status** from the Status menu.

The Database Dual write field displays Copying to remote *nn%*. When the database copy completes successfully, the standby Library Manager is enabled and the overall system field changes to OK.

Active Library Manager failure

This section discusses an active Library Manager failure due to a catastrophic failure or an unrecoverable code-detected error. When the active Library Manager fails, the attached hosts receive the operational state change message "CBR3002E Library *library-name* no longer usable."

The impact of an active Library Manager failure is:

- ▶ Jobs that have their tapes mounted continue to run. Jobs, which have requested tape mounts that have not completed, fail. If all the tapes needed to complete the job are mounted, the job runs to completion. At the end of the job, the tapes rewind and unload. Any demount commands fail with an initial status indicating that LMA is offline.
- ▶ The active Library Manager maintains the only copy of the command queue, and during a switchover, the command queue is lost.
- ▶ If a new mount request arrives during the switchover, it fails with an initial status indicating that the Library Manager is offline.

During normal operations, the Standby Library Manager window (Figure 9-29 on page 450) displays.

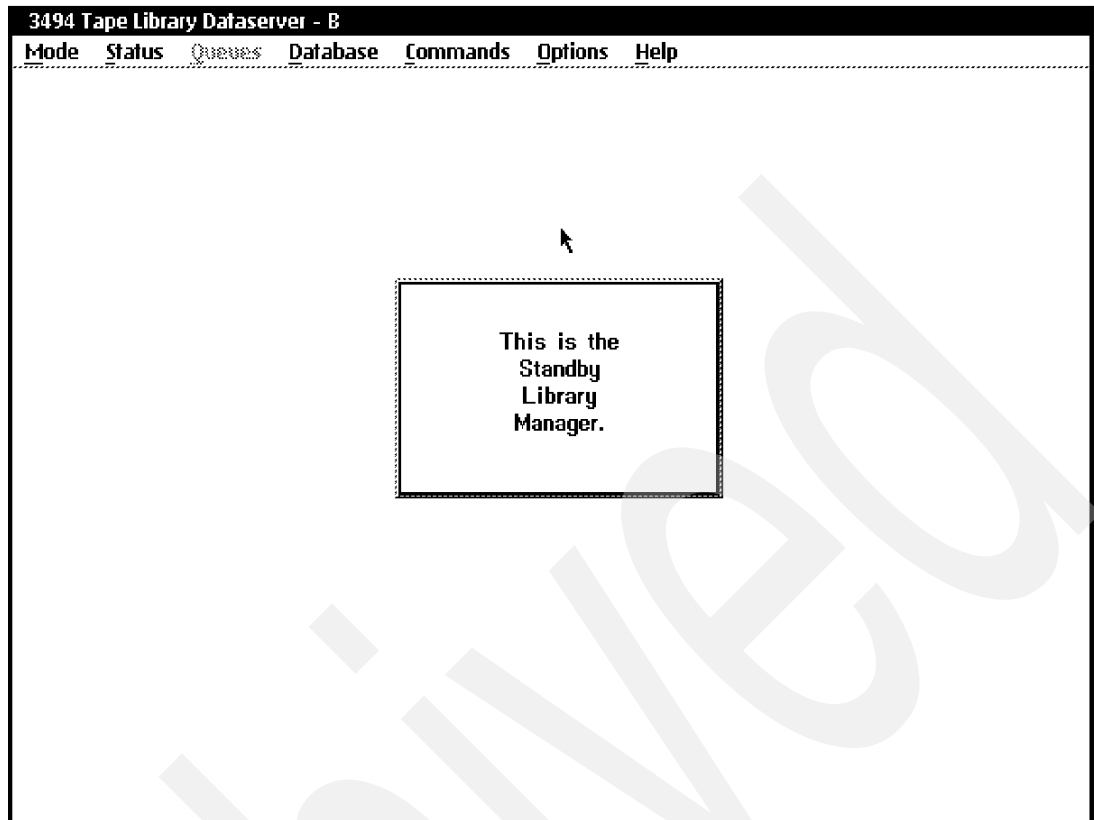


Figure 9-29 Standby Library Manager window

During Library Manager switchover, the window shown in Figure 9-29 is replaced by the Library Manager switching window (Figure 9-30).



Figure 9-30 Library Manager switching window

When the standby Library Manager becomes active, the window (Figure 9-30) is no longer displayed. The System Summary window displays indicating a transition to auto mode. The accessor is also switched, because it becomes unavailable when the Library Manager to which it is attached fails.

During Library Manager switchover, there is no host interaction. Switchover can take several minutes. We recommend that the operator monitor the switchover process on the Library Manager.

When the switchover has completed, the System Summary window shows:

- ▶ **Overall System:** Degraded
- ▶ **Standby LM:** Disabled
- ▶ **Standby Accessor:** Not Available

The attached hosts receive an operational state change message (see “Standby Library Manager failure” on page 449).

In this scenario, this message is an indication to the host operator that the library is available. The operator needs to vary the library online and restart any jobs that have failed. When you have resolved the failure on the standby Library Manager (LMA) and powered it on, the standby accessor (Accessor A) becomes *Available* as soon as the base Library Manager code is loaded.

After LMA is initialized, the Library Manager database on LMA is initialized, and the database is copied from the active Library Manager (LMB) to the standby Library Manager (LMA). The database copy can take a long time depending on the size of the database and the activity on the library during the copy process. The database copy also uses many of the Library Manager resources. Therefore, we recommend that you do *not* attempt any other Library Manager actions during this process.

Note: With the VTS advanced functions installed from a host perspective, the library remains online and operational during the switchover. When a Library Manager switchover occurs, an operational state change bit is sent to the host (Library Manager switchover in progress), causing the message “CBR3783E Library Manager switchover in library <library-name> in progress.”

After the switchover completes, you see a new message “CBR3784I Library Manager switchover in library <library-name> is now complete.” The Check 1 bit that caused the library to go offline and that issued CBR3002E is no longer set.

Library Manager switchover on demand

Library Manager switchover on demand is an operator-initiated function. It causes the active Library Manager to become the standby Library Manager and the standby Library Manager to become the active Library Manager.

This process, which is less disruptive than a Library Manager switchover due to Library Manager failure, involves the following operator actions:

- ▶ The library must be placed in a paused offline state. All drives in the library must be taken offline, and the library must be quiesced.
- ▶ The switchover is initiated by the operator selecting **Switch Active Library to Standby** from the Mode menu.
- ▶ When the switchover is complete, the active Library Manager is in paused and offline mode. The operator must vary the Library Manager to *auto* and *online* from the Mode menu.

When the operator performs a Library Manager switchover manually, no Library Manager database copy occurs, because the Library Manager keeps the two copies of the database in sync and knows that they are identical.

Standby accessor failure

When the standby accessor fails, the System Summary window shows:

- ▶ **Overall System:** Degraded
- ▶ **Standby LM:** Enabled
- ▶ **Standby Accessor:** Not Available

The attached hosts receive an operational state change message (see “Standby Library Manager failure” on page 449). The library continues to function but in degraded mode.

Active accessor failure

When the active accessor fails, the System Summary window shows:

- ▶ **Overall System:** Degraded
- ▶ **Standby LM:** Enabled
- ▶ **Standby Accessor:** Not Available

The attached hosts receive an operational state change message, which can be accompanied by one or more messages indicating that operator intervention is required, such as removing a cartridge from the gripper of the failed accessor. Here are examples of these messages:

```
CBR3758E Library library-name operation degraded.  
CBR3762E Library library-name intervention required.  
CBR3776I Volume VOLSER inaccessible in library library-name.
```

Accessor switchover takes about two minutes. During this time, the following actions occur:

- ▶ The library automatically goes into a temporary pause mode.
- ▶ The standby accessor (Accessor B), which becomes the active accessor, comes out of its service bay and pushes the failed accessor (Accessor A) into Accessor A's service bay.

When accessor switchover is completed, the library automatically goes into auto online mode, and normal operations resume.

Accessor switchover on demand

Accessor switchover on demand is an operator-initiated function that causes the active accessor to become the standby accessor and the standby accessor to become the active accessor. Accessor switchover is initiated by selecting Switch Accessor to Standby on the Mode menu.

Accessor switchover takes approximately two minutes. During this time, the following actions occur:

- ▶ The library automatically goes into temporary pause mode.
- ▶ The active accessor (assume Accessor B) goes to its service bay.
- ▶ Accessor A comes out of its service bay and calibrates itself on both ends of the library.
- ▶ If a volume was in the gripper of Accessor A, the volume is placed in the recovery cell.
- ▶ The volume is scanned, and its home cell is checked.
- ▶ If this volume's home cell is empty, the volume is taken from the recovery cell and placed in its home cell.

When accessor switchover completes, the library automatically goes into auto online mode, and normal operations resume. We recommend that you periodically switch between accessors to verify that the standby accessor is functional.

HA1 and gripper failure

If you lose one gripper in a dual gripper accessor, the Library Manager sends an operational state change message to all attached hosts, informing the hosts that the 3494 subsystem is now operating in degraded mode. The accessor does not switch to the standby accessor. The operator can switch the accessor by using the Library Manager menu. If the accessor is switched, the 3494 subsystem is still considered to be operating in degraded mode until the failing gripper on the standby accessor is repaired.

If the accessor does not have the dual gripper feature installed, and the gripper experiences a failure, the active Library Manager sends an operational state change message to all attached hosts, informing the hosts that the 3494 is operating in degraded mode. The active Library Manager then parks the disabled accessor in its service bay and sends commands to the standby Library Manager over internal links. The standby Library Manager then executes the commands, using its accessor. Control of the 3494 does not switch to the standby Library Manager.

HA1 and the secondary Library Manager disk drive

With the HA1, both Library Managers have the operating system and the database on their primary disks. Both primary disks are kept in synchronization over the internal LAN. The secondary disks are not used if both Library Managers are functional. With the HA1 installed, a failure of the primary hard drive causes a switchover to the standby Library Manager, and normal operations continue.

In an HA1 configuration, both Library Managers must have the secondary hard disk feature installed. The secondary disks are not used if both Library Managers are functional. If one of the Library Managers experiences a problem, the active Library Manager uses both of its own disks. The active Library Manager's primary hard disk contains the operating system and database, and the secondary hard disk becomes the backup disk.

9.10.2 Dual Active Accessor recovery scenarios

This section describes failure scenarios with the Dual Active Accessor (DAA) feature installed and enabled and the operational impacts of the failure and recovery. We discuss the conditions that cause a Library Manager switchover in 9.10.1, "HA1 recovery scenarios" on page 448.

Standby Library Manager failure with the DAA feature

A standby Library Manager failure with the installed DAA feature does not cause any host messages to be issued unless the failure is severe enough to cause the failure of the accessor that is "owned" by it. Refer to "Accessor failure with DAA feature" on page 454 for details about accessor failure.

The System Summary window shows:

- ▶ **Overall System:** Degraded
- ▶ **Standby LM:** Disabled
- ▶ **Standby Accessor:** Available/not available

When the failure on the standby Library Manager is resolved and the standby Library Manager is restarted, the Library Manager database is initialized, and the database is copied from the active Library Manager.

When the database copy has completed successfully, the standby Library Manager is enabled, and the Overall system field changes to OK.

Active Library Manager failure with DAA

When the active Library Manager fails, the standby Library Manager switches from standby to active. There can be a time delay before the attached hosts receive any operational state change messages:

```
CBR3002E Library library-name no longer usable.  
CBR3729I Library Manager for library library-name offline.  
CBR3763E Library library-name Library Manager check 1 condition.
```

On a z/OS host, you can issue the D SMS,LIB(*library-name*),DETAIL command. The resulting display shows that the library is offline and degraded, has a Check 1 condition, and indicates whether one of the accessors is placed offline.

The System Summary window shows:

- ▶ **Overall System:** Degraded
- ▶ **Standby LM:** Disabled
- ▶ **Standby Accessor:** Available/Not Available

The impact of the active Library Manager failing is described in “Active Library Manager failure” on page 449.

When the Library Manager switchover completes, put the library in *auto online* mode and vary the library online to the attached hosts.

After the failed Library Manager is repaired and powered on, the Library Manager database is initialized. The database is copied from the active Library Manager (LMB) to the standby Library Manager (LMA). The progress of the database copy can be monitored as explained in “Standby Library Manager failure” on page 449.

The database copy can take a long time, depending on how big the database is and how busy the library is during the copy process. The database copy also uses many of the Library Manager resources. We recommend that you do *not* attempt any other Library Manager actions during this process.

Library Manager switchover on demand with DAA feature

This procedure does not differ from the Library Manager switchover on demand without DAA (refer to “Library Manager switchover on demand” on page 451 for details).

Accessor failure with DAA feature

When an accessor fails with the DAA feature installed and enabled, the System Summary window shows:

- ▶ **Overall System:** Degraded
- ▶ **Standby LM:** Enabled
- ▶ **Standby Accessor:** Not Available
- ▶ **Active Accessor:** A/B

The attached hosts receive an operational state change message and one or more informational messages:

```
CBR3758E Library library-name operation degraded.  
CBR1110I Operation degraded due to unavailable hardware resource.
```

The library automatically goes into a temporary pause mode, and the active accessor pushes the failed accessor into its service bay. Then, the library automatically switches to auto online mode and normal operations resume.

After the failed accessor is repaired, use the work item 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 9-31. Then, click **Enable DAA** to enable the Dual-Active Accessor Capacity.

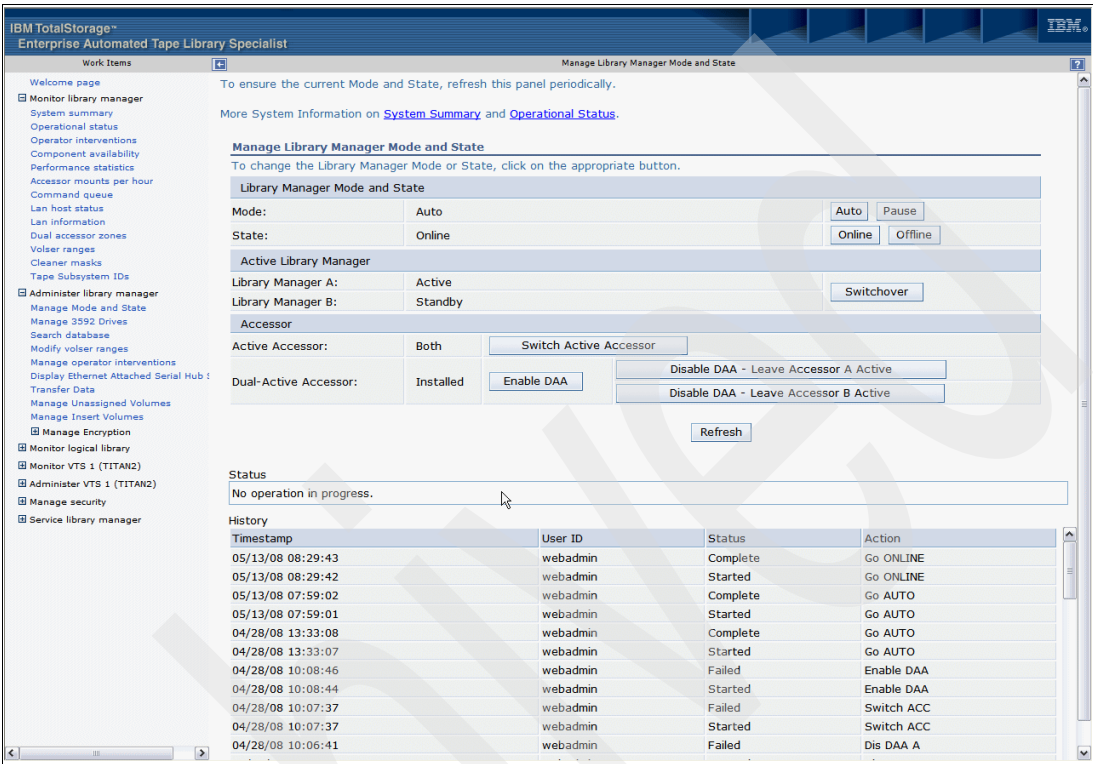


Figure 9-31 Manage Mode and State panel

The active accessor goes to its service bay. The recovered accessor calibrates on both ends of the library. Normal operations resume with both accessors active.

Archived

Tape drives in silo compatible frames

This appendix provides an overview of the technique to install IBM tape drives in Sun StorageTek Automated Cartridge Systems (ACS) Silo Frames.

The IBM TotalStorage Silo Compatible Tape Drive Frame 3592 Model C20 (3592 Model C20) in Figure A-1 on page 461 supports the IBM 3592-J1A Tape Drive, the TS1120-E05 Tape Drive, and the 3592-E06 Tape Drive (hereafter referred to collectively as the 3592 tape drives) attached to the Sun StorageTek 9310 PowderHorn Tape Library. This attachment can be either Enterprise Systems Connection (ESCON) or Fibre Channel Connection (FICON) (for System z) through an externally attached TS1120 Tape Controller Model C06 or 3592 Model J70 Tape Controller.

This appendix is not detailed or complete enough to guide you through an actual installation.

For more information, refer to *IBM TotalStorage 3592 Tape Frame Model C20, Introduction, Planning, and User's Guide GA32-0463-06*, and contact your IBM marketing representative.

Why use IBM tape drives in a Sun StorageTek Silo

Certain installations have used Sun StorageTek (STK) Silos for many years. These clients have extensive experience with the hardware and software that is involved. They have automation and handling procedures in place and perhaps use the feature provided by STK. Normally, they are satisfied with the environment they have already installed.

Here are several reasons why you might want to install IBM System Storage tape drives in an STK Silo:

- ▶ You need a high performance, high capacity drive and cartridge.

The 3592 tape drives are designed to provide high capacity and performance for storing mission critical data.

Offering significant advancements in capacity and data transfer rates, the 3592 tape drives help address storage requirements that are often addressed by two types of drives: those drives that provide fast access for data access and those drives that provide high capacity for backups.

- ▶ An STK Silo supports up to twenty 3592 tape drives.

The 3592 product line has had significant improvement over the years. With the introduction of the TS1130 Tape Drive, a single tape cartridge can hold up to 1 TB of uncompressed data, with a native data rate of 160 MB per second. With the attachment capabilities of TS1120-C06 Controller and through the external 3952-F05 tape frame, you can use ESCON, FICON, or a combination of both attachment methods to attach the TS1130 in environments where channel attachment is constrained and yet still deliver high throughput.

- ▶ You need a higher bandwidth in the attachment.

With the introduction of FICON, an extremely high performance channel is available. Refer to 3.8.6, "Performance overview" on page 143 for information about the FICON throughput rates.

- ▶ You need more cartridges in a single environment than an IBM 3494 can provide.

The capacity of a single Sun StorageTek Silo (depending on the attachment of drives) can be up to 5,500 cartridges. However, STK provides the ability to combine silos into one automatic cartridge system (ACS). Therefore, the total number of cartridges available in a single ACS is more than an IBM 3494 can provide.

Overview of a Sun StorageTek solution

The Sun StorageTek solution is based on hardware and software:

- ▶ Library storage module (LSM) and library control unit (LCU)
- ▶ Library management unit (LMU)
- ▶ Host software component (HSC)
- ▶ Control datasets
- ▶ Library station component and client software component
- ▶ Automated cartridge system library software (ACSL)

Library storage module and library control unit

The LSM, commonly referred to as a *silo*, is a twelve-sided housing unit that encloses the robotics arm, vision system, tape gripper, and storage capacity for approximately 6,000 cartridges. The storage capacity depends on the number of installed drive walls and installed drives. Therefore, a silo with 5,200 to 5,500 available slots is not unusual.

The LCU controls the robotics motion and interfaces with the drives through the LCU-to-drive path. The LCU is directly attached to the LSM, and each LSM has its own associated LCU.

LSMs can be combined with additional “passthru,” so an ACS can contain more than one LSM.

Library management unit

The LMU provides an interface between the HSC or ACSLS and the LCUs that are attached to each LSM. One LMU is required for each ACS. The HSC can attach by using a 3174 connection or TCP/IP.

Note: The LMU handles only control information (movements, database updates, acknowledgements, and so forth). The user data (data that is written onto tape) is handled by the attachment that you choose (ESCON, FICON, Fibre Channel, or SCSI).

Software components

For the System z HSC, the library station component and the client software component are available. The HSC is required, and the library station component and the client software component are optional.

HSC and the control datasets

STK HSC is the mandatory z/OS application software that controls the automated mounting and demounting of cartridges for the library-attached transports. After the HSC intercepts a mount or demount message, it issues cartridge movement requests to the LMU. The LMU then communicates with the LCU, causing the robot in the silo to perform the requested function. In addition to controlling the automated mounting and demounting of cartridges and other functions, HSC performs the following functions:

- ▶ HSC attempts to influence drive allocation by manipulating the eligible device list (EDL).
- ▶ It ensures that the correct media is mounted in the correct transport. This function is provided through the use of different control statements, user exits, or both.
- ▶ HSC provides operator commands to control and monitor library functions.
- ▶ It provides exit points for user-defined customization of the library operation.
- ▶ HSC provides enhancements for device separation.

The library can be attached to a maximum of 16 CPUs (hosts). If more attached hosts are necessary, you must install the library station component and client software component. HSC can manage up to 16 silos in a single ACS, and you can define up to 256 ACSs. You must install HSC on each of the attached hosts.

Note: HSC is a started task.

Control datasets

You place all of the information about the Sun StorageTek environment in *control datasets*.

You define the following base information through an HCS-owned process (LIBGEN) to the control datasets:

- ▶ Number of ACSs and LSMs
- ▶ Placement of drive walls and actual installed drives
- ▶ Passthru
- ▶ Attached HSC hosts

Permanent updated information includes:

- ▶ The inserted cartridges and their positions in the ACS are part of the information.
- ▶ Additional information is included about these cartridges, such as Status, Entry Date, last used, and so forth.
- ▶ Additional information for Virtual Storage Manager™ (VSM) is included. Compared to a VTS, VSM is the outboard database of the VTS.

There are three types of control datasets:

- ▶ Primary (the active dataset)
- ▶ Secondary (a copy of the primary control dataset)
- ▶ Standby (used in case of a failure from primary or secondary)

A primary control dataset is mandatory. The secondary and standby control datasets are optional, but for disaster recovery reasons, we highly recommend them.

Library Control System (LCS) and client software component (CSC)

If you must attach more than 16 systems or if the systems cannot run an HSC on their own, you can use the LCS and CSC. LCS must be installed as a second component on one of the HSC hosts. The CSC is installed on every client to which you want to connect.

CSCs have no actual attachment to the LMU and cannot perform mounts or demounts by themselves. They also have no access to the control dataset. Therefore, every action, such as a mount, a demount, updating the CDS with information about the status of cartridges, and so forth, requires communication to an HSC. You can provide attachment to the HSC through TCP/IP, Advanced Program-to-Program Communication (APPC) LU6.2, and cross-system coupling facility (XCF) if a z/OS client is located in the same sysplex.

You can prepare more hosts to be the LCS host, but only one host is the active host. If a failure of the active host occurs, the prepared standby host handles the failure.

Automated cartridge system library software (ACSLs)

If you have no HSC installed, or you do not want the HSC to be the “focal point,” ACSLS is an alternative. The ACSLS runs on UNIX platforms (for instance, AIX or Solaris) and provides functions comparable to HSC. The ACSLS server communicates with the LMU and keeps the necessary information (similar to the control dataset).

