IBM i
Version 7.2

Storage solutions

IBM

Note

Before using this information and the product it supports, read the information in "Notices" on page 179.

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Contents

Storage solutions

There are four main types of media available for your system. The Storage solutions topic collection provides information to help you decide which form of media is best for your environment. It includes information about planing, installing, configuring, maintaining, using, and troubleshooting.

As your company produces a greater volume of information, and as the value of that information grows, the methods you use to protect and preserve it become vital corporate strategies. Storage has gone from being a feature of a system to being an entity unto itself.

It performs several valuable functions within your enterprise, including the following:

Availability
> Your storage solution must enable you to access your data when you need it, without exception. In some settings, such as a hospital, access to data can mean the difference between life and death.

Integrity
> Your data must be in exactly the same condition when it returns to you as it was when it was stored. That means it must be safe from corruption, loss, and outside attack.

Recoverability
> Your storage solution should ensure that you can recover your data in the event of a natural disaster, such as a fire, flood, or tornado.

Related information

Getting your media ready to save your system

IBM System Storage

What's new for IBM i 7.2

Read about new or significantly changed information for the Storage solutions topic collection.

IBM Navigator for i
There are changes to the instructions for multiple tasks using IBM® Navigator for i in the Storage Solutions topic.

Image catalogs

The instructions for creating an image catalog and transferring a virtual tape image catalog to a remote IBM system are updated. For more information, see the Setting up virtual tape storage and Transporting virtual images to another system topics.

What's new as of August 2018

Miscellaneous technical updates have been made since the previous publication.

What's new as of October 2016

Support has been added for Container media. For more information, see the Removable Mass Storage topic.

What's new as of October 2015

Support has been added to duplicate IPL capable media to other optical media that has different physical characteristics. For more information, see the Duplicating Optical Volumes topic.

Multipath tape support has been enhanced. For more information, see the Tape multipath topic.

What's new as of April 2015

Multipath tape support has been added. For more information, see the Tape multipath topic.

What's new as of October 2014

There are more supported tape drives and tape libraries. For more information, see the Comparing tape solutions topic.

How to see what's new or changed

To help you see where technical changes have been made, the information center uses:

- The » image to mark where new or changed information begins.
- The « image to mark where new or changed information ends.

In PDF files, you might see revision bars (|) in the left margin of new and changed information.

To find other information about what's new or changed this release, see the Memo to users.

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Related reference

Related information for Storage solutions
Product manuals, IBM Redbooks publications, Web sites, and other information center topic collections contain information that relates to the Storage solutions topic collection. You can view or print any of the PDF files.

How storage is viewed

The disk space on your system and your system's main memory is viewed as one large storage area known as *single-level storage*. The Single-level storage example provides a visual representation of how storage is viewed.

The following figure shows how single-level storage works:

Figure 1. Single-level storage

When you save a file, you do not assign it to a storage location. Instead, the system places the file in the location that ensures the best performance. One option is the data is spread in the file across multiple disk units. When you add more records to the file, the system assigns additional space on one or more disk units.

Disk

Disk units provide many forms of protection. You can create disk pools, to group your disks together. You protect your disk units using Device parity protection, creating redundant information. Or you can mirror your disk units using Mirrored protection, to create duplicated information.

Disk units are storage units that are typically internal to your system. However, they can also be attached externally. You can group your disk drives into group of disk units on your system called *disk pools* (also known as auxiliary storage pools or ASPs). One reason to do this is to provide a level of protection for your data. If one disk unit fails, you only must recover the data stored in the disk pool that the failed disk unit was a part of.

Disk pools also enable you to set disk space aside for a particular purpose, application, or data type. For example, you may create a disk pool for backups done to save files. You can then move these save files to tape or other media when it is convenient for you. The following figure shows a disk pool that is composed of disk units 1, 4, 5, 7, and 11.
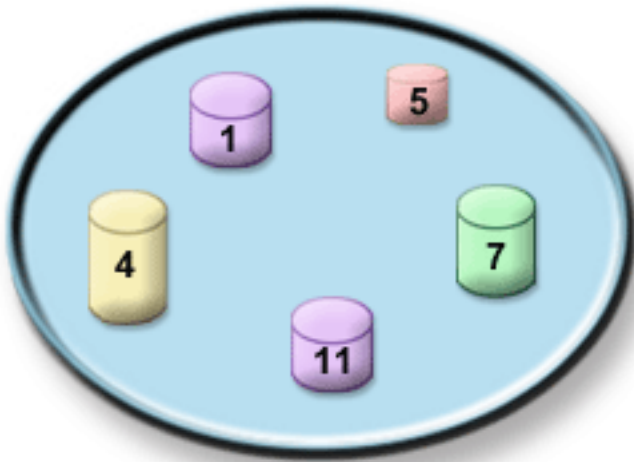
Figure 2. Disk pool with disk units

For detailed information about disk pools, disk pool types, and examples of how to use disk pools for different purposes, see Disk pools. For information about how to configure disk units and disk pools, see Manage disk pools.

Independent disk pools are disk pools that can be brought online or taken offline without any dependencies on the rest of the storage on a system. This is possible because all of the necessary system information associated with the independent disk pool is contained within the independent disk pool. Independent disk pools offer a number of availability and performance advantages in both single and multiple system environments. For detailed information, see Using independent disk pools.

Besides disk pools, there are a few other ways to protect your disk units and the data on them. *Mirrored protection* protects your data by keeping a copy of the data on two separate disk units. When a disk-related component fails, the system may continue to operate without interruption by using the mirrored copy of the data until the failed component is repaired. *Device parity protection* is a hardware function that enables your system to reconstruct data in the event of a disk failure. It is important to remember that these disk protection methods are not a guarantee against failure or data loss. You still need to have a good backup and recovery strategy in place in order to truly protect your data. For detailed information about disk protection methods, see Plan for disk protection.

Removable mass storage (RMS) is a separate type of storage that is not part of the system disk storage pool. Removable disk (RDX) media are managed as removable media similar to optical and tape. See "Removable Mass Storage (RMS)" on page 74 for more information.

Compared to tape or optical, disk is a more expensive storage option. However, the data on disk is more quickly accessible than on tape or optical. It is important to balance the cost of storing data on disk with the speed and convenience with which you can access that data. For example, if you have older data that you access infrequently, you may want to consider storing it on tape or optical, rather than on disk. Likewise, current information that you access frequently might be worth the cost of disk storage because you can access it quickly. This type of storage strategy is called *hierarchical storage management*. The following figure shows the different layers of hierarchical storage management:
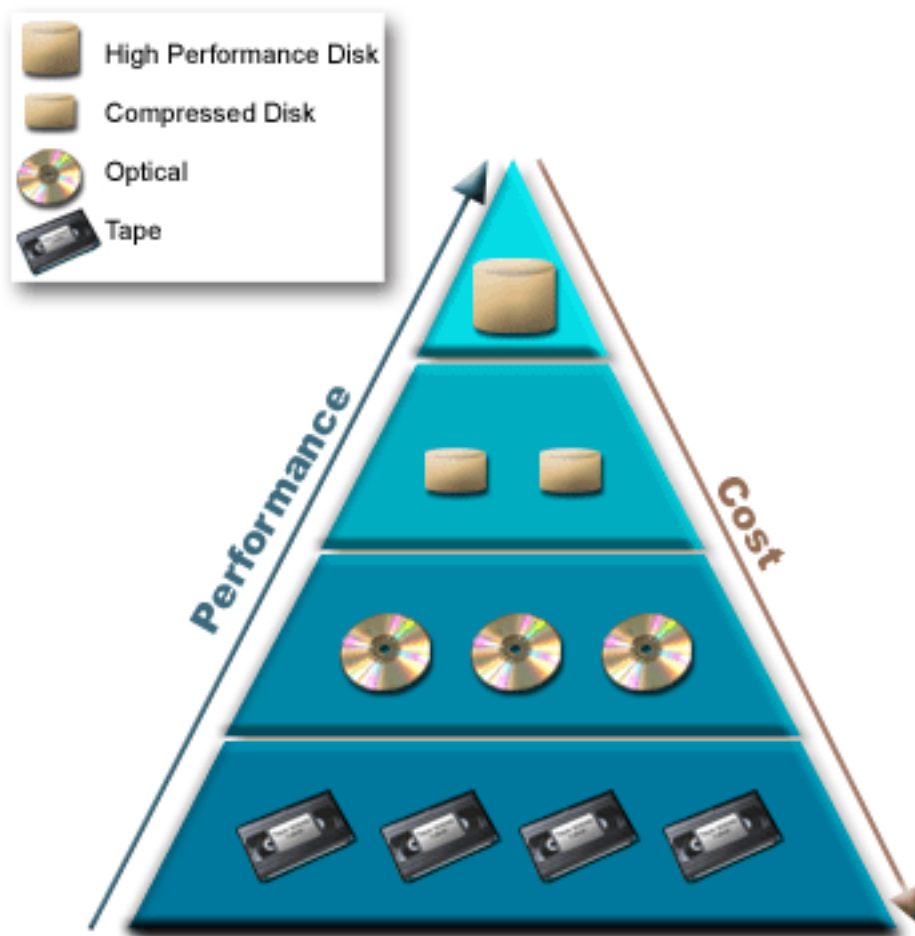
Figure 3. Storage management hierarchy

It is not always the same data that resides in the high performance storage components. Data is moved among the different layers according to the current system needs. The key to successful and seamless hierarchical storage management lies in the management and distribution of data across the different layers. For detailed information, see Hierarchical Storage Management.

Related information

Disk pools

Independent disk pool examples

Disk protection

Tape

Tape is the most common form of removable storage media. It widely adopted and popular. There are several advantages to using tape over other storage devices.

Cost
> Tape is cost effective, when compared to disk. While the cost of disk storage is falling, the cost of tape is also falling on a per-GB basis.

Security
> It is easy to keep your data secure by securely storing backups or copies at an off-site location. This also guards against on-site data corruption from viruses, fire, natural disasters, accidental deletions, and other data-loss incidents.

Reusable
> You can rotate your tapes for backups, which means that you have more than one set of tapes. When one set expires, you can write over the data on it and use the media again.

Capacity
> As the amount of data you create grows, you can increase your capacity by adding additional tape volumes.

While there are many advantages to using tape, there are also some drawbacks:

Durability
> Tape is reusable, but tapes do wear out over time and require replacement. If they are not replaced when needed, your data can be compromised.

Sequential access to data
> Tapes give you access to the data on them in the order in which that data was recorded. If you are looking for a particular item on a tape, it might take some time to locate it.

Types of tape solutions

Single tape devices are preferable when there is only a small amount of information that needs to be backed up. Automated tape devices are excellent for multiple cartridges and unattended backups.

Single tape devices

Single tape devices enable you to enjoy the benefits of tape media with your system. They are excellent for smaller companies that may not have much data to back up or to retrieve. If a full backup of your system fits on a single tape, you can perform unattended backups with a single tape device. However, after your backup exceeds one tape, someone needs to be present to switch the tapes in the drive as the backup runs.

Many tape devices support data compression, which increases the apparent capacity of your media by encoding the data to use less space. The data is compressed and decompressed by the hardware each time it is read or written on your tape device and is not apparent to applications.

Automated tape devices

These topics contain information about what tape automation is and how it can help you manage your data and more efficiently carry out your backup strategy. The two types of tape automation are:

Related information
Tape Offerings

Automatic cartridge loaders

Automatic cartridge loaders can hold multiple cartridges and perform unattended backups. Though they have fewer automation capabilities than tape libraries, you can use tape management software to support automated, centrally scheduled, and policy-managed backup and storage operations.

There are two ways that you can use tape cartridges with an automatic cartridge loader:

Manual mode
> You insert tape cartridges one at a time.

Auto mode
> You can preinstall multiple tape cartridges. A tape cartridge automatically loads when the previous cartridge is unloaded.

Related information
Tapes Supported on iSeries

Tape libraries

Tape libraries can help you perform unattended save and restore operations, archival and retrieval operations, spool archiving, and other tape-related tasks.

Tape libraries are often used with some form of automation software, and are capable of supporting multiple systems across different platforms and large quantities of cartridges. In these environments, a media management application often maintains the cartridge inventory and handles most of the tape library tasks. However, you can also use tape libraries without a media management application. In these environments the tape library can still support some automated tape functions.

The following topics introduce the major elements of a tape library and the related information required for creating a tape library solution.

Tape library types and major components

Use this illustration to see the parts of a tape library. The figure represents some typical tape libraries, but does not describe all possible configurations.
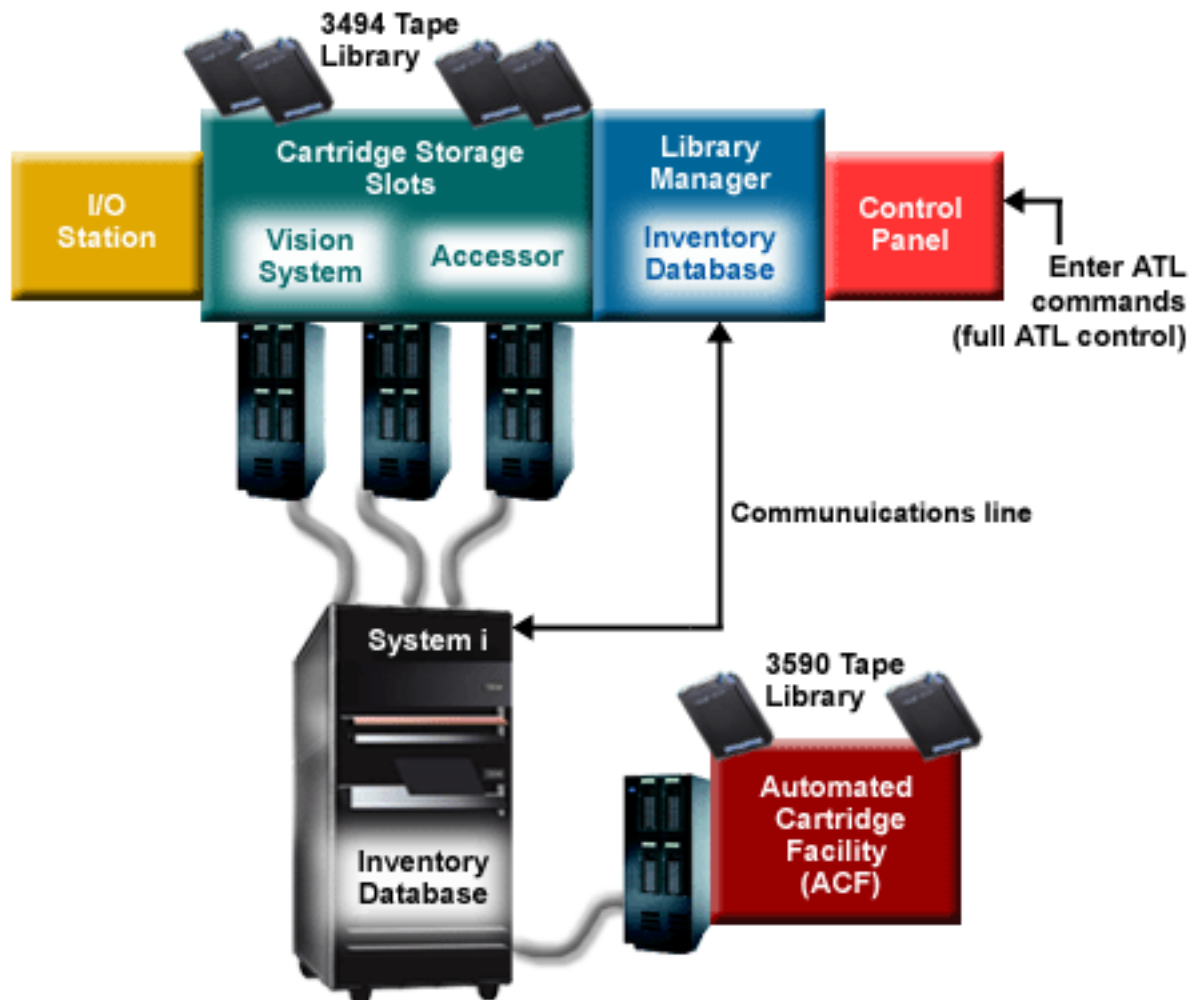
Figure 4. Illustration of tape library parts

Tape library operating modes

Most tape library devices support three basic modes of operation.

The terminology that is used to describe these operational modes varies with the type of tape library, but the concepts are the same. The operating modes are the following:

Manual mode
> When a tape library is in manual mode it behaves like a stand-alone tape device. You must install all cartridges manually. See "Setting up a tape library as a stand-alone device" on page 45 for more information about using a tape library as a stand-alone device.

Automatic cartridge loader or sequential mode
> When a tape library is in this mode it behaves like a stand-alone tape device with an automatic cartridge loader. When a cartridge is unloaded, the next cartridge is loaded until all cartridges have been used.

Library mode
> In library mode, a tape library provides full tape automation.

See the operator's manual for your tape library about specific information for configuring these modes on your tape library.

Related tasks
Setting up a tape library as a stand-alone device
Occasionally, it might be necessary to use the tape resources in a tape library without the benefit of automation; for example, when you perform an alternate IPL or when the tape library automation is disabled.

Common configuration types for tape libraries
There are several common configurations for tape libraries.

The system is connected to the tape drive through a SCSI, SAS, or fiber channel interface. A 3494 tape library requires a separate connection, either through an EIA-232 line or through a local area network (LAN), to communicate with the library manager. For all other tape library devices at least one of the attached tape drives must be configured as a control path drive.

When more than one drive with the same capability is within a tape library that is connected to the same IBM i partition, the drives can be pooled together to form a single logical library. Drives that are attached using an IOP based configuration will not be pooled together with drives attached using an IOPless configuration.

Tape library devices and disk units should not be attached to the same IOA.

See "Configuring tape libraries" on page 31 for additional configuration requirements.

IBM i supports the following tape library configurations:

Single system connected to a dedicated tape library
> A system can connect to one or more drives within a tape library.

Multiple systems or logical partitions connected to the same tape library
> For a tape library with multiple drives, it is possible to attach multiple systems or logical partitions to the same tape library. Some tape library devices limit the number of attached host systems to 32.

Multiple system types connected to the same tape library
> Different types of host systems can share automated tape libraries.