Hardware and software requirements

The hardware requirements to install the IBM TS1120-C06 Controller and TS1130 tape drives in an Sun StorageTek Silo are provided in Chapter 3, “Tape drives and controllers” on page 91.

We describe the software requirements to support the drives in the following relevant detailed platform chapters:

- ▶ Chapter 6, “Running z/OS production systems” on page 261
- ▶ Chapter 7, “Software implementation: Other System z platforms” on page 301
- ▶ Chapter 8, “Software implementation: Open Systems environments” on page 331

IBM TotalStorage Silo Compatible Tape Frame 3592 Model C20



Figure A-1 3592 Model C20

The 3592 Model C20 with 3592 tape drives is designed to provide additional performance and capacity for Sun StorageTek Automated Cartridge System (ACS) users while helping to reduce the requirement for additional automation hardware. The additional cartridge capacity available with the 3592 Tape Drive benefits clients who utilize system backup and restore applications. The IBM TotalStorage Silo Compatible Tape Drive Frame 3592 Model C20 supports all 3592 tape drives (see Figure A-1). Due to the smaller size of the 3592 drive (when compared with the 3590 family of drives), the Model C20 frame holds up to 20 drives, which is more than three times the number of drives allowed in any preceding silo compatible frame.

The 3592 Model C20 attached to a Sun StorageTek ACS provides for attachment of 3592 tape drives to host systems with Fibre Channel adapters. In this Fibre Channel attachment offering, the 3592 Model C20 allows hosts, such as System z Linux, System p, RS/6000, HP (Hewlett Packard), or Sun servers, to attach to 3592 tape drives in an ACS without the need for an additional control unit and with no disruption to the library environment.

Alternatively, 3592 tape drives in the 3592 Model C20 can also be attached to ESCON or FICON hosts through an externally attached TS1120 Tape Controller (3592 Model C06) in a 3592 F05 frame, or a 3592-J70 Controller or 3590 Model A60 Controller in a 3590 Model C10 Silo Compatible Frame.

To support Silo operation, each 3592 Tape Drive in a 3592 Model C20 communicates with the Library Control Unit (LCU) of the Library Storage Manager (LSM) by using Sun StorageTek library ports. The Enterprise tape controllers provide emulation capability allowing attached 3592 tape drives to appear to the host system as 3490E or 3590 tape drives. This capability enables 3592 tape drives in a 3592 Model C20 to be integrated into an existing ACS environment, typically without host software modifications.

Silo compatible components

The Silo Compatible Tape Drive Frames consist of the following models:

- ▶ **The 3592 Model C20 frame:** This frame can contain one to twenty 3592 tape drives. You can connect up to four 3592-C20 frames per ACS.
- ▶ **The 3592 Model F05 frame:** This frame can contain from one to three IBM TS1120 Model C06 Tape Controllers. Each controller can attach up to sixteen 3592 tape drives. We recommend two SAN switches for each controller that is also installed in this frame.
- ▶ **The 3590 Model C10 frame:** This frame can contain one or two IBM TotalStorage Enterprise Tape Controllers 3592 Model J70 or Model A60 or one of each. A maximum of twelve drives can be attached to each controller.

Note: Effective 29 September 2006, the 3590 Model C10 frame and the 3590 Model C12 frame were withdrawn from marketing.

Both ESCON and FICON attachments are supported on the controllers, allowing drives to be shared between ESCON and FICON servers. The 3592 Model J70 provides up to eight ESCON channel attachments and up to four FICON channel attachments, or a mixture of both. Redundant Fibre Channel switch attachment is available for the TS1120-C06 to attach 3592 tape drives.

C20 ACS wall panel requirements

The 3592 Model C20 attaches to a Sun StorageTek Automated Cartridge System (ACS) and holds up to twenty 3592 tape drives. You need to carefully plan the drive population of the C20 frame. Two basic drive wall configurations exist.

The 4/10 drive wall

The original silo wall panel can accommodate either four or ten 3592 drives:

- ▶ You can have up to 10 drives in the C20 (see Figure A-2).
- ▶ The left side frame positions are 0...9 (starting at the top).
- ▶ The Left Half-Filled Frame Feature (FC4840) requires the silo air box cover. See Figure A-2.

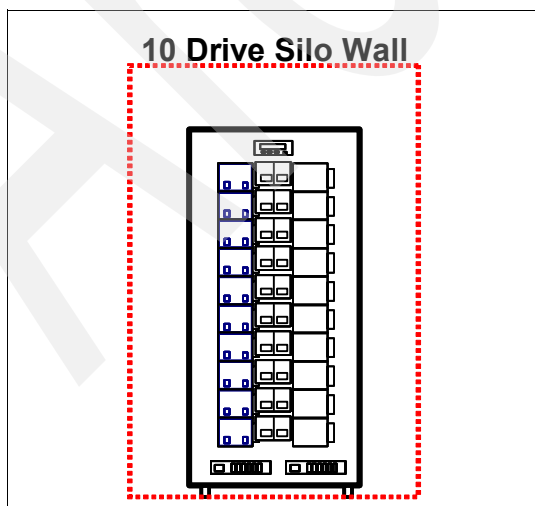


Figure A-2 3592-C20 frame 10 Drive Silo Wall

The 20 Drive Wall

Figure A-3 illustrates a fully populated 3592 Model C20:

- ▶ The 20 Drive Wall is required for more than 10 drives.
- ▶ You lose 150 storage cells from the 4/10 wall.
- ▶ The air box cover is included with the wall.
- ▶ You install the hardware for a drive pair level.
- ▶ Then, you install 3592 tape drives.

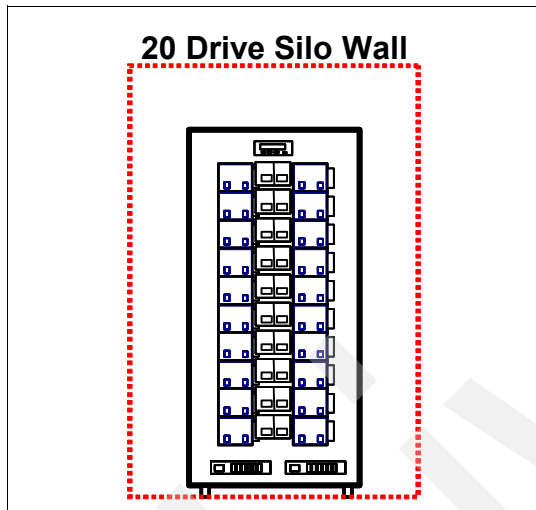


Figure A-3 The 3592-C20 frame 20 Drive Silo Wall

Note: When there are fewer than twenty drives installed in a 3592 Model C20, ensure that you describe the drive address positions accurately in LIBGEN with the proper syntax for unused drive locations. With Open Systems attachment, ensure that the drive designations refer to the proper position in the drive panel.

ACS media coexistence

Sun StorageTek's Host Software Component (HSC) manages mixed media and model types within a Sun StorageTek ACS complex:

- ▶ You can handle 3592 media by 9310 and 4410 LSM/pass-through ports.
- ▶ A new cleaning cartridge is required.
- ▶ HSC requires standard 3480/3590-style volume serial number (VOLSER) labels.
- ▶ The 3592 tape drives can coexist with varying combinations of Sun StorageTek tape models, based on the level of HSC or ACSLS that is used. The 3592 drives in the same ACS with Sun StorageTek tape drives are configured as:
 - HSC 2.x, 4.x, and NCS 5.x. The 3592 drives are defined to HSC or NCS as STK drive models. You can intermix the 3592s in the same ACS with any *other* STK device models.
 - ACSLS. The 3592 tape drives are identified to Sun StorageTek ACSLS as STK drive models. The ACSLS client application must maintain the drive to media relationship.

Interchanging silo media with the IBM 3494 Tape Library

The following technique allows cartridges with silo compatible barcode labels to be used in the IBM 3494 Tape Library Dataserver. This technique is intended to facilitate the interchange of 3590 and 3592 media with silo compatible labels in and out of 3494 libraries. Like the silo, the 3494 uses tape cartridge labels containing human readable cartridges and barcodes to identify the volume's VOLSER and, optionally, its media type. Also, like the silo, unrecognized VOLSER and media type labels cannot be entered into the 3494 library without an accommodating method. For 3494 libraries, the VOLSER is a six character alphanumeric volume serial number that is used to physically identify a tape cartridge. The media type is a one or two characters in length. The media type characters are used by the library to determine which type of media is contained in the cartridge. For the 3494 Tape Library, the cartridge labels appear in three configurations:

- ▶ A six character VOLSER without a media type. These cartridges are typically the early 3490 tape cartridges.
- ▶ A six character VOLSER with a separate, single character media type. These cartridges are the 3490 and 3590 media.
- ▶ An eight character barcode within which the first six characters are the VOLSER and the last two characters are the media type. These cartridges are the 3592 media. The silo cannot read these labels.

To allow IBM media with non-IBM media type characters (STK labels) to be inserted into the 3494, any unrecognized media type characters are ignored by the 3494. The VOLSER range table and default media type are then used to determine the volume's media type. The unrecognized characters are any characters other than 1, E, J, K, Q, JA, JB, JJ, JR, JX, and JW.

Operating environments

The Model C20 frame supports multiplatform attachment to IBM System z, zSeries (S/390), IBM System p, IBM pSeries (RS/6000, SP), IBM System x, and xSeries servers. The Model C20 frame also supports selected Open Systems servers, such as products from Sun Microsystems and Hewlett-Packard, and Intel-based systems running Microsoft Windows operating systems.

System z, zSeries, and S/390

Supported operating systems are:

- ▶ FICON and ESCON host attachment
- ▶ Sun StorageTek HSC
- ▶ Nearline™ Control Software (NCS) 4.0 (includes HSC's Library Station)
- ▶ HSC 4.0, Library Station 4.0, and Client System Component (CSC) 4.0

Open Systems support

Supported environments are:

- ▶ FC-2 attachment
- ▶ Supported environments:
 - IBM System p, pSeries, IBM System x, and xSeries servers
 - Sun Solaris and HP-UX servers
 - Microsoft Windows NT and Windows 2000 Server servers
- ▶ Automated Cartridge System Library Software (ACSL) 6.0 or higher
- ▶ Applications must maintain their drive to media relationship

Note: System z and Open Systems drives can coexist in the same C20 frame.

Obtain an update of the Open Systems device drivers to ensure support for the attachment of the 3592-J1A and TS1120-E05 tape drives to various servers. Clients, who have already installed the Open Systems device drivers, can download new device drivers through anonymous FTP from:

<ftp://ftp.software.ibm.com/storage/devdvr/>

Important planning considerations for the first 3592-C20 frame

The following items help ensure a successful order and installation of the first C20 frame. Subsequent C20 frames tend to mimic the configuration of the first C20 frame. You must consider:

► Drive emulation

Determine which STK drive the 3592 drive will emulate. The 3592 drive must emulate a STK drive when attached to the silo. The emulation type then determines the media type labels applied to the cartridges. For example, if the 3592 drives will be emulating STK Redwood (or SD-3) drives, the “A” character label is applied to the 3592 data cartridges, and the “D” character is applied to the 3592 cleaner cartridges.

► Media ordering:

- Order the 3592 data and cleaner cartridges without the integrated media type VOLSER labels (no JA, JB, JJ, JW, JX, or JR characters).

Note: Order media without labels, which means the media also does not have the radio frequency identification (RFID).

- Order and apply the media type characters as determined by the STK drive emulation type, which includes both the data and the cleaner cartridge labels.

An example of the labels for 3592 emulating the Redwood drive is the character “A” for the data cartridges and “D” for the cleaner cartridge.

► C20 frame configuration

Determine to which type of silo wall panel you will attach the 3592-C20 frame, which determines the maximum number of 3592 drives possible in the C20 frame (either 10 or 20) and the various feature codes to support the attachment.

► Silo configuration

Arrange with the silo maintenance provider to support the 3592-C20 frame. The silo support required for the C20 is identical to support required for an STK drive frame.

► Host system attachment requirements:

- Host system device drivers
- Physical Infrastructure: host bus adapters (HBAs), Fibre Channel (FC) cables, and switches
- Configure STK software. STK’s ACSLS software typically controls the silo.
- J70 controller installed in the C10 frame or TS1120 Tape Controller installed in the F05 frame
- ESCON and FICON host adapters in the controller
- FC cables and switches between the controller and the 3592 drives

- Remote support hardware
- Configure STK's software. The silo is typically controlled by STKfs NCS or HSC software.

C20 feature codes

The 3592 Model C20 is attached to a Sun StorageTek Automated Cartridge System (ACS) and can hold up to twenty 3592-J1A or TS1120-E05 tape drives.

Table A-1 describes the device attachment feature codes (FCs) for the 3592 Model C20.

Table A-1 3592 Model C20 device attachment features

Category	Feature code	Description
C20	FC4830	Install 3592 Model C20 Drive Shelf Pair
	FC4831	Field Install 3592 Model J1A Tape Drive in 3592 Model C20
	FC4832	Remove 3592 Tape Drive from 3592 Model C20
	FC4833	Field Install 3592 Model E05 Tape Drive in 3592 Model C20
	FC4835	Replace 3592 Model J1A with Model E05 Tape Drive in 3592 Model C20
	FC4840	Install 10-Drive Air Box Cover
	FC9675	Plant Install 3592 Model J1A, E05, or E06 Tape Drive in 3592 Model C20
	FC9679	Plant Install 3592 Model E05 Tape Drive in 3592 Model C20
	FC9951	110 VAC Power Cord and Plug, US/Canada
	FC9952	110 VAC Power Cord and Plug, Chicago
	FC9986	220 VAC Chicago Power Cord and Plug
Note: The appropriate default 3592 Model C20 power cords are attached at the plant based on the order destination country code. FC9951, FC9952, and FC9986 replace the default power cords.		

FC4830 (Install 3592 Model C20 Drive Shelf Pair)

This feature installs the redundant power supplies and hardware on a horizontal drive shelf for mounting up to two 3592 tape drives. There are up to two 3592 tape drive canisters, either:

- ▶ Model J1A (FC4831 or FC9675)
- ▶ Model E05 (FC4833, FC4835, or FC9679)
- ▶ Model E06/EU6 (FC4836, FC4837, or FC9693)

Up to two 3592 tape drive canisters can be installed in each 3592 Model C20 Drive Shelf Pair. If FC4840 is installed, only one 3592 tape drive canister can be installed for each shelf pair.

Maximum: 10. Plant or field installation.

FC4831 (Field Install 3592 Model J1A Tape Drive in 3592 Model C20)

This feature provides the hardware and instructions for field merge or field installation of one 3592 Model J1A tape drive canister in a C20 Drive Shelf Pair in the 3592 Model C20. Two tape drive canisters can be installed in each C20 Drive Shelf Pair (FC4830).

Maximum: 20 if FC4840 is not installed, or a maximum of 10 if FC4840 is installed. Field installation only.

Prerequisite: An available C20 Drive Shelf Pair (FC4830) according to:

- ▶ The number of drives installed (FC4831, FC9675, FC4833, FC4835, or FC9679) can be no greater than twice the number of C20 Drive Shelf Pair features (FC4830), if the Air Box Cover (FC4840) is not installed.
- ▶ The number of drives installed (FC4831, FC9675, FC4833, FC4835, or FC9679) can be no greater than the number of C20 Drive Shelf Pair features (FC4830), if the Air Box Cover (FC4840) is installed.

FC4832 (Remove 3592 Tape Drive from 3592 Model C20)

This feature removes a 3592 tape drive canister that is installed in a C20 Drive Shelf Pair in a 3592 Model C20. This feature does not remove a C20 Drive Shelf Pair, associated power supplies, or other associated hardware. Maximum: None. Field installation only.

Corequisite: One FC4831, FC9675, FC4833, FC4835, or FC9679 must be removed with this feature.

FC4833 (Field Install the 3592 Model E05 in a Model C20 Frame)

This feature provides the hardware and instructions for field merge or field installation of one 3592 Model E05 tape drive canister in a C20 Drive Shelf Pair in the 3592 Model C20. Two tape drive canisters can be installed in each C20 Drive Shelf Pair feature (FC4830).

Maximum: 20, if the Air Box Drive Cover (FC4840) is not installed, or a maximum of 10 if FC4840 is installed.

Prerequisite: An available C20 Drive Shelf Pair feature (FC4830) according to:

- ▶ The number of drives installed (FC4831, FC9675, FC4833, FC4835, or FC9679) can be no greater than twice the number of C20 Drive Shelf Pair features (FC4830) if the Air Box Drive Cover (FC4840) is not installed.
- ▶ The number of drives installed (FC4831, FC9675, FC4833, FC4835, or FC9679) can be no greater than the number of C20 Drive Shelf Pair features (FC4830) if the Air Box Drive Cover (FC4840) is installed.

FC4835 (Replace Model J1A Tape Drive with a Model E05)

This feature is required to provide the mounting changes to replace a 3592 Model J1A tape drive with a Model E05 tape drive in a currently installed Model C20 frame.

Maximum: The sum of features FC4831, FC4833, FC4835, FC9675, and FC9679 can be a maximum of twenty.

FC4836 (Field Install the 3592 Model E06 in a Model C20 Frame)

This feature provides the hardware and instructions for field merge or field installation of one 3592 Model E06 tape drive canister in a C20 Drive Shelf Pair in the 3592 Model C20. Two tape drive canisters can be installed in each C20 Drive Shelf Pair feature (FC4830).

Maximum: 20 if the Air Box Drive Cover (FC4840) is not installed, or a maximum of 10 if FC4840 is installed.

FC4837 (Field Install the 3592 Model EU6 in a Model C20 Frame)

This feature provides the hardware and instructions for field merge or field installation of one 3592 Model EU6 tape drive canister in a C20 Drive Shelf Pair in the 3592 Model C20. Two tape drive canisters can be installed in each C20 Drive Shelf Pair feature (FC4830).

Maximum: 20 if the Air Box Drive Cover (FC4840) is not installed, or a maximum of 10 if FC4840 is installed.

FC4840 (Air Box Cover)

This feature provides a 10 Drive Air Box Cover for a Sun StorageTek PowderHorn 9310 Tape Library. If the Sun StorageTek LSM has the 4 Drive or 10 Drive wall panel, this 10 Drive Air Box Cover must be installed to allow up to 10 tape drives to be installed in the left column of the C20. Maximum: One. Plant or field installation.

FC4841 (Replace Model J1A/E05 Tape Drive with a Model E06/EU6)

This feature is required to provide the mounting changes to replace a 3592 Model J1A or E05 tape drive with a Model E06/EU6 tape drive in a currently installed Model C20 frame.

FC9675 (Plant Install 3592 Model J1A Tape Drive in 3592 Model C20)

This feature notifies the plant to plant install a new 3592 Model J1A tape drive into a new 3592 Model C20 coming from the plant. Plant installation only. FC9675 must also appear on the 3592-J1A tape drive order.

FC9679 (Plant Install 3592 Model E05 Tape Drive in 3592 Model C20)

This feature notifies the plant to plant install a new 3592 Model E05 tape drive into a new 3592 Model C20 coming from the plant. This code must appear on the 3592 tape drive order and also on the 3592 Model C20 order. Plant installation only. FC9675 must also appear on the 3592-E05 tape drive order.

FC9688 (Field Merge 3592 Model EU5 or E06 in a Model C20 Frame)

This feature provides the hardware and instructions for field merge or field installation of 3592 Model EU5 or E06 tape drives in a C20 frame.

FC9693 (Plant Install 3592 Model E06 Tape Drive in 3592 Model C20)

This feature notifies the plant to plant install a new 3592 Model E06 tape drive into a new 3592 Model C20 coming from the plant. This code must appear on the 3592 tape drive order and also on the 3592 Model C20 order. Plant installation only. FC9675 must also appear on the 3592-E06 tape drive order.

FC9951 (110 VAC Power Cord and Plug, US/Canada)

This feature provides two 4.3 meter (14 ft.) 110 V power cords with a non-watertight Twist-Lock plug.

FC9952 (110 VAC Power Cord and Plug, Chicago)

This feature provides two 1.8 meter (6 ft.) 110 V power cords with a non-watertight Twist-Lock plug.

FC9986 (6 ft. 220 VAC Chicago Power Cord and Plug)

This feature provides two 1.8 meter (6 ft.) 220 V power cords with a watertight plug.

Table A-2 provides the attachment feature codes for the 3592 Model F05 tape frame.

Table A-2 3592-F05 attachment features

Category	Feature code	Description
3952-F05	FC1903	Dual AC Power
	FC3492	External Fabric Support (Field)
	FC3493	Direct Connect Drives (Field)
	FC3516	FC Switch Mount Kit
	FC3517	Redundant FC Attach
	FC5875	Field Merge 3592-J70
	FC5877	Field Install 3592-J70
	FC5878	Field Merge 3592-C06
	FC5879	Plant Install 3592-C06
	FC5880	Field Install 3592-C06
	FC7315	TS7640 Silo Compatible Controller Attachment
	FC7316	Enterprise Tape Library Attachment (3494 Outbound Controller Frame)
	FC9492	External Fabric Support (Plant)
	FC9493	Direct Connect Drives (Plant)
	FC9954	NEMA L6-30 Power Cord
	FC9955	RS 3750 DP Power Cord
	FC9956	IEC 309 Power Cord
	FC9957	PDL 4.3 Power Cord
	FC9958	Korean 4.3 Meter Power Cord
	FC9986	220 V Chicago Power Cord

FC3492 (External Fabric Support - Field)

This feature indicates that you will connect 3592 tape drives to the TS1120 Tape Controller through an external client-supplied Fibre Channel SAN. The client is responsible for providing the cables from the TS1120 Tape Controller installed in a 3952 Model F05 frame to a client-supplied Fibre Channel switch. (You can order cables from the switch to the 3592 tape drives with the 3592 tape drives, or the client can supply them.)

Maximum: One.

Prerequisites: FC7315 or FC7316 on the 3952 Model F05 frame. This feature is mutually exclusive of FC3493, FC9493, and FC9492.

FC3493 (Direct Connect Drives - Field)

This feature on the 3952 Model F05 frame indicates that 3592 tape drives will be directly connected to a TS1120 Tape Controller. Either FC3493 (Direct Connect Drives/Field) or FC9493 (Direct Connect Drives/Plant) must be specified on the TS1120 Tape Controller. The client is responsible for providing the cables from the TS1120 Tape Controller installed in a 3952 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.)

Maximum: One.

Prerequisites: Must specify FC7315 or FC7316 on the 3952 Model F05 frame. This feature is mutually exclusive with FC9492, FC9493, and FC3492.

FC3516 (FC Switch Mount Kit)

One of these features is required for each TS1120 Tape Controller that supports attachment of 3592 tape drives with a 2 Gbit or 4 Gbit Fibre Channel switch in a 3952 Model F05 Silo Compatible Frame. (Intermixing 2 Gbit and 4 Gbit switches is not supported.) This feature includes the required mounting hardware and instructions for installing a 2 Gbit or 4 Gbit Fibre Channel switch in the Model F05, including the associated Ethernet hub and cabling between the TS1120 Tape Controller and the switch and drives in that Model F05. Up to twelve 3592 tape drives in the C20 frame can be attached to the TS1120 Tape Controller.

Maximum: Three.

Prerequisites: FC7315 is required. FC4887, FC3488, or FC4897 is required on the TS1120 Tape Controller. One of FC4831, FC9675, FC4833, FC4835, or FC9679 must be installed on each 3592 Model C20 frame for each attached 3592 tape drive. Fibre Channel cables from the 3592 tape drives to the 2 Gbit or 4 Gbit Fibre Channel switch must be ordered with FC6013, FC6025, or FC6061 with each tape drive in the 3592 Model C20 Silo Compatible Frame.

Maximum: Two switches, TS1120 Tape Controller FC3488 or FC4897, can be mounted in one F05 frame.

Prerequisite: FC3516 when the Redundant Fibre Channel Attach feature FC3517 is also specified.

FC3517 (Redundant FC Attach)

This feature provides the mounting hardware and instructions for installing a second 2 Gbit or 4 Gbit Fibre Channel switch in the 3952 Model F05 frame. Plant or field-installed.

Maximum: Three.

Prerequisites: One FC3516 must be installed on the 3952 Model F05 frame for each FC3517. One FC3517 is required on this frame for each TS1120 Tape Controller that supports a second 2 Gbit or 4 Gbit Fibre Channel switch. A second FC4887, FC3488, or FC4897 is required on the TS1120 Tape Controller. One of FC4831, FC9675, FC4833, FC4835, or FC9679 must be installed on each 3592 Model C20 frame for each attached 3592 tape drive.

Fibre Channel Cables from the 3592 tape drives to the 2 Gbit or 4 Gbit Fibre Channel switch must be ordered with FC6013, FC6025, or FC6061 with each tape drive in the 3592 Model C20 Silo Compatible Frame.

A second cable is required on each tape drive to attach to the redundant switch.

FC4870 (Replace Controller with C06)

This feature is required to provide the mounting changes to replace a 3592 Model J70 Controller with a TS1120 Tape Controller in a currently installed 3952 Model F05 frame.

Maximum: Three.

FC5875 (Field Merge 3592-J70)

This feature provides mounting hardware and notifies the plant that a client-supplied 3592 Model J70 Controller will be installed into a 3952 Model F05 frame coming from the plant as part of the final client installation.

Maximum: Two of FC5875 or FC5877.

FC5877 (Field Install 3592 Model J70)

This feature provides mounting hardware to field install a client-supplied 3592 Model J70 Controller.

Maximum: Two FC5875s or FC5877s with Silo Attachment FC7315, or a maximum of four if ordered with the 3494 Attachment FC7316.

FC5878 (Field Merge 3592-C06)

This feature provides mounting hardware and notifies the plant that a client-supplied TS1120 Tape Controller will be installed into a 3952 Model F05 frame coming from the plant as part of the final client installation.

Prerequisites: This feature must appear on the 3952 Model F05 and FC9885 must appear on the TS1120 Tape Controller order.

Maximum: Three, if ordered with the Silo Attachment FC7315, or a maximum of four if ordered with the 3494 Attachment FC7316.

FC5879 (Plant Install 3952-C06)

This feature code provides the mounting hardware and plant installs a TS1120 Tape Controller into a new 3952 Model F05 frame.

Prerequisites: This feature must appear on the 3952 Model F05 frame and FC9876 must appear on the TS1120 Tape Controller order.

Maximum: Three if ordered with the Silo Attachment FC7315, or a maximum of four if ordered with the 3494 Attachment FC7316.

FC5880 (Field Install 3952-C06)

This feature provides mounting hardware to field install a client-supplied TS1120 Tape Controller.

Maximum: Three if ordered with the Silo Attachment FC7315, or a maximum of four if ordered with the 3494 Attachment FC7316.

Prerequisites: This feature must appear on the 3952 Model F05, and FC9885 must appear on the TS1120 Tape Controller order.

FC7315 (TS7640 Silo Compatible Controller Attachment)

This feature identifies this 3952 tape frame as a TS7640 Silo Compatible Controller Attachment.

Maximum: One. This feature is mutually exclusive with FC7310, FC7311, FC7312, FC7313, FC7314, and FC7316.

Prerequisites: FC1903 is required with FC7315.

FC7316 (Tape Library Attachment 3494 Outbound Controller Frame)

This feature identifies this 3952 tape frame as the 3494 Outbound Controller Frame.

Maximum: One. This feature is mutually exclusive with FC7310, FC7311, FC7312, FC7313, FC7314, and FC7315.

FC9492 (External Fabric Support - Plant)

This feature on the 3952 Model F05 frame indicates that 3592 tape drives will be connected to a TS1120 Tape Controller through an external client-supplied Fibre Channel switch or directly to the controller.

Maximum: One.

Prerequisites: FC7315 on the 3952 Model F05 frame. This feature is mutually exclusive with FC3493, FC9393, and FC9492.

FC9493 (Direct Connect Drives - Plant)

This feature on the 3952 Model F05 frame indicates that 3592 tape drives will be connected to a TS1120 Tape Controller through an external client-supplied Fibre Channel switch or directly to the controller. The cables are provided to direct connect the 3592 tape drives in a rack to the TS1120 Tape Controller by specifying FC3062 when the external fabric feature FC3493 or FC9493 is specified.

Maximum: One.

Prerequisites: Must specify FC7315 or FC7316 on the 3952 Model F05 frame. This feature is mutually exclusive of FC3492, FC3493, and FC9492.

FC9954 (NEMA L6-30 Power Cord)

One 4.3 meter (14 ft.) 200-208/240V ac, 24 amp, non-watertight power cord. Suggested for use in the USA, Canada, Latin America, and Japan.

FC9955 (RS 3750 DP Power Cord)

One RussellStoll 3750 DP 4.3 meter (14 ft.) 200-208/240V ac, 24 amp watertight power cord. Suggested for use in the USA (highly recommended in Chicago, Illinois, to conform with local requirements), Canada, Latin America, and Japan.

FC9956 (IEC 309 Power Cord)

One 4.3 meter (14 ft.) power cord. Provides an IEC-309, p + n + g power cord rated at 230 V ac/24 amp. Suggested for use in Europe, the Middle East, and Africa.

FC9957 (PDL 4.3 Meter Power Cord)

PDL 4.3 - One 4.3 meter (14 ft.) 230-240 V ac, 24 amp power cord. Suggested for use in Australia and New Zealand.

FC9958 (Korean 4.3 Meter Power Cord)

One Korean 4.3 meter (14 ft.) 220 V ac, 24 amp power cord. Suggested for use in South Korea.

FC9986 (Chicago Power Cord)

This feature installs a Chicago 220 V ac watertight power cord and plug instead of the default 220 V ac cord.

Maximum: One. Plant or field installation.

Table A-3 provides the IBM TS1120 Model C06 Controller attachment features.

Table A-3 TS1120 Model C06 Controller attachment features

Category	Feature code	Description
TS1120-C06 Controller	FC0520	Microcode Firmware Upgrade
	FC2714	Console Expansion
	FC2715	Console Attachment
	FC2720	TS3000 System Console
	FC3062	Drive-to-Switch Cables/Rack
	FC3440	Dual ESCON Host Adapter
	FC3441	FICON Attachment-Long Wavelength
	FC3442	FICON Attachment-Short Wavelength
	FC3443	FICON Long Wave 10 km Attachment (FC3443)
	FC3478	Two Dual-Ported Fibre Adapters
	FC3488	4 Gbit Fibre Channel switch
	FC3492	External Fabric Support - Field
	FC3493	Direct Connect Drives - Field
	FC3494	Fibre Channel switch Rack Mount Kit
	FC3495	Redundant Fibre Channel Attach
	FC4641	Install Controller in Rack
	FC4887	Reinstall 2 Gbit Fibre Channel switch
	FC4897	Reinstall 4 Gbit Fibre Channel switch
	FC9000	System z, ES/9000, S/390, or zSeries Attachment
	FC9478	3592 Tape Drive Attachment
	FC9492	External Fabric Support
	FC9493	Direct Connect Drives
	FC9885	Field Merge C06 in 3952-F05
	FC9886	Plant Install C06 in 3952-F05
	FC9887	Field Merge C06 in 3953-F05
	FC9888	Plant Install C06 in 3953-F05

Category	Feature code	Description
Switch	FC3488	4 Gbit Fibre Channel switch
	FC3494	Fibre Channel switch Rack Mount Kit
	FC3495	Redundant Fibre Channel Rack Attach
	FC4897	Reinstall 4 Gbit Fibre Channel switch
External Fabric	FC3492	External Fabric Support/Field
	FC9492	External Fabric Support/Plant

FC0520 (Microcode Firmware Upgrade)

This feature provides an update to the microcode of an installed 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 connecting 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 connecting FC2715 or another FC2714. FC2714 can attach to any existing FC2713, FC2718, FC2720, or FC2721 console.

A minimum of one FC2714, FC2715, or FC2720 is required. A maximum of one FC2714, FC2715, or FC2720 attaches the unit to the TS3000 System Console. A maximum of one other Console Expansion feature (FC2714) can be connected to the Ethernet switch provided by this FC2714. A maximum of two of FC2714 can be included in a single TS3000 System Console facility (providing a total maximum of 43 unit connections). Plant or field installable.

FC2715 (Console Attachment)

This feature provides a cable to attach one of the above units to the Ethernet switch provided by the TS3000 System Console (FC2720), Master Console For Service (FC2713), or Console Expansion (FC2714). A maximum of 40 of FC2715 can be included in a single TS3000 System Console facility.

A minimum of one FC2714, FC2715, or FC2720 is required. A maximum of one FC2714, FC2715, or FC2720 attaches the unit to the TS3000 System Console. Plant or field installable.

FC2720 (TS3000 System Console)

This feature provides the enhanced TS3000 System Console, an Ethernet switch, and 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 TS3000 System Console facility. The Ethernet switch provides 14 additional connections for cables supplied with FC2714 or FC2715.

A minimum of one FC2714, FC2715, or FC2720 is required. A maximum of one FC2714 can be connected to FC2720. FC2720 is plant or field installable.

FC3062 (Drive-to-Switch Cables/Rack)

This feature provides a single Fibre Channel cable between a 3592 tape drive and a 2 Gbit or 4 Gbit switch in a stand-alone rack for connection to a TS1120 Tape Controller installed in the

stand-alone rack. One of these features must be specified for each 3592 tape drive to be attached to the TS1120 Tape Controller in the rack.

Prerequisites: FC3478 (Two Dual-Ported Fibre Adapters) and FC4641 (Install Model C06 in a rack).

FC3440 (Dual ESCON Host Adapter)

This feature provides an ESCON adapter for attachment of 3592 tape drives through the TS1120 Tape 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 kilometers (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 Tape Controller to a FICON host system long wavelength 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 FC3440 to FC3441.

Maximum: Four. One of FC3440, FC3441, or FC3442 is required on each TS1120 Tape Controller. Permitted combinations of FC3440, FC3441, and FC3442 are shown in Table 3-15 on page 148. Plant or Field Installation.

FC3442 (FICON Attachment Long Wavelength)

This feature provides one long wavelength FICON adapter, with an LC Duplex connector, for the attachment of 3592 tape drives through the TS1120 Tape Controller to a FICON host system long wave channel utilizing a 50-micron multimode fibre cable. The total cable length cannot exceed 4 km (2.4 miles). Each FICON attachment can support up to 128 logical channels. A feature conversion is available to convert FC3440 to FC3442.

Maximum: Four.

Minimum: One of FC3440, FC3441, or FC3442 is required on each TS1120 Tape Controller. Permitted combinations of FC3440, FC3441, and FC3442 are shown in Table 3-15 on page 148. Plant or field installation.

FC3443 (FICON 4 Gbit 10 km Long Wavelength Attachment)

This feature provides one long wavelength FICON adapter, with an LC Duplex connector, for the attachment of 3592 tape drives through the TS1120 Tape 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.

Maximum: Four.

Minimum: One FC3440, FC3441, FC3442, or FC3443 is required on each TS1120 Tape Controller. Plant or field installation.

FC3478 (Two Dual-Ported Fibre Channel Adapters)

This feature installs two short wavelength 4 Gbps Dual-Ported Fibre Channel adapters with LC connectors in a TS1120 Tape Controller for attaching up to sixteen 3592 tape drives when attached through a 4 Gbit Fibre Channel switch. Total cable length from the adapters to the switch cannot exceed 500 meters (1640.5 ft.). Plant installed.

Maximum: One.

Minimum: One.

FC3488 (4 Gbit Fibre Channel switch)

This feature provides a 4 Gbit Fibre Channel switch with 20 LC Short wave ports for attachment of up to sixteen 3592 tape drives to a TS1120 Tape Controller. Hardware errors detected on the switch are managed by the controller. The 4 Gbit Fibre Channel switch has dual power connection for attachment to separate power supplies. Intermix of the 2 Gbit and 4 Gbit Fibre Channel Switches is *not* supported within the TS1120 Tape Controller.

Prerequisites: FC3476 or FC3478 on the TS1120 Tape Controller. This feature is mutually exclusive with FC3492, FC3493, FC4887, FC9492, and FC9493 for the TS1120 Tape Controller.

FC3493 (Direct Connect Drives - Field)

This feature on the controller indicates that 3592 tape drives will be connected to the TS1120 Tape Controller through an external client-supplied Fibre Channel switch or directly to the controller. Direct connect drives require either this feature or FC9493 (External Fabric Support - Plant) specified on the TS1120 Tape Controller with one to four FC3062s.

The cables are provided to direct connect the 3592 tape drives in a rack to the TS1120 Tape Controller by specifying FC3062 when the external fabric FC3493 or FC9493 is specified.

Maximum: One.

Prerequisite: FC3478. This feature is mutually exclusive with FC3488, FC4897, and FC9493.

FC3494 (Fibre Channel switch Rack Mount Kit)

This feature provides the required hardware to support attachment of 3592 tape drives through a 2 Gbit or 4 Gbit Fibre Channel switch (FC3487, FC3488, FC4887, or FC4897) for connection to a 3592 Model C06 Controller in a rack. It includes the mounting hardware and instructions for installing the 2 Gbit or 4 Gbit Fibre Channel switch in the rack. Fibre Channel cables from the 3592 tape drives to the switch in the rack with the Model C06 are included by specifying FC3062 (one or two for each tape drive). For the multi-rack attachment of 3592 tape drives in other racks to the switch, the cables must be ordered with the drives. The cables are provided to direct connect the 3592 tape drives in a rack to the TS1120 Tape Controller by specifying FC3062 when the external fabric FC3493 or FC9493 is specified.

Maximum: One.

Prerequisites: FC4641 plus FC3488, FC4887, or FC4897 must be installed on the TS1120 Tape Controller.

FC4641 (Install Controller in Rack)

This optional feature provides the rack mounting hardware to install a TS1120 Tape Controller in a rack. Plant or field-installed.

Maximum: One.

This feature is mutually exclusive with FC9875, FC9876, FC9885, and FC9886.

FC4887 (Reinstall 2 Gbit Fibre Channel switch)

This feature is the same as feature FC3487 but allows the client to provide a 2 Gbit Fibre Channel switch feature (FC3487) that was removed from a 3592 Controller or a 3953 Model F05 and reinstall it for attachment to this 3592 Tape Controller. Intermix of the 2 Gbit and 4 Gbit Fibre Channel switches is *not* supported within the 3592 Tape Controller. This feature code is mutually exclusive of FC3488, FC3492, FC3493, FC4897, FC9492, and FC9493 on the TS1120 Tape Controller.

Maximum: Two.

Prerequisites: FC3476 or FC3478 on the TS1120 Tape Controller.

FC4897 (Reinstall 4 Gbit Fibre Channel switch)

This feature is the same as FC3488 but allows the client to provide a 4 Gbit Fibre Channel switch feature, FC3488, that was removed from a 3592 Controller in a 3952 Model F05 frame or 3953 Model F05 frame and reinstall it for attachment to this TS1120 Tape Controller. Plant or field-installed.

Maximum: Two.

Prerequisite: FC3478. This feature is mutually exclusive with FC3492 and FC9491.

FC9478 (3592 Tape Drive Attached to Model C06)

This feature is required on all 3952 Model F05 frames that will have a 3592 tape drive attached.

Minimum: One.

Maximum: One.

FC9492 (External Fabric Support - Plant)

This feature on the controller indicates that 3592 tape drives will be connected to the 3952 Model F05 frame through an external client-supplied Fibre Channel switch or directly to the controller.

Maximum: One.

Prerequisite: FC3478. This feature is mutually exclusive with FC3488, FC4897, and FC9493. The client is responsible for providing the cables from the TS1120 Tape Controller installed in a 3952 or 3953 Model F05 frame to a client-supplied Fibre Channel switch. Cables from the switch or controller 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 on the controller indicates that 3592 tape drives will be connected to the 3952 Model F05 frame through an external client-supplied Fibre Channel switch or directly to the controller. Direct connect drives require either this feature or FC3493 (Direct Connect Drives - Field) specified on the TS1120 Tape Controller with one to four FC3062s. Plant installed. This feature is mutually exclusive with FC3488, FC4897, and FC9492.

Maximum: One.

Prerequisite: FC3478.

FC9885 (Field Merge 3592-C06 into 3952-F05)

This feature specifies the attachment of a new TS1120 Tape Controller to an installed 3952 Model F05 frame. Field-installed. This feature is mutually exclusive with FC4641, FC9875, FC9876, and FC9886.

Maximum: One.

Corequisites: One field install/field merge TS1120 Tape Controller feature (FC5878) must be ordered on the 3952 Model F05 frame.

FC9886 (Plant Install 3592-C06 into 3952-F05)

This feature specifies the plant attachment of a new TS1120 Tape Controller to a new 3952 Model F05 frame from the plant. This feature must appear on both the TS1120 Tape Controller and the 3952 Model F05 orders. This feature is mutually exclusive with FC4641, FC9875, FC9876, and FC9885.

Maximum: One.

Corequisites: One plant install TS1120 Tape Controller FC5879 must be ordered on the 3952 Model F05 frame.

FC9887 (Field Merge 3592-C06 in 3953-F05)

This feature specifies that a TS1120 Tape Controller will be field-merged or field-installed into a 3952 Model F05 frame.

Maximum: One.

Corequisites: One Field Install/Field Merge cartridge accessor feature (FC5878) must be ordered on the 3952 Model F05 frame.

FC9888 (Plant Install 3592-C06 in 3953-F05)

This feature specifies the plant attachment of a new TS1120 Tape Controller to a 3952 Model F05 frame.

Maximum: One.

Corequisites: One Plant Install TS1120 Tape Controller (FC5879) must be ordered on the 3952 Model F05 frame.

FC3488 (4 Gbit Fibre Channel switch)

This feature provides a 4 Gbit Fibre Channel switch with 20 LC short wave ports for attachment of up to sixteen 3592 tape drives to a TS1120 Tape Controller. Hardware errors detected on the switch are managed by the TS1120 Tape Controller. The 4 Gbit Fibre Channel switch has dual power connection for attachment to separate power supplies. Plant or field-installed.

Maximum: Two.

Prerequisite: FC3478. This feature is mutually exclusive with FC3492 and FC9491.

FC3494 (Fibre Channel switch Rack Mount Kit)

This feature provides the required hardware to support attachment of 3592 tape drives through a 4 Gbit Fibre Channel switch (FC3488 or FC4897) for connection to a TS1120 Tape Controller in a rack. It includes the mounting hardware and instructions for installing the 4 Gbit Fibre Channel switch in the rack, including associated Ethernet cabling between the TS1120

Tape Controller and the switch. Fibre Channel cables from the 3592 tape drives to the switch in the rack with the TS1120 Tape Controller are included by specifying FC3062 (one or two for each tape drive). For the multi-rack attachment of 3592 tape drives in other racks to the switch, order the cables with the drives. Plant or field-installed.

Maximum: One.

Prerequisites: FC4641 plus FC3488 or FC4897.

FC3495 (Redundant FC Rack Attach)

This feature provides the mounting hardware and instructions for installing a second 4 Gbit Fibre Channel switch in the rack. Plant or field-installed.

Maximum: One.

Prerequisites: FC3494 and a second FC3488 or FC4897.

FC4897 (Reinstall 4 Gbit Fibre Channel switch)

This feature is the same as FC3488 but allows the client to provide a 4 Gbit Fibre Channel switch feature FC3488 that was removed from a 3592 Controller in a 3952 Model F05 frame or 3953 Model F05 frame and reinstall it for attachment to this TS1120 Tape Controller. Plant or field-installed. This feature is mutually exclusive with FC3492 and FC9491.

Maximum: Two.

Prerequisite: FC3478.

FC3492 (External Fabric Support - Field)

This feature on the controller indicates that 3592 tape drives will be connected to the TS1120 Tape Controller through an external client-supplied Fibre Channel switch or directly to the controller. Field-installed.

Maximum: One.

Prerequisite: FC3478. This feature is mutually exclusive with FC3488, FC4897, and FC9491. The client is responsible for providing the cables from the TS1120 Tape Controller installed in a 3952 Model F05 frame to a client-supplied Fibre Channel switch. Cables from the switch or controller to the 3592 tape drives can be ordered with the 3592 tape drives or supplied by the client.

FC9492 (External Fabric Support - Plant)

This feature on the controller indicates that 3592 tape drives will be connected to the 3952 Model F05 frame through an external client-supplied Fibre Channel switch or directly to the controller.

Maximum: One.

Prerequisite: FC3478. This feature is mutually exclusive with FC3488, FC4897, and FC9493. The client is responsible for providing the cables from the 3952 Model F05 frame installed in a 3952 or 3953 Model F05 frame to a client-supplied Fibre Channel switch. Cables from the switch or controller to the 3592 tape drives can be ordered with the 3592 tape drives or supplied by the client.

Archived

Monitoring and reporting

This appendix briefly describes the available products and tools for monitoring and reporting, as well as general considerations about these topics. It provides details about the Enterprise Tape Library (ETL) Specialist and a subset of the tape tools:

- ▶ MOUNTMON
- ▶ TAPEWISE
- ▶ VTSSTATS
- ▶ VEHSTATS
- ▶ ST@S3494
- ▶ TS7700 monitoring using BVIR

This appendix does not provide detailed information about all tools and reports. For detailed information, refer to the appropriate sources listed throughout this appendix.

Monitoring and reporting tools

This section explains where to find and how to use the tape tools. It gives a brief overview about the ETL Specialist. We describe the ETL Specialist in Chapter 2, “IBM TotalStorage Enterprise Automated Tape Library” on page 25.

General considerations about monitoring and reporting

As long as you have additional capacity in your environment, monitoring and reporting are not a priority. However, today most companies define their environment in terms of “rightsizing” and “downsizing.”

The extension of a tape library takes more planning and time, including outage time, than installing a new DASD device. Therefore, having knowledge about how well your environment operates is the key. This knowledge shows you potential areas of concern and helps you develop the options that you can deploy to ensure that your tape environment meets your needs.

Changes in your tape operational environment, such as new workloads, and production processing time frames can cause your tape hardware needs to change. IBM provides you with tools that can help you monitor the utilization of your tape library, as well as provide information to assist you in troubleshooting and problem determination. These tools can help you avoid problems by giving you early warning when you need to reorganize your job scheduling or upgrade your current tape environment.