When more than one system or logical partition is connected to the same tape library it is recommended that you use a tape management application, such as Backup, Recovery and Media Services (BRMS), to manage and secure the tape cartridges.

Related information
Backup, Recovery, and Media Services (BRMS)

Cartridge concepts for tape libraries
Working with tape cartridges is an important and routine part of operating your tape library.

Cartridge status
These descriptions describe the status for a tape cartridge in relation to a tape library.

Inserted
> The cartridge has been moved into the media library device and has been placed in the inserted category. The cartridge is not available until you add it to a usable cartridge category.

Available
> The cartridge exists in a usable category and is available for use.

Mounted
> The cartridge exists in a usable cartridge category and is currently in a tape resource. The tape resource might not be attached to this system. This situation is common for large 3494 configurations. If a cartridge is mounted in a device that is not attached to this system, the system returns an error when the cartridge is requested.

Duplicate
> The cartridge identifier exists more than once in the inventory. Only one entry is established for the cartridge identifier. This error should not occur on the 3494 because the Library Manager software does not allow duplicate cartridge identifiers in the device.
>
> When a 3590 with an automated cartridge loader is operating in random mode and has the GENCTGID(*VOLID) parameter in the device description, this error can happen often. You must remove one of the duplicate cartridge identifiers before the tape library can use the other cartridge.

Not Available
> The 3494 Library Manager software has determined that the cartridge is not available for use. A possible reason can be that it has been lost or misplaced in the inventory.

Error
> The cartridge is in error. See the QSYSOPR message queue to determine why the cartridge is in error.

Ejected
> The cartridge has been removed or is in the process of being removed.

Related concepts
Cartridge categories
A *category* is a logical grouping of cartridges. A category allows you to refer to a group of cartridges by category name instead of the individual cartridge identifiers.

Related tasks
Making cartridges available to the tape library inventory
Before you can use the tape library, you must have media loaded and available.

Cartridge categories
A *category* is a logical grouping of cartridges. A category allows you to refer to a group of cartridges by category name instead of the individual cartridge identifiers.

Categories are intended for tape libraries like the 3494 where there is a library manager function that uses categories to provide security and special functions.

Categories are as follows:

Inserted
> The cartridge has been moved into the tape library device and has been placed in the Inserted category. The cartridge is not available until you add it to a usable category.

Not shared
> The cartridge has been assigned to a category that is only available to the system defined as the primary owner. Only tape library devices with Library Manager software that contains category information (3494, for example) and has access to multiple systems can ensure that the cartridge is used only by the primary owning system.

Shared

The cartridge has been assigned to a category that is available to all System i® that is attached to the tape library device.

Ejected

The cartridge has been removed from the inventory and is waiting for physical removal or waiting for the convenience station or high capacity output area to be cleared.

Convenience

The convenience category is designed for the user who just needs to use a tape quickly and get it out of the tape library device. A tape in the convenience category is ejected (removed) after it has been mounted and then unloaded. The ejecting process takes place when a user specifies the end option (ENDOPT) parameter of *UNLOAD. The cartridge is not ejected when IBM i unloads the tape resource for another request.

Alternate restart

This category is provided by IBM i for tape cartridges that can be used for a load source (D-mode) IPL. The tapes in this category must be maintained by the user. IBM i does not guarantee or verify that the tape cartridges have the appropriate data on them.

Nonlabeled

Tapes in this category must be nonlabeled tapes. A nonlabeled tape is a tape volume with no logical volume identifier.

System generated

All cartridge identifiers are assigned to this category when the tape library device description has the GENCTGID parameter set to *SYSGEN. This function allows tape library devices with no bar code reader to bypass all system category checks on the cartridge for fast use of cartridges. Cartridges cannot be added or changed to this category.

User-defined

Note: If you are using BRMS, you should not attempt to use user-defined categories.

User-defined categories can be created and deleted. These categories allow users to create their own logical groupings of tape cartridges. The Create Tape Category (CRTTAPCGY) and Delete Tape Category (DLTTAPCGY) commands are used for this function. The Display Tape Category (DSPTAPCGY) command displays a list of user-defined and system-defined categories on a given system.

Categories and the system name

Category names are of the form *name sysname*, where the *name* is the category name and *sysname* is the name of the system that owns the category. If you change the system name, the cartridges in the associated categories and the not-shared category are unavailable until you create a category with the previous system name. Remove all cartridges from the tape library or change them to the shared category before changing the system name. See Cartridge assignment when the system name changes for more information about changing the system name.

Categories for tape libraries without a library manager

For tape libraries without a library manager, categories have a limited purpose. The security that the tape library manager provides does not exist. Cartridges that are added to a category on one system are not necessarily in the same category on other attached systems. Therefore, when you operate tape libraries that do not have a library manager, only the following categories apply:

- Inserted
- Ejected
- Convenience
- Shared

The not-shared category does not prevent other systems from accessing the cartridges. The remaining categories do not apply for tape libraries without library managers. Categories that are created for

nonlibrary-manager tape libraries are only known to the system where they are created and not across all attaching systems. For these types of tape libraries, the cartridges must be added to each system and then managed across all the systems by the tape management software.

Related concepts

Cartridge status
These descriptions describe the status for a tape cartridge in relation to a tape library.

Related tasks

Reassigning cartridges when the system name changes
When the system name is changed, you should reassign cartridges.

Making cartridges available to the tape library inventory
Before you can use the tape library, you must have media loaded and available.

Related reference

Create Tape Category (CRTTAPCGY) command
Delete Tape Category (DLTTAPCGY) command
Display Tape Category (DSPTAPCGY)

Cartridge identifiers and volume identifiers
Cartridge and volume identifiers are used to label each cartridge so they can be tracked and located in the tape library.

Every cartridge and volume ID can contain the characters A through Z, 0 through 9, $, @, and #. Only the first 6 characters are recognized by IBM i. Therefore, the uniqueness of the cartridge identifier must be within the first 6 characters of the name. The first 6 characters of the cartridge identifier must match the volume identifier for the tape.

Special generated cartridge identifiers exist for the tape libraries that do not have a bar code reader, that are missing the bar code label, or that cannot read the label by the bar code reader. These identifiers are as follows:

NLT*xxx*
Non-Labeled Tape: This cartridge contains data written in non-Standard Tape Label format.

CLN*xxx*
Cleaning: This cartridge has been identified as a cleaning tape.

BLK*xxx*
Blank: This cartridge contains no data.

UNK*xxx* or U@*xxxx*
Unknown: This cartridge was not identifiable.

IMP*xxx*
Import: Refers to a cartridge that is in an input/output station of the tape library.

SLT*xxx*
Slot: Refers to the cartridge by slot number. If the device description is created with the GENCTGID parameter set to the *SYSGEN mode, then the cartridges in the tape library inventory appear as SLT *xxx* where *xxx* is the slot number.

Comparing offline storage

It is important that you understand the differences among different forms of media when you decide which one is right for you. Use the table provided to determine your preferred form of media.

The most common forms of offline storage are tape media and optical media. Although optical media is becoming more prevalent, tape media is the most common media. Another option that you can use is virtual media. You can use virtual media to save to a virtual image, which is stored on your disk units. You can then copy that image to media, or distribute it over your network.

The following table describes some of the differences:

Characteristic	Comparison
Access to data	Optical and virtual optical media provide random access, whereas tape provides access to data sequentially.
Capacity	The lowest capacity tape has a similar capacity to DVD-RAM, but medium range and high-capacity tapes typically have 10 to 50 times the capacity of optical.
Compression	The system uses *software* compression to save compressed data to your optical media. This process takes considerable processing unit resources and may increase your save and restore time. Most tape media devices use *hardware* compression, which is typically faster.
Cost	Because you can store a larger amount of data on tape, tape has a lower cost per GB.
Data transfer rates	Data transfer rates for tape tend to be much higher than for optical media, particularly if you use tape drive compression.
Number of media passes or mounts	Optical media can be mounted anywhere from 50000 to 1 million times, depending on the type of media used. The number of media passes supported by tape varies, but is typically lower than optical media.
Reusability	Not all optical media is rewritable. Some optical media are write-once media, which means that after they are written to, they cannot be reused. Tape is reusable.

Related concepts

Optical storage
Use the information that is described as an overview and reference guide for IBM optical support to a system with the IBM i operating system. *Optical storage* is any storage method that uses a laser to store and retrieve data from optical media.

Planning for a tape solution

Read about the many considerations necessary for providing a tape solution.
Related information

Tapes Supported on iSeries

Tape resource management with BRMS
Backup, Recovery and Media Services (BRMS) is a licensed program that helps you create a disciplined approach to managing your backups, and provides you with an orderly way to retrieve lost or damaged data. There are a number of advantages to using tape automation and BRMS together.

Reduce operational costs
Less manual intervention is required to operate tape units because most of your tape operation is automated and unattended.

Improve system availability
BRMS enables you to streamline your backups by reducing the time that is required for tape mounting and backup operations.

Reduce capital cost
> Archiving and retrieving functions enable you to increase the quantity of online (on-disk) data that can be moved to less expensive tape media.

Improve service
> You can experience faster and more accurate responses to your tape-related requests. You can gain more control of your tape management operation.

Reduce management cost
> Day-to-day operations, such as tape and disk capacity management, are more automated and simplified.

Related information

Backup, Recovery, and Media Services

Comparing tape solutions
The system supports various single tape devices, autoloaders, and tape libraries. Compare the various devices for a tape solution.

Note: Some of the older tape devices and tape libraries that are shown are no longer supported on newer server models or newer IBM i releases.

Product name	Description	Media	Storage	Data transfer	Drives
Single tape devices					
IBM Magstar® 3570 Tape Subsystem Model C00	The 3570 Model C00 is a compact, high-capacity storage device.	1 cartridge type	7 GB (21 GB compressed) per cartridge	7 MB per second (MBps) (15 MBps compressed)	1
IBM 3580 Ultrium External Tape Drive	The 3580 is an external tape device that complies with Linear Tape-Open (LTO) specifications.	1 cartridge type	Ultrium 1: Up to 100 GB (200 GB compressed)	Ultrium 1: Up to 15 MBps (30 MBps compressed)	1
			Ultrium 2: Up to 200 GB (400 GB compressed)	Ultrium 2: Up to 35 MBps (70 MBps compressed)	

Product name	Description	Media	Storage	Data transfer	Drives
IBM 3580 Ultrium External Tape Drive	The 3580 is an external tape device that complies with Linear Tape-Open (LTO) specifications. Ultrium 4 (LTO 4) and newer drives support data encryption when they are in a tape library device.	2 cartridge types 1 data 1 WORM	Ultrium 3: Up to 400 GB (800 GB compressed)	Ultrium 3: Up to 80 MBps (160 MBps compressed)	1
			Ultrium 4: Up to 800 GB (1600 GB compressed)	Ultrium 4: Up to 120 MBps (240 MBps compressed)	
			Ultrium 5: Up to 1.5 TB (3.0 TB compressed)	Ultrium 5: Up to 140 MBps (280 MBps compressed)	
			Ultrium 6: Up to 2.5 TB (6.25 TB compressed)	Ultrium 6: Up to 160 MBps (400 MBps compressed)	
			Ultrium 7: Up to 6.0 TB (15 TB compressed)	Ultrium 7: Up to 300 MBps (600 MBps compressed)	
			Ultrium 8: Up to 12.0 TB (30 TB compressed)	Ultrium 8: Up to 300 MBps (600 MBps compressed)	
IBM System Storage® Enterprise Tape Drive 3592	The 3592 is a tape device that provides both fast access to storage and high-capacity storage.	4 cartridge types 2 data 2 WORM	J1A: 300 GB (900 GB compressed) per cartridge	J1A: 40 MBps (100 MBps compressed)	1
IBM System Storage Enterprise Tape Drive 3592	The 3592 is a tape device that provides both fast access to storage, high-capacity storage, and data encryption.	12 cartridge types 7 data 5 WORM	E05: 700 GB (2.1 TB compressed)	E05: 100 MBps (250 MBps compressed)	1
			E06: 1.0 TB (3.0 TB compressed)	E06: 120 MBps (250 MBbs compressed)	
			E07: 4.0 TB (12.0 TB compressed)	E07: 250 MBps (575 MBbs compressed)	
			E08: 10.0 TB (30.0 TB compressed)	E08: 360 MBps (600 MBbs compressed)	

Product name	Description	Media	Storage	Data transfer	Drives
IBM 7206 Model VX2 External VXA-2 Tape Drive	The 7206 Model VX2 is a higher capacity, cost-effective alternative to DDS tape technology.	1 cartridge type	1 - 80 GB (160 GB compressed) per cartridge	6 MBps (12 MBps compressed)	1
IBM 7207 Model 122 4 GB External SLR5 QIC Tape Drive	The 7207 Model 122 is a quarter inch tape device.	1 cartridge type	4 GB (8 GB compressed) per cartridge	1 - 380 KB per second (kbps) (760 kbps compressed)	1
IBM 7208 Model 342 External 8 mm Tape Drive	The 7208 Model 342 is an external tape device. It is backward compatible with ability to read 7 GB, 5 GB, and 2.3 GB 8 mm tape formats.	1 cartridge type	20 GB (40 GB compressed) per cartridge	Up to 3.0 MBps (6 MBps compressed)	1
IBM 7208 Model 345 External 8 mm Tape Drive	The 7208 Model 345 is an external tape device. It is backward compatible with ability to read 7 GB, 5 GB, and 2.3 GB 8 mm tape formats.	1 cartridge type	60 GB (150 GB compressed) per cartridge	Up to 12.0 MBps (20 MBps compressed)	1
Tape libraries					
IBM 3490E Model F *xx* Tape Subsystem	The 3490E F series is a family of high-performance, high reliability streaming tape devices. It can handle from 1 up to 10 tapes.	1 - 10 cartridges	Up to 800 MB (2.4 GB compressed) per cartridge	Sustained rate of up to 6.8 MBps with a maximum SCSI burst rate of 20 MBps.	1 to 4
IBM System Storage Enterprise Tape Library 3494	The 3494 is a modular, flexible storage solution. It is expandable from 1 to 16 library frames and can handle from 1 up to 6240 tapes.	1 - 6240 cartridges	Varies according to drives	Varies according to drives	1 to 76

Product name	Description	Media	Storage	Data transfer	Drives
IBM Magstar 3570 Tape Subsystem	The 3570 models C01, C02, C11, and C12 provide a medium range tape storage solution.	20 cartridges	7 GB (21 GB compresses)	7 MBps (15 MBps compressed)	C01 and C11: 1 C02 and C12: 2
Magstar 3575 Tape Library Dataserver	The 3575 models are compact, high-capacity, integrated storage devices that are available as stand-alone units.	1 - 324 cartridges (depending on model)	7 GB	Up to 324 GB per hour	1 to 6 (depending on model)
IBM System Storage LTO Ultrium Tape Autoloader 3581	The 3581 is an automation solution that complies with LTO specifications.	1 - 7 cartridges	Up to 100 GB (200 GB compressed) per cartridge. Total storage of 700 GB (1.4 TB compressed).	Up to 15 MBps (30 MBps compressed)	1
IBM System Storage LTO Ultrium Tape Autoloader 35812U	The 35812U is an automation solution that complies with LTO specifications.	1 - 8 cartridges	Varies according to drives	Varies according to drives	1
IBM System Storage LTO Ultrium Tape Library 3582	The 3582 is an ideal automation solution for handling the storage needs of small-to-medium sized environments.	1 - 34 cartridges	Varies according to drives	Varies according to drives	1 - 2

Product name	Description	Media	Storage	Data transfer	Drives
IBM System Storage TS2900 Tape Library	The IBM System Storage TS2900 Tape Autoloader Express® is designed for entry level automated backup for rack systems and small to midsize business environments.	Up to 9 cartridges	Varies according to drives	Varies according to drives	1
IBM System Storage TS3100 and TS3200 Tape Library	The TS3100 and TS3200 provide for a wide range of backup, archive, and disaster recovery data storage needs. They comply with Linear Tape-Open (LTO) specifications.	24 - 48 cartridges (depending on model)	Varies according to drives	Varies according to drives	1 - 4 (depending on model)
IBM System Storage TS3310 Tape Library	The TS3310 provides for a wide range of backup, archive, and disaster recovery data storage needs. It complies with Linear Tape-Open (LTO) specifications.	36 - 402 cartridges (depending on model)	Varies according to drives	Varies according to drives	1 - 18 (depending on model)
IBM System Storage TS3400 Tape Library	The TS3400 provides an enterprise-class tape solution that provides the highest levels of performance and reliability with 3592 tape devices.	18 cartridge slots	Varies according to drives	Varies according to drives	1 or 2

Product name	Description	Media	Storage	Data transfer	Drives
IBM System Storage TS3500 Tape Library	The TS3500 provides for a wide range of backup, archive, and disaster recovery data storage needs. It complies with Linear Tape-Open (LTO) and 3592 Enterprise tape drive specifications.	Up to 15,000 cartridges (depending on model)	Varies according to drives	Varies according to drives	1 - 192 (depending on model)
IBM System Storage TS4300 Tape Library	The IBM TS4300 Tape Library is a high-density, highly scalable, easy-to-manage solution designed to keep data securely stored long term.	Up to 272 cartridges.	Varies according to drives.	Varies according to drives	1 to 21
IBM System Storage TS4500 Tape Library	The IBM TS4500 tape library is a storage solution that is designed to help midsize and large enterprises respond to storage challenges.	Up to 4690 cartridges (depending on model)	Varies according to drives	Varies according to drives	1 - 60 (depending on model)
IBM System Storage Enterprise Tape System 3590	The 3590 is an enterprise-class tape solution that provides the highest levels of performance and reliability of any IBM tape subsystem.	1 - 10 cartridges	Up to 60 GB (180 GB compressed) per cartridge	Up to 14 MBps	1

Product name	Description	Media	Storage	Data transfer	Drives
IBM 7329 SLR100 Autoloader	The 7329 is a high-capacity tape autoloader with the ability to provide unattended backups.	1 - 8 cartridges	Up to 50 GB (100 GB compressed) per cartridge	5 MBps (10 MBps)	1

Related information

Tapes Supported on iSeries

Tape Offerings

DAT cartridge and tape unit compatibility
The capacity and read/write capabilities for your media type are provided.