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. You can use the MI 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.

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 the volume mount analyzer to study tape mount activity and monitor tape media use. This program was originally introduced to gather information for preparing tape mount management (TMM).

Note: VMA is no longer supported. We recommend that you use Tapewise to monitor your tape environment.

Volume mount analyzer is a good source to provide a lot of 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 you determine whether new applications or users can 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 IBM 3494 Tape Libraries, you can create a focal point to get exact information about the total workload transferred to the IBM 3494.

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. The information from VMA allows continuous tracking and monitoring of your workload and provides a trend of your data growth. It enables you to recognize bottlenecks and to perform the appropriate sizing for upgrades.

Note that there are restrictions regarding VMA and Virtual Tape Server (VTS).

Installation and customization

VMA is a no-charge feature from DFSMS, which ships with the base code. VMA requires no additional installation. You use SMF type 14, 15, 21, and 30 records for the input for VMA. If the SMF record is not already enabled, add it to SMFPRMxx in SYS1.PARMLIB.

Creating an extractor file

In the SMF records (especially types 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 compact 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. They help 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 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 makes VMA an extremely powerful tool.

Restrictions with VTS

A workload that is directed to a VTS shows you 3490E traffic and the virtual drive view. There is no way to obtain information about:

- ▶ The usage of the physical installed 3590 models
- ▶ The back-end traffic regarding reclaim
- ▶ Recall times
- ▶ The physical mounts and demounts in the 3494

This information is only provided in SMF94, which is not used by VMA.

Note: For information about the total exchanges (mounts and demounts) from an IBM 3494, use the ETL Specialist. If it is not installed, use the Library Manager.

Implementation considerations for multiple System z users

This section provides hints and tips to create an environment for monitoring and troubleshooting in a multiple z/OS and 3494 Tape Library environment.

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 or sysplex?
 - How many drives are needed in a time frame from the system or sysplex?
 - Which workload is done (HSM, DFDSS, and so forth)?
 - What is the trend of this workload (increasing)?
- ▶ The installed I/O devices and tape library view:
 - How many workloads are directed in total to a library in:
 - One day?
 - One hour?
 - The batch window?
 - How many drives are used in what time frame?
 - How many exchanges (mounts and demounts) are handled?

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 or sysplex and store it in a generation dataset (GD). Include at least 30 consecutive days.
2. Run the necessary VMA reports on a daily basis, scheduled through your scheduling system:
 - Total workload from this system or sysplex (all tape devices or all libraries)
 - Workload to a specific library from this system or 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 of the systems in your environment.
6. Run an extractor of the SMF record file that was created in step 5 and store it in a Generation Data Group dataset (GDGD). Include at least 30 consecutive days.
7. Run the necessary VMA reports on a daily basis scheduled through your scheduling system. The reports need to be based on the total workload, including all of the system or sysplex down 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 platform and hardware view
- ▶ Have comparison data
- ▶ Have data from three weekends and month-end processing

- ▶ Have the necessary data available for IBM sizing tools
- ▶ Can always run additional VMA reports without having to read 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 various tools, the benefits that they offer, the input source that they need, and the output that they deliver. Tape tools are available on the following client site:

<ftp://ftp.software.ibm.com/storage/tapetool>

Additional tools (see “Additional tools” on page 495) are available only for IBM Business Partners or IBM employees.

For questions or suggestions regarding tape tools, send an e-mail to:

<mailto:TAPETOOLS@us.ibm.com>

Tape tools for multiplatform systems

VTSLGRP is the only monitoring tool for shared VTSs 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 Tape Volume Cache (TVC), such as cache hits and misses.

VTSLGRP does not support Peer-to-Peer Virtual Tape Server (PtP VTS).

Table B-1 lists the PC-based tape tools.

Table B-1 PC-based tape tools

Tool	Major use
VTSLGRP	Multiplatform VTS monitoring tool, run on the 3494 Library Manager (PC-based)
VTSGRAPH	Creates Freelance presentations, based on VTSLGRP 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 B-2 on page 486 and Table B-3 on page 489 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 tool jobs.

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 Tape Library Specialist.

Table B-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 makes 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 BVIRRPRT.
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 users 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 <i>n</i> 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 a 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 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 runtime improvements.
TAPEWISE	Identifies tape usage improvement opportunities.	Helps to improve the tape usage. Shows the wrong allocation types.
QSAMDRVR	Monitors and reports write/read throughputs on tape drives.	Possible unequal loads.
Helpful tools		
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	Changes the SMF-ID in cases where multiple SMF files are to be processed.	Improves the quality of a tape analysis.

Table B-3 Tape tools: Necessary input, given output, and prerequisites

Tools for TS3500 and TS7700/VTs			
Tool name	Input	Output	Prerequisites
VEPSCAN	Data from BVIR facility	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 <i>n</i> 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
DCOLLRPx	DFHSM MCDS file	Number of files and GB	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 <i>nn</i> 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
Helpful tools			
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 three of these products:

- ▶ MOUNTMON
- ▶ TAPEWISE
- ▶ VTSSTATS

MOUNTMON

Use MOUNTMON to answer the following questions:

- ▶ How many tapes do we mount 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 allocated to many drives?

MOUNTMON is the most accurate source of concurrent drive usage reports. For details about 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?
- ▶ Are media errors occurring?
- ▶ How long are allocation delays?
- ▶ Does remounting of the same VOLSERs occur?
- ▶ Are there allocations without open?
- ▶ Which is being used: UNIT=AFFF or UNIT=(TAPE,2)?
- ▶ Long allocation of tapes, but why is only a small amount of data transferred?
- ▶ What datasets are recalled in a VTS?

For details about TAPEWISE, see the presentation available on the FTP server at:

<ftp://ftp.software.ibm.com/storage/tapetool/tapeWise.pdf>

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 look at the workloads running on 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
- ▶ Performing trend analysis 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 or small block sizes)

VEHSTATS

VEHSTATS is for analyzing statistics from the TS7700 that were obtained using the Bulk Volume Information Retrieval (BVIR) function. This historical data from the TS7700 is formatted by VEHSTATS for analysis.

For details about VEHSTATS, see the sample output available on the FTP server at:

<ftp://ftp.software.ibm.com/storage/tapetool/vehstats.samprpt.pdf>

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 R.1.4A to evaluate the copy status on one or more TS7700 clusters in a grid:
 - You 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 can be useful also 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 return the results. By using a standard tape volume, no special interfaces or access methods are necessary 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 R 1.4A:

► 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 or resume logical volume copies on a cluster basis. For example, you can suspend the copy for a specific logical volume in a 3-site grid (local-local-remote) on the remote cluster only.

There are two steps to obtain information using this facility (see Figure B-1):

1. A single dataset with the information request is written to a logical volume. During close processing, the TS7700 Virtualization Engine server will recognize this volume 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.

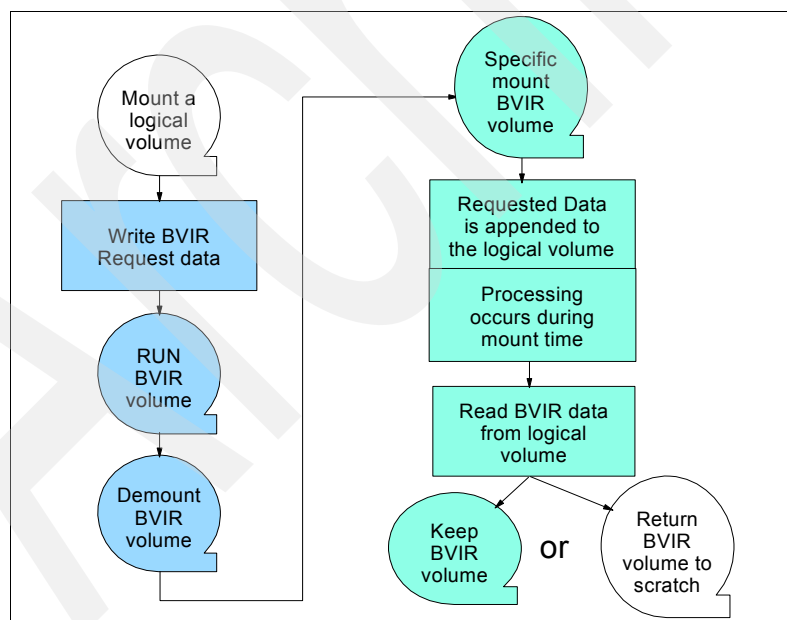


Figure B-1 BVIR process flow

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 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

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.

ST@S3494

ST@S3494 is also based on the SMF94 records. It provides an overview of the entire physical library for all of the attached users. It provides:

- ▶ Physical mounts (every mount regardless of native traffic or mounts for VTS back-end processing)
- ▶ Number of enters and ejects
- ▶ Average and maximum residency times
- ▶ For each logical library:
 - The number of drives and the number of mounts of physical drives
 - The average and maximum mount time of physical drives

Use ST@S3494 to provide trend analysis to see whether the physical limits of your library are reached and upgrades are needed.

Additional tools

Certain tools are not available through the client site. Table B-4 provides an overview of the tools that IBM uses.

Table B-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. This tool has been enhanced for the TS7700.
Tapemagic	Use this PC-based tool for VTS sizing.
PERF3494	Use this tool for Dual Active Accessor performance projection (Lotus® 1-2-3®).
EXIMCALC	This tool is a VTS Import/Export time estimator (Lotus 1-2-3).
3494SLOT	This tool calculates available slots based on the configuration (Lotus 1-2-3).

For more information, see the following site:

<ftp://vtstools@service2.boulder.ibm.com>

Various monitoring and reporting scenarios

There are two views for reporting:

- ▶ The view from your operating system platform (which workload and which 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 records 14, 15, 21, and 30, and review it with VMA (see “Volume mount analyzer (VMA) reporting for tape utilization” on page 482). Other platforms do not provide this information.

- ▶ The view of the tape library system or VTS (what is processed in that library system or VTS)

The SMF94 record contains all of this information. The 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 on the z/OS system, such as ST@S3494 and VTSSTATS, you receive information about the workloads that the library or VTS handled, in addition to the z/OS system, where the job runs.

If no z/OS system is attached, you can use VTSLOGRP for VTS monitoring. To monitor the 3494, you need the ETL Specialist.

If you share your library or VTS among different users or platforms, you must consider that VMA reports are not sufficient to get a complete picture of the workload in a library.

When you share your library or VTS among different platforms, the ELT Expert is the best choice to gain a full picture of your environment. Even if you use ST@S3494 to provide all of the library information and VTSSTATS or VTSLOGRP to get the information from the VTS, you must have access to the platform that you established for your monitoring (z/OS or the PC).

With the ETL Specialist, all authorized people can view the monitoring and performance data without z/OS access or z/OS knowledge.

Problem determination scenarios

This section provides example problem determination scenarios. It is not intended as a complete list, but it serves as a pointer to probable causes for common problems.

Native mounts are not handled in an adequate time

Possible reasons for this scenario are:

- ▶ The library is degraded.
- ▶ There is too much physical movement in the library.
- ▶ Scratch cartridges are relabeled because of an intermix of different 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 ((Library Manager Console or Enterprise Tape Library (ETL)) ST@S3494

- ▶ Check with your IBM 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 a possible reason.

Possible solutions are:

- ▶ Repair the hardware.
- ▶ Reduce physical movement:
 - Check the home cell mode and positioning of cartridges.
 - Check movements for VTS reclaims (Threshold setting).
 - Reduce your Advanced Policy Management (APM) pools.
 - There are too many users accessing the library.
 - Introduce a second gripper.
 - Introduce the Dual Active Accessor (DAA) feature (if a library has more than four frames).
- ▶ This information only applies to scratch cartridges. If it happens, check with your IBM SSR. The IBM SSR 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 is an indicator that a relabeling has occurred.

VTS logical scratch mounts are not handled in an adequate time

A possible reason for this scenario 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 situation are:

- ▶ No units (native or VTS) are available.
- ▶ Bottlenecks are in the channels.
- ▶ The control unit is busy.
- ▶ There is bad traffic.
- ▶ There is 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 ETL Specialist

Unable to monitor FICON using FICON directors in the intersection between the Director and 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 an A60 controller.
- ▶ For bad traffic, try to migrate to 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.

VTS recalls are not fast enough

Possible reasons for this are:

- ▶ Hardware is degraded.
- ▶ There are not enough physical drives installed.
- ▶ The migration threshold is too high for stacked volumes.
- ▶ Too many physical pools are introduced with APM.
- ▶ There is bad or no cache management.

You might want to look at the following areas to resolve the problem:

- ▶ z/OS display commands, ETL Specialist
- ▶ ETL Specialist
- ▶ ETL Specialist and VTSSTATS
- ▶ APM and physical movement of cartridges in ETL Specialist or ST@3494
- ▶ VTSSTATS

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:

- ▶ The hardware is degraded.
- ▶ There is too much physical traffic in the library.

You might want to look at the following areas to resolve the problem:

- ▶ z/OS Display commands, ETL Specialist
- ▶ ST@3494 or ETL Specialist

Possible solutions are:

- ▶ Repair the hardware.
- ▶ Look for a better time frame for eject (less movement in 3494).

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 DEVSUPxx member SYS1.PARMLIB. The appropriate member must be pointed to by IEASYSxx. See the DEVSUP discussion in 4.3.2, "Updating SYS1.PARMLIB" on page 174.

Table C-1 Library Manager volume categories

Category (in hexadecimal)	Used by	Definition
0000	Null category	This pseudo-category is used in certain library commands to specify that the category that 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 hexadecimal)	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 TotalStorage Enterprise Tape Cartridge 3592 Extended.
000A	DFSMS/MVS	Indicates scratch MEDIA10. MEDIA10 is the IBM TotalStorage Enterprise Tape Cartridge 3592 Extended WORM.
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 hexadecimal)	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 hexadecimal)	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.

Category (in hexadecimal)	Used by	Definition
00BD	Native VSE/ESA	Indicates that the volume belongs to the VSE category SCRATCH29.
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	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	i5/OS (MLDD)	Indicates that the volume has been assigned to category *NOSHARE. Volumes in this category can be accessed only by the 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 request of a host.
012C	TSM for AIX	Indicates a private volume. Volumes in this category are managed by IBM 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 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 request of a host.

Category (in hexadecimal)	Used by	Definition
0FFF	BTLS	Indicates a scratch volume. Volumes in this category belong to the default scratch pool used by BTLS. Note: If you are planning to migrate to DFSMS/MVS, you need to use only this default scratch category.
1000 to F00D	N/A	No assignment to a specific host system. These categories can be dynamically assigned by the Library Manager on 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 being demounted.
F00F to FFFF	N/A	No assignment to a specific host system. These categories can be dynamically assigned by the Library Manager on 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 (VTS)	Stacked Volume Insert category for a Virtual Tape Server. 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. 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. 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	Stacked Volume Private category for a Virtual Tape Server. This category is used by the VTS for its private stacked volumes. If LIC level is 527 or higher, this category includes both scratch and private volumes.
FF05	Virtual Tape Server	Stacked Volume Disaster Recovery category for a Virtual Tape Server. A volume is set to this category when its volume serial number (VOLSER) is in the range specified for stacked volumes for any VTS library partition <i>and</i> the Library Manager is in disaster recovery mode.
FF06	Virtual Tape Server	This category is used by the VTS 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 Server	This category is reserved for future hardware functions.

Category (in hexadecimal)	Used by	Definition
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	<p>Convenience Eject category</p> <p>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.</p> <p>Note: Logical volumes cannot be ejected from the library. They can be deleted or exported.</p>
FF11	Library Manager	<p>Bulk Eject category</p> <p>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.</p> <p>Note: Logical volumes cannot be ejected from the library. They can be deleted or exported.</p>
FF12	Virtual Tape Server	<p>Export Pending category</p> <p>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.</p> <p>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.</p>
FF13	Virtual Tape Server	<p>Exported category</p> <p>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.</p>
FF14	Virtual Tape Server	<p>Import category</p> <p>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.</p>

Category (in hexadecimal)	Used by	Definition
FF15	Virtual Tape Server	<p>Import Pending category</p> <p>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 will fail.</p> <p>Engineering note: If the library import operation is cancelled or fails, any volumes assigned to this category are deleted from the library inventory.</p>
FF16	Virtual Tape Server	<p>Unassigned category</p> <p>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.</p> <p>Manual intervention is required to assign the cartridges to the proper category. For exported stacked volumes, the proper category is the import category (FF14).</p>
FF17	Virtual Tape Server	<p>Export Hold category</p> <p>Physical volumes are assigned to this category on completion of processing for an export stacked volume.</p>
FF18 and FF19	N/A	<p>Reserved for library</p> <p>These categories are reserved for future hardware functions.</p>
FF20	Peer-to-Peer (PtP) Virtual Tape Server	<p>Corrupted Token Volume category</p> <p>In a Peer-to-Peer VTS, volumes are assigned to this category by an AX0 controller when it has determined that the tokens associated with the volume have been corrupted. This assignment prevents the volume from being selected by a category mount request.</p>
FF21 to FFF5	N/A	<p>Reserved for library</p> <p>These categories are reserved for future hardware functions.</p>
FFF4	Library Manager	<p>3592 Cleaner Volume</p> <p>Cleaner volumes for 3592 type devices in the library are assigned to this category automatically.</p>
FFF5	Library Manager	<p>3592 Service Volume</p> <p>Volumes are assigned to this category by the Library Manager when it detects that a volume has a unique service cartridge volume serial number (VOLSER) and a media type compatible with a 3592 device.</p>
FFF6	Library Manager	<p>3590 Service Volume category</p> <p>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.</p>

Category (in hexadecimal)	Used by	Definition
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.

Archived

Basic tape library environment

This appendix reviews the fundamental factors to consider when implementing Basic Tape Library Support (BTLS). First, it explains the logic of BTLS and the basic BTLS installation tasks. Then, it addresses the tape management system and JES3 considerations in a BTLS environment. It also discusses installation verification and software customization topics.

For more information about BTLS, see *BTLS V1R1 User's Guide and Reference*, SC26-7016.

Implementing BTLS

Installation of the BTLS software changes the following components:

- ▶ Message display
- ▶ Allocation
- ▶ Dynamic device reconfiguration (DDR)
- ▶ IDCAMS LIBRARY command
- ▶ Tape library attention messages
- ▶ Tape library statistics SMF type 94 record

Message display is the z/OS function that sends messages to the tape drive message displays. BTLS modifies these messages to send **mount** and **demount** commands to the Library Manager. **Mount** causes a cartridge to be mounted on a drive. **Demount** causes a cartridge to be demounted from a drive and returned to the storage cells.

Allocation has been changed to use the BTLS rules as defined in the records in the master catalog. These rules are defined through the IDCAMS LIBRARY command. Allocation can be controlled by an esoteric or job name, a procedure name, and a user exit. BTLS modifies the list of eligible devices to include all library-resident or library-nonresident devices before device allocation.

DDR controls the swapping of cartridges after an I/O error. BTLS changes DDR to ensure that the swap goes to the same device type in the same library. DDR swaps within a library no longer require operator intervention.

BTLS provides an *IDCAMS LIBRARY command* for the control and definition of the IBM 3494 Tape Library. The command enables functions, such as:

- ▶ Change cartridge status from private to scratch.
- ▶ Define library devices.
- ▶ Define allocation rules.
- ▶ Obtain lists of cartridges from the Library Manager.
- ▶ Issue commands to the IBM 3494 Tape Library, such as mount or demount and load or unload integrated cartridge loaders (ICLs).

Through the IDCAMS LIBRARY commands, a set of rules by which BTLS controls tape allocations is defined in the master catalog. BTLS also maintains a catalog of library-resident volumes to satisfy specific mount requests. BTLS can support up to eight tape libraries. Figure D-1 on page 511 lists the IDCAMS LIBRARY commands.

LIBRARY	AUDIT	UNIT(unit) [VOLSER(volser)] [FORCE]
	COUNTS	UNIT(unit)
	DEFINE	[VOLSER(volser)] [LIBNAME(libname)]
	DELETE	[VOLSER(volser)] [LIBNAME(libname)]
	DEMOUNT	UNIT(unit)
	DEVICES	<i>(devicerange devicerange ...)</i> [LIBNAME(libname)]
	INVENTORY	UNIT(unit) CATEGORY(category)
	JOBNAMES	<i>(jobname...)</i> [LIBNAME(libname)]
	LISTVOL	[LIBNAME(libname)]
	MOUNT	UNIT(unit) [VOLSER(volser)]
	OPTIONS	<i>(option)</i>
	REPORT	[LIBNAME(libname)]
	RESETACL	UNIT(unit)
	RESETDEVICE	UNIT(unit)
	SETACL	UNIT(unit) CATEGORY(category)
	SETCATEGORY	UNIT(unit) CATEGORY(category) [VOLSER(volser)]
	SETCEXIT	UNIT(unit)
	SETDEVICE	UNIT(unit) CATEGORY(category)
	THRESHOLD	<i>(count)</i> [CATEGORY(category)] [LIBNAME(libname)]

Figure D-1 IDCAMS LIBRARY commands

The IBM 3494 Tape Library reports the completion of a mount or demount and error conditions to the host through attention messages. It also provides support to read the messages and report relevant messages to the system operator.

Control datasets

BTLS uses catalog records to define a library configuration and allocation rules. Each volume in an IBM 3494 Tape Library is also defined by a catalog record that names the library in which the volume resides. You need to allocate a user catalog for the BTLS volume entries. Figure D-2 on page 512 shows the catalog records that BTLS uses.

	Catalog Record Name	Description
Library	SYS1.BTLS.LIB.LIBn	Defines the device addresses in library LIBn
Options	SYS1.BTLS.LIB.OPT	Defines the options used by an allocation
Jobname	SYS1.BTLS.JOBn	Defines the job names that should use a library scratch allocation
Volume	BTLS.BTLS.VOL.vvvvvv	Indicates the library containing volume vvvvvv

Figure D-2 BTLS catalog records

Catalog records whose names start with SYS1 are cataloged in the master catalog. The volume catalog records are cataloged in the BTLS user catalog.

Figure D-3 shows the BTLS catalog record structure.

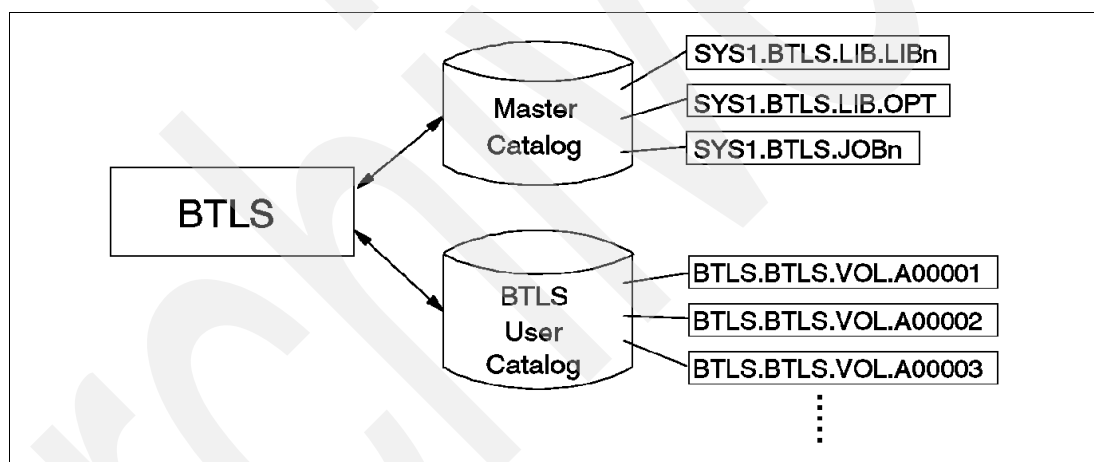


Figure D-3 BTLS catalog record structure

Installation tasks

This section describes the BTLS installation tasks. For more information about installation tasks and the details of the IDCAMS command, LIBRARY, see the *BTLS V1R1 User's Guide and Reference*, SC26-7016.

The following procedure shows you the installation tasks:

1. Define the IDCAMS command LIBRARY as a TSO command by using the Job Control Language (JCL) that is shown in Figure D-4 on page 513.

```

//COMMAND JOB ,
//      TIME=(0,5),MSGCLASS=A
//LKED   EXEC  PGM=HEWL,REGION=2048K,
//      PARM='XREF,LET,RENT,LIST,NCAL'
//SYSUT1 DD   DSN=&&SYSUT1, UNIT=SYSDA,
//      SPACE=(1024,(50,20))
//SYSPRINT DD  SYSOUT=*
//SYSLMOD DD   DSN=SYS1.LINKLIB,DISP=SHR
//SYSLIB  DD   DSN=SYS1.CMDLIB,DISP=SHR
//SYSLIN  DD
//      INCLUDE SYSLIB(IDCAMS01)
//      ALIAS  LIBRARY
//      SETCODE AC(1)
//      NAME IDCAMS01(R)
/*

```

Figure D-4 Sample JCL to define the IDCAMS command LIBRARY

2. Authorize the IDCAMS command LIBRARY by adding it to IKJTSO00 in SYS1.PARMLIB. After updating IKJTSO00, the PARMLIB UPDATE(00) command authorizes the IDCAMS command LIBRARY.
3. Define the library devices.

Use the IDCAMS command LIBRARY DEVICES to define the device addresses for a library. A 3490 control unit can contain up to 16 tape drives. Even if any of the control units in an IBM 3494 Tape Library have fewer than 16 drives, all 16 possible addresses still must be defined in the host system. It is necessary to include uninstalled devices in the IDCAMS command LIBRARY DEVICES. If invalid addresses are specified, the results are unpredictable.

Figure D-5 shows a sample job to define library devices. Library LIB1 (default) is defined as containing devices 180-18F and 190-19F. One BTLS system supports up to eight libraries, which must be called LIB n , where n is 1 to 8.

```

//LIBJOB    JOB
//          EXEC  PGM=IDCAMS
//SYSPRINT  DD   SYSOUT=*
//SYSIN     DD   *
//          LIBRARY DEVICES ( 18018F 19019F )
/*

```

Figure D-5 Sample JCL to define library devices

Recording technology (128 track, 256 track, 384 track, or EFMT1 tracks) information is not kept in a BTLS environment. Therefore, with mixed device types and mixed media types in an IBM 3494 Tape Library, we recommend that you define multiple logical libraries, such as LIB1 for the IBM TotalStorage Enterprise 3590B tape drives, LIB2 for the 3590E drives, and LIB3 for the 3590H drives, to facilitate the conversion to DFSMS tape and to control the use of the device and media types. The following example shows a command to define two logical libraries:

```

LIBRARY DEVICES (17017F) LIBNAME(LIB1)
LIBRARY DEVICES (18018F) LIBNAME(LIB2)

```

Note: BTLS offers support for four-digit device numbers. Support is provided with JDZ11BS. For releases prior to JDZ11BS, support is provided by OW12877. Library devices must be restricted to the four-digit address range: 0000 through 0FFF. All other devices, including tape drives, can use any of the four-digit addresses in the 0000 through FFFF range. BTLS commands and messages use only the three significant digits 000 through FFF and assume that the fourth digit is always zero.

4. Create an esoteric device group name.

Create an esoteric device group name for the library devices to facilitate allocation to the IBM 3494 Tape Library. The esoteric device group name does not have to match the library name (for example, LIB1). However, the address range of the esoteric device group name must match the library device definitions, which ensures that allocation recovery messages include only the appropriate set of tape drives.

5. Create SYS1.PARMLIB member BTLPRM00.

Define the defaults used by BTLS in SYS1.PARMLIB member BTLPRM00. Each parameter statement must begin in column 1. The following definitions are supported:

- **THRESHOLD(count)** establishes a low threshold value for scratch volumes. When the number of scratch volumes falls below the *count*, the operator receives a warning message.

The threshold value established at initial program load (IPL) by the THRESHOLD parameter is replaced when the IDCAMS command LIBRARY THRESHOLD is executed. If multiple threshold values are required, use the IDCAMS command LIBRARY THRESHOLD after IPL. The command supports multiple libraries and multiple scratch categories. The LIBRARY REPORT command can be used to display the threshold values that have been established.

- **SCRATCHn** establishes a default category for scratch mounts. Unless specified, scratch mounts use volumes assigned to the SCRATCH1 volume category (X'0FFF'). When more than one host shares a library, a different scratch volume category is used by each host. The BTLPRM00 PARMLIB member for each host names the scratch volume category that host will use for scratch mounts.
- **AUTODEMOUNT** indicates that library volumes must be automatically demounted if they become mounted on unallocated devices. When AUTODEMOUNT is specified and BTLS detects a mount completion for an unallocated device, the volume is unloaded and demounted automatically.

In a BTLS library, a volume can become mounted on an unallocated device when a job is canceled or abends during mount pending. Because the mount is not completed before the job terminates, a demount is not sent to the library. Even though the job is terminated, the mount is eventually completed in the library. If the device is not yet allocated to another job, the volume stays mounted.

The purpose of AUTODEMOUNT is to solve the following two problems created by volumes mounted on unallocated drives:

- If another job allocates the drive and needs a private volume mounted, the job demounts but keeps the previously mounted volume. The demount causes a scratch volume to be assigned to the private category even though it was never used.
- If another job allocates a different tape drive and needs a volume that is already mounted on an unallocated drive, the mount fails with the message ERA=64 "volume in use."

- **LIBAFFINITY** indicates that BTLS must break affinity when an invalid UNIT=AFF condition is detected. If LIBAFFINITY is not used, invalid affinity is reported by message BTLS104I, and the job is terminated.

To validate affinity, BTLS compares the allocation requirements of the target DD(DD1) and the UNIT=AFF DD(DD2). The following conditions are valid:

- Both DD1 and DD2 require drives in the same library.
- Both DD1 and DD2 require nonlibrary drives.
- Either DD1 or DD2 can use *any* drive. BTLS allows *any* drive when Option I is used (Table D-1 on page 518) to control scratch allocation and for any SCRATCH request that specifies UNIT=AFF.

When an invalid condition is detected, and the LIBAFFINITY option is in effect, BTLS breaks the invalid affinity. The following example shows how BTLS breaks affinity:

```
//DD1 DD VOL=SER=VOL001,UNIT=TAPE
//      DD VOL=SER=VOL002,UNIT=AFF=DD1
//      DD VOL=SER=VOL003,UNIT=AFF=DD1
//      DD VOL=SER=VOL004,UNIT=AFF=DD1
```

Note: VOL001 and VOL004 are defined to BTLS as LIB1. VOL002 and VOL003 are not defined to BTLS.

When the previous JCL is executed, BTLS directs the allocation for DD1 to LIB1. It detects an error because VOL002 is not in LIB1, yet it specifies affinity with DD1. When the LIBAFFINITY option is in effect, BTLS causes the JCL to allocate as though it were written this way:

```
//DD1 DD VOL=SER=VOL001,UNIT=TAPE
//DD2 DD VOL=SER=VOL002,UNIT=TAPE
//      DD VOL=SER=VOL003,UNIT=AFF=DD2
//      DD VOL=SER=VOL004,UNIT=AFF=DD1
```

For LIBAFFINITY to successfully break affinity, the set of devices determined by the UNIT parameter of the target DD must include devices that also satisfy the requirements of the broken DD.

If the sample JCL was coded as in the following example, the allocation for VOL002 fails because UNIT=LIB1DEVS names an esoteric unit that does not include any devices in LIB2 (and VOL002 is defined to BTLS as a LIB2 volume):

```
//DD1 DD VOL=SER=VOL001,UNIT=LIB1DEVS
//      DD VOL=SER=VOL002,UNIT=AFF=LIB1
//      DD VOL=SER=VOL003,UNIT=AFF=LIB1
//      DD VOL=SER=VOL004,UNIT=AFF=LIB1
```

Note: LIBAFFINITY is not supported when MVS/SP™ 5.2 is installed.

- **EXPDT98000|EXPD** option allows a duplicate of a BTLS library volume to be mounted on a drive outside the library.

BTLS does not check that there is an internal label on the cartridge, so NL and Bypass Label Processing (BLP) tapes are supported. The IBM 3494 Tape Library requires every volume to have an external volume serial number (VOLSER) that is unique to that library. However, because all volume records are stored in the BTLS catalog, each VOLSER number that BTLS manages must be unique.

When the EXPDT98000 option is used and a DD statement includes EXPDT=98000, BTLS does not validate or interfere with the allocation. Therefore, you can allocate a

drive outside the library for a VOLSER number that is defined to BTLS as a library volume.

Here is an example of the BTLPRMxx parameters:

```
THRESHOLD(50)    /* Minimum scratch threshold warning to ops
AUTODEMOUNT      /* Demount cartridges from unallocated drives
SCRATCH3         /* if no scratch pool is specified use SCRATCH3
```

6. Define a user catalog for BTLS volume records.

Define a user catalog named BTLS that will be used by BTLS to define 'BTLS.BTLS.VOL.VOLSER' catalog records. The catalog must be an ICF catalog. It can be defined as shared if library volumes are to be shared by more than one host. If this catalog is to be shared by more than one host, the catalog must reside on a shared DASD volume and be connected to the master catalogs of the other hosts.

Note: The name of the catalog cannot be changed to a user-defined name.

Here is a sample command to define the user catalog:

```
DEFINE UCAT (NAME(BTLS) MEGABYTES(1 1) ICFCATALOG -
            VOLUME(COMCAT) SHAREOPTIONS(3 4))
```

7. Install the BTLS allocation interface.

For releases earlier than MVS/SP 5.1, ensure that APAR OY63009 is installed (OY63009 is included with MVS/SP 5.1). OY63009 provides the interface used by BTLS to control tape allocations.

OY63009 is not used with MVS/SP 5.2. Instead, BTLS uses the tape allocation subsystem interface. When MVS/SP 5.2 is installed, add the following command to SYS1.PARMLIB member IEACMD00:

```
SETSSI ADD,SUBNAME=BTLS,INITRTN=AOMALSSI
```

You can also issue the SETSSI command from the operator's console. The SETSSI command activates the BTLS tape allocation SSI so that BTLS can begin to control tape allocations. When the command executes, the following messages are received at the operator console:

```
BTLS401I START OF BTLS INITIALIZATION
BTLS402I BTLS INITIALIZATION COMPLETE
```

8. Obtain an inventory list from the library.

After inventory processing is completed at the IBM 3494 Tape Library, use the IDCAMS command LIBRARY INVENTORY to obtain a list of the volumes in the INSERT category in the IBM 3494 Tape Library. The volume list is printed in the dataset of the LIBOUT DD statement.

Figure D-6 on page 517 shows the sample JCL to obtain a list of the volumes in the INSERT category.

```

//LIBJOB      JOB
//            EXEC PGM=IDCAMS
//SYSPRINT    DD  SYSOUT=*
//LIBOUT      DD  DSN=dsname,
//            DISP=(NEW,CATLG),UNIT=SYSDA,
//            DCB=(LRECL=80,BLKSIZE=0,RECFM=FB)
//SYSIN       DD  *
              LIBRARY INVENTORY UNIT(180) CATEGORY(INSERT)
/*

```

Figure D-6 Sample JCL to obtain a list of volumes in the INSERT category

9. Assign a volume category.

Determine which VOLSER number to assign to the private category and which VOLSER number to assign to the scratch category. Then, issue the following command to assign each volume to the appropriate category:

```
LIBRARY SETCATEGORY
```

Figure D-7 shows a sample JCL where all volumes specified in the LIBIN DD dataset are assigned to the SCRTCH category.

```

//LIBJOB      JOB
//            EXEC PGM=IDCAMS
//SYSPRINT    DD  SYSOUT=*
//LIBIN       DD  DSN=dsname,DISP=SHR
//SYSIN       DD  *
              LIBRARY SETCATEGORY UNIT(180) CATEGORY(SCRTCH)
/*

```

Figure D-7 Sample JCL to assign volumes to the scratch category

With mixed media types in an IBM 3494 Tape Library, we recommend that you assign different volume categories for each media type to facilitate the conversion to DFSMS tape and to control the use of the media types.

If you plan to use multiple scratch pools, you must decide how you will control scratch selection. The selection can be done by assigning a device to a specific scratch pool or using the message display exit IGXMSGEX.

BTLS can support a maximum of eight scratch pools, which must be called SCRTCH1 to SCRTCH8. SCRTCH1 is an alias for SCRTCH when only one media type is used. BTLS determines which scratch pool to use by first checking the unit control block (UCB) to see whether a specific scratch pool has been assigned to the device. If a scratch pool has not been assigned, BTLS uses the default scratch pool unless ISGMSGEX passes BTLS a scratch pool name from the mount message (see “Message display” on page 520). Note that DFSMSrmm and other tape management systems can use the mount message to pass BTLS the scratch pool name.

To assign a scratch pool to a specific device, use the LIBRARY SETDEVICE command as shown here:

```

LIBRARY SETDEVICE UNIT(700) CATEGORY(SCRTCH3)
LIBRARY SETDEVICE UNIT(701) CATEGORY(SCRTCH7)

```

10. Create volume records.

Use the IDCAMS command LIBRARY DEFINE to create a volume record for each volume. Figure D-8 shows the sample JCL to create volume records for the volumes. All volumes specified in the LIBIN DD dataset are cataloged as residing in library LIB1 (default).

```
//LIBJOB      JOB
//           EXEC PGM=IDCAMS
//SYSPRINT   DD  SYSOUT=*
//LIBIN      DD  DSN=dsname,DISP=SHR
//SYSIN      DD  *
              LIBRARY DEFINE
/*
```

Figure D-8 Sample JCL to create volume records

For a specific volume request (private volume), if the volume is not defined in this catalog entry as a library volume, the volume is assumed to reside outside of the library, and only nonlibrary devices are used to satisfy the allocation.

11. Create the operator procedure.

Create a procedure to be used by the operator to issue the IBM 3494 Tape Library mounts and demounts. The procedure needs to invoke the IDCAMS LIBRARY command.

12. Define the options for scratch allocation.

Before you set the BTLS options, first decide how you want BTLS to act. BTLS can influence allocation in the following ways:

- Esoteric
- Job name, procedure name
- All allocations to library devices
- No allocations to library devices

Table D-1 shows the combinations for the options.

Table D-1 BTLS library options

Option 1	Option 2	Option 3	Description
J			Scratch allocation is based on JOBNAME. When this option is used, only job names or procedure names defined with LIBRARY JOBNAME are directed to the 3494 Tape Library for scratch allocation.
A			All scratch allocations go to a library device.
M			All scratch allocations go to a nonlibrary device, that is, a normal manual tape device.
I			All scratch allocations are controlled by an esoteric name.
	E		This option enables BTLS allocation support.
	D		This option disables BTLS allocation support.
	T		This option traces BTLS allocation support for diagnostic purposes.
		E	This option enables dynamic device reconfiguration (DDR) support.

Option 1	Option 2	Option 3	Description
		D	This option disables DDR support.
		T	This option traces DDR support for diagnostic purposes.

If you decide to control allocation by job name or procedure name, a maximum of 50 names (or masks) can be specified for each library. If fewer than eight characters are defined as a name, BTLS uses this name as a mask and matches these characters with the start of the job or procedure name. If you decide to control allocation by an esoteric name, the esoteric unit can only contain library-resident drives. Sending all allocations to library-resident drives can be used if nonlibrary devices are not installed or are no longer used. Sending all allocations to nonlibrary devices can be used during installation or for problem analysis.

The LIBRARY OPTIONS command is used to indicate how BTLS controls allocation. The LIBRARY OPTIONS command is also used to change the BTLS defaults set in BTLSPRM00 or to display the BTLS options currently set. The sample LIBRARY OPTIONS command tells BTLS to base allocation on the job or procedure name and that its allocation assist function and DDR support are enabled:

```
LIBRARY OPTIONS(JEE)
```

For further control over allocation when you use JOBNAME, you can use the allocation installation exit, AOMABEXT. For example, if you want a workload to go to any IBM 3494 Tape Library, you must code the exit to pass the addresses of all eligible library-resident drives.

An example of the LIBRARY JOBNAMES command is shown here:

```
LIBRARY JOBNAMES(PRODAHSM GO2LIB1) LIBNAME(LIB1)
LIBRARY JOBNAMES(TESTJOB2 GO2LIB2) LIBNAME(LIB2)
```

In this example, PRODAHSM is directed to LIB1. TESTJOB2 goes to LIB2. Any job or procedure starting with GO2LIB1 goes to LIB1. And, any job or procedure starting with GO2LIB2 goes to LIB2.

If you later decide to add to or change the list of names for BTLS to use, you must include in the command the names that you want BTLS to continue to control. The original BTLS record is overwritten each time that you issue the LIBRARY JOBNAMES command.

13. Secure the IDCAMS command, LIBRARY.

If you want to control use of the IDCAMS command LIBRARY, define IDCLI01 to RACF as a resource name within the RACF resource class PROGRAM. This definition allows only authorized users to send requests to the IBM 3494 tape libraries. A sample command to define IDCLI01 to RACF is shown here:

```
RDEFINE PROGRAM IDCLI01 UACC(NONE)
PERMIT IDCLI01 CLASS(PROGRAM) -
ID(oper) -
ACCESS(READ)
```

14. Create an internal volume label.

Use IEHINITT to label any cartridges that require internal volume labels.

Enter M to reply to the console message IEC701D for each volume. When volumes are demounted by IEHINITT, they are assigned to the private category. Use the LIBRARY SETCATEGORY command to assign the volumes to the appropriate category.

Installation exits

Installation exits are provided to enable you to extend or replace the BTLS replaceable module. The exits are optional. For sharing and partitioning an IBM 3494 Tape Library in a BTLS environment, you do not have to customize the system by using the installation exits.

For details about the installation exits discussed next, see the *BTLS V1R1 User's Guide and Reference*, SC26-7016.

Set volume category

The set volume category installation exit, IDCLI04, is called by IDCLI01 when the SETCEXIT command is specified. Use the installation exit to specify the VOLSER number and category to be sent to the IBM 3494 Tape Library as a SETCATEGORY request. Certain tape management system vendors use this exit to drive their own programs in support of the IBM 3494 Tape Library functions.

Message display

You can use the message display installation exit (IGXMSGEX) to select a BTLS scratch category that satisfies a library scratch mount. If one of the supported scratch categories is specified to the message display installation exit, that scratch category is used to override the scratch category that is otherwise used.

Allocation

You can use the allocation installation exit, AOMABEXT, to control library allocation. It can influence an allocation in one of the following ways:

- ▶ It has no influence.
- ▶ The allocation can be directed to a device in the specified library.
- ▶ The allocation can be directed to a device in any library.
- ▶ The allocation can exclude all library devices.

Tape management system considerations

Tape management systems cannot interface with a BTLS system. When you install a tape management system, you must define the volumes to both the tape management system and the BTLS system. To have both control datasets match, if the tape management system changes a volume's status from private to scratch, you must use the LIBRARY SETCATEGORY command or the SETCEXIT (set volume category exit) to update the Library Manager volume category for the volume.

JES3 support for BTLS

There is no interface to allow the automatic update of BTLS records during the maintenance functions of DFSMSrmm. Therefore, you must update the BTLS catalog accordingly using the IDCAMS LIBRARY command:

- ▶ The tape subsystems in the IBM 3494 Tape Library must not be defined in the JES3 initialization deck and, therefore, are not managed by JES3.
- ▶ z/OS performs all IBM 3494 Tape Library tape device allocations with the allocation assist function of BTLS. BTLS is responsible for communication with the Library Manager in the IBM 3494 Tape Library.
- ▶ BTLS functions in the JES3 environment are identical to the BTLS functions in the JES2 environment.

- JES3 DSPs or JES3 tape commands for tape drives inside an IBM 3494 Tape Library are unsupported.

JES3 can continue to manage tape devices outside the IBM 3494 Tape Library as long as those devices do not belong to the same generic or esoteric unit types as tape devices inside the IBM 3494 Tape Library. For example, you must not have JES3-managed 3490E devices outside the IBM 3494 Tape Library while IBM 3490E devices are inside the IBM 3494 Tape Library. You can have JES3-managed IBM 3480 and 3490 base devices (non-3490E) outside of the IBM 3494 Tape Library while the devices inside the IBM 3494 Tape Library are all IBM 3490Es.

IBM 3490 base devices (non-3490E) are identical to IBM 3480 devices as far as z/OS JES3 is concerned. Therefore, you cannot have IBM 3490 base devices (non-3490Es) inside the IBM 3494 Tape Library and JES3-managed IBM 3480 or 3490 base (non-3490E) devices outside the library.

BTLS Library Manager categories

When volumes are added to the IBM 3494 Tape Library, they are placed in the Library Manager INSERT category. BTLS does not support automatic insert processing.

To tell BTLS which cartridges it will manage in the library, you must first ask the Library Manager which cartridges are in the INSERT category. Then, update the Library Manager to reflect their true status as scratch or private. If multiple scratch pools are used, each pool is assigned to a different Library Manager category.

Table D-2 lists the Library Manager volume categories that are used by BTLS.

Table D-2 BTLS Library Manager volume categories

Name	Use ^a	Library Manager code ^b	Category description
INSERT	I	FF00	Volumes inserted in the library that have not yet been assigned to another category.
EJECT	S	FF10	Convenience I/O eject.
XEJECT	S	FF10	Same as EJECT. X indicates that, in addition to ejecting the volume from the library, the catalog record from the volume must be deleted.
EJECTB	S	FF11	Bulk I/O eject.
XEJECTB	S	FF11	Same as EJECTB. X indicates that, in addition to ejecting the volume from the library, the catalog record from the volume must be deleted.
SCRATCH	IASDT	0FFF	Default scratch volume category.
SCRATCH1	IASDT	0FFF	Default scratch volume category (alias name for SCRATCH).
SCRATCH2	IASDT	0FF2	Alternate scratch volume category.
SCRATCH3	IASDT	0FF3	Alternate scratch volume category.
SCRATCH4	IASDT	0FF4	Alternate scratch volume category.
SCRATCH5	IASDT	0FF5	Alternate scratch volume category.