Table 1. Media type, cartridge part number, capacity ,and data transfer rate			
Media type	**Cartridge part number**	**Capacity**	**Data transfer rate**
DDS1	21F8754	2 GB	
DDS2	8191151	4 GB	
DDS3	59H3465	12 GB	
DDS4	59H4456	20 GB	3MB/s
DAT72	18P7912	36 GB	3MB/s
DAT160	23R5635	80 GB	6MB/s
DAT320	46C1936	160 GB	12MB/s
DAT72 Test Cartridge	19P4879		
DAT160 Test Cartridge	19P4880		
DAT 320 test Cartridge	18P6484		
DAT72 Cleaning	35L1044		
DAT160 Cleaning	59H2678		
DAT320 Cleaning			

Note: DDS1, DDS2, DDS3, and DDS4 tape drives are not supported by IBM i

Table 2. Read/write capabilities			
Media type	**DAT72**	**DAT160**	**DAT320**
DDS1			
DDS2			
DDS3	R/W		
DDS4	R/W	R/W	
DAT72	R/W	R/W	
DAT160		R/W	R/W

Table 2. Read/write capabilities (continued)			
Media type	**DAT72**	**DAT160**	**DAT320**
DAT 320			R/W
DAT72 Test Cartridge	R/W		
DAT160 Test Cartridge		R/W	
DAT320 Test Cartridge			R/W

Related concepts

Cleaning DAT tape drives
Clean the head on DAT tape drives after every 8 hours of tape movement when using IBM tape cartridges. Other tape media might require cleaning more frequently.

Eight-millimeter cartridge and tape unit compatibility
The capacity and read/write capabilities for your media type are provided.

Table 3. Media type, capacity ,and format			
Media type	**Cartridge part number**	**Capacity**	**Format**
X6 62m	24R2134	20 GB	VXA2/VXA3
X10 124m	24R2136	40 GB	VXA2/VXA3
X23 230m	24R2137	80 GB	VXA2VXA2/VXA3
X6 62m test cartridge	24R2135	20 GB	VXA2VXA2/VXA3
X cleaning cartridge	24R2138	80 GB	
V6 62m	19P4878	20 GB	VXA2
V17 170m	19P4877	59 GB	VXA2
V23 230m	19P4876	80 GB	VXA2VXA2/VXA3
V6 62m test cartridge	19P4879	20 GB	VXA2
V cleaning cartridge	19P4880	20 GB	
225m AME with Smart Clean	18P6484	60 GB	FMT60GB
150m AME with Smart Clean	09L5323	40 GB	FMT60GB
75m AME with Smart Clean	35L1044	20 GB	FMT60GB
170m AME	59H2678	45 GB	FMT60GB
125m AME		30 GB	FMT60GB
45m AME		12 GB	FMT60GB
22m AME		5.5 GB	FMT60GB
170m AME		20 GB	FMT20GB
125m AME		14 GB	FMT20GB
45m AME		5.6 GB	FMT20GB
22m AME		2.6 GB	FMT20GB

Table 3. Media type, capacity ,and format (continued)			
Media type	**Cartridge part number**	**Capacity**	**Format**
160m		7 GB	FMT7GB
112m		5 GB, 2.3 GB	FMT5GB
112m			FMT2GB
M1/M2 Cleaning Cartridge	35L1409		
Cleaning Cartridge	16G8467		

Table 4. Read/write capabilities										
Media type	**VXA-320**	**VXA-2**	**6390**	**7208-002**	**7208-012**	**7208-222**	**7208-232**	**7208-234**	**7208-342**	**7208-345**
X6 62m	R/W	R/W								
X10 124m	R/W	R/W								
X23 230m	R/W	R/W								
X6 62m test cartridge	R/W	R/W								
X cleaning cartridge	X									
V6 62m		R/W								
V17 170m		R/W								
V23 230m	R/W	R/W								
V6 62m test cartridge		R/W								
V cleaning cartridge		X								
225m AME with Smart Clean										R/W
150m AME with Smart Clean										R/W
75m AME with Smart Clean										R/W
170m AME (FMT60GB)										R/W
125m AME (FMT60GB)										R/W
45m AME (FMT60GB)										R/W
22m AME (FMT60GB)										R/W
170m AME (FMT20GB)									R/W	R/O

Media type	VXA-320	VXA-2	6390	7208-002	7208-012	7208-222	7208-232	7208-234	7208-342	7208-345
Table 4. Read/write capabilities (continued)										
125m AME (FMT20GB)									R/W	R/O
45m AME (FMT20GB)									R/W	R/O
22m AME (FMT20GB)									R/W	R/O
160m			R/W			R/W		R/W	R/O	
112m (FMT5GB)			R/W		R/W	R/W	R/W	R/W	R/O	
112m			R/W	R/W	R/W	R/W	R/W	R/W	R/O	
M1/M2 Cleaning Cartridge										
Cleaning Cartridge										

Related concepts

Cleaning eight-millimeter tape drives
The eight-millimeter tape drives count the number of hours of tape motion and indicate when it is time to clean the tape drive by displaying a message to clean soon and by turning on the Fault status light.

Quarter-inch cartridge and tape unit compatibility
The capacity and read/write capabilities for your media type are provided.

Table 5. Media type, Cartridge part number, capacity, and Data transfer rate

Media type	Cartridge part number	Capacity	Data transfer rate
SLR100-50GB	35L0968	50 GB	5 Mbps
SLR60-37.5GB	24R0146	37.5 GB	4-5 Mbps
SLR60-30GB	19P4209	30 GB	4-5 Mbps
SLR100-5GB	35L0661	5 GB	4-5 Mbps
SLR5-4GB	59H3660	4 GB	0.4 Mbps
MLR3-25GB	59H4128	25 GB	2 Mbps
MLR1-16GB	59H4175	16 GB	1.5 Mbps
MLR1-13GB	No longer available	13 GB	1.5 Mbps
MLR1-2GB	35L0589	2 GB	1.5 Mbps
DC9250	16G8436	2.5 GB	0.3 Mbps
DC9120	21F8730	1.2 GB	0.3 Mbps
DC6525	21F8697	0.5 GB	0.2 Mbps
DC6150	21F8578	0.1 GB	0.1 Mbps

If the quarter-inch cartridge (QIC) format and the tape cartridge are not compatible, an error message is displayed. Errors can occur for the following conditions:

- While selecting a QIC format that cannot be written on the tape. For example, you insert a DC6150 tape cartridge and specify a QIC1000 format.
- While attempting to process a high-density tape cartridge in a low-density tape unit. For example, you try to process an SLR5-4 GB cartridge in a 6381 tape unit.
- While attempting to add a file and selecting a QIC format different from the format previously recorded on the tape. For example, you insert a tape cartridge recorded in QIC525 format and specify a QIC120 format.

Table 6. read/write and read/only capabilities

Media type	QIC-120	QIC-525	QIC-100	QIC-2GB	QIC-2GB (DC)	4/8GB SLR5 QIC-4GB-DC	MLR1 QIC-5010-DC	MLR1-S QIC-5010-DC	MLR3	SLR60	SLR100
SLR100-50GB (35L0968)											R/W
SLR60 Enhanced Capacity										R/W	R/W
SLR60-30GB										R/W	R/W
SLR100-5GB										R/W	R/W
MLR3-25GB									R/W	R/W	R/W
MLR1-16GB							R/W	R/W	R/W	R/W	R/O
MLR1-13GB							R/W	R/W	R/W	R/W	R/O
MLR1-2GB							R/W	R/W	R/W	R/W	R/O
SLR5-4GB						R/W		R/O	R/O	R/O	R/O
DC9250 (QIC-2DC tape format)					R/W	R/W		R/O	R/O	R/O	
DC9250 (QIC-2GB tape format)				R/W	R/W	R/W	R/W	R/O	R/O	R/O	
DC9120			R/W	R/W	R/W	R/W	R/W				
DC6525		R/W	R/W	R/W	R/W	R/W	R/W				
DC6150	R/W	R/W	R/W	R/W	R/W	R/W	R/W				

Related concepts

Cleaning quarter-inch tape drives
For quarter-inch tape drives, you should clean the head after every 8 hours of tape movement when using IBM tape cartridges. Other tape media might require cleaning more frequently.

Half-inch and Magstar MP cartridges and tape unit compatibility
The tape units and half-inch and Magstar MP cartridges compatibility are provided.

There are compatibility guidelines that need to be considered when working with 3592 tape units and cartridges.

Table 7. Media Type, part number, and capacity

Media Type	Part Number	Native Capacity
JE Advanced Data	02CE960	20 TB (GEN6)
JZ Advanced WORM	02FJ980	20 TB (GEN6)
JL Advanced Economy	02CE961	5 TB (GEN6)
JD Advanced Data	2727263	15 TB (GEN5A)
		10 TB (GEN5)
JZ Advanced WORM	2727264	15 TB (GEN5A)
		10 TB (GEN5)
JL Advanced Economy	2727265	3 TB (GEN5A)
		2 TB (GEN5)
JC Advanced Data	46X7452	7000 GB (GEN5)
		4000 GB (GEN4)
JY Advanced WORM	46X7454	7000 GB (GEN5)
		4000 GB (GEN4)
JK Advanced Economy	46X7453	900 GB (GEN5)
		500 GB (GEN4)
JB Extended Data	23R9830	1600 GB (GEN4)
		1000 GB (GEN3)
		700 GB (GEN2)
JX Extended WORM	23R9831	1600 GB (GEN4)
		1000 GB (GEN3)
		700 GB (GEN2)
JA Data	18P7534	640 GB (GEN3)
		500 GB (GEN2)
		300 GB (GEN1)
JJ Economy	24R0316	128 GB (GEN3)
		100 GB (GEN2)
		60 GB (GEN1)
JW Worm	18P7538	640 GB (GEN3)
		500 GB (GEN2)
		300 GB (GEN1)
JR Economy WORM	24R0317	128 GB (GEN3)
		100 GB (GEN2)
		60 GB (GEN1)
Cleaning cartridge	18P7535	

Tape unit	JE/JM/JV cartridge	JD/JL/JZ cartridge	JC/JK/JY cartridge	JB/JX cartridge	JA/JJ/JW/JR cartridge
3592-60F tape unit (GEN6)	R/W	R/W	R/W		
3592-55F tape unit (GEN5A)		R/W	R/W		
3592-E08 tape unit (GEN5)		R/W	R/W		
3592-E07 tape unit (GEN4)			R/W	R/W	R/O
3592-E06 tape unit (GEN3)				R/W	R/W
3592-E05 tape unit (GEN2)				R/W	R/W
3592-J1A tape unit (GEN1)					R/W

Table 8. Read/write capabilities

Tape unit	Cartridge part number	Capacity	Compression	Length
3590	05H4434	10 GB 20 GB 30 GB	30 GB 60 GB 90 GB	320 m (1050 ft)
	05H3188	20 GB 40 GB 60 GB	60 GB 120 GB 180 GB	634 m (2070 ft)
	05H3302			
	08l6091			
3490E	09G4494	800 MB	2.4 GB	335 m (1000 ft)
3480	4479753	200 MB		175 m (575 ft)
3570	05H2462	5 GB	15 GB	547 ft (167 m)
	08L6187			
	08L6663	7 GB	21 GB	227 m (745 ft)

Related concepts

Cleaning half-inch tape drives
There are specific methods for cleaning half-inch tape drives.

LTO cartridges and tape unit compatibility
There are compatibility guidelines that need to be considered when working with Linear Tape Open (LTO) Ultrium tape units and cartridges.

Media type	Part number	Native Capacity
LTO Ultrium 8	01PL041	12.0 TB
LTO Ultrium 8 WORM	01PL042	12.0 TB
LTO Ultrium M8		9.0 TB

Table 9. Media type, part number, and capacity

Table 9. Media type, part number, and capacity (continued)		
Media type	**Part number**	**Native Capacity**
LTO Ultrium 7	38L7302	6.0 TB
LTO Ultrium 7 WORM	38L7303	6.0 TB
LTO Ultrium 6	00V7590	2.5 TB
LTO Ultrium 6 WORM	00V7591	2.5 TB
LTO Ultrium 5	46X1290	1.5 TB
LTO Ultrium 5 WORM	46X1293	1.5 TB
LTO Ultrium 4	95P4436	800 GB
LTO Ultrium 4 WORM	95P4450	800 GB
LTO Ultrium 3	24R1922	400 GB
LTO Ultrium 3 WORM	96P1203	400 GB
LTO Ultrium 2	08L9870	200 GB
LTO Ultrium 1	08L9120	100 GB
Ultrium Universal cleaning cartridge	35L2086	

Table 10. Read/write capabilities									
	LTO Ultrium 8 cartridge	**LTO Ultrium M8 cartridge**	**LTO Ultrium 7 cartridge**	**LTO Ultrium 6 cartridge**	**LTO Ultrium 5 cartridge**	**LTO Ultrium 4 cartridge**	**LTO Ultrium 3 cartridge**	**LTO Ultrium 2 cartridge**	**LTO Ultrium 1 cartridge**
LTO Ultrium 8 tape unit	R/W	R/W	R/W						
LTO Ultrium 7 tape unit			R/W	R/W	R/O				
LTO Ultrium 6 tape unit				R/W	R/W	R/O			
LTO Ultrium 5 tape unit					R/W	R/W	R/O		
LTO Ultrium 4 tape unit						R/W	R/W	R/O	

	LTO Ultrium 8 cartridge	LTO Ultrium M8 cartridge	LTO Ultrium 7 cartridge	LTO Ultrium 6 cartridge	LTO Ultrium 5 cartridge	LTO Ultrium 4 cartridge	LTO Ultrium 3 cartridge	LTO Ultrium 2 cartridge	LTO Ultrium 1 cartridge
LTO Ultrium 3 tape unit							R/W	R/W	R/O
LTO Ultrium 2 tape unit								R/W	R/W
LTO Ultrium 1 tape unit									R/W

Table 10. Read/write capabilities (continued)

Related concepts

Cleaning LTO Ultrium tape drives

All IBM Ultrium tape drives have an integrated cleaning device which brushes the head when loading and unloading a cartridge. Along with this, each drive has a cleaning procedure using a special cleaning cartridge.

Multiple IBM i products sharing a tape library

Multiple systems can share a tape library.

The IBM System Storage Enterprise Tape Library 3494 can be shared by as many as 32 systems. Each system requires one communication line and one tape drive attachment. With BRMS controlling the 3494 tape library, the cartridges within the library can be shared among any of the attached systems when you use the common media inventory function of BRMS.
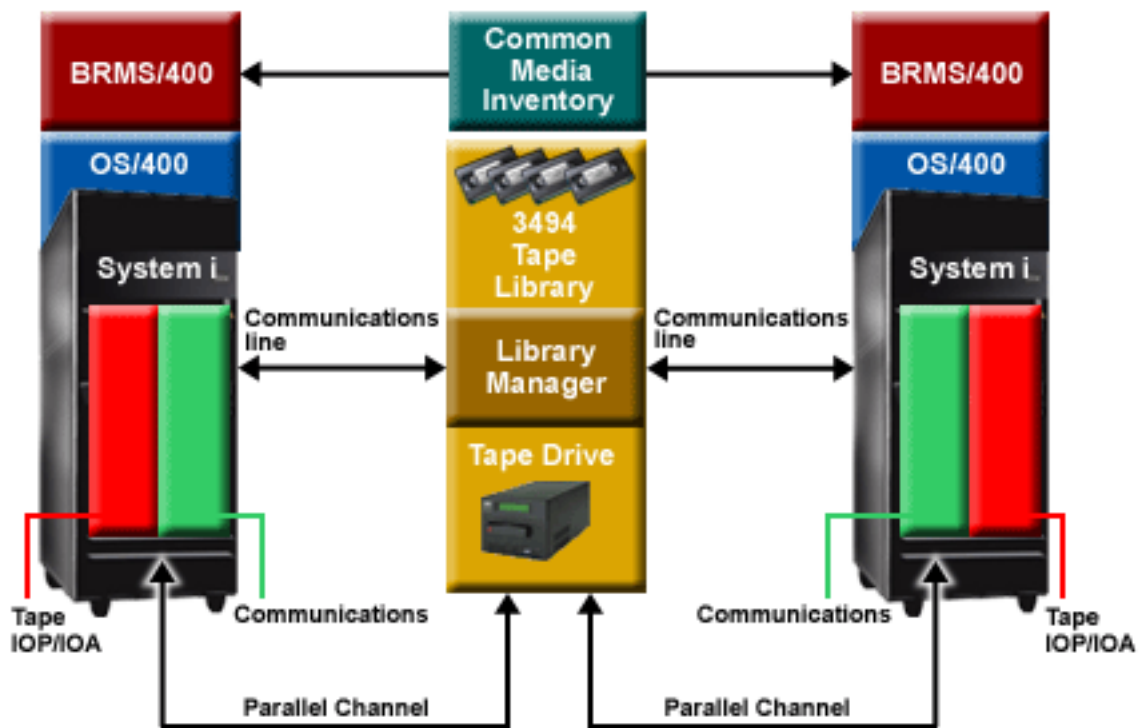
Figure 5. Systems sharing a 3494 tape library

Multiple tape libraries to a partition
Multiple Tape Libraries can be attached to a partition.

Each tape library must have at least one tape drive connected to the partition. For 3494 tape libraries there must also be at least one communication path to the system. For other tape libraries at least one of the attached drives must be configured as a control path drive. Backup, Recovery, and Media Services (BRMS) provides support for multiple tape libraries attached to a single partition.

Multiple tape drives in a Tape Library
Larger systems can reduce backup times by breaking the operation into multiple concurrent save operations to multiple devices.

Not all connections between a partition and a tape library device are valid. A single system can be connected to multiple tape drives. However, a single partition in the system cannot be connected multiple times to the same tape drive, because this creates a serial number conflict and results in nonfunctional drives. This scenario might be evident during an IPL. With IBM i 7.2 TR2 and later releases, this restriction applies only to 3494 type tape library devices and SAS attached tape library devices. However, it is no longer needed for Fibre Channel attached tape library device types.

For more information, see the Tape multipath topic.

You can connect a single System i to multiple tape drives.