Name	Use ^a	Library Manager code ^b	Category description
SCRATCH6	IASDT	0FF6	Alternate scratch volume category.
SCRATCH7	IASDT	0FF7	Alternate scratch volume category.
SCRATCH8	IASDT	0FF8	Alternate scratch volume category.
PRIVATE	IS	FFFF	Private volume category.
ERROR	I	F00E	Error volume category. Volumes are assigned to the error category during demount if the VOLSER number specified for demount does not match the external label of the volume being demounted.
CLEANER	I	FFFE	Cleaner cartridge.
SERVICE	N/A	FFF6	3590 Service volume. This category is reported by the COUNTS command but is not valid with any other LIBRARY command (such as SETACL or INVENTORY).
SERVICE	N/A	FFF9	3490 Service volume. This category is reported by the COUNTS command but is not valid with any other LIBRARY command (such as SETACL or INVENTORY).
EJCTM	I	FFFA	Manually ejected volume. Volumes in this category still have an entry in the Library Manager database. You can delete the entry from the Library Manager database by specifying the PURGE category in a SETCATEGORY command.
PURGE	S	FFFB	Purge volume. The PURGE category name is used to remove the Library Manager database record for a volume that is either manually ejected or misplaced.

a. Describes which LIBRARY command can read or change the Library Manager category:

I = INVENTORY
A = SETACL
S = SETCATEGORY
D = SETDEVICE
T = Threshold

b. The hexadecimal Library Manager volume category code

Testing to verify the installation

Because migration to and from BTLS is similar to migration in system-managed tape in many ways, this section limits its discussion predominantly to the differences.

All testing tasks apply to BTLS, although the results differ slightly in many cases:

- ▶ Insert processing is not handled automatically. Use LIBRARY INVENTORY commands to define cartridges to BTLS after they are inserted.
- ▶ Eject processing is invoked by a LIBRARY SETCATEGORY EJECT/XEJECT command. No console or integrated storage management facility (ISMF) interface is available. Certain tape management systems drive this command through the BTLS command interface exit (IDCLI04).
- ▶ Allocation is driven by BTLS, using either esoteric units or job names to select a library drive. You have to test the definitions. Make sure you have the right datasets in the library.

- ▶ You can use IEHINITT to label tapes inside a library.
- ▶ The specifications of the SYS1.PARMLIB ALLOCnn member apply to BTLS.

Software customization

Because migration to and from BTLS is similar to migration in system-managed tape in many ways, this section limits its discussion predominantly to the differences.

Backup and synchronization

The repositories of BTLS are the system master catalog and the BTLS user catalog. As with system-managed tape, protect the catalogs using standard ICFCATALOG backup and recovery procedures, such as ICFRU.

If you have a catalog recovery tool, you can use it to recover the catalog from a backup and accumulated SMF records.

If the BTLS user catalog fails, you can obtain the list of the volumes by using the LIBRARY INVENTORY command and then define the volumes to the new BTLS user catalog by using the LIBRARY DEFINE command. In this way, you can recover the BTLS user catalog definitions of volumes in the library.

To detect anomalies and to generate reports, BTLS provides the following functions:

- ▶ **LIBRARY AUDIT:** Use the robotic system to verify that volumes are physically present in the library.
- ▶ **LIBRARY COUNTS:** Obtain a count of all volumes in each category in a library.
- ▶ **LIBRARY INVENTORY:** Obtain a list of VOLSERS for all of the volumes by category.

When you use the LIBRARY INVENTORY command to obtain the list of volumes, the Library Manager returns a complete list of its inventory in response to this request. BTLS assigns its private volumes to Library Manager volume category X'FFFF'. DFSMS/VM and VSE/ESA also use the same Library Manager volume category. In addition, AIX and the Control Path Server can use the user-specified Library Manager volume category.

After you obtain the list of the private category volumes, you must be careful to select BTLS volumes. Therefore, we recommend that you use a different range of volume serial numbers for each system.

- ▶ **LIBRARY LISTVOL:** List the volumes that are cataloged for a library.
- ▶ **LIBRARY REPORT:** Create a report of all of the devices that are defined for a library.

Most of these commands use datasets as either input or output. You can easily reuse them if you need to go through an entire set of commands to achieve a certain result.

To update or correct BTLS information, use these commands:

- ▶ **LIBRARY DEFINE:** Define either a volume or a library record.
- ▶ **LIBRARY DELETE:** Delete either volume or library records.
- ▶ **LIBRARY SETCATEGORY:** Assign a volume to the category specified.
- ▶ **LIBRARY SETDEVICE:** Associate a scratch category with a device.

Automation considerations are different from system-managed tape. Because neither object access method (OAM) nor storage management subsystem (SMS) is used, CBR* or IGD* library messages are not issued at the z/OS console. Refer to the *BTLS V1R1 User's Guide and Reference*, SC26-7016, for a complete update about all BTLS messages.

DFSMSHsm and BTLS

Because DFSMSHsm runs as a started task, you must specify DFSMSHsm procedure names in the LIBRARY JOBNAMES command when you want to use the library in BTLS with OPTIONS(Jxx). When you use aggregate backup and recovery support (ABARS) in BTLS, you must also specify the ABARS procedure name.

Because BTLS also honors esoteric names, you can control the DFSMSHsm function level granularity to exploit the library, if the esoteric option is specified.

Because the SETSYS LIBRARYMIGRATION and LIBRARYBACKUP parameters are valid only for system-managed tape libraries, DFSMSHsm uses the same characteristics as it does for nonlibrary tapes. However, a tape drive within the proper library is always selected for a library-resident volume. The DFSMSHsm unit name affects device allocation. Read compatibility works automatically on input device allocations of DFSMSHsm-owned volumes. The unit name can be a generic or esoteric name.

Note: Special circumstances apply if you use a generic device name in the SETSYS unit-type statements and you do not have 3490E devices installed. When you vary the 3490E library devices online, all hierarchical storage management (HSM) input allocations are directed to the new 3490E units, because z/OS device preferencing tries to use non-ICL devices in preference to ICL-capable devices for specific mounts.

DFHSM forces data compaction (IDRC or IBMLZ1) for the 3490E or 3590 when it is used as the output device. SETSYS TAPEHWC or SETSYS NOTAPEHWC effectively controls IDRC only for the 3490 base models. The DFHSM default for the 3490 base models is NOTAPEHWC.

The TAPECOPY command provides a way of copying migration level 2 and backup single file tape volumes. When you use 3480, 3480X, 3490, and 3590 generic unit names for input volumes for TAPECOPY, you must consider device compatibility. The original volumes and the alternate volumes that are created must use the same recording technology and media type. DFHSM verifies device compatibility automatically.

During TAPECOPY processing, if MEDIA1 is mounted when MEDIA2 is needed, or alternatively, the process fails. To avoid this situation, the SETSYS TAPEOUTPUTPROMPT(TAPECOPY(YES)) command forces a message to the operator indicating which media type to mount. By defining two scratch media categories with the LIBRARY SETCATEGORY command, SCRTCH for MEDIA1 and SCRTCH2 for MEDIA2, the z/OS operator can mount the correct media type for the request.

Controlling and operating considerations

The operational interface to BTLS is provided by the IDCAMS LIBRARY command. The LIBRARY command performs operations needed to manage tape volumes that reside in a tape library.

You can run the IDCAMS LIBRARY command as either a TSO command or with JCL. Refer to the *BTLS V1R1 User's Guide and Reference*, SC26-7016, for more information about the IDCAMS LIBRARY command.

Return to scratch processing

In a BTLS environment, when the volume resident in the tape library is used by host tape processing, the Library Manager category of the volume is automatically updated to the private category. For a scratch mount request, the Library Manager selects only the volume assigned to the scratch category. Therefore, when the data on the private category volume is no longer usable, the Library Manager volume category must be updated to the scratch category to recycle the volume to be used by a scratch mount request.

The only way to return the volume category to scratch in a BTLS environment is to use the LIBRARY SETCATEGORY command. The command assigns a volume to the category specified by the CATEGORY parameter with the appropriate BTLS scratch category name. Figure D-9 shows a sample JCL to assign volumes to the scratch category.

```
//LIBJOB JOB ...  
//STEP1 EXEC PGM=IDCAMS  
//SYSPRINT DD SYSOUT=*  
//LIBIN DD DSN=ASSIGN.VOLUMES.TO.SCRTCH,DISP=SHR  
//SYSIN DD *  
LIBRARY SETCATEGORY UNIT(xxx) CATEGORY(SCRTCH)  
/*
```

Figure D-9 Sample JCL to assign volumes to a scratch category

In this example, all of the volumes listed in the LIBIN dataset are assigned to category SCRTCH.

Note: UNIT(yyy) specifies one of the tape drive addresses installed in the tape library.

BTLS has no function to manage the retention of the tape dataset residing in the BTLS-managed volumes. Therefore, you must develop a procedure or use the tape management system to manage the tape dataset retention period.

Cartridge insert processing

When the cartridges are inserted into the tape library, the Library Manager creates the volume records for each cartridge, assigns the INSERT category as the volume category, and sends the volume information to all of the connected host systems. BTLS has no functional interface to receive the volume information from the Library Manager and to automatically set up the volume status.

You must complete the following steps using the LIBRARY command:

1. Obtain a list of the volumes in the INSERT category. Use the LIBRARY INVENTORY command with the CATEGORY(INSERT) parameter to obtain the list.
2. Assign volumes to the scratch or private category. Use the LIBRARY SETCATEGORY command and the volume list obtained in step 1 to assign an appropriate volume category to the volume records in the Library Manager.

3. Create BTLS volume catalog records. Use the LIBRARY DEFINE command and the volume list from step 1 to create BTLS volume catalog records in the BTLS user catalog. For specific volume requests, BTLS uses the volume catalog records to control allocation.

Figure D-10 shows a sample JCL for INSERT processing.

```
//LIBJOB JOB ...
//STEP1 EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//LIBOUT DD DSN=INSERT.VOLUMES.LIST,DISP=(NEW,CATLG),
// UNIT=SYSALLDA,DCB=(RECFM=FB,LRECL=80),SPACE=(CYL,(1,1))
//LIBIN DD DSN=INSERT.VOLUMES.LIST,DISP=SHR
//SYSIN DD *
        LIBRARY INVENTORY UNIT(XXX) CATEGORY(INSERT)
        LIBRARY SETCATEGORY UNIT(XXX) CATEGORY(SCRATCH)
        LIBRARY DEFINE
/*
```

Figure D-10 Sample JCL for INSERT processing

In this example, an inventory list is obtained for all of the volumes in the INSERT category through the LIBRARY INVENTORY command. The volume serial number list is created in dataset INSERT.VOLUMES.LIST. The LIBRARY SETCATEGORY command causes the volumes to be placed in the scratch category in the Library Manager. The LIBRARY DEFINE command causes the volumes to be defined in the BTLS user catalog as residing in LIB1.

Note: UNIT(XXX) specifies one of the tape drive addresses installed in the tape library.

Cartridge eject processing

The Library Manager ejects the volumes in the EJECT categories from inside of the tape library to the convenience I/O station or the high capacity output cells. The EJECT categories are the *convenience eject category* and the *bulk eject category*. The volume in the convenience eject category is ejected to the convenience I/O station. The volume in the bulk eject category is ejected to the high capacity output cell.

You can only use the Library Manager to eject cleaning cartridges without the host eject command. The data cartridges cannot be ejected through Library Manager console commands. Host interaction is needed.

In a BTLS environment, you can use the LIBRARY SETCATEGORY command to assign the eject category to the volume that you want to eject from the tape library (see Figure D-11 on page 527).

In Figure D-11 on page 527, all of the volumes listed in the LIBIN dataset are assigned to the convenience eject category. The BTLS volume catalog records for the volumes must also be deleted.

Note: UNIT(XXX) specifies one of the tape drive addresses installed in the tape library.


```

//LIBJOB  JOB ...
//STEP1   EXEC PGM=IDCAMS
//SYSPRINT DD SYSOUT=*
//LIBIN    DD DSN=EJECT.VOLUMES.LIST,DISP=SHR
//SYSIN     DD *
           LIBRARY SETCATEGORY UNIT(XXX) CATEGORY(XEJECT)
/*

```

Figure D-11 Sample JCL to eject a volume

Media selection

For a scratch mount request, BTLVS volume selection is based on the scratch category assigned to the allocated tape drive. It is not based on the volume media type. To select by media type, assign a different scratch category to each media-type volume.

The system default scratch category name is SCRTCH1 (the alias name for SCRTCH). BTLVS supports eight scratch categories: SCRTCH1 through SCRTCH8. The system default can be changed by specifying a scratch category name in SYS1.PARMLIB member BTLSPRMxx. For example, if you specify SCRTCH2 in BTLSPRMxx, SCRTCH2 becomes the system default scratch category.

Use the IDCAMS LIBRARY SETDEVICE command to indicate that a tape drive use a scratch category name other than the system default.

The category used to satisfy a scratch mount request issued to a particular tape drive is determined this way:

- ▶ If the LIBRARY SETDEVICE command is used to associate a category name with the tape drive, the category name specified in the SETDEVICE command is used.
- ▶ If the LIBRARY RESETDEVICE command is used to restore the default state of the device (or the SETDEVICE command has never been issued to the device), the system default category name is used.

Archived

JES3 examples and information

This appendix describes the JES3 processing of tape requests and the JES3 support for system-managed tape. This appendix presents configuration examples and discusses other JES3 considerations. It describes these four configuration examples:

- ▶ Two libraries with an intermix of 3592-J1A, 3592-E05, and 3592-E06 encryption-enabled drives
- ▶ Two libraries with an intermix of 3592-J1A, 3592-E05, and 3592-E06 encryption-enabled drives and a stand-alone Virtual Tape Server (VTS) installed
- ▶ Three libraries with an intermix of 3592-J1A, 3592-E05, and 3592-E05 encryption-enabled drives, a stand-alone VTS, and a Peer-to-Peer (PtP) VTS installed
- ▶ Two libraries with a mix of 3490E, 3590E, 3590H, and a stand-alone VTS installed

With these examples, we intend to provide all the necessary information to install any possible configuration in a 3494 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 TotalStorage Virtual Tape Server Planning, Implementing, and Monitoring*, SG24-2229
- ▶ *IBM TotalStorage Peer-to-Peer Virtual Tape Server Planning and Implementation Guide*, SG24-6115

JES3 tape processing

Although no JCL changes are required, a few processing restrictions and limitations are associated with using the IBM 3494 Tape Library in a JES3 environment:

- ▶ JES3 spool access facility (SPAF) calls are not used.
- ▶ Two calls, one call 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 E-1 on page 531.
- ▶ The main device scheduler (MDS) processing phases, system select and system verify, do not occur for tape datasets.
- ▶ The MDS verify phase is bypassed for IBM 3494 Tape Library mounts, and mount processing is deferred until job execution.

Figure E-1 on page 531 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 fundamental differences between IBM 3494 Tape Library deferred mounting and tape mounts for nonlibrary drives are:

- ▶ Mounts for nonlibrary 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 3494 Tape Library drives are issued by z/OS.
- ▶ If all mounts within a job are deferred because there are no nonlibrary tape mounts, that job is not included in the setup depth parameter (SDEPTH).
- ▶ MDS mount messages are suppressed for the IBM 3494 Tape Library.

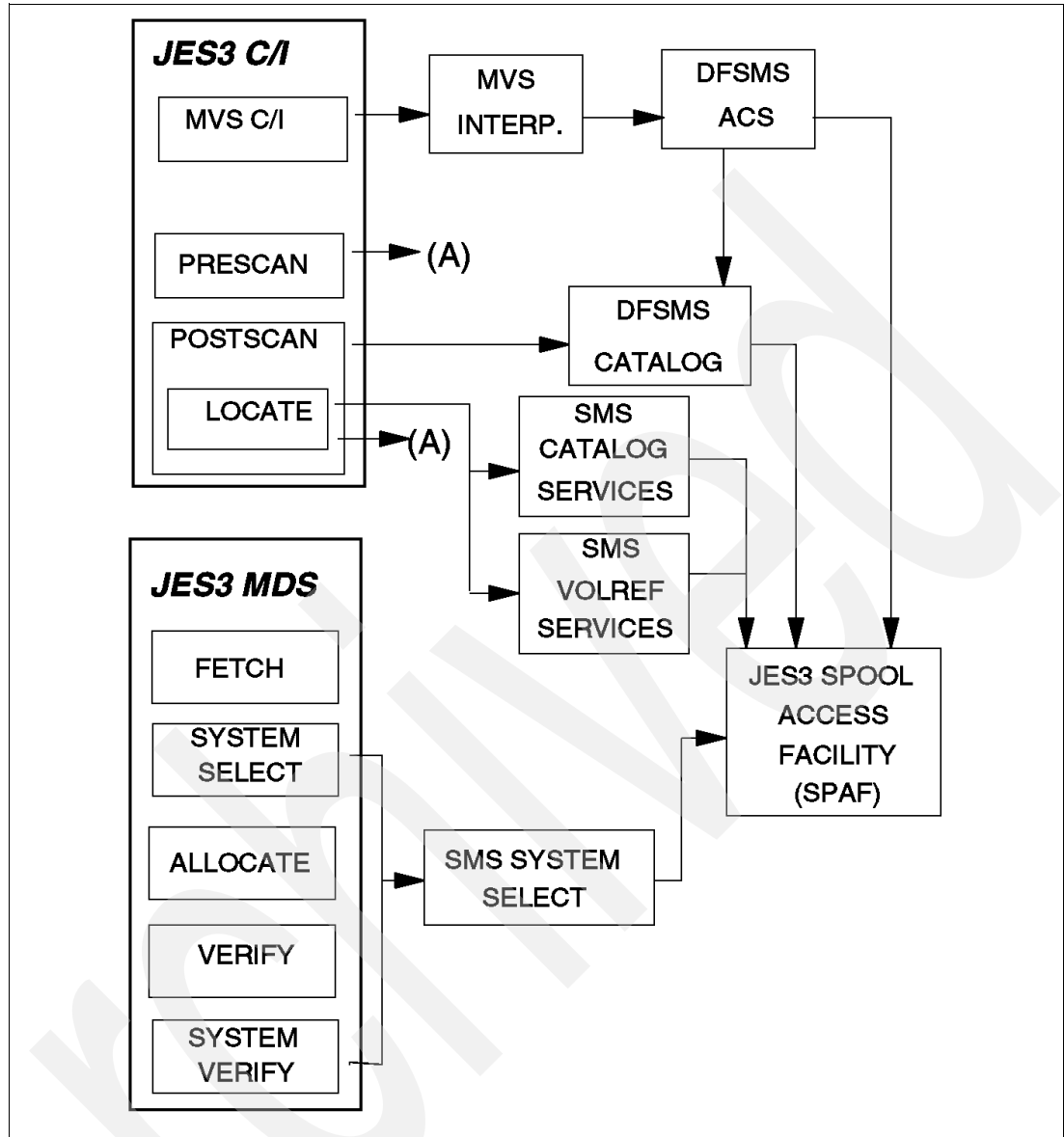


Figure E-1 JES3 C/I and MDS processing phases

JES3/DFSMS processing

The z/OS interpreter calls DFSMS 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 3494 Tape Library unit, a list of device pool names is passed, and from that list, a library device group (LDG) name is assigned to the DD request. This action results in an LDG name being 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 of the 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 of the subsystems in one IBM 3494 Tape Library, the library-specific LDG name (in our examples, LDGF4001, LDGF4001, and so forth) is used.
- ▶ When the list contains only subsystems for a specific device type within one IBM 3494 Tape Library, the LDG device-type library name (in our example, LDEF4001, and so on) 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 3494 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 volume serial number (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 3494 Tape Library when the volumes containing the dataset are located within that IBM 3494 Tape Library. For old datasets, the list is restricted to the IBM 3494 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, which are a subsystem interface call to catalog locate processing, are used for normal locate requests. DFSMS catalog services are invoked during locate processing. DFSMS catalog services invoke 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 a 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 of the 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 3494 Tape Library supports the following features:

- ▶ Identifies the DDs that are IBM 3494 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

As IBM 3494 Tape Library cartridges are mounted and demounted by the library accessor, fetch messages to an operator are unnecessary and can be confusing. With this support, all fetch messages (IAT5110) for IBM 3494 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 main device scheduler (MDS) controls the fetching, allocation, and mounting of the tape volumes requested in the JCL for each job 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 of the steps in a job for all of the 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 3494 Tape Library allocation request through a subsystem interface (SSI) request to JES3 during step initiation when the job is executing under the initiator. This support is unchanged from previous releases.

DFSMS/MVS and z/OS provide all of the IBM 3494 Tape Library support except the interfaces to JES3 for MDS allocation and processor selection.

JES3 MDS continues to select tape units for the IBM 3494 Tape Library. MDS no longer uses the UNIT parameter for the allocation of tape requests for IBM 3494 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 change is made 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 to be used 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 3494 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 3494 Tape Library. They call a Data Facility Product (DFP) service and library automation communication services (LACS), instead of issuing a write to operator (WTO). This request is done by z/OS allocation, so all mounts are deferred until job execution. The IBM 3494 Tape Library 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 IBM 3494 Tape Library.

JES3 support for system-managed tape

This section describes JES3 IBM 3494 Tape Library support with DFSMS. The primary purpose of this support is to maintain JES3 resource allocation and share tape allocations. For detailed information, see 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 3494 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 3494 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 3494 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 HWSNAME statement.

All IBM 3494 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 3494 Tape Library cannot be used by JES3 dynamic support programs (DSPs).

Define all devices in the libraries through DEVICE statements. All IBM 3494 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 3494 Tape Library definitions can result in jobs failing to be allocated.

Library device groups

Library device groups (LDGs) isolate the IBM 3494 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 eight character string composed of LDG prefixing the five digit library identification number. It allows you to address every device and device type in that specific library.
- ▶ The *complex-wide device type*, which is shown in Table E-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 E-1 Library device groups: Complex-wide device type specifications

Device type	Complex-wide device type definition
3490	LDG3490
3490E	LDG3490E
3590-B1A	LDG3591
3590-E1A	LDG359E
3590-H1A	LDG359H
3592-J1A	LDG359J
3592-E05	LDG359K
3592-E05 encryption-enabled	LDG359L
3592-E06	LDG359M

- A *library-specific device type name*, which is an eight character string, starts with a different prefix for each device type, followed by the five digit library device number. See Table E-2.

Table E-2 Library device groups: Library-specific device type names

Device type	Library-specific device type name	Content
3490	LDD + library number	All 3490 in lib xx
3490E	LDE + library number	All 3490E in lib xx
3590B	LDB + library number	All 3590 Model B1A in lib xx
3590E	LDC + library number	All 3590 Model E1A in lib xx
3590H	LDF + library number	All 3590 Model H1A 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 encryption-enabled	LDL + library number	All encryption-enabled 3592 Model E05 in lib xx
3592-E06	LDM + library number	All 3592 Model E06 in lib xx, and all encryption-enabled 3592 Model E06

It also allows you to address a specific device type in a specific tape library. In an PtP 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 these definitions:

- DEVICE statements
- SETNAME statements
- High watermark setup statements

We describe these statements in detail in the following sections.

DEVICE statement: Defining I/O devices for IBM 3494 Tape Libraries

Use the DEVICE format to define a device so that JES3 can use it. You must define a DEVICE statement (see Figure E-2 on page 537) for each string of IBM 3494 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 device is a CARTRIDGE device.

```

*/ Devices 3592-E05 and 3592-E05 encryption enabled in a Library...../*
DEVICE,XTYPE=(LB1359K,CA),XUNIT=(0230,*ALL,,OFF),numdev=8
DEVICE,XTYPE=(LB1359L,CA),XUNIT=(0240,*ALL,,OFF),numdev=8,

```

Figure E-2 DEVICE statement sample

Note: You cannot use 3494 Tape Library tape drives as support units by JES3 DSPs. Therefore, do not specify DTYPE, JUNIT, and JNAME parameters on the DEVICE statements. There is no checking during initialization to prevent 3494 Tape Library drives from being defined as support units, and there is no checking to prevent the drives from being allocated to a DSP if they are defined. Any attempt to call a tape DSP by requesting a 3494 Tape Library fails, because the DSP is unable to allocate a 3494 Tape Library drive.

SETNAME statement

Use the SETNAME statement for proper allocation in a JES3 environment. For tape devices, SETNAME tells JES3 which tape device belongs to which library by specifying the relationships between the XTYPE values (coded in the DEVICE statement) and the LDG names (see Figure E-3). You must define a SETNAME statement for each unique XTYPE in the device statements.

The rules for SETNAME statements 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=LB13592E,
  NAMES=(LDGW3495,LDGF4001,LDG359L,LDLF4001)
      Complex  Library  Complex  Library
      Wide     Specific Wide     Specific
      Library  Library  Device  Device
      Name     Name    Name     Name

```

Figure E-3 SETNAME rules

Note: Do not specify esoteric and generic unit names, such as 3590, 3592, SYS3480R, and SYS348XR. Also, never use esoteric names, such as TAPE and CART.

High watermark setup (HWSNAME) names

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.

```
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 for use in device selection.

Consider the following example:

```
HWSNAME, TYPE=(LDGW3495, LDGF4001, LDGF4006, LDG359J, LDG359K, LDG359L,  
LDJF4001, LDKF4001, LDLF4006)
```

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-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 3494 Tape Library, the complex-device type name is equivalent to that library name. In this case, the library name must also be specified as an alternate.
- ▶ The library-specific device type name must be included. Alternate names can be specified:
 - When all drives within the IBM 3494 Tape Library have the same device type, the library-specific device type name is equivalent to the library name. In this case, the library-specific name must be specified as an alternate.
 - When these drives are the only drives of this type in the complex, the complex-device type name is equivalent to the library-specific device type name.

Make sure that all valid alternate names are specified.

First configuration example

Figure E-4 on page 539 shows a JES3 complex with two IBM 3494 Tape Libraries attached to it.

Library 1 has a LIBRARY-ID of F4001 and a mix of 3592-J1A and 3592-E05 tape drives installed.

Library 2 has a LIBRARY-ID of F4006 and only TS1120 Model E05 encryption-enabled drives are installed.

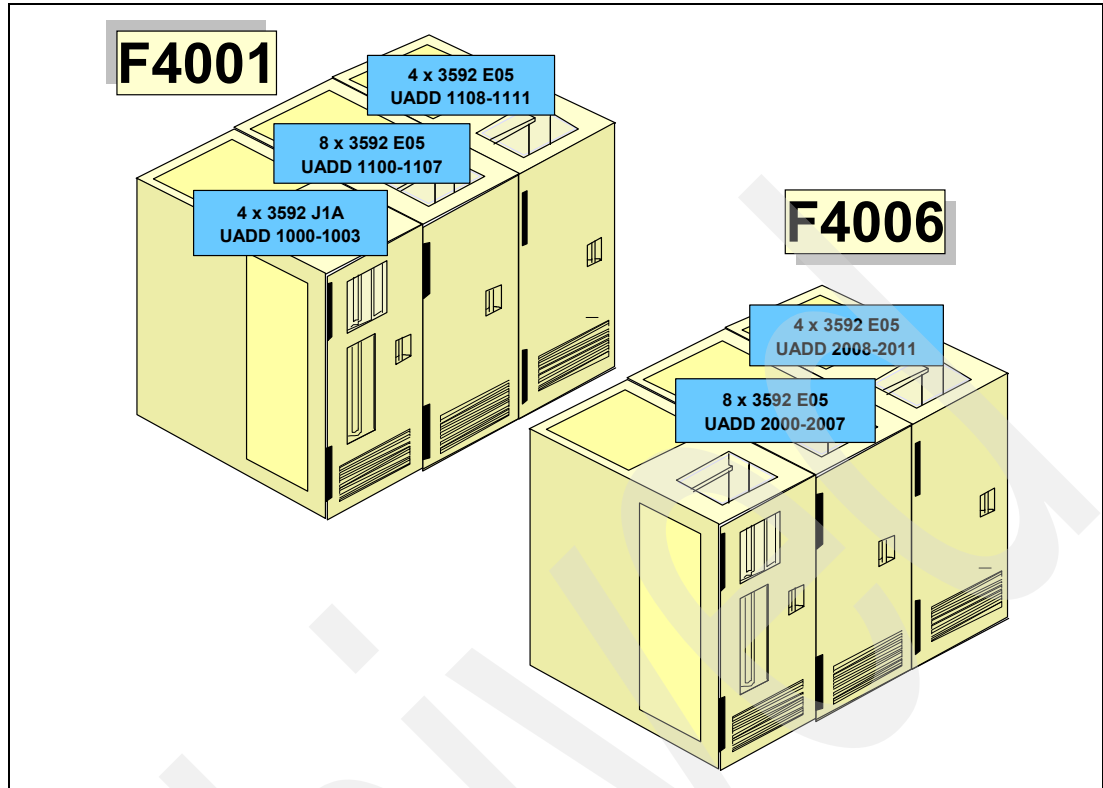


Figure E-4 JES3 first configuration example

LDG definitions necessary for this example

Table E-3 shows all the LDG definitions needed in the HCD. You must define a total of nine esoterics.

Table E-3 LDG definitions for the first configuration example

LDG definition	Value of LDG	Explanation
Complex-wide name	LDGW3495	Standard name that appears once
Library-specific name	LDGF4001 LDGF4006	One definition for each library
Complex-wide device type	LDG359J LDG359K LDG359L	One definition for each installed device type: Represents the 3592-J1A devices Represents the 3592-E05 devices Represents the 3592-E05 devices that are encryption-enabled
Library-specific device type	LDJF4001 LDKF4001 LDLF4006	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 encryption-enabled in library F4006

DEVICE statements needed for this configuration

In our examples, we use a naming convention for XTYPE that contains the library (LB1 or LB2) in the first three digits and then the device type (see Figure E-5). A naming convention for XTYPE is not mandatory, but it helps with the use of the JES3 INISH deck.

```
*/ Devices 3592-J1A and 3592-E05 in Library 1 ...../*  
  
DEVICE,XTYPE=(LB1359J,CA),XUNIT=(1000,*ALL,,OFF),numdev=4  
DEVICE,XTYPE=(LB1359K,CA),XUNIT=(1100,*ALL,,OFF),numdev=12,  
  
*/ Devices 3592-E05 Encryption-enabled in Library 2 ...../*  
  
DEVICE,XTYPE=(LB2359L,CA),XUNIT=(2000,*ALL,,OFF),numdev=12
```

Figure E-5 First configuration example: Device type definition sample

SETNAME statements needed for this configuration

Figure E-6 includes all the SETNAME statements for example 1.

```
SETNAME,XTYPE=(LB1359J,CA),NAMES=(LDGW3495,LDGF4001,LDG359J,LDEF4001)  
  
SETNAME,XTYPE=(LB1359K,CA),NAMES=(LDGW3495,LDGF4001,LDG359K,LDKF4001)  
  
SETNAME,XTYPE=(LB1359L,CA),NAMES=(LDGW3495,LDGF4006,LDG359L,LDLF4006)
```

Figure E-6 First configuration example: SETNAME definition sample

You need three SETNAME statements, because you have:

- ▶ One library with two different device types, which requires two SETNAME statements
- ▶ One library with one device type, which requires one SETNAME statement

HWSNAME statement needed for this configuration

The HWSNAME definition is complicated and requires consideration; therefore, we explain every statement that is shown in Figure E-7. If you are inexperienced in JES3, read carefully through the explanation.

```
HWSNAME,TYPE=(LDGW3495,LDGF4001,LDGF4006,LDJF4001,LDKF4001,LDLF4006,LDG359J,LDG359K,  
LDG359L)1  
HWSNAME,TYPE=(LDGF4001,LDJF4001,LDKF4001,LDG359J,LDG359K)2  
HWSNAME,TYPE=(LDGF4006,LDLF4006,LDG359L)3  
HWSNAME,TYPE=(LDJF4001,LDG359J)4  
HWSNAME,TYPE=(LDKF4001,LDG359K)5  
HWSNAME,TYPE=(LDLF4006,LDG359L)6  
HWSNAME,TYPE=(LDG359J,LDJF4001)7, 8  
HWSNAME,TYPE=(LDG359K,LDKF4001)9, 10  
HWSNAME,TYPE=(LDG359L,LDLF4006,LDGF4006)11
```

Figure E-7 HWSNAME definition sample

The following numbers, which correspond to those in Figure E-7 on page 540, explain the statements in the sample:

1. All LDG definitions are a subset of the complex-wide name.
2. All 3592-J1As in library F4001 (LDJF4001) and all 3592-E05s in library F4001 (LDLF4001) are a subset of library F4001. All 3592-J1As and 3592-E05s are a subset of library F4001, because the other library only has 3592-E05 encryption-enabled tape drives installed.
3. All 3592-E05 encryption-enabled drives in library F4006 (LDLF4006) are a subset of library F4006. We also need to specify the 3592-E05 encryption-enabled drives (LDG359L), because no 3592-E05 encryption-enabled tape drives are installed in the other library.
4. All 3592-J1A tape drives (LDG359J) are a subset of the 3592-J1A tape drives in library F4001, because no other 3592-J1A drives are installed.
5. All 3592-E05 tape drives (LDG359K) are a subset of the 3592-E05 tape drives in library F4001, because no other 3592-E05 non-encryption-enabled drives are installed.
6. All 3592-E05 encryption-enabled tape drives (LDG359L) are a subset of 3592-E05 encryption-enabled tape drives in library F4006, because no other 3592-E05 encryption-enabled tape drives are installed.
7. All 3592-J1A tape drives in library F4001 (LDJF4001) are a subset of the 3592-J1A, because no other 3592-J1A tape drives are installed.
8. LDGF4001 is *not* a subset of 3592-J1A, because 3592-E05s are also installed.
9. LDGF4001 is *not* a subset of 3592-E05, because 3592-J1As are also installed.
10. All 3592-E05s in library F4001 (LDCF4001) are a subset of 3592-E05, because no other 3592-E05s are installed.
11. All 3592-E05 encryption-enabled tape drives in library F4006 (LDFF4006) are a subset of 3592-E05 encryption-enabled, because no other 3592-E05 encryption-enabled tape drives are installed. LDGF4006 (the entire library with the ID F4006) is a subset of 3592-E05 encryption-enabled, because only 3592-E05 encryption-enabled tape drives are installed in this library.

Second configuration example

This 3494 JES3 configuration example (Figure E-8 on page 542) shows a JES3 configuration with two IBM 3494 Tape Libraries attached to it. Library 1 has:

- ▶ A LIBRARY-ID of F4001
- ▶ A mix of 3592-J1A and 3592-E05 tape drives
- ▶ A stand-alone VTS installed with a VTS LIBRARY-ID of 13001

Library 2 has:

- ▶ A LIBRARY-ID of F4006
- ▶ A mix of 3592-J1A, 3592-E05, and 3592-E06 tape drives installed

Figure E-8 on page 542 does not show the actual required configuration regarding the number of frames and the back-end drives for the VTS.

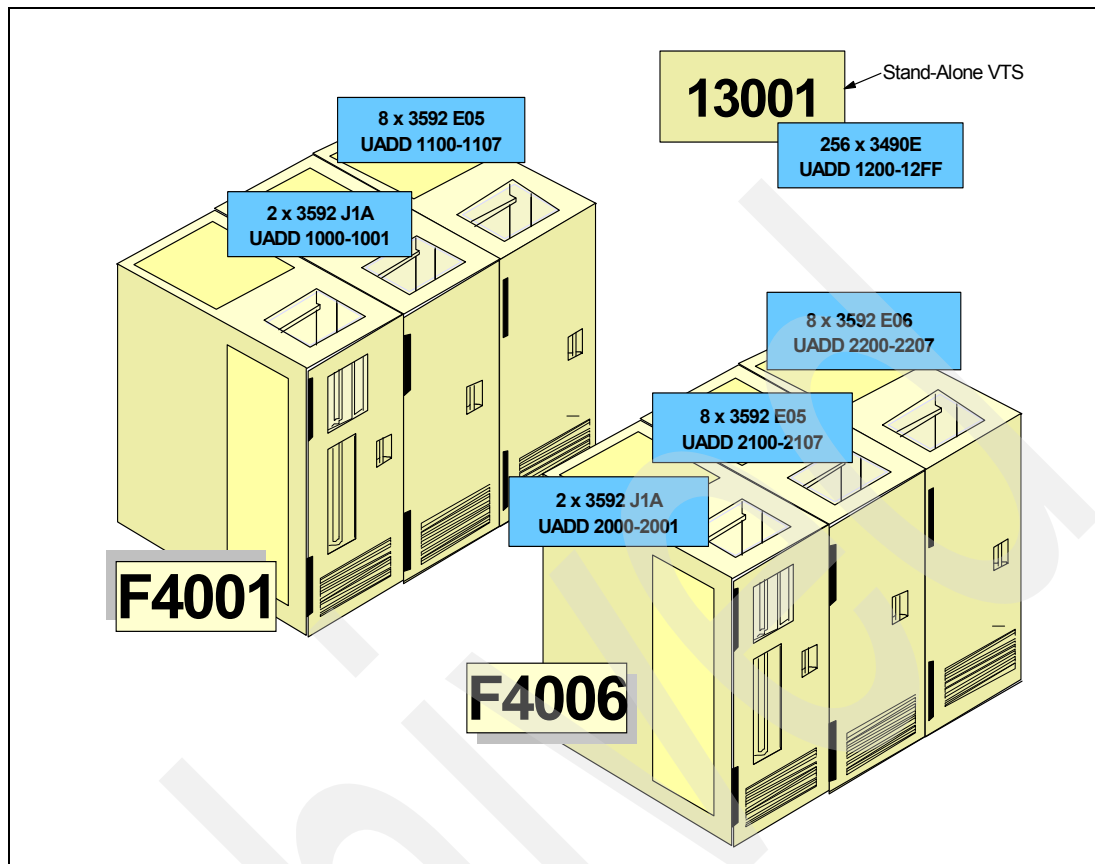


Figure E-8 Second configuration example

Library device group (LDG) definitions needed for example 2

Table E-4 shows all of the LDG definitions that you need in the hardware configuration definition (HCD). You must define a total of 11 esoterics.

Table E-4 LDG definitions for the second configuration example

LDG definition	Value for LDG	Explanations
Complex-wide name	LDGW3495	Standard name that appears once
Library-specific name	LDGF4001 LDGF4006 LDG13001	One definition for each library
Complex-wide device type	LDG359J LDG359K LDG359M	One definition for each installed device type: Represents the 3592-J1A devices Represent the 3592-E05 devices Represents the 3592-E06 devices

LDG definition	Value for LDG	Explanations
Library-specific device type	LDJF4001 LDE13001 LDKF4001 LDJF4006 LDKF4006 LDMF4006	One definition for each device type in each library: Represents the 3592-J1A in library F4001 Represents the VTS drives in library F4001 Represents the 3592-E05 in library F4001 Represents the 3592-J1A in library F4006 Represents the 3592-E05 in library F4006 Represents the 3592-E06 encryption-enabled in library F4006

Note that you need 3592-E05 devices that are defined with a different device type in the LDG definitions, depending on whether they are encryption-enabled (**LDLxxxxx** and **LDG359L**) or not encryption-enabled (**LDKxxxxx** and **LDG359K**). 3592-E06 are always encryption-enabled and defined as one device type.

DEVICE statement for example 2

Figure E-9 shows you all of the DEVICE statements for example two. No different online or offline values are specified for different attached systems. They are coded with *ALL.

```

*/  Devices 3592-J1A, 3592-E05 and VTS in Library 1 ...../*

DEVICE,XTYPE=(LB1359J,CA),XUNIT=(1000,*ALL,,OFF),numdev=2
DEVICE,XTYPE=(LB1359K,CA),XUNIT=(1100,*ALL,,OFF),numdev=8
DEVICE,XTYPE=(LB1VTS1,CA),XUNIT=(1200,*ALL,,OFF),numdev=256

*/  Devices 3592-J1A, 3592-E05 and 3592-E06 in Library 2 ...../*

DEVICE,XTYPE=(LB2359J,CA),XUNIT=(2000,*ALL,,OFF),numdev=2
DEVICE,XTYPE=(LB2359K,CA),XUNIT=(2100,*ALL,,OFF),numdev=8
DEVICE,XTYPE=(LB2359M,CA),XUNIT=(2200,*ALL,,OFF),numdev=8

```

Figure E-9 DEVICE statement for example 2

SETNAME statements for example 2

Figure E-10 includes all the SETNAME statements for example 2. There is a SETNAME statement for the 3490E native devices, and there is a SETNAME statement for the 3490E emulated devices in a VTS.

```

SETNAME,XTYPE=LB1359J,NAMES=(LDGW3495,LDGF4001,LDG359J,LDJF4001)
SETNAME,XTYPE=LB1359K,NAMES=(LDGW3495,LDGF4001,LDG359K,LDEF4001)
SETNAME,XTYPE=LB1VTS1,NAMES=(LDGW3495,LDG13001,LDG3490E,LDE13001)
SETNAME,XTYPE=LB2359J,NAMES=(LDGW3495,LDGF4006,LDG359J,LDJF4006)
SETNAME,XTYPE=LB2359K,NAMES=(LDGW3495,LDGF4006,LDG359K,LDKF4006)
SETNAME,XTYPE=LB2359M,NAMES=(LDGW3495,LDGF4006,LDG359M,LDMF4006)

```

Figure E-10 Setname statement values for example 2

High watermark setup name (HWSNAME) statements for example 2

Figure E-11 shows the high watermark setup name (HWSNAME) statements.

```
HWSNAME,TYPE=(LDGW3495,LDGF4001,LDGF4006,LDG13001,LDG359J,LDG359K,LDG359M,LDG3490E,  
LDE13001,LDJF4001,LDJF4006,LDKF4001,LDKF4006,LDMF4006)  
HWSNAME,TYPE=(LDGF4001,LDJF4001,LDKF4001)  
HWSNAME,TYPE=(LDGF4006,LDG359M,LDJF4006,LDKF006,LDMF4006)  
HWSNAME,TYPE=(LDG13001,LDE13001)  
HWSNAME,TYPE=(LDG359J,LDJF4001,LDJF4006)  
HWSNAME,TYPE=(LDG359K,LDKF4001,LDKF4006)  
HWSNAME,TYPE=(LDG359M,LDMF4006)  
HWSNAME,TYPE=(LDMF4006,LDG359M)  
HWSNAME,TYPE=(LDE13001,LDG13001)
```

Figure E-11 High watermark setup statements for example 2

Third configuration example

Figure E-12 on page 545 shows a JES3 configuration with three IBM 3494 Tape Libraries attached to it.

Library 1 has a LIBRARY-ID of F4001, a mix of 3592-J1A and 3592-E05 tape drives, and a half of a PtP VTS (Distributed Library) installed.

Library 2 has a LIBRARY-ID of F4006, a mix of 3592-E05 and 3592-E05 encryption-enabled tape drives, and the second Distributed Library of the PtP VTS installed. The PtP VTS has a Composite LIBRARY-ID of 47110.

Library 3 has a LIBRARY-ID 22051 with 3592-E05 and 3592-E05 encryption-enabled tape drives and a stand-alone VTS installed with a VTS LIBRARY-ID of 13001. Figure E-12 on page 545 does not show the actual configuration needed in regard to the number of frames and the number of back-end drives for the VTS and PtP VTS configurations.

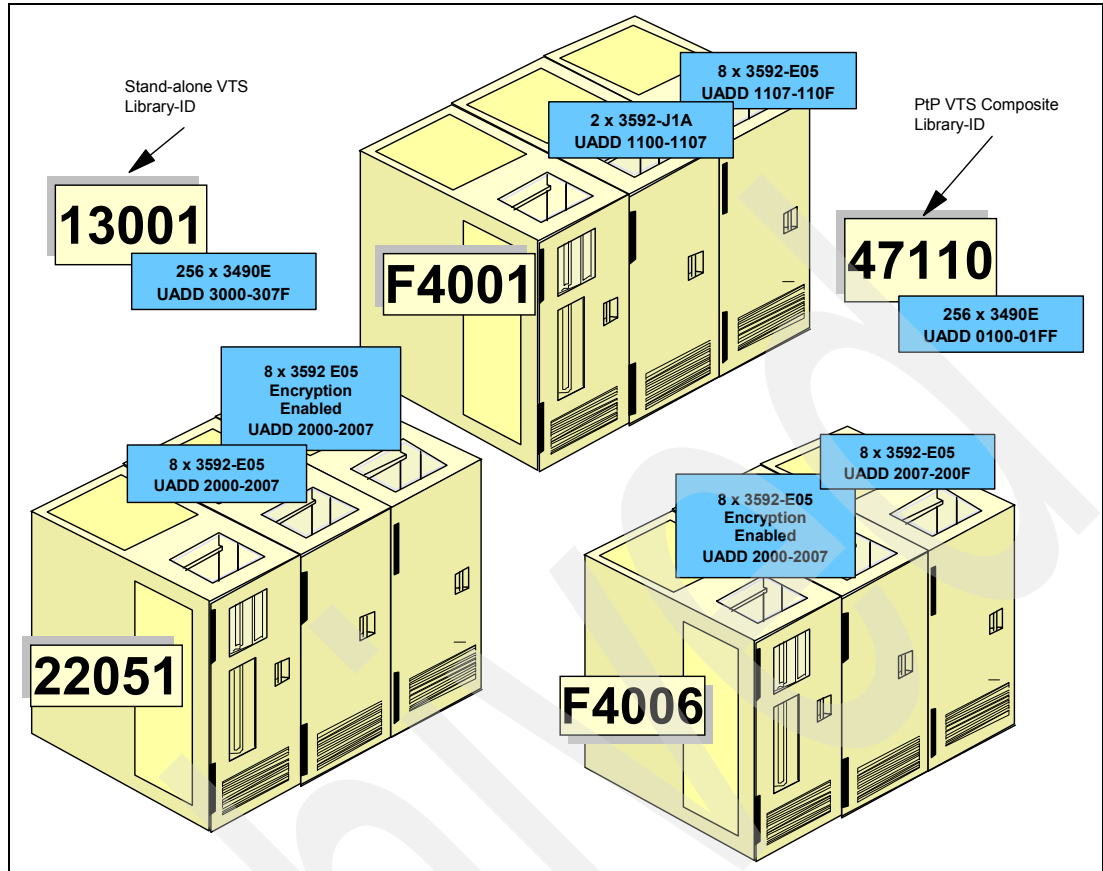


Figure E-12 Third configuration example

LDG definitions needed for example 3

Table E-5 shows all of the LDG definitions needed in the HCD. There are 17 esoterics to define.