3494   **3494**
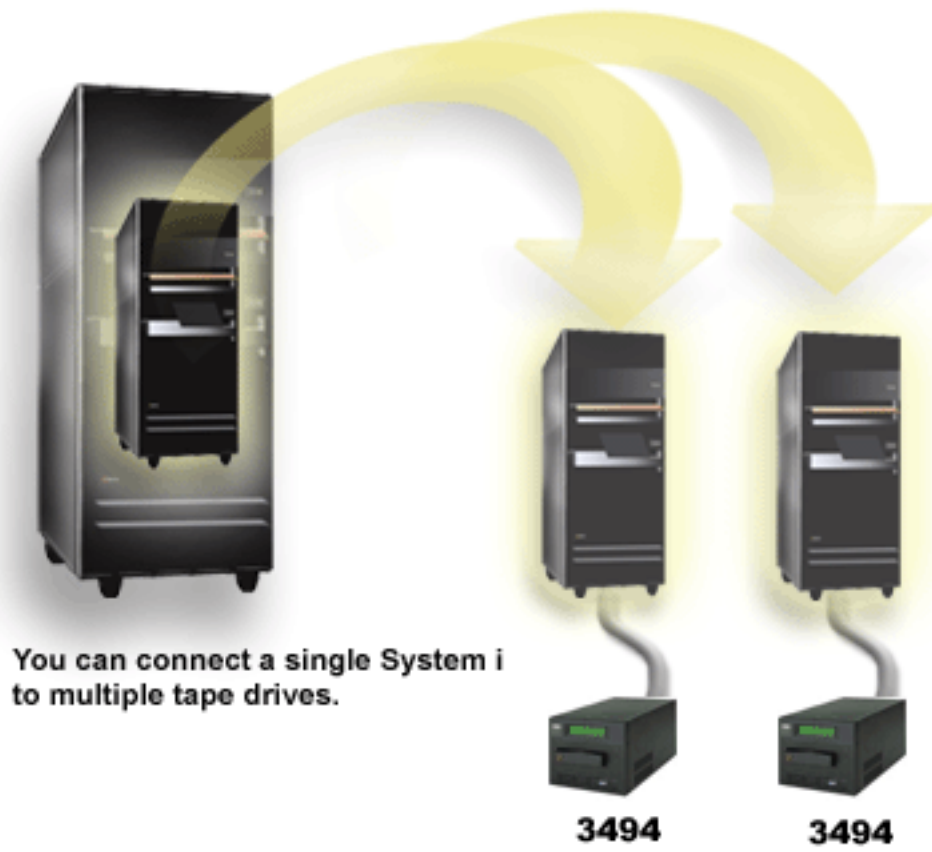
Figure 6. Supported configuration

You cannot connect a
single partition twice
to the same tape drive.

3494   3494
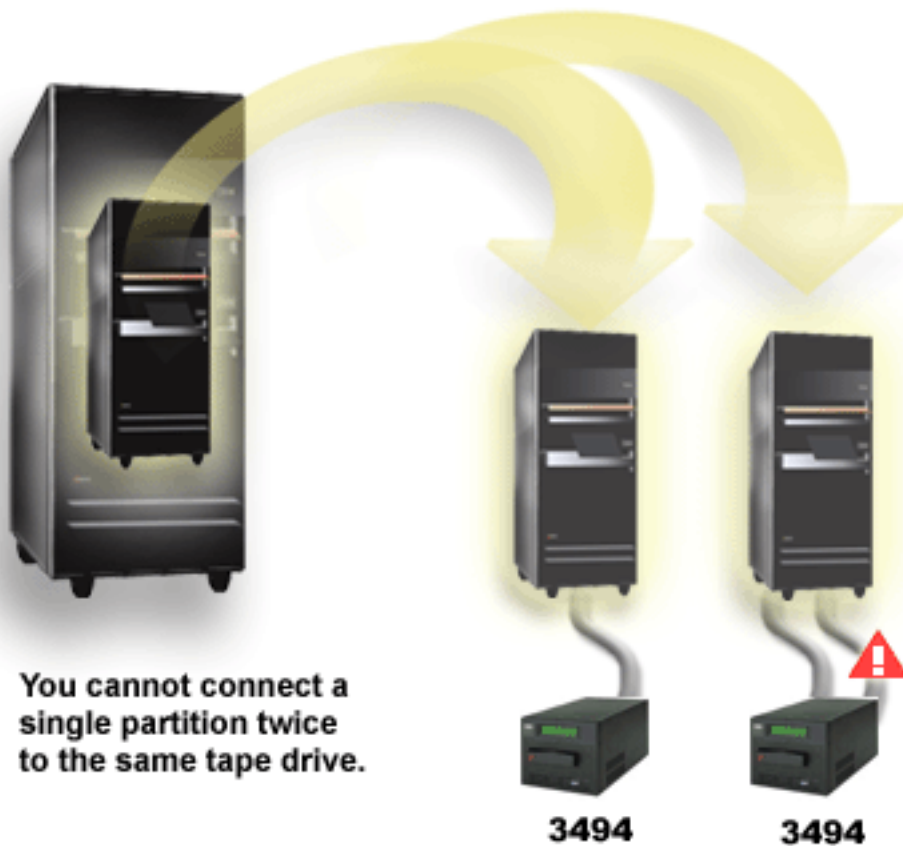
Figure 7. Unsupported configuration

Configuring of different platforms with the 3494 Enterprise Tape Library
The IBM System Storage Enterprise Tape Library 3494 can be shared by IBM i, System p, and ES/9000 systems for a total of 16 systems. IBM i products can share cartridges in the library.

The other systems can share the library by partitioning the 3494 tape library, and individual cartridges can be assigned to a particular processor. This is done by assigning each cartridge to a category.

Installing stand-alone tape devices

The instructions for installing and configuring your tape device vary based on which model of IBM i you have and which type of tape device you are installing.

Related information
Tape Storage Publications

Sharing tape drives between partitions
You can assign a stand-alone tape device to a partition or leave a tape device unassigned and share it between partitions.

You can choose whether you want your stand-alone tape device assigned to a partition when the tape device is varied on. Assigning a tape device reserves the tape device specifically for one partition. If it is not assigned, then multiple partitions can share the device. For a device to be shared it either needs to have multiple ports or be connected via a SAN.

Note: If a SAS tape or library device is shared between partitions, IPLing the adapter or partition will disrupt any operation using the device from the other partition, even if the device is assigned to the other partition.

To assign a tape device to a system, do the following steps.

1. Use the Work with Device Description (WRKDEVD *TAP) command to work with the tape device description.
2. Select 8 (Work with status) to view the current device status. If the device is varied on it will need to be varied off before the assign value can be changed. Use option 2 (Vary off) to vary off the tape device if necessary.
3. Select 2 (Change) for the tape device you want to use and enter *YES for the *Assign device at vary on* parameter.
4. Select 8 (Work with Status) and use option 1 (Vary on) to vary on the tape device.

If the tape device is being used by another partition, a message is displayed that indicates the tape device is assigned elsewhere. The tape device must be varied off at the other partition before it can be varied on at a new partition.

To leave a tape device unassigned, do the following steps.

1. Use the Work with Device Description (WRKDEVD *TAP) command to work with the tape device description.
2. Select 8 (Work with status) to view the current device status. If the device is varied on it will need to be varied off before the assign value can be changed. Use option 2 (Vary off) to vary off the tape device if necessary.
3. Select 2 (Change) for the tape device you want to use and enter *NO for the *Assign device at vary on* parameter.
4. Select 8 (Work with status) and use option 1 (Vary on) to vary on the tape device.

An unassigned tape drive can be in the varied on state on multiple partitions at the same time, but only one partition can be actively using the device.

Configuring the SCSI address for half-inch and Magstar MP tape units
Configure the Small Computer System Interface (SCSI) address for half-inch and Magstar MP tape units.

For a 34*xx* or 35*xx* tape device attached to a SCSI input/output adapter (IOA), you must set the SCSI address to 0 when the device is used for an initial program load (IPL). The SCSI address can be set to any address except 7 when the device is not being used for an IPL.

For a 34*xx* tape device attached to a type 2644 IOP, you must set the controller address to address 7. The device address must be set to address 0 when the device is used for an IPL. You can use address 8 when there is no device at address 0. You can set the controller and device to any value when the device is not being used for an IPL.

Installing tape libraries

When you install tape libraries the system automatically configures and varies on an attached tape library.
Related concepts
Setting up a tape library as an alternate IPL device
Use the devices in a tape library for alternate initial program load (IPL) when they are attached to an input/output processor (IOP) and input/output adapter (IOA) in a position that supports an alternate IPL.

Related information
Tape Storage

Configuring tape libraries

After you have set up the tape library and connected it to your partition, the partition automatically configures it.

If you change the physical or logical configuration of a tape library you need to re-IPL all of the attached IOPs or cycle power on all of the attached IOAs to cause the IBM i partition to re-configure the tape library. Because of this requirement, tape library devices and disk units should not be on the same IOA.

The system creates a device description that is named TAPMLB *xx*, where *xx* is the next available device description number, and configures any associated tape resources (MLBRSC) and tape device descriptions (TAP *xx*). The system creates tape device descriptions for each tape resource that is connected to the primary path. These tape device descriptions are used for stand-alone operations for service and when the tape library is in stand-alone, auto (sequential), or manual mode.

Configuration Requirements:

1. A tape device description is required for each device resource for the tape library device to operate properly.

2. A maximum of 32 drives from a logical library can be attached to an IBM i partition.

3. When the tape library is attached using an I/O adapter with an IOP, or when running releases earlier than IBM i 7.1, drives with different capabilities within the same tape library must either be connected to separate IOAs or the tape library must be partitioned so that each type of drive is in a separate logical partition. When running IBM i 7.1 or later with an IOPless configuration, drives with different capabilities can be connected to the same IOA. There must be at least one control path drive that is defined for each kind of drive. There is a separate tape library device description created for each kind of tape device within the tape library.

4. If multiple tape library devices are attached to a multiple port SCSI IOA, every library device and drive attached to the same IOA must have a unique SCSI address.

5. Tape library devices and tape drives are not allowed to have multiple connections to the same IBM i partition unless the partition is running IBM i 7.2 TR2 or a later release. For more information about multiple connections, see the Tape multipath topic.

6. When running IBM i 6.1 and an IOPless configuration there must be at least 1 control path drive per IOA. Multiple control path drives are not recommended. All of the media in the tape library is required to have a bar code label. The maximum number of elements in one logical library is limited to 5000.

7. When running IBM i 6.1.1 with an IOPless configuration and PTF MF50093 applied there must be at least 1 control path driver per IOA port. Multiple control path drives are not recommended. The maximum number of elements in one logical library is limited to 5000 unless PTFs MF55406 and MF50093 are applied. PTF MF55406 enables support for tape library devices with up to 15,000 storage elements.

8. When running IBM i 7.1 with an IOPless configuration there must be at least one control path drive per IOA port. Multiple control path drives can be attached to the same IOA port and if a control path drive fails the library operations will automatically switch over to use a different control path drive. The maximum number of elements in one logical library is limited to 5000 unless PTF MF55409 is applied. PTF MF55409 enables support for tape library devices with up to 15,000 storage elements.

9. If a TS7610/TS7650 (ProtecTIER®) drive is going to be used for an alternate IPL device (D-mode), there can only be one drive visible on the adapter as the alternate restart device.

To prepare a tape library, other than a 3494 tape library, for use, take the following steps.

1. Ensure that the tape library is set to random or library mode. If it is not, use the device panel or GUI interface to set the correct mode.

2. At the character-based interface, type WRKMLBSTS and press Enter. This command allows you to work with the status of the device.

3. In the option field next to each resource, select option 4 (ALLOCATE) or option 5 (UNPROTECTED) and press Enter. This step makes the resource available to the tape library.

4. Add cartridges to the tape library. See the documentation for your media management application, or "Making cartridges available to the tape library inventory" on page 47 for more information.

The 3494 tape library supports connections to multiple 3490, 3590, and 3592 tape devices within the same physical unit. When the system configures these devices, it creates a unique device description for each kind of tape device in the physical 3494 tape library. When any of these device descriptions is varied on, all devices of that type within that 3494 tape library will be associated with it.

To prepare a 3494 tape library for use, take the following steps.

1. Ensure that the tape library is set to automated mode. If it is not, use the device panel to set it to automated mode.
2. Create a data link for a 3494 tape library. Creating a data link defines the communication line associated with the tape library.
3. At a command line, type WRKMLBSTS and press Enter. This allows you to work with the status of the device.
4. In the option field next to each resource, enter option 4 (ALLOCATE) or option 5 (UNPROTECTED) and press Enter. These options make the resource available to the tape library.
5. Add cartridges to the tape library.

Related tasks
Making cartridges available to the tape library inventory
Before you can use the tape library, you must have media loaded and available.

Reassigning cartridges when the system name changes
When the system name is changed, you should reassign cartridges.

Adding a tape library to a LAN
Follow these steps to add a LAN to your library.

To add the LAN host to the 3494 tape library, you need the LAN connection information from the system.

To receive that information, use the following command:

```
DSPLANMLB LIND(TRNLINE) OUTPUT(*)
```

The command displays the following information.

Field	Description
Communication protocol	APPC
Host transaction program name	QMLD/QMLDSTRCC
Host network identifier	APPN
Host location name	SYSNAME
Host adapter address	0123456789AB

Add the LAN host to the 3494 tape library using the communication protocol given by the Display LAN Media Library (DSPLANMLB) command.

If you rename the Default local location name or the Local control point name on your system, the communication protocol type you use changes. You need to restart the 3494 tape library for these changes to take effect.

Related concepts
Creating a data link
A communication line must be created between the tape library and the library manager.

Creating a data link
A communication line must be created between the tape library and the library manager.

The 3494 tape library requires a communication line for the library manager functions. The communication line can be RS-232 asynchronous (ASYNC), LAN, or TCP/IP. Before the 3494 tape library can be varied on, the communication line needs to be specified in the ROBOTDEV or ROBOTHOST parameter in the tape library device description.

To create the data link between the tape library and the library manager, use the Configure Device MLB (CFGDEVMLB) command. This command uses the required input parameters to configure and connect the communications line to the tape library device description and attempts to vary on the tape library.

Notes:

1. To use the LAN connection, you must also add the LAN host to the 3494 Library Manager. For complete instructions, see the 3494 documentation.

2. If your 3494 tape library has the high-availability option installed so that your 3494 tape library uses two Library Manager personal computers, you need to configure two communication lines, one for each Library Manager personal computer.

Use one of the following procedures to create a data link.

Create an RS-232 ASYNC connection

To configure an RS-232 ASYNC connection to communicate with the 3494 Library Manager, use the following command:

```
CFGDEVMLB DEV(TAPMLB01) ADPTTYPE(*RS232) RSRCNAME(CMN02)
```

The following list explains the details of this command:

DEV(TAPMLB01)
Specifies the name of the tape library device description.

ADPTTYPE(*RS232)
Indicates that this tape library is attached through an RS-232 ASYNC line.

RSRCNAME(CMN02)
Specifies the resource name of the RS-232 port. Use Work with Hardware Resources (WRKHDWRSC) TYPE(*CMN) to determine what resource name is used.

Note: The RS-232 ASYNC line, controller, and device descriptions will be created as ONLINE(*NO). Do not vary them on. They will be varied on as needed by the operating system when the tape library is varied on.

Create a LAN connection using APPC

To configure a LAN connection to communicate using APPC, use the following command:

```
CFGDEVMLB DEV(TAPMLB01) ADPTTYPE(*LAN) PROTOCOL(*APPC) LIND(TRNLINE)
RMTLOCNAME(APPN.MLD01) ADPTADR(0123456789AB)
```

The following parameter list explains the details of this command:

DEV(TAPMLB01)
Specifies the name of the media library (MLB) device description.

ADPTTYPE(*LAN)
Indicates that this MLB is attached through a LAN line.

PROTOCOL(*APPC)
Specifies that APPC will be used as the communications protocol for the LAN connection to the 3494 tape library.

LIND(TRNLINE)
Specifies the line description name for the LAN line being used. Use Work with Configuration Status (WRKCFGSTS) CFGTYPE(*LIN) to display the list of valid LAN line descriptions. The line description for the LAN must be created before using the Configure Device Media Library (CFGDEVMLB) command.

RMTLOCNAME(APPN.MLD01)
Refers to the name of the Library Manager that is connected through the LAN line. It is of the form *nnnnnnnn.cccccccc* where *nnnnnnnn* is the network identifier and *cccccccc* is the remote location name. If no network identifier is specified, use Display Network Attributes (DSPNETA) to determine the default value. Obtain this parameter from the 3494 Library Manager console using the menu options, LAN options, and LM LAN information.

ADPTADR(0123456789AB)
Specifies the LAN adapter address of the Library Manager. You can obtain the parameter from the 3494 library manager console by selecting the following:

- Commands
- LAN options
- LM LAN information

Notes:

1. The LAN transaction program remains as QMLD/QMLDSTRCC and is contained in the Licensed Internal Code.
2. For APPC, any routers between thesystemand the 3494 tape library need to allow SNA traffic.

To configure a LAN connection using APPC to communicate to the 3494 Library Manager, use the following command:

```
DSPLANMLB LIND(TRNLINE) OUTPUT(*)
```

For detailed information about working with this information, see Adding a tape library to a LAN.

Create a TCP/IP connection

To configure a LAN connection using TCP/IP to communicate to the 3494 Library Manager, use the following command:

```
CFGDEVMLB DEV(TAPMLB01) ADPTTYPE(*LAN) PROTOCOL(*TCP) ROBOTHOST(MLD01) LCLINTNETA(192.168.5.10)
```

The following parameter list explains the details of this command:

DEV(TAPMLB01)
Specifies the name of the media library description.

ADPTTYPE(*LAN)
Indicates that this media library is attached through a LAN line.

PROTOCOL(*TCP)
Specifies that TCP/IP is used as the communications protocol for the LAN connection to the 3494 tape library.

ROBOTHOST(MLD01)
Specifies the TCP/IP host name for the 3494 tape library. The host name can be a fully qualified domain and host name.

LCLINTNETA(192.168.5.10)
Specifies the local Internet address of the interface that is connecting to the 3494 Library Manager. When TCP/IP needs to be started to use the 3494 tape library, the system will start the interface address.

Note: For TCP/IP only, after the media library device description is configured, use the Change Device Description-Media Library (CHGDEVMLB) command to set the Online at IPL parameter to *NO.