Table E-5 LDG definitions for the third configuration example

LDG definition	Value for LDG	Explanations
Complex-wide name	LDGW3495	Standard name that appears once
Library-specific name	LDGF4001 LDGF4006 LDG22051 LDG13001 LDG47110	One definition for each library and for each VTS. For a PtP VTS, only the Composite ID is specified.
Complex-wide device type	LDG3490E LDG359J LDG359K LDG359L	One definition for each installed device type: Represents the devices in PtP VTS Represents the 3592-J1A Represents the 3592-E05 Represents the 3592-E05 encryption-enabled

LDG definition	Value for LDG	Explanations
Library-specific device type	LDKF4001 LDE13001 LDE47110 LDKF4006 LDLF4006 LDE22051 LDK22051 LDL22051	One definition for each device type in each library, except for the PtP VTS: Represents the 3592-E05 in library F4001 Represents the VTS in library 22051 Represents the PtP VTS in both libraries Represents the 3592-E05 in library F4006 Represents the 3592-E05 encryption-enabled in library F4006 Represents the 3490E VTS in library 22051 Represents the 3592-E05 in library 22051 Represents the 3592-E05 encryption-enabled in library 22051

Device statement needed for example 3

Figure E-13 shows all of the device statements for example 3.

```

*/  Devices 3592 J1A and 3592 E05 in Library 1 ...../*

DEVICE,XTYPE=(LB1359K,CA),XUNIT=(1000,*ALL,,OFF),numdev=8
DEVICE,XTYPE=(LB1359L,CA),XUNIT=(1100,*ALL,,OFF),numdev=8,

*/  Devices 3592 E05 and 3592 E05 Encryption-enabled in Library 2 ...../*

DEVICE,XTYPE=(LB2359K,CA),XUNIT=(2000,*ALL,,OFF),numdev=8
DEVICE,XTYPE=(LB2359L,CA),XUNIT=(2100,*ALL,,OFF),numdev=8

/  Devices VTS, 3592 E05 and 3592 E05 Encryption-enabled in Library 3 ...../*

DEVICE,XTYPE=(LB3VTS1,CA),XUNIT=(3000,*ALL,,OFF),numdev=256
DEVICE,XTYPE=(LB3359K,CA),XUNIT=(3100,*ALL,,OFF),numdev=8
DEVICE,XTYPE=(LB3359L,CA),XUNIT=(3200,*ALL,,OFF),numdev=8

*/  Devices PtP VTS in libraries F4001 and F4006...../*
ADDRSORT=NO

DEVICE,XTYPE=(VTSPTP1,CA),XUNIT=(0110,*ALL,S3,OFF)
DEVICE,XTYPE=(VTVPTP1,CA),XUNIT=(0120,*ALL,S3,OFF)
DEVICE,XTYPE=(VTSPTP1,CA),XUNIT=(0130,*ALL,S3,OFF)
DEVICE,XTYPE=(VTSPTP1,CA),XUNIT=(0140,*ALL,S3,OFF)
DEVICE,XTYPE=(VTSPTP1,CA),XUNIT=(0111,*ALL,S3,OFF)
DEVICE,XTYPE=(VTSPTP1,CA),XUNIT=(0121,*ALL,S3,OFF)
DEVICE,XTYPE=(VTVPTP1,CA),XUNIT=(0131,*ALL,S3,OFF)
DEVICE,XTYPE=(VTVPTP1,CA),XUNIT=(0141,*ALL,S3,OFF)
; ; ; ; ;
DEVICE,XTYPE=(VTSPTP1,CA),XUNIT=(01FF,*ALL,S3,OFF)

```

Figure E-13 DEVICE statements for example 3

Restriction: If you code NUMDEV in a PtP VTS environment, the workload balancing from the AX-0 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.

SETNAME statements needed for example 3

Figure E-14 includes the necessary SETNAME statements.

```
SETNAME,XTYPE=LB1359K,NAMES=(LDGW3495,LDGF4001,LDG359K,LDKF4001)
SETNAME,XTYPE=LB1359L,NAMES=(LDGW3495,LDGF4001,LDG359L,LDLF4001)
SETNAME,XTYPE=LB2359K,NAMES=(LDGW3495,LDGF4006,LDG359K,LDKF4006)
SETNAME,XTYPE=LB2359L,NAMES=(LDGW3495,LDGF4006,LDG359L,LDLF4006)
SETNAME,XTYPE=LB3VTS A1,NAMES=(LDGW3495,LDG13001,LDG22051,LDG3490E,LDE22051,LDE13001)
SETNAME,XTYPE=LB3359K,NAMES=(LDGW3495,LDG22051,LDG359K,LDK22051)
SETNAME,XTYPE=LB3359L,NAMES=(LDGW3495,LDG22051,LDG359L,LDL22051)

SETNAME,XTYPE=VTSPTP1,NAMES=(LDGW3495,LDG47110,LDG3490E,LDE47110)
```

Figure E-14 SETNAME statement values for example 3

High watermark setup name (HWSNAME) statements for example 3

Figure E-15 shows the high watermark setup name (HWSNAME) statements.

```
HWSNAME,TYPE=(LDGW3495,LDGF4001,LDGF4006,LDG22051,LDG13001,LDG47110,LDG359J,LDG359K,
LDG359L,LDG13001,LDE47110,LDE22051,LDKF4001,LDK22051,LDKF4001,
LDKF4006,LDLF4006,LDL22051)
HWSNAME,TYPE=(LDGF4001,LDJF4001,LDKF4001)1
HWSNAME,TYPE=(LDGF4006,LDKF4006,LDLF4006)1
HWSNAME,TYPE=(LDG22051,LDE22051,LDK22051,LDL22051)1
HWSNAME,TYPE=(LDG47110,LDE47110)
HWSNAME,TYPE=(LDG13001,LDE13001)
HWSNAME,TYPE=(LDG3490E,LDE47110,LDE22051)2
HWSNAME,TYPE=(LDG359J,LDKF4001)
HWSNAME,TYPE=(LDG359K,LDKF4001,LDK22051,LDKF4006)
HWSNAME,TYPE=(LDG359L,LDLF4006,LDL22051)
```

Figure E-15 High watermark setup name statements for example 3

Footnotes for Figure E-15:

1 All library HWS names include only the specific drive-library LDG names. No device is installed only in a single library; therefore, no device-specific LDG name is a valid subset of any library.

2 The LDG3490E contains the 3490E VTS emulated drives.

Fourth configuration example

The fourth 3494 JES3 configuration example (Figure E-16 on page 548) shows a JES3 configuration with two IBM 3494 Tape Libraries attached to it.

Library 1 has a LIBRARY-ID of F4001 and a mix of 3490E, 3590E, and a stand-alone VTS installed with a VTS LIBRARY-ID of 13001.

Library 2 has a LIBRARY-ID of F4006 and a mix of 3490E, 3590E, and 3590H installed. Figure E-16 on page 548 does not show the actual configuration needed in regard to the number of frames and the number of back-end drives for the VTS.

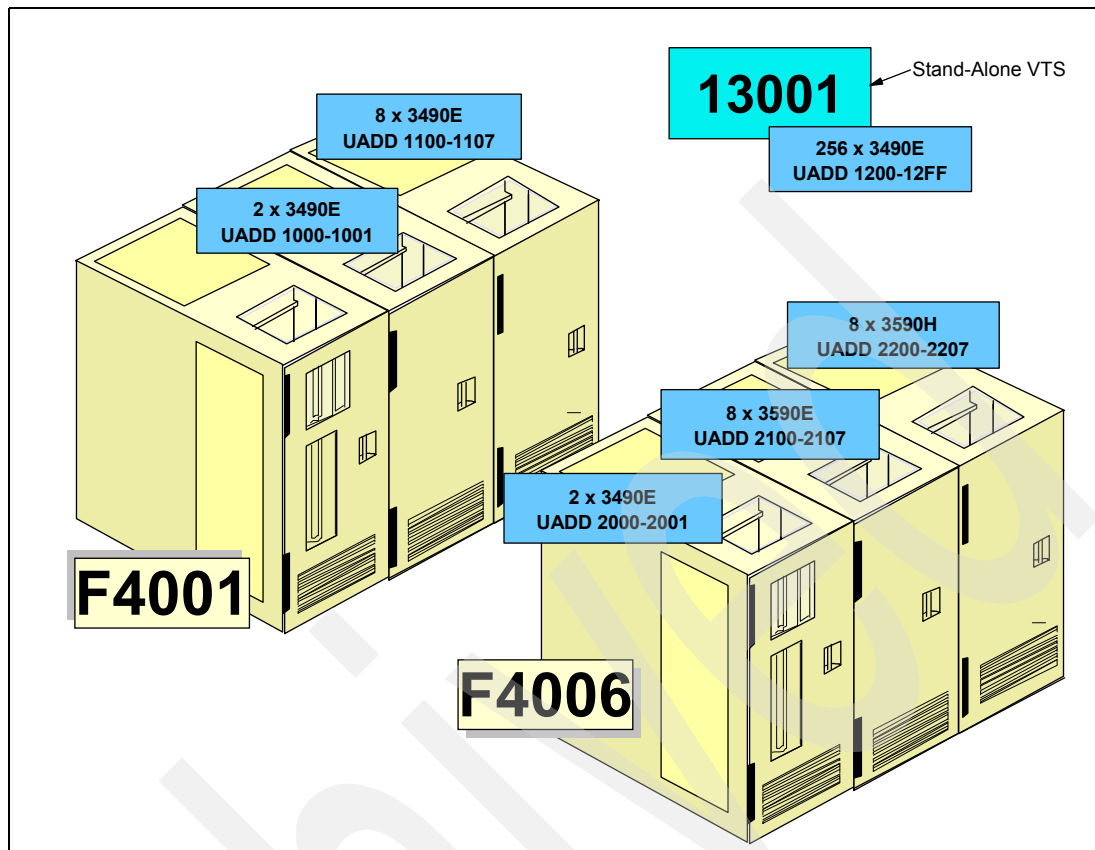


Figure E-16 Fourth configuration example

Library device group (LDG) definitions needed for example 4

Table E-6 shows all of the LDG definitions that you need in the hardware configuration definition (HCD). There are 11 esoterics to define.

Table E-6 LDG definitions for the fourth configuration example

LDG definition	Value for LDG	Explanations
Complex-wide name	LDGW3495	Standard name that appears once
Library-specific name	LDGF4001 LDGF4006 LDG13001	One definition for each library
Complex-wide device type	LDG3490E LDG359E LDG359H	One definition for each installed device type: Represents the 3590E devices Represent the 3590-E1A devices Represents the 3590H devices
Library-specific device type	LDEF4001 LDE13001 LDCF4001 LDEF4006 LDCF4006 LDFF4006	One definition for each device type in each library: Represents the 3490E in library F4001 Represents the VTS Drives in library F4001 Represents the 3590E in library F4001 Represents the 3490E in library F4006 Represents the 3590E in library F4006 Represents the 3590H in library F4006

DEVICE statements for example 4

Figure E-17 shows you all of the DEVICE statements for example 4. No different online or offline values are specified for different attached systems. They are coded with *ALL.

```
*/ Devices 3490E, 3590E and VTS in Library 1 ...../*  
  
DEVICE,XTYPE=(LB13490E,CA),XUNIT=(1000,*ALL,,OFF),numdev=2  
DEVICE,XTYPE=(LB13590E,CA),XUNIT=(1100,*ALL,,OFF),numdev=8  
DEVICE,XTYPE=(LB1VTS1,CA),XUNIT=(1200,*ALL,,OFF),numdev=256  
  
*/ Devices 3490E, 3590E and 3590H in Library 2 ...../*  
  
DEVICE,XTYPE=(LB23490E,CA),XUNIT=(2000,*ALL,,OFF),numdev=2  
DEVICE,XTYPE=(LB23590E,CA),XUNIT=(2100,*ALL,,OFF),numdev=8  
DEVICE,XTYPE=(LB23590H,CA),XUNIT=(2200,*ALL,,OFF),numdev=8
```

Figure E-17 DEVICE statements for example 4

SETNAME statements for example 4

Figure E-18 includes all of the SETNAME statements for the fourth configuration example. There is a SETNAME statement for the 3490E native devices, and there is a SETNAME statement for the 3490E emulated devices in a VTS.

```
SETNAME,XTYPE=LB13490E,NAMES=(LDGW3495,LDGF4001,LDG3490E,LDEF4001)  
SETNAME,XTYPE=LB13490E,NAMES=(LDGW3495,LDGF4001,LDG3490E,LDEF4001)  
SETNAME,XTYPE=LB1VTS1,NAMES=(LDGW3495,LDG13001,LDGF4001,LDG3490E,LDEF4001,LDE13001)  
SETNAME,XTYPE=LB23490E,NAMES=(LDGW3495,LDGF4006,LDG3490E,LDEF4006)  
SETNAME,XTYPE=LB23590E,NAMES=(LDGW3495,LDGF4006,LDG359E,LDCF4006)  
SETNAME,XTYPE=LB23490H,NAMES=(LDGW3495,LDGF4006,LDG359H,LDF4006)
```

Figure E-18 SETNAME statement values for example 4

High watermark setup name (HWSNAME) statements for example 4

Figure E-19 shows the high watermark setup name (HWSNAME) statements.

```
HWSNAME,TYPE=(LDGW3495,LDGF4001,LDGF4006,LDG13001,LDG3490E,LDG359E,LDG359H,LDEF4001,  
LDEF4006,LDE13001,LDCF4001,LDCF4006,LDF4006)  
HWSNAME,TYPE=(LDGF4001,LDCF4001)  
HWSNAME,TYPE=(LDGF4006,LDG359H,LDEF4006,LDCF4006,LDF4006)1  
HWSNAME,TYPE=(LDG13001,LDE13001)  
HWSNAME,TYPE=(LDG3490E,LDEF4001,LDEF4006,LDE13001)  
HWSNAME,TYPE=(LDG359E,LDCF4001,LDCF4006)  
HWSNAME,TYPE=(LDG359H,LDF4006)2  
HWSNAME,TYPE=(LDF4006,LDG359H)  
HWSNAME,TYPE=(LDE13001,LDG13001)
```

Figure E-19 High watermark setup name statements for example 4

Footnotes for Figure E-19:

1 LDG359H is a subset, because no other 3590Hs are installed.

2 LDF4006 is a valid substitution of LDG359H, because no other 3590Hs are installed.

Archived

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 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. Deneleh                      */
/* 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 */
vtllib1 = LIBVTS1 /* for 3494VTS */
vtllib2 = LIBVTS2 /* for 3494VTS */

/*****
/*
/* Open the file and queue the all records.
/*
*****/

"execio * diskrc tcdbrcv 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 VOENTRY (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 a non-mixed environment*/
/* use the correct recording technology for your drives:*/
/* 3590B = 128*/
/* 3590E = 256*/
/* 3590H = 384*/
/* 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

```

Related publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this book.

IBM Redbooks publications

For information about ordering these publications, see “How to get IBM Redbooks publications” on page 558. Note that some of the documents referenced here might be available in softcopy only:

- ▶ *Lights Out! Advanced Tape Automation Using VM/ESA*, GG24-4347
- ▶ *NaviQuest Demonstration and Hands-On Usage Guide*, SG24-4720
- ▶ *Backup Recovery Media Services: A Practical Approach*, SG24-4840
- ▶ *ICF Catalog Backup and Recovery: A Practical Guide*, SG24-5644
- ▶ *DFSMSrmm Primer*, SG24-5983
- ▶ *IBM TotalStorage Peer-to-Peer Virtual Tape Server Planning and Implementation Guide*, SG24-6115
- ▶ *IBM eServer iSeries in Storage Area Networks: Implementing Fibre Channel Disk and Tape with iSeries*, SG24-6220
- ▶ *Continuous Availability S/390 Technology Guide*, SG24-2086
- ▶ *Continuous Availability Systems Design Guide*, SG24-2085
- ▶ *DFSMS Release 10 Technical Update*, SG24-6120
- ▶ *Enterprise Systems Connection (ESCON) Implementation Guide*, SG24-4662
- ▶ *Guide to Sharing and Partitioning IBM Tape Library Dataservers*, SG24-4409
- ▶ *IBM eServer zSeries Connectivity Handbook*, SG24-5444
- ▶ *IBM Fiber Saver (2029) Implementation Guide*, SG24-5608
- ▶ *DFSMS/MVS V1R5 Technical Guide*, SG24-4892
- ▶ *IBM TotalStorage Virtual Tape Server: Planning, Implementing, and Monitoring*, SG24-2229
- ▶ *IBM TotalStorage Enterprise Tape: A Practical Guide*, SG24-4632
- ▶ *Introduction to IBM S/390 FICON*, SG24-5176
- ▶ *FICON Native Implementation and Reference Guide*, SG24-6266
- ▶ *IBM TS3500 Tape Library with System z Attachment: A Practical Guide to Enterprise Tape Drives and TS3500 Tape Automation*, SG24-6789
- ▶ *IBM System Storage Tape Encryption Solutions: Planning, Implementation, and Usage Guide*, SG24-7320
- ▶ *Implementing IBM in i5/OS*, SG24-7440

Other publications

These publications are also relevant as further information sources:

- ▶ *IBM System Storage TS1120 Tape Drive and Controller Operator Guide*, GA32-0556
- ▶ *IBM System Storage TS1120 Tape Drive and Controller Introduction and Planning Guide*, GA32-0555
- ▶ *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
- ▶ *IBM TotalStorage Enterprise Tape System 3590 Introduction and Planning Guide*, GA32-0329
- ▶ *IBM TotalStorage Silo-Compatible Tape Frame 3590 Introduction, Planning, and User's Guide*, GA32-0366
- ▶ *IBM TotalStorage Enterprise Automated Tape Library (3494) Introduction and Planning Guide*, GA32-0448
- ▶ *IBM TotalStorage Automated Tape Library (3494) Operators Guide*, GA32-0449
- ▶ *IBM 3494 User's Guide: Media Library Device Driver for AS/400*, GC35-0153
- ▶ *IBM TotalStorage Tape Device Drivers Installation and User's Guide*, GC35-0154
- ▶ *z/OS JES3 Initialization and Tuning Guide*, SA22-7549
- ▶ *z/OS JES3 Initialization and Tuning Reference*, SA22-7550
- ▶ *z/OS V1R3.0 MVS Planning: Operations*, SA22-7601
- ▶ *z/OS Security Server RACF Command Language Reference*, SA22-7687
- ▶ *DFSMS/MVS V1R5 OAM PISA for Object Support*, SC26-4918
- ▶ *DFSMS/MVS V1R4 DFSMSdss Storage Administration Guide*, SC26-4930
- ▶ *BTLS V1R1 User's Guide and Reference*, SC26-7016
- ▶ *z/OS V1R3.0 DFSMS Access Method Services for Catalogs*, SC26-7394
- ▶ *z/OS V1R3 DFSMS Installation Exits*, SC26-7396
- ▶ *IBM TotalStorage 3494 Tape Library Introduction and Planning Guide*, GA32-0279
- ▶ *z/OS DFSMSdfp Storage Administration Reference*, SC26-7402
- ▶ *z/OS Object Access Method Planning, Installation and Storage Administration Guide for Tape Libraries*, SC35-0427
- ▶ *Implementing System Managed Storage*, SC26-7407
- ▶ *z/OS DFSMSShsm Storage Administration Guide*, SC35-0421
- ▶ *z/OS DFSMSShsm Implementation and Customization Guide*, SC35-0418
- ▶ *z/OS DFSMSrmm Guide and Reference*, SC26-7404
- ▶ *z/OS DFSMSrmm Implementation and Customization Guide*, SC26-7405
- ▶ *Recovery and Reconfiguration Guide*, SA22-7623
- ▶ *z/OS DFSMSdss Storage Administration Reference*, SC35-0424
- ▶ *z/OS DFSMSdss Storage Administration Guide*, LY35-0116
- ▶ *z/OS Object Access Method Planning, Installation and Storage Administration Guide for object Support*, SC26-0426
- ▶ *IBM TS3500 Tape Library Introduction and Planning Guide*, GA32-0469

- ▶ *IBM TS3500 Tape Library Operator Guide*, GA32-0468
- ▶ *IBM 3953 Tape Frame Model F05 and Library Manager Model L05 Introduction and Planning Guide*, GA32-0472
- ▶ *IBM TotalStorage 3953 Tape Frame Model F05 and Library Manager Model L05 Operator Guide*, GA32-0473
- ▶ *IBM TotalStorage 3494 Tape Library Introduction and Planning Guide*, GA32-0279
- ▶ *IBM TotalStorage 3494 Tape Library Operator's Guide*, GA32-0280
- ▶ *3490E Installation Planning and Operator's Guide*, GA32-0378
- ▶ *S/390 Input/Output Configuration Program User's Guide and ESCON Channel-to-Channel Reference*, GC38-0401
- ▶ *z/OS Hardware Configuration Definition User's Guide*, SC33-7988
- ▶ *z/OS MVS Initialization and Tuning Reference*, SA22-7592
- ▶ *DFSMS/VM Function Level 221 Removable Media Services User's Guide and Reference*, SC35-0141
- ▶ *IBM TotalStorage Virtual Tape Server Performance*. This white paper can be found under "White Papers" at:
<http://www.ibm.com/support/techdocs>
- ▶ *IBM TotalStorage Enterprise Automated Tape Library (3494) Systems Assurance Product Review (SAPR) Guide*, SA01-005-05, which is available from your IBM marketing representative or can be found at:
<http://w3-1.ibm.com/support/assure/assur30i.nsf/PubAllNum/SA185?OpenDocument>
- ▶ *z/OS DFSMS Software Support for IBM System Storage TS1120 Tape Drive (3592)* SC26-7514

Online resources

These Web sites and URLs are also relevant as further information sources:

- ▶ *IBM TotalStorage Virtual Tape Server 3494 Bulk Volume Information Retrieval Function User's Guide*, available for IBM employees and IBM Business Partners on the Web from:
<http://w3-03.ibm.com/support/techdocs/atmastr.nsf/WebIndex/WP100430>
Available for clients at:
http://www-1.ibm.com/support/docview.wss?rs=0&q1=BVIR&uid=tss1wp100430&loc=en_US&cs=utf-8&cc=us&lang=en
- ▶ *Statistical Analysis and Reporting System User Guide*
<http://www-1.ibm.com/support/docview.wss?uid=ssg1S7000247>
- ▶ *IBM Magstar® Tape Drives: AIX High Availability SAN Failover for 3590*
http://www.storage.ibm.com/tape/drives/3590/prod_data/pdf/magstarwp.pdf
- ▶ Computer Associates
<http://www.ca.com>
- ▶ Unicom System, Inc.
<http://www.unicomsi.com>

- ▶ Innovation Data Processing
<http://www.innovationdp.com>
- ▶ OpenTech Systems
<http://www.opentechsystems.com>
- ▶ VSE/ESA
<http://www-1.ibm.com/servers/eserver/zseries/os/vse>
- ▶ PG Software
<http://www.pfeilschifter-gmbh.de/english/index.htm>
- ▶ I/O connectivity
<http://www.ibm.com/servers/eserver/zseries/connectivity/index.html>
- ▶ Enterprise Tape Drive
http://www.storage.ibm.com/hardsoft/tape/3590/prod_data/magstarwp.pdf
- ▶ Search for bookshelves
http://publibz.boulder.ibm.com/cgi-bin/bookmgr_OS390/Shelves?filter=Z%2Fos

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