Related concepts
Adding a tape library to a LAN
Follow these steps to add a LAN to your library.

Related reference
Configure Device Media Library (CFGDEVMLB)

Sharing tape library resources
You can specify properties for a tape library to share tape library resources between systems.

Because library devices can be shared among multiple systems and users, it is possible to run more jobs that use a tape library than there are resources in the library.

As users send commands to the tape library, requests to use a resource are sent to a tape resource manager. The request waits until a resource becomes available. When a resource is available, the job is assigned the resource to complete that step. How the system handles the requests depends on the

Properties that you specify for the tape library in IBM Navigator for i, or by using the Change Job Media Library Attributes (CHGJOBMLBA) command.

To specify the properties for your tape library, do the following steps.

1. In IBM Navigator for i expand **Configuration and Service** > **All Tasks** > **Tape Devices** > **Tape Libraries**.
2. Right-click the library you want to work with and select **Properties**.
3. Select **Options**.
4. Specify the options that you want:
   - Tape resource selection priority
   - Initial mount wait time
   - End of volume mount wait time

The order in which requests are given a resource is determined by the option you specify for Tape resource selection priority. The length of time a request waits for a resource to become available is controlled by the length of time you specify for the request in Initial mount wait time and End of volume mount wait time. The time you specify in these properties can also be set in the tape library device description.

The character-based interface equivalent to the properties are the following parameters of the CHGJOBMLBA command:

- Resource allocation priority (RSCALCPTY)
- Initial mount wait time (INLMNTWAIT)
- End of volume mount wait time (EOVMNTWAIT)

You can use these parameters as a default or for a particular job using the CHGJOBMLBA command or the Change Job Media Library Attributes (QTACJMA) API. These values are used when a request is first sent to the resource manager. After a request has been sent to the resource manager and is waiting to be processed, it can be monitored and changed using the Work with Media Library Resource Queue (WRKMLBRSCQ) command.

The system can automate how multiple library resources are shared. For example, assume ten save operations (SAVLIBs) are issued, with ten different cartridges, to a tape library device description (TAPMLB01). If TAPMLB01 has only four tape resources available to it, the first four requests are issued, one to each tape resource. The remaining six are placed on a queue and are issued as tape resources become available. The order in which they are placed on the queue is based on the RSCALCPTY parameter in the tape library device description. The resource manager eliminates any idle time between jobs due to early completion, from either changing data or job failure.

You can use the initial mount wait time (INLMNTWAIT) value to alert you of a problem. In the previous example, the ten save operations are started at a given time and known, through estimates or benchmarking, to complete in six hours. Set the INLMNTWAIT time limit to six hours. If any of the save operations do not complete in six hours, an escape message is signaled to the jobs. A pager system can monitor for this message and page an operator to determine the necessary recovery actions.

You can share tape library resources between more than one system. Tape resources can be set to ALLOCATED, UNPROTECTED, or DEALLOCATED. To better facilitate sharing between systems, the UNPROTECTED status was added. When the tape resource is set to UNPROTECTED status, the tape resource is not assigned until it is needed. This prevents a tape resource from being assigned to a system that is not presently using it.

When sharing tape resources between systems and on the same system, each system has a resource manager with its queue controlled by the priority and time-out values. Between the systems, the tape resources are set to UNPROTECTED status. While sharing between systems does not have a priority concept, the UNPROTECTED status and the fact that tape resources are only assigned when they are in use allows the systems to effectively share the tape resources. The resource manager tries to get a resource by attempting to assign it. If another system has the resource, the job is placed back in the

queue and waits. In a few seconds another attempt is made to assign the job. If the job now gets the resource, the tape operation continues.

Using tape devices
Use the provided information to learn how to use your stand-alone tape device and tape libraries.
Related information
Tape and Optical Storage Publications

Using tape cartridges
Work with tape cartridges for both stand-alone tape devices and tape libraries.

To work with cartridges in stand-alone devices, follow these steps:

1. From IBM Navigator for i, expand **Configuration and Service** > **All Tasks** > **Tape Devices** > **Stand-Alone Devices**.
2. Select your stand-alone device.

To work with cartridges in tape libraries, follow these steps:

1. From IBM Navigator for i, expand **Configuration and Service** > **All Tasks** > **Tape Devices** > **Tape Libraries** > *your library*.
2. Select **Cartridges**.

For a detailed description of how to work with cartridges, see the IBM Navigator for i online help information. You can also work with cartridges by using the Work with Tape Cartridges (WRKTAPCTG) command from the character-based interface.

Duplicating tape cartridges
You can duplicate tape cartridges in both stand-alone tape devices and tape libraries.

For stand-alone devices to duplicate a tape, you must have two tape devices and follow these steps:

1. Make sure that the tape devices are available (varied on).
2. Load the tape to be copied into one tape device.
3. Load the tape receiving the information in the other tape device.

For stand-alone devices to duplicate a tape, the stand-alone devices must have a status of **Available**. Then, follow these steps:

1. In System i Navigator, expand *your system* > **Configuration and Service** > **Hardware** > **Tape Devices** > **Stand-Alone Devices**.
2. Right-click the tape device that contains the cartridge you want to duplicate and select **Duplicate**.

For tape library devices to duplicate a tape, you must have a library device with two or more tape resources or two devices, and complete the following steps before you duplicate a tape:

1. Make sure the tape library devices are available.
2. Make sure that the cartridges you want to duplicate are available for use by the tape library device.

If the tape that receives the information is new, you must format it before continuing.

For tape library devices to duplicate tape cartridges, the cartridge must have a status of **Available** or **Mounted**. Then, follow these steps:

1. In System i Navigator, expand *your system* > **Configuration and Service** > **Hardware** > **Tape Devices** > **Tape Libraries**.
2. Expand the tape library that contains the tapes you want to duplicate.
3. Select **Cartridges**.
4. Right-click the tape that you want to duplicate and select **Duplicate**. You can select multiple cartridges to duplicate.

Related tasks

Formatting tape cartridges
When you format a tape cartridge, a standard volume label is recorded at the beginning of the magnetic tape medium.

Formatting tape cartridges
When you format a tape cartridge, a standard volume label is recorded at the beginning of the magnetic tape medium.

When you format a tape, any information previously recorded on the tape medium is erased and written over with new information. Information is also written over when new data files are appended to the newly recorded volume label.

Note: Do not reuse an old tape volume if permanent read or write errors have been detected more than two times. Also do not reuse an old tape volume if temporary read or write errors for that volume are excessive. To determine if temporary errors are excessive, see Ensure tapes are in good condition.

To format a tape in a stand-alone device, the stand-alone device must have a status of **Available**. Then, follow these steps:

1. In System i Navigator, expand *your system* > **Configuration and Service** > **Hardware** > **Tape Devices** > **Stand-Alone Devices**.
2. Right-click your tape device and select **Format**.

To format a tape in a tape library device, the tape cartridge must have a status of **Available** or **Mounted**. Then you take the following steps to format the tape.

1. In System i Navigator, expand *your system* > **Configuration and Service** > **Hardware** > **Tape Devices** > **Tape Libraries** > your tape library.
2. Select **Cartridges**.
3. Right-click the cartridge that you want to format and select **Format**. You can select multiple cartridges to format.

The most commonly used options for formatting a tape cartridge are:

- Volume label
- Check for active files
- Tape density

Related tasks

Duplicating tape cartridges
You can duplicate tape cartridges in both stand-alone tape devices and tape libraries.

Ensuring tapes are in good condition
To ensure that your tapes are in good condition, keep track of the tape volume statistics on your system.

Using stand-alone devices
Learn how to use and manage your stand-alone tape devices.

There are several types of tape cartridges and stand-alone tape devices that are commonly used on the IBM i. See the operator's manual for your tape device for specific operating instructions. This information is common for most stand-alone devices.

Status lights
You can use the status lights to determine the status of the tape unit.

Quarter-inch tape status lights
Learn how to interpret the status lights for the SLR60 and SLR100 tape units.

Figure 8. SLR60 and SLR100 tape unit
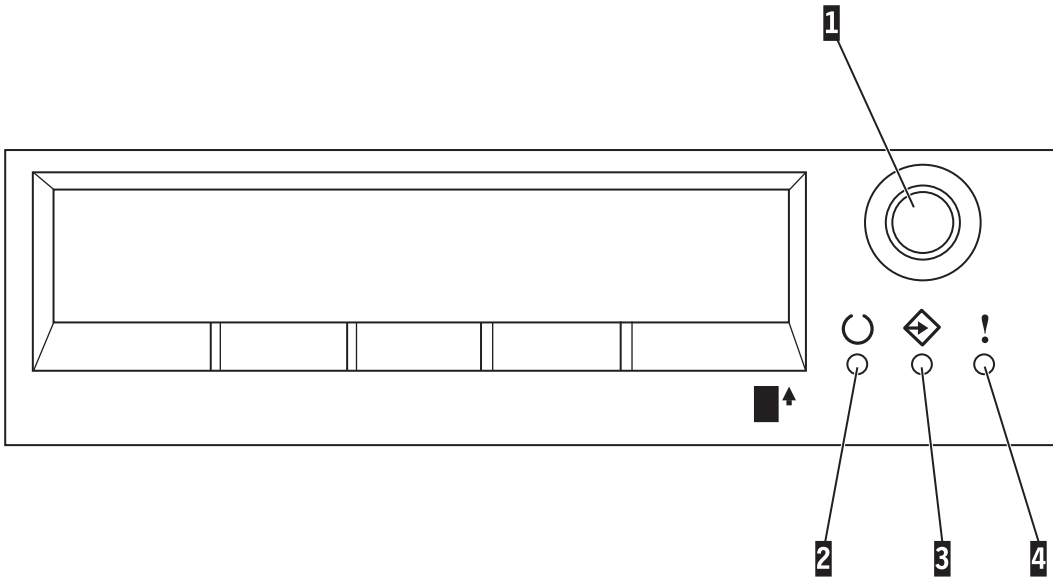
RZAM4518-1

The symbols that are located next to the status lights are the International Organization for Standardization (ISO) symbols that define the general functional of the status lights as follows.

Table 11. Interpreting the status lights			
Operation	**LED 2 Ready (green)**	**LED 3 Activity (green)**	**LED 4 Cleaning (amber)**
Power On LED Test (The LEDs are turned On One by One. The power-On self test starts in parallel with this test.)	On for 2.0 seconds	On for 2.0 seconds	On for 2.0 seconds
Diagnostic activity	Flashing	Off	Off
Cartridge not inserted or tape not loaded	Off	Off	Off
Cartridge not inserted or tape not loaded, cleaning required	Off	Off	On
Tape loaded, no tape movement	On	Off	Off
Tape loaded, tape movement	On	Flashing	Off
Tape loaded, no tape movement, cleaning required	On	Off	On
Tape loaded, tape movement, cleaning required	On	Flashing	On
Tape loading or unloading, or cartridge ejecting	On	Flashing	Off

Table 11. Interpreting the status lights (continued)

Operation	LED 2 Ready (green)	LED 3 Activity (green)	LED 4 Cleaning (amber)
Tape loading or unloading, or cartridge ejecting, cleaning required	On	Flashing	On
Cleaning	Off	Flashing	On
Unrecoverable drive failure, cartridge failure or microcode download failure	Off	Off	Flashing

Eight-millimeter tape status lights
Learn how to interpret the status lights for the VXA2 and VXA320 tape units.
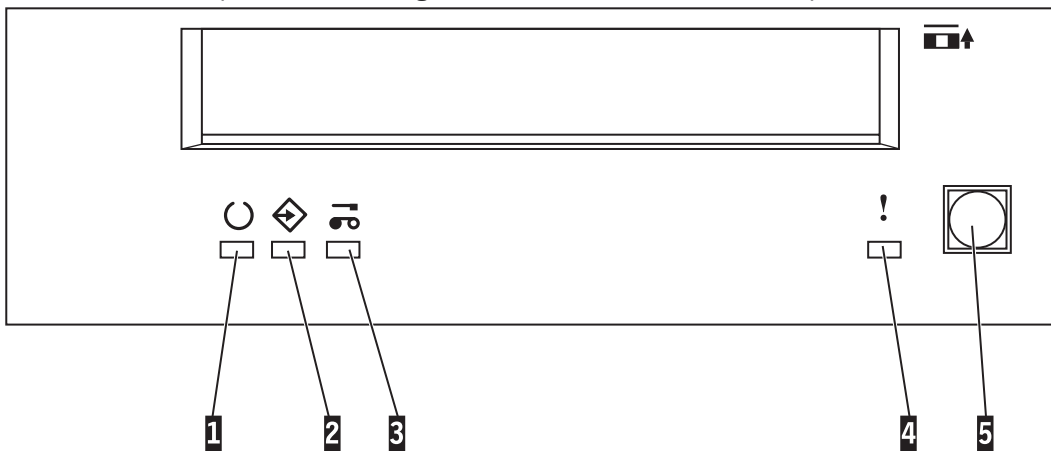
RZAM4517-1

Table 12. Interpreting the status lights

Operation	LED 1 Ready (green)	LED 2 Activity (green)	LED 3 Fault (amber)
Power-on LED test (The LEDs are turned on one by one.)			
Diagnostic activity	Flashing	Off	Off
Cartridge not inserted or tape not loaded	Off	Off	Off
Cartridge not inserted or tape not loaded, cleaning required	Off	Off	On
Tape loaded, no tape movement	On	Off	Off
Tape loaded, tape movement	On	Flashing	Off
Tape loaded, no tape movement, cleaning required	On	Off	On

Table 12. Interpreting the status lights (continued)

Operation	LED 1 Ready (green)	LED 2 Activity (green)	LED 3 Fault (amber)
Tape loaded, tape movement, cleaning required	On	Flashing	On
Tape loading or unloading, or cartridge ejecting	On	Flashing	Off
Tape loading or unloading, or cartridge ejecting cleaning required	On	Flashing	On
Cleaning	Off	Flashing	On
Unrecoverable drive failure, cartridge failure or microcode download failure	Off	Off	Flashing

Note:

1. Some of the LED indication states are difficult to see due to the short duration of the illumination.

2. The LED indicator lights are also used to indicate serious errors during the power-on stage. Serious errors are communicated during power-on by illuminating a single LED.

3. The Fault LED will flash to indicate an unrecoverable error. An unrecoverable error is an error condition that results in the drive not being able to function unless initiator, operator, or service intervention is applied. An unrecoverable drive failure is typically the result of a hardware error condition. One of the following actions is needed to clear the flashing Fault LED:

   - Hard SCSI reset
   - Cartridge eject
   - Power cycle
   - Try microcode download again

   An unrecoverable cartridge (media) failure is typically the result of a defective cartridge, media, or cartridge state and requires the drive to eject the cartridge (if possible) to clear the flashing LED.

4. The Fault LED steady On indicates that a head cleaning operation is recommended (the drive is still fully operational with this LED steady On). The LED is triggered after 50 hours of that the tape run time has elapsed or if a hard read error had occurred. The LED is reset by operating the cleaning cartridge in the drive.

DAT tape status lights
Learn how to interpret the status lights for the Dat72 4mm, DAT160 SAS, and DAT320 SAS tape units.

See Status Lights (FC 6258) for details on DAT72 status lights.

See Status Lights (FC 5619 and EU16) for details on DAT160 status lights.

See Status Lights (FC 5661) for details on DAT320 status lights.

LTO2 tape status lights
Learn how to interpret the status lights for the Half Inch LTO2 tape unit.

See Status Lights (FC 5755) for details on LTO2 status lights.

LTO4 tape status lights
Learn how to interpret the status lights for the Half Inch LTO4 tape unit.

See Status Lights (FC 5746) for details on LTO4 status lights.

LTO5 tape status lights
Learn how to interpret the status lights for the Half Inch LTO5 tape unit.

See Status Lights (FC 5638) for details on LTO5 status lights.

LTO6 tape status lights
Learn how to interpret the status lights for the Half Inch LTO6 tape unit.

See Status Lights (FC EU11) for details on managing tape drives.

Viewing the capabilities of a stand-alone device
Use IBM Navigator for i to view some of the capabilities for each stand-alone device.

- Assign capability
- Hardware data compression
- Whether the device is self-configured
- The highest instantaneous performance that is reported by the tape device.
- Densities supported by the tape device
- Capabilities associated with each density

To view the capabilities of a stand-alone tape device, follow these steps:

1. From IBM Navigator for i, expand **Configuration and Service** > **All tasks** > **Tape Devices**.
2. Select **Stand-Alone Devices**.
3. Right-click the tape device with the capabilities you want to view, and select **Properties**.
4. Select the Capabilities page.

Using tape libraries
You can use tape libraries to manage large amounts of data, either as part of a backup, archival and recovery system, or as part of typical IT operations.

Media management software, such as BRMS, automates many tape library functions. However, operating the tape library still requires that you manage both how the tape library resources are utilized and how it uses resources on the system. Moreover, maintaining cartridges is an integral part of tape library automation.

Tape library use without a media management application
While a media management application greatly simplifies and extends a tape library's capabilities, you can perform many tape functions in a IBM i environment with control language (CL) commands, which are part of the operating system.

The following table shows the typical setup and operational tasks and associated CL commands for the tape library.

Note: You need to use these commands if you do not use a media management application such as BRMS.

Task	Command
Creating a tape library device description	Auto-configured or use Create Device Description (Media Library) (CRTDEVMLB)
Displaying RS-232/LAN resource and description	Display Hardware Resources (DSPHDWRSC)
Configuring the 3494 communication (RS232/LAN/TCP)	Configure Device Media Library (CFGDEVMLB)

Task	Command
Display LAN information for 3494 and LAN host	Display LAN Media Library (DSPLANMLB)
Removing a tape library device description	Delete Device Description (DLTDEVD)
Changing the tape library device description	Change Device Description (Media Library) (CHGDEVMLB)
Changing the tape library device attributes for a job	Change Job MLB Attributes (CHGJOBMLBA) command or Change Job MLB Attributes (QTACJMA) API
Displaying the tape library device attributes for a job	Display Job (DSPJOB) OPTION(*MLBA) or Work with Job (WRKJOB) OPTION(*MLBA)
Retrieving the tape library device attributes for a job	Retrieve Job MLB Attributes (QTARJMA) API
Displaying tape library information	Display Tape Status (DSPTAPSTS)
Checking the status of the tape library	Work with Media Library Status (WRKMLBSTS)
Creating user categories	Create Tape Category (CRTTAPCGY)
Mounting a category	Set Tape Category (SETTAPCGY) OPTION(*MOUNTED)
Demounting a category	Set Tape Category (SETTAPCGY) OPTION(*DEMOUNTED)
Assigning a mounted category to a different job	Set Tape Category (SETTAPCGY) OPTION(*ASSIGN)
Releasing a mounted category from a job	Set Tape Category (SETTAPCGY) OPTION(*RELEASE)
Deleting a user category.	Remove all the cartridges from the category. Use the Delete Tape Category (DLTTAPCGY) command
Listing all user or system categories	Display Tape Category (DSPTAPCGY)
Changing the category for cartridges	Change Tape Cartridge (CHGTAPCTG) or Work with Tape Cartridges (WRKTAPCTG)
Inserting cartridges	Add Tape Cartridge (ADDTAPCTG) or Work with Tape Cartridges (WRKTAPCTG)
Ejecting cartridges	Remove Tape Cartridge (RMVTAPCTG) or Work with Tape Cartridges (WRKTAPCTG)
Mounting cartridges for input or output commands	Specify the tape library device and cartridge identifier with the commands
Demounting a cartridge	Demounting is implicit with ENDOPT(*UNLOAD), a demount of a category, or a new mount request
Working with a list of cartridges within a tape library	Work with Tape Cartridges (WRKTAPCTG)
Displaying information about a cartridge	Display Tape Cartridge (DSPTAPCTG) or Work with Tape Cartridges (WRKTAPCTG)
Working with the tape library resource manager queue	Work with MLB Resource Queue (WRKMLBRSCQ)

Task	Command
Retrieving the capabilities for a tape library device or resource	Retrieve Device Capabilities (QTARDCAP) API
Retrieve the status for a tape library device or resource	Retrieve Device Status (QTARDSTS) API
Retrieving the information for a tape library	Retrieve Device Information (QTARDINF) API

Note: An end-of-tape option of *UNLOAD for any of the tape commands causes the cartridge to be returned to a storage cell when the tape operation has completed processing. It might not be returned to its original storage cell. When using the *REWIND parameter the cartridge remains in the drive after the tape operation has completed. However, this cartridge is unloaded if another cartridge has been requested. When using *LEAVE the cartridge remains in the drive after the tape operation has completed.

Related information

Control language (CL)

Reassigning cartridges when the system name changes
When the system name is changed, you should reassign cartridges.

If you change your system name, you must move the cartridges from the categories that were owned by the old system name to categories that are owned by the new system name. If you do not do this, the cartridges will not appear in the inventory for the new system name.

For some library types, the cartridges may appear when you use the parameter CGY(*ALL *ALL) for the Work with Tape Cartridges (WRKTAPCTG) or the Display Tape Cartridge (DSPTAPCTG) command, but you will not be able to use the cartridges.

If you have already changed the system name and need to recover the cartridges, perform the following steps:

1. Type DSPTAPCGY (the Display Tape Category command) to display all of the tape categories. Record the names of the user-defined categories for use in step 3, and then exit.
2. Temporarily change the system name back to the previous name by using the Change Network Attributes (CHGNETA) command.

   Important: Do not restart the system.
3. If you were using user-defined categories with the old system name, type CRTTAPCGY (the Create Tape Category command) to create the same user-defined categories from step 1, for the new system name.
4. Type WRKTAPCTG (the Work with Tape Cartridge command) to work with all of the categories that are associated with the old system name.

   ```
   WRKTAPCTG DEV(mlb-name)
     CGY(*ALL old_system_name)
   ```

5. Change the category system name to the new system name by selecting 2 **Change** with the parameter CGY(*SAME new_system_name).
6. Type CHGNETA (Change Network Attributes) to return the system name to the new system name.

Important: Do not restart the system.

Related concepts

Cartridge categories
A *category* is a logical grouping of cartridges. A category allows you to refer to a group of cartridges by category name instead of the individual cartridge identifiers.

Related tasks

Configuring tape libraries

After you have set up the tape library and connected it to your partition, the partition automatically configures it.

Setting up a tape library as a stand-alone device
Occasionally, it might be necessary to use the tape resources in a tape library without the benefit of automation; for example, when you perform an alternate IPL or when the tape library automation is disabled.

Using the tape resource in this fashion is referred to as stand-alone mode. In stand-alone mode, the tape resource operates like other tape devices that are not in a tape library. Most tape libraries provide modes or commands to move media to a tape resource. See the operator information for your tape library for the different operating modes available. When automation is not used, the tape library operates as an automatic cartridge loader for the tape device and loads cartridges individually or sequentially in the device.

Tape library devices are configured with tape library device descriptions for the tape library. There are also separate tape device descriptions for the tape resources. These tape device descriptions are the devices that are used for stand-alone operation.

Restriction: To use the tape resources in stand-alone mode, the resource must be available to the tape device description.

Do the following steps:

1. Either deallocate the tape resource from the tape library or vary off the tape library device.
2. Vary on the tape device description, and send commands to this device.

   The tape resource in System i Navigator shows a status of **Unavailable**. No tape library functions operate for this tape resource.
3. Mount the cartridges manually, by a device mode, or by device operator panel commands.

Related concepts
Tape library operating modes
Most tape library devices support three basic modes of operation.

Setting up a tape library as an alternate IPL device
Use the devices in a tape library for alternate initial program load (IPL) when they are attached to an input/output processor (IOP) and input/output adapter (IOA) in a position that supports an alternate IPL.

The devices must be set to the correct address.

You can use alternate installation for tape libraries that are attached to an IOP and IOA even if the alternate installation is not in a position that supports alternate IPL.

Related concepts
Installing tape libraries
When you install tape libraries the system automatically configures and varies on an attached tape library.

Related information
Recovering your system
Managing Devices

Controlling tape library resources using tape library attributes
Depending on your business environment you might want to control the use of tape resources to allow important jobs to finish quickly. IBM i provides several features for this.

You can use the Change Job Media Library Attributes (CHGJOBMLBA) command to change the priority of tape resource requests for a particular job, and the Work with MLB Resource Queue (WRKMLBRSCQ) command to work with the tape resource manager queue.

Changing tape library job attributes

The CHGJOBMLBA command allows you to change the resource allocation attributes for your own job or another user's job if you have *JOBCTL special authority. You can use the resource allocation priority to change the priority of requests to use a tape resource within a tape library. You can assign a higher priority to certain jobs to allow them to get a tape resource as soon as one becomes available. You can assign a lower priority to jobs that can wait until all other higher priority jobs finish using the tape resources. Typically, very short-running tape operations such as the dynamic retrieval of an object that was saved storage free should be assigned a high resource allocation priority. Long-running jobs that are not required to finish quickly, such as Duplicate Tape (DUPTAP) or Display Tape (DSPTAP), can be assigned a lower resource allocation priority.

You can also add *MLBA to either the Work with Job (WRKJOB) or Display Job (DSPJOB) command in order to view or adjust your tape library attributes.

Changing access to a tape resource within a library

The WRKMLBRSCQ command allows you to manipulate the requests to use a tape resource within a tape media library. The WRKMLBRSCQ command shows the resources that are currently processing a request that have a category mounted, or the requests that are waiting to be assigned a tape resource. You can change the resource allocation attributes for requests that are waiting to use a tape resource by using the (Change Request MLB) attributes on the Work with MLB Resource Queue (WRKMLBRSCQ) display. The attributes for the next request can be changed by using the CHGJOBMLBA command to change the resource allocation attributes for the job that is currently using the tape resource. You can do this by using the (Work with job) attributes on the Work with MLB Resource Queue (WRKMLBRSCQ) display, and then selecting (Work with media library) attributes.

There are times when a request shows a priority of 0. These requests occur when a tape resource is being used by the system for a tape operation. An example is when a tape command using ENDOPT(*UNLOAD) is completed and the system is still unloading the cartridge.

Related information

Control language (CL)

Controlling tape library resources with APIs
Use the Retrieve Job Media Library Attributes (QTARJMA) and Change Job Media Library Attributes (QTACJMA) APIs to retrieve and to change the tape library attributes for a specific job.

Special attention to authority requirements is required when retrieving and changing the resource allocation attributes. The following provides examples of using both APIs.

1. An application using the QTARJMA API retrieves information about the tape library attributes for the current job where the user running the job does not have *JOBCTL special authority.

Current library attributes			
MLB name	**RSCALCPTY**	**INLMNTWAIT**	**EOVMNTWAIT**
*DEFAULT	*DEV	*DEV	*DEV

2. The application then uses the QTACJMA API to change the initial mount wait time (INLMNTWAIT) and the end of volume mount wait time (EOVMNTWAIT).

The application changes the library attributes			
MLB name	**RSCALCPTY**	**INLMNTWAIT**	**EOVMNTWAIT**
*DEFAULT	*DEV	*IMMED	*NOMAX

3. A system administrator with *JOBCTL special authority uses the CHGJOBMLBA command to change the resource allocation priority (RSCALCPTY), initial mount wait time, and the end of volume mount wait time.

System administrator changes attributes			
MLB name	**RSCALCPTY**	**INLMNTWAIT**	**EOVMNTWAIT**
*DEFAULT	50	*IMMED	500

4. The application tries to use the QTACJMA API to restore the tape library attributes it retrieved earlier by using the QTACJMA API *REPLACE option. However, this function fails with an error message of CPF67B4 because the user does not have *JOBCTL special authority. None of the attributes are changed.

Original application fails to restore attributes			
MLB name	**RSCALCPTY**	**INLMNTWAIT**	**EOVMNTWAIT**
*DEFAULT	50	*IMMED	500

Related reference

Retrieve Job Media Library Attributes (QTARJMA) API
Change Job Media Library Attributes (QTACJMA) API

Making cartridges available to the tape library inventory
Before you can use the tape library, you must have media loaded and available.

If a tape library is empty, open the door and insert all available media into the empty slots. This can be done to save time rather than inserting only a small number at a time through the convent input/output (I/O) station. When the door is closed, the tape library inventories the contents. Each cartridge ID is noted and recorded in the operating system and the Library Manager (if present).

Most tape libraries provide an I/O station for adding cartridges without interrupting any automatic operations. An I/O station can have multiple slots or just a single slot. Some tape libraries have no I/O station. For these tape libraries, cartridges are added by stopping the automation and opening the door to access the storage slots.

Tape cartridges that are placed in the 3494 I/O station are moved to a storage slot by the 3494 Library Manager software. For other tape libraries, the tape cartridges remain in the I/O station until you make them available using System i Navigator. When you make a cartridge available you must specify a category of media. Also, making a cartridge available changes the cartridge status.

To make a cartridge available, do the following steps:

1. In System i Navigator, expand **My Connections** > *your system* > **Configuration and Service** > **Hardware** > **Tape Devices** > **Tape Libraries** > *your tape library*.
2. Select **Cartridges**.
3. Right-click a cartridge that has a status of Inserted and select **Make Available**. You can select multiple cartridges to add to a category.

You can also use the Add Tape Cartridge (ADDTAPCTG) command to make a cartridge available.

Related concepts

Cartridge categories
A *category* is a logical grouping of cartridges. A category allows you to refer to a group of cartridges by category name instead of the individual cartridge identifiers.

Cartridge status
These descriptions describe the status for a tape cartridge in relation to a tape library.

Related tasks

Configuring tape libraries
After you have set up the tape library and connected it to your partition, the partition automatically configures it.

Related information

Add Tape Cartridge (ADDTAPCTG) command

Ejecting cartridges from the tape library inventory
All tape library devices use System i Navigator to eject cartridges. You can also use the Remove Tape Cartridge (RMVTAPCTG) command to change media to the *EJECT category.

When you eject a cartridge, you can eject it to one of three locations:

- Tape library default
- Convenience station
- High capacity output station

To select tapes to eject from the Cartridge folder, follow these steps:

1. In System i Navigator, expand **My Connections** > *your system* > **Configuration and Service** > **Hardware** > **Tape Devices** > **Tape Libraries** > *your tape library*.
2. Select **Cartridges**.
3. Right-click the cartridge you want to eject and select **Eject Cartridge**. You can select multiple cartridges to eject.

Note: If you are using the character-based interface, cartridges that are in the convenience (*CNV) category are exported when they are unloaded from a tape resource for a tape command that is using ENDOPT(*UNLOAD). If a cartridge in the *CNV category is unloaded from a tape resource by the system to load another cartridge, the cartridge that was in the tape resource will not be ejected from the tape library.

Related reference
Remove Tape Cartridge (RMVTAPCTG) command

Using the mounted category to load groups of tapes into a tape device
The mounted category allows a group of tapes to automatically be loaded into a tape device.

The media is mounted in the order in which it was placed into the category. It is similar in function to an Automatic Cartridge Loader (ACL) on the stand-alone 3490 devices. This function is available with the Set Tape Category (SETTAPCGY) command. The mounted category is provided for all tape library devices.

Loading groups of tapes into a tape device

To load groups of tapes into a tape device for 3494 devices, use the Library Manager software. To load groups of tapes into a tape device for libraries other than 3494, use the SETTAPCGY command.

The 3494 Library Manager software loads the next tape as soon as the previous tape is unloaded. For all other libraries, the tape resource is not loaded until a tape command requiring media is issued to the tape library device.

With a category mounted, a tape resource is dedicated for category mount operations until a SETTAPCGY (*DEMOUNTED) command is issued. When the SETTAPCGY has been issued, any IBM i command to the tape library device with VOL(*MOUNTED) will be directed to the tape resource that is set up for the mounted category.

Mounting category considerations

One category of cartridge can be mounted per available tape resource. To mount more than one category for a tape library, the MNTID parameter must be used with the SETTAPCGY command to identify the mounted category operations. A job can only have one mounted category session active at a time. The mounted category session can be released from the job that mounted the category of cartridges and can be assigned to another job by using the *RELEASE and *ASSIGN options on the SETTAPCGY command.

Notes:

1. Tape management systems are notified when a category of cartridges is mounted and demounted. When a command comes from a user to VOL(*MOUNTED), the tape management system has the ability to accept or reject the operation.

2. Backup, Recovery, and Media Services (BRMS) does not use the mounted category to perform its processing. Avoid using the mounted category in combination with BRMS functions. Mounting a category of cartridges while concurrently using BRMS to perform tape operations can have unpredictable results.

Related reference

Set Tape Category (SETTAPCGY) command

Sharing cartridges
You can share the cartridges in a tape library between multiple platforms and systems.

When the system is using a cartridge in a 3494 tape library, the cartridge must be in a category accessible to the system. This can be the *SHARE400 category or a user-defined category.

Volume protection between platforms

When initializing a tape, the system cannot write a 1-character security flag to the tape label. This is to restrict users who might read data from tapes initialized this way. Even though writing this security flag is not available in IBM i, it can read tapes written with this security flag in the tape label. When IBM i detects the security flag, it decides whether that user can read the data, depending on the user's special authorities.

When the tape contains EBCDIC data, all users can read the tape when the security flag contains a space (hexadecimal 40), a zero (hexadecimal F0) or a hexadecimal 00. If it contains any other value, the user needs *ALLOBJ and *SECADM authority to read data from the tape.

If the tape contains ASCII data, all users can read the tape if the security flag contains an ASCII space (hexadecimal 20). If it contains any other value, the user requires *ALLOBJ and *SECADM authority to read data from the tape.

You cannot specify this security flag when a tape is initialized on the system and is to be read on another platform.

End of volume
If your system runs out of tape cartridges specified in the volume list, the CPA6798 inquiry message appears.

To be a fully automated solution without a tape management system, each volume needed must be specified in the VOL parameter on the command. If the system runs out of tape cartridges specified in the volume list, the CPA6798 inquiry message is issued, which directs the user to supply an additional cartridge so that the tape operation can continue. If the cartridge supplied is not found or not available, the CPA6797 inquiry message is sent, which directs the user to supply an alternate cartridge to continue the tape operation. Tape management systems have the ability to provide more volumes through exit points in the IBM i tape functions.

Related concepts

Avoiding deadlocked files during save and restore operations with tape libraries
Tape automation uses special files located in the QUSRSYS library. If these files do not exist on the system, IBM i supports a limited set of automation functions.

Avoiding deadlocked files during save and restore operations with tape libraries
Tape automation uses special files located in the QUSRSYS library. If these files do not exist on the system, IBM i supports a limited set of automation functions.

For automation in the early stages of recovery scenarios, you can mount cartridges by specifying the cartridge identifiers in the VOL parameter of the IBM i commands. However, this type of automation does not support the use of the cartridge commands, such as Work with Tape Cartridges (WRKTAPCTG) or Display Tape Cartridge (DSPTAPCTG).

When the QUSRSYS library is being saved, the files that allow use of the WRKTAPCTG or DSPTAPCTG commands might be put in a restricted state and made unavailable for use. This can result in a deadlock and eventually end the save operation. To avoid this situation, when the QUSRSYS library is being saved,

it must not cross a volume boundary. It must fit on the mounted volume. Alternatively, you can save the QUSRSYS library by using the save-while-active function.

Related concepts

End of volume

If your system runs out of tape cartridges specified in the volume list, the CPA6798 inquiry message appears.

Optimizing tape library performance

Optimize the performance of your tape library by using work management and load balancing techniques. You can also attempt to improve the performance by using different connection configurations.

Note: If you attach a tape library containing high speed tape drive resources (LTO4, LTO5, LTO6, LTO7, LTO8, 3593-E06, 3592-E07, 3592-E08, and 3592-55F) you should avoid attaching multiple high speed tape devices to the same IOA port if you are planning to use them simultaneously.

If you are running IBM i 7.2 TR2 or a later release and have a multipath connection to a Fibre Channel tape device, you might be able to change the preferred path to one with a faster interface. For more information, see the Tape multipath topic.

See the Save/Restore Performance chapter of the IBM i Performance Capabilities Reference for more information.

For more detailed information about performance, see the Resource Library section of the Performance Management Web site.

Related information

Performance Management

Viewing the capabilities of a tape library

You can use IBM Navigator for i to view the capabilities for each tape library.

- Assign capability
- Hardware data compression
- Whether the device is self-configured
- The highest instantaneous performance that is reported by the tape device
- Densities supported by the tape device
- Capabilities associated with each density

To view the capabilities for a tape library, follow these steps:

1. In IBM Navigator for i, expand **Configuration and Service** > **All tasks** > **Tape Devices** > **Tape Libraries**.
2. Expand the tape library.
3. Select **Tape Resources**.
4. Right-click the tape resource that has the capabilities you want to view, and select **Properties**.
5. Select the Capabilities page.

Tape Multipath

Allow most Fibre Channel tape and tape library devices to be attached multiple times to the same partition.

With IBM i 7.2 TR2 and later releases, support is added to allow most Fibre Channel tape and tape library devices to be attached multiple times to the same IBM i partition.

- Up to eight paths are supported for each device.
- The multipath functions available depends upon the capabilities of the attached tape and tape library devices.
- For maximum redundancy, you can use both ports of the tape devices to attach to the partition.

- Because tape devices are sequential access devices, only one path to the device can be active at a time.

Multipath support with failover is provided for the following newer technology tape and tape library devices.

- Fibre Channel LTO5, LTO6, LTO7, and LTO8 drives in the 7226 enclosure.
- TS3100/TS3200 (3573) with LTO5, LTO6, LTO7, and LTO8 Fibre Channel drives.
- TS3310 (3576) with LTO5, LTO6, LTO7, and LTO8 Fibre Channel drives.
- TS3500/TS4500 with LTO5, LTO6, LTO7, LTO8, 3592-E07, and 3592-E08, 3592-55F, and 3592-60F Fibre Channel drives.
- TS3500 with 3592-E05 and 3592-E06 Fibre Channel drives. (requires 7.2 PTF MF64644 or 7.3 PTF MF64645 or 7.4)
- ProtecTIER virtual tape library.

Multipath support with automatic failover

For the newer technology tape and tape library devices and IBM i 7.2 TR3 and later releases, attaching the same device multiple times to different adapters or adapter ports on the same IBM i partition provides a configuration where I/O path failures can be automatically recovered for most types of errors by the system switching the I/O to an alternative path. In the cases where automatic recovery is not possible then the manual failover support added with IBM i 7.2 TR2 can still be used.

Multipath support with manual failover

For the newer technology tape and tape library devices and IBM i 7.2 TR2, attaching the same device multiple times to different adapters or adapter ports on the same IBM i partition provides a configuration where I/O path failures can be recovered by vary off and vary on of the affected device descriptions, or deallocate and allocate of a failing resource within a tape library device to switch to an alternative path.

Multipath tolerance

For most of the older technology tape and tape library devices, attaching the same device multiple times to a different adapter or adapter ports on the same IBM i partition provides a usable configuration that behaves the same as if there was only one path to the device for most operations.

Multipath tolerance is provided for the following drives:

- TS3100/TS3200 (3573) with LTO3 and LTO4 Fibre Channel drives.
- TS3310 (3576) with LTO3 and LTO4 Fibre Channel drives.
- TS3400 (3577) with 3592-E05 and 3592-E06 Fibre Channel drives.
- TS3500 with LTO2, LTO3, LTO4, 3592-J1A Fibre Channel drives.
- SAS attached tape devices and tape libraries.

Note: It is strongly recommended that you do not leave the above devices in a multipath configuration.

The following restrictions apply for these devices:

- A different device description can be automatically varied on during each partition IPL for each multipath attached device.
- It takes more time to process any Online at IPL requests for tape during partition IPL.
- For these devices, there is a 9020 Product Activity Log entry with secondary code 00000050 created for every additional path to the device.
- The system will not be able to recover from configuration changes and I/O path errors for these devices.

No multipath support

Multipath tape attachment is not supported for the following devices.

- SCSI attached tape devices.

- 3494 tape library.

For more information about tape multipath support, see IBM Removable Media on IBM i

How to use tape multipath devices

For multipath attached tape library devices, there is a Media Library (MLB) device description that is created for each path to the tape library device that has a control path drive. The same tape device resource names are shown for each of the MLB device descriptions and they can be deallocated, allocated, or allocated unprotected as wanted with the **WRKMLBSTS** (Work with Media Library Status) command. The resource names that are shown in the **WRKMLBSTS** command do not always indicate the active path resource. Any varied on MLB device description with allocated resources can be used for commands.

For multipath attached stand-alone tape devices, a tape device description is created for only the preferred path to the tape device. If the preferred path is changed, a new device description is created for the resource that uses that path. The resource name that is associated with this device description might not be the resource name of the active path. The varied on device description can be used for commands.

Managing tape multipath
Manage tape multipath with Dedicated Service Tools (DST) or System Service Tools (SST).

Tape multipath configurations are managed by using the DST or SST tools and use the same interfaces that are used for managing disk device multipath configurations.

Viewing the multipath connections

1. From the **Use Dedicated Service Tools** or **System Service Tools** display, select **Start a Service Tool**.
2. From the **Start a Service Tool** display, select **Hardware service manager**.
3. From the **Hardware Service Manager** display, select **Packaging hardware resources (systems, frames, cards,...)**.
4. Find the packaging resource for the Tape Subsystem that you want to work with and select **Hardware contained within package** to show the **Devices Contained Within Package** display.

The tape multipath information is shown as part of a "Tape Subsystem" package.

- There is a tape subsystem package for each logical tape library.
- There is one tape subsystem package for all of the stand-alone tape drives.
- The tape subsystem package is there even when there is only one path.

The first view of the **Devices Contained Within Package** display shows the Logical Address and adapter Location information for each path to each device. Use function key F11 to switch the view to show the device resource name, device status, and path count information for each

Viewing and changing the preferred path device

The preferred path device is the device resource whose path is selected at vary on time, or during allocation of the device to a tape library, for tape I/O. If the path to the preferred path device is not available, then one of the alternative paths to that device is selected instead.

Note: Before the preferred path for a tape device can be changed:

- It must be varied off.
- It must not be in use by Dedicated Service Tools.
- It must not be associated with a varied on Network Service Description.
- Any tape resources within a tape library device must be deallocated from the tape library.

Using the Hardware Service Manager to view or change the preferred path device

1. From the **Use Dedicated Service Tools** or **System Service Tools** display, select **Start a Service Tool**.

2. From the **Start a Service Tool** display, select **Hardware service manager**.

3. From the **Hardware Service Manager** display, select **Packaging hardware resources (systems, frames, cards,...)**.

4. Find the packaging resource for the Tape Subsystem that you want to work with and select **Hardware contained within package**.

5. From the **Devices Contained Within Package** display, select **Paths to multiple path device** for the device for which you want to set the preferred path.

The first device resource in the list of resources that are shown in the **Paths to Multiple Path Device** display is the current preferred path device. Selecting option 9 next to a resource in the list and pressing enter moves that device resource to the top of the list. It also selects it to be the preferred path device the next time the device description is varied on, or during allocation of the device to a tape library, or when the partition is restarted.

Note: For IBM i 7.2 option 9 is a hidden option.

Using the iotapepaths Advanced Analysis macro to change the preferred path

With IBM i 7.2 PTF MF65029, IBM i 7.3 PTF MF65030, and IBM i 7.4, support was added for changing the preferred path using the iotapepaths Advanced Analysis macro.

1. From the **Use Dedicated Service Tools** or **System Service Tools** display, select **Start a Service Tool**.

2. From the **Start a Service Tool** display, select **Display/Alter/Dump**.

3. From the **Display/Alter/Dump Output Device** display, select **Dump to printer** or **Display/Alter storage**.

4. From the **Select Data** display, select **Licensed Internal Code (LIC) data**.

5. From the **Select LIC Data** display, page down and select **Advanced analysis**.

6. From the **Select Advanced Analysis Command** display, type a 1 in the **Option** field next to the blank line and enter `iotapepaths` as the **Command**.

7. From the **Specify Advanced Analysis Options** display:

   • Enter the resource name of the device to make the preferred path device and the option `-PREFER` to change the preferred path.

Verifying a path connection

Dedicated Services Tools or System Service Tools can be used to verify that there is a working path to a device for a specific IOP.

1. From the **Use Dedicated Service Tools** or **System Service Tools** display, select **Start a Service Tool**.

2. From the **Start a Service Tool** display, select **Hardware service manager**.

3. From the **Hardware Service Manager** display, select **Logical hardware resources (buses, IOPs, controllers,...)**.

4. From the **Logical Hardware Resources** display, select **System bus resources**.

5. Find the Virtual IOP with the path to the device that you want to verify and select **Resources associated with IOP**.

6. Find the specific tape unit that you want to verify the path connection for and select **Verify**.

If the test completes successfully, there is a working path to the device by the virtual IOP you selected in step 5.

If the test fails with the message `Device is busy, make the device ready and run the test again`, communication to the device worked, but it is assigned to a different active path on the same partition. In this case, there is also a working path to that device by the virtual IOP you selected in step 5.

Retrieving detailed information about the multipath configuration

The iotapepaths Advanced Analysis macro can be used to display or print detailed information about the multipath configuration. Use the following steps to run the iotapepaths Advanced analysis macro:

1. From the **Use Dedicated Service Tools** or **System Service Tools** display, select **Start a Service Tool**.
2. From the **Start a Service Tool** display, select **Display/Alter/Dump**.
3. From the **Display/Alter/Dump Output Device** display, select **Dump to printer** or **Display/Alter storage**.
4. From the **Select Data** display, select **Licensed Internal Code (LIC) data**.
5. From the **Select LIC Data** display, page down and select **Advanced analysis**.
6. From the **Select Advanced Analysis Command** display, type a 1 in the **Option** field next to the blank line and enter `iotapepaths` as the **Command**.
7. From the **Specify Advanced Analysis Options** display:

   - Leave the **Options** field blank and press **Enter** to retrieve path information for all devices, or:
   - Enter a resource name to filter the information retrieved.

     a. IOP resource name - Retrieve tape resources configured on this IOP.

     b. Tape Library resource name – Retrieve all tape resources associated with this logical tape library.

     c. Tape Device resource name – Retrieve all the paths to this resource.

Recover from tape multipath errors
Recover from errors that occur using tape multipath when automatic failover was not possible.

If you have multiple connections to a tape or tape library device type that supports tape multipath with manual failover, then an I/O path failure can be recovered by:

- Vary off and then vary on the tape device description or Media Library (MLB) device description that was being used when the failure occurred.
- Perform deallocate and then allocate of a FAILED device resource within a tape library.

During vary on or allocate processing the system searches for working alternative paths to the devices that were being used by the failing command. If the preferred path is available, then it is activated, otherwise all of the other paths are searched until the next available path is found. After vary on or allocate completes, it is necessary to resubmit the failing commands.

Maintaining tape resources

This information discusses how to keep your tape resources in good condition.

Storage and handling of tape cartridges
Tape drives require specific maintenance and environmental conditions to operate well over time.

To avoid problems with your IBM tape drive you should:

- Use high quality, data grade media
- Handle and store this media properly
- Operate the tape drive in a clean environment
- Keep the tape drive properly cleaned

Media grades

IBM uses two different grades of media. IBM supplies program temporary fixes (PTFs) on a tape that is designed to be written to only once and read from a few times. This tape is designed for limited use, not as a backup medium. IBM also sells media that is designed for storage use.

If analysis by IBM service personnel indicates a problem with non IBM media, it may be necessary for you to replace the media.

Tape environment
Tape drives are designed to operate in a clean environment.

Problem factors are dirt, dust, fibers, and airborne particles. Airborne particles are the most difficult to address. When you install a tape in the tape drive, the clearance between the heads and the tape is measured in microns. Particles can damage the tape or the head if they come in contact with either. IBM offers a tape drive filter enclosure for some systems to solve this problem. The enclosure draws air in through a filter and supplies the tape drive with clean air. You are responsible to provide a clean operating environment for the tape drive and system.

For specific requirements for environmental conditions such as temperature and humidity, see the operator's manual for your tape cartridge.

Tape handling and storage
Most tapes arrive in sealed cartridges so that the tape will remain in a clean environment.

Opening the cartridge allows dirt and airborne particles to enter and then become a source of contamination. Only the tape drive should open the cartridge, not an operator. Inside the cartridge, the tape is under correct tension. If the cartridge is dropped, this tension will be relaxed. Inserting a dropped cartridge into a tape drive can cause incorrect loading and result in a jam. This will ruin the tape and can cause physical damage if the cartridge is not removed properly.

To store the tapes properly, put them in their protective containers and store them on their ends. The storage area must be clean, dry, at room temperature, and away from any magnetic fields.

Protecting data on tape cartridges
Learn how to protect data on a tape cartridge by reading the following information.

Tape cartridges have a switch that you can use to write-protect the data on the tape. The switch typically has a label that indicates that it is write-protected such as:

- A padlock icon
- A dot on the switch
- A label such as **SAFE** or **SAVE**.

The following instructions are an example of protecting data from being overwritten on a quarter-inch tape. See the operator's guide for your tape device instructions that are specific to your tape cartridge. Do one of the following:

- Set the pointer toward **SAFE** for older-style tape cartridges, as shown in the first figure below.
- Set the pointer toward the locked padlock icon for the newer style tape cartridges, as shown in the second figure below.

To not protect the data do one of the following:

- Set the pointer away from **SAFE** for the older style tape cartridges, as shown in the first figure below.
- Set the pointer toward the unlocked padlock icon, for the newer-style tape cartridges, as shown in the second figure below.
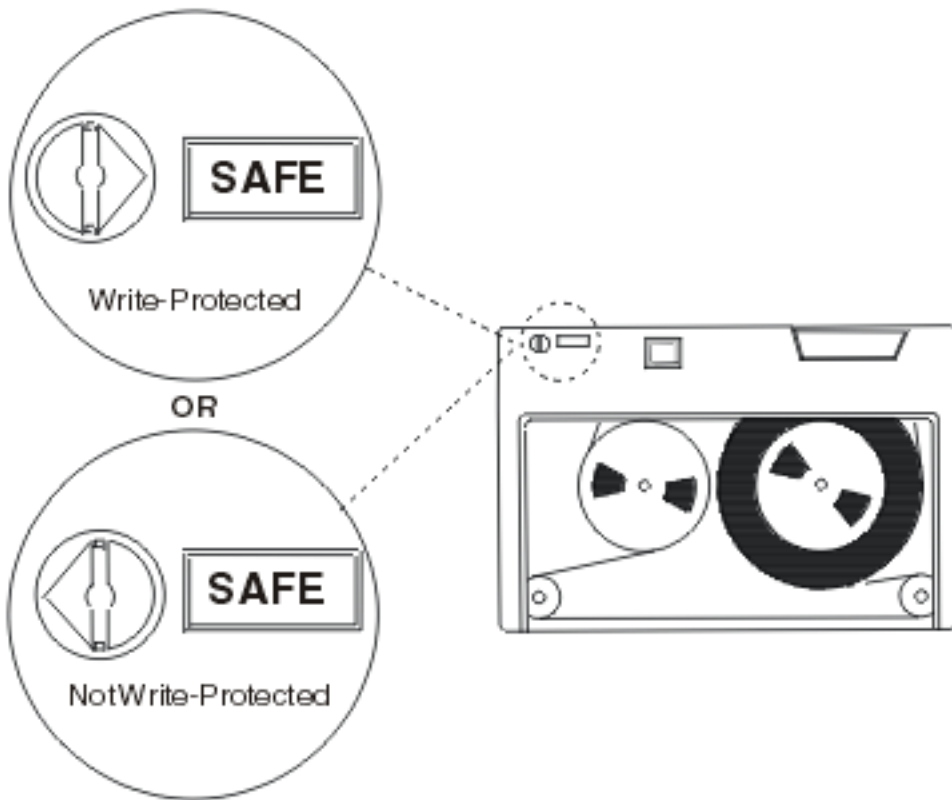
Figure 9. Write-protect positions for an older-style tape cartridge
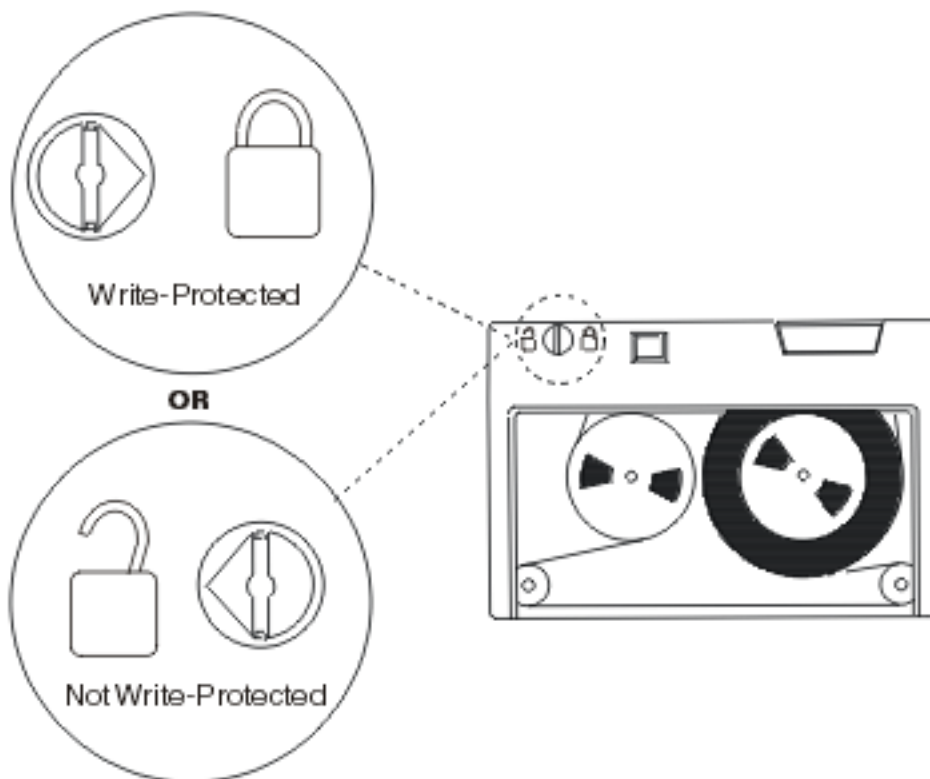
Figure 10. Write-protect positions for a newer-style quarter-inch tape cartridge

For information about your tape device, see Tapes Supported on System i. If your tape device is an LTO tape device, see IBM LTO Ultrium Tape Libraries Guide (SG24-5946).

For specific instructions about protecting data on a tape cartridge, see the manual for your tape drive.

Related information
Tapes Supported on iSeries
IBM System Storage Tape Libraries Guide for Open Systems

Ensuring tapes are in good condition
To ensure that your tapes are in good condition, keep track of the tape volume statistics on your system.

1. Type STRSST (the Start System Service Tools command).
2. Select **Start a service tool** on the System Service Tools menu.
3. Select **Product Activity Log** on the Start a Service Tool menu.
4. Select **Work with removable media lifetime statistics** on the Product Activity Log menu.
5. Select the type of removable media for which you want data on the Select Media Option display.
6. If you see the >> or > symbols preceding the volume ID on the Work with Lifetime Statistics display, take the appropriate action as is described in the table following the image of the Work with Lifetime Statistics display.

Table 13. Symbols in the Work with Lifetime Statistics display

Symbol	Explanation	Action to take
>>	Media replacement recommended	Copy the contents of the media to a new tape and discard the old tape.

>	Media approaching replacement criteria	• Replace the tape if the tape format is:
		
		  – QIC-120
		
		  – 7208 2.3 GB
		
		  – 6250 bpi density
		
		• If the tape format does not fulfill the previous conditions, continue to keep track of this tape to ensure that media replacement is not necessary.

Note: To ensure accurate statistics, each tape cartridge or reel must have a unique volume ID.

Note: For newer tape drive technologies, the information that is contained within the media statistics that are stored on IBM i is no longer used to determine when media needs replacement.

After media has been replaced, remove the lifetime statistics entry by using option 4 (delete entry). Also, you can use the Print Error Log (PRTERRLOG) command to print and delete the entry by typing the following command.

```
PRTERRLOG TYPE(*VOLSTAT) VOLTYPE(xxxx) VOL(xxxxxx) VOLSTAT(*DLT)
```

Related tasks
Formatting tape cartridges

When you format a tape cartridge, a standard volume label is recorded at the beginning of the magnetic tape medium.

Cleaning your tape drives
Dirt can build up on the heads of any tape drive, no matter how clean the environment. Every time tape motion occurs, some of the media surface comes off on the heads. Over time, this builds up and causes errors in reading and writing. Cleaning the read/write head prevents a build up of debris that can cause unrecoverable errors when writing or reading data.

You can only use cleaning cartridges a limited number of times. When a cleaning cartridge has been used to its maximum number of times, the usefulness of the cartridge expires. When cartridges expire, replace them. Never reuse an expired cleaning cartridge. An expired cleaning cartridge introduces previously removed dirt to the tape drive. When you have cleaned the tape drive, mark the usage on the cartridge in order to best determine when your IBM cleaning cartridge has expired.

When you use cleaning cartridges you should not use a grease pencil on the label of the cleaning cartridge. Also, the cleaning cartridge should be undamaged and clean when it is inserted into a tape unit.

Cleaning quarter-inch tape drives
For quarter-inch tape drives, you should clean the head after every 8 hours of tape movement when using IBM tape cartridges. Other tape media might require cleaning more frequently.

When you use a new tape cartridge, it is advisable to clean the head after 2 hours of tape movement, or before loading each new tape cartridge.

System messages are posted when the tape unit determines that cleaning is required. The MLR1, MLR1-S, and MLR3 tape units also have a cleaning status light that indicates that cleaning is required. It is important to respond to these cleaning indicators and clean the head using a recommended cleaning method.

Table 14. Recommended IBM cleaning cartridges			
Tape unit identification		**Cleaning cartridge part number**	
Front bezel label	Feature code numbers	35L0844	16G8572
SLR100	4487 4587 4687	Best	Do not use
MLR3	4486 4586 6386 6486	Best	Do not use
SLR60	4584 4684 6384 6484	Best	Do not use
MLR1-S QIC-5010-DC	4483 4583 6383 6483	Best	Do not use

Table 14. Recommended IBM cleaning cartridges (continued)			
Tape unit identification		**Cleaning cartridge part number**	
QIC-4GB-DC	4482 4582 6382 6482 7201-122	Best	Acceptable
QIC-2GB (DC)	6381 6481	Best	Acceptable
QIC-2GB	6380 6480	Best	Acceptable

Related concepts

Quarter-inch cartridge and tape unit compatibility
The capacity and read/write capabilities for your media type are provided.

Cleaning DAT tape drives
Clean the head on DAT tape drives after every 8 hours of tape movement when using IBM tape cartridges. Other tape media might require cleaning more frequently.

System messages are posted when the tape unit determines that cleaning is required. The DAT72 and DAT160 tape units also have a cleaning status light that indicates that cleaning is required. It is important to respond to these cleaning indicators and clean the head using a recommended cleaning method.

Replace cleaning cartridges after 50 uses.

Table 15. Recommended IBM cleaning cartridges	
Front Bezel Label	**Cleaning cartridge part number**
DAT72	21F8763
DAT160	23R5638
DAT320	46C1937

Related concepts

DAT cartridge and tape unit compatibility
The capacity and read/write capabilities for your media type are provided.

Cleaning eight-millimeter tape drives
The eight-millimeter tape drives count the number of hours of tape motion and indicate when it is time to clean the tape drive by displaying a message to clean soon and by turning on the Fault status light.

Tape unit	**Cleaning cartridge part number**
4585 4685 7206-VX2	19P4880
7208-002	16G8467
6390 7208-012	16G8467

Tape unit	Cleaning cartridge part number
7208-222	16G8467
7208-232	16G8467
7208-234	16G8467
7208-342	35L1409
7208-345	35L1409
9427-210 9427-211	16G8467

Related concepts

Eight-millimeter cartridge and tape unit compatibility
The capacity and read/write capabilities for your media type are provided.

Cleaning half-inch tape drives
There are specific methods for cleaning half-inch tape drives.

On the average, clean the tape path on each drive every seven days. If you use an unusually large amount of tape, clean the tape path more often. If the tape unit displays a *CLEAN message or a "C", clean the tape drive path as soon as possible. You should also clean the tape path after each initial program load (IPL), after a drive is reset, or whenever the tape unit has been interrupted.

To clean the tape path, insert the special cleaning cartridge as you similarly to a typical tape cartridge. Keep track of the number of uses on the label provided with each cleaning cartridge.

- 3490 cleaning cartridges need to be replaced after 500 uses.
- 3570 and 3590 cleaning cartridges need to be replaced after 100 uses.
- 3592 cleaning cartridges need to be replaced after 50 uses.

If your tape drive has the automatic cartridge loader feature, put the cartridge into the feed position and press the start button. The cleaning cartridge can also be put into the input stack, and the cleaning procedure takes place whenever the cleaning cartridge is loaded into the drive. If you start cleaning during a job, an inquiry message is displayed. After responding to the message, the drive threads the cleaning tape, cleans the read/write head, and then rewinds and unloads the cleaning cartridge. When the cartridge has been unloaded, remove it and mark the usage label.

Cleaning the 3490, 3570, 3590, and 3592 tape drives

These tape drives provide random access to the tape cartridges. When the device detects that cleaning is needed and if the cleaning cartridge is in the internal cell known only to the Random Access Cartridge Loader, the tape drive performs the cleaning operation. The tape drive keeps track of the number of cleaning operations performed by the cleaning cartridge and ejects the cleaning cartridge through the priority cell when the cleaning cycles that are allowed for the cleaning cartridge have been used up.

The cleaning cartridges for half-inch tape drives are specified in the following table:

Tape drive	Cleaning cartridge part number
3490	4780527
3570	05H2463
3590	05H4435
3592	05H3929

Related concepts

Half-inch and Magstar MP cartridges and tape unit compatibility
The tape units and half-inch and Magstar MP cartridges compatibility are provided.

Cleaning LTO Ultrium tape drives
All IBM Ultrium tape drives have an integrated cleaning device which brushes the head when loading and unloading a cartridge. Along with this, each drive has a cleaning procedure using a special cleaning cartridge.

Note: LTO Ultrium cleaning cartridges need to be replaced after 50 uses.

The only time you must clean your Ultrium tape drive is when the tape drive alerts you to clean it.

The following table shows cleaning cartridges for Ultrium tape devices.

Type	Cleaning cartridge part number
Ultrium 1	08L9124
Ultrium 2	35L2086
Ultrium 3	35L2086
Ultrium 4	35L2086
Ultrium 5	35L2086
Ultrium 6	35L2086
Ultrium 7	35L2086
Ultrium 8	35L2086

Related concepts

LTO cartridges and tape unit compatibility
There are compatibility guidelines that need to be considered when working with Linear Tape Open (LTO) Ultrium tape units and cartridges.

Related information

IBM System Storage Tape Libraries Guide for Open Systems

Licensed Internal Code updates
IBM occasionally releases updated Licensed Internal Code for the tape drives. When a Licensed Internal Code update is developed, IBM makes it available to you through the service organization or by electronic delivery.

Licensed Internal Code updates are also available by downloading and installing fixes using electronic customer support, or by ordering and installing cumulative fix packages from IBM Global Services.

Running retention operations for tape cartridges
Learn about the importance of retention operations for tape cartridges.

For older tape cartridge types, the quarter-inch tape units run a retention operation whenever a tape cartridge is loaded. *Retention* means that the tape unit moves the tape to the end-of-tape position and rewinds it to the beginning-of-tape position. The retention operation is part of the load sequence. The tape unit also runs a retention operation if a tape cartridge is in the tape unit when the door is closed.

When using MLR3-25GB, DC5010, MLR1-16GB, SLR100, and SLR60 tape cartridges, the tape units run the retention operation only when necessary (as determined by the tape unit) to maintain correct tape tension. The approximate retention times are as follows.

Table 16. Retention times for quarter-inch tape cartridges	
Tape cartridge	**Approximate retention time**
DC5010	Fewer than 6 minutes
DC6150	Fewer than 3 minutes
DC6320	Fewer than 3 minutes
DC6525	Fewer than 4 minutes
DC9120	Fewer than 4 minutes
DC9250	Fewer than 4 minutes
MLR1-16GB	Fewer than 8 minutes
MLR3-25GB	Fewer than 8 minutes
SLR5-4GB	Fewer than 8 minutes
SLR60	Fewer than 8 minutes
SLR100	Fewer than 8 minutes

Example: Managing tape resources
Learn how to manage tape resources through the example that is provided.

Each system in the following example reports two tape subsystems, or resources. These tape resources are connected to the tape library resource. In this example, the tape library resource is the 3494 Data Server. The 3494 Data Server then generates an automatic configuration of a device description for a media library device (MLD). In this situation, any request to the tape library device (the 3494 Data Server) results in the tape library resource manager allocating which tape resource to use. This simplifies tape management tasks for most users because the system is responsible for the majority of those tasks.

Note: Users with multiple systems and limited attachment capabilities might still need to force the use of specific resources.

The Work with Media Library Status (WRKMBLSTS) command allows you to view the tape libraries and associated tape resources from a configuration standpoint. Using this command on each of the three systems in the example results in the following displays.
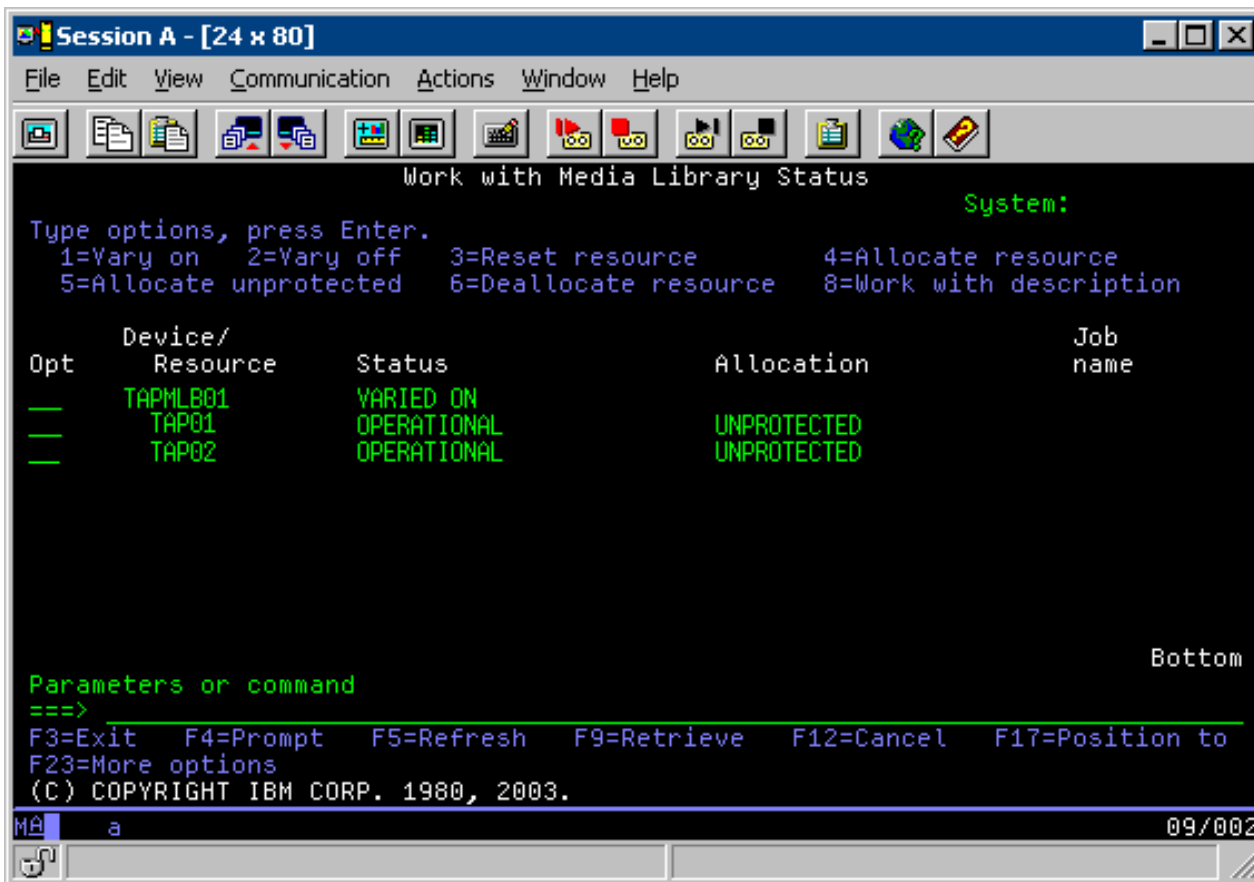
Figure 11. View of tape library TAPMLB01 from System A
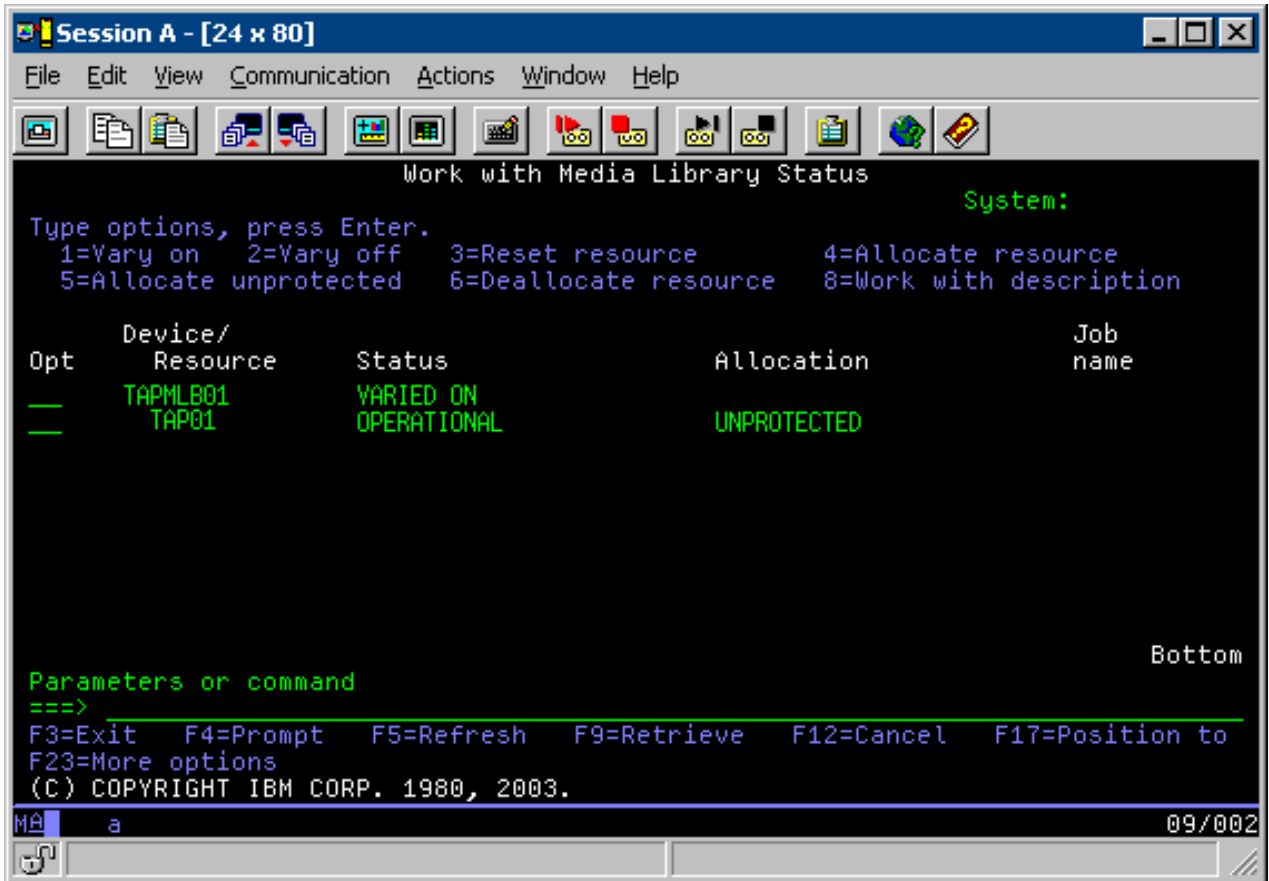
Figure 12. View of tape library TAPMLB01 from System B

Figure 13. View of tape library TAPMLB01 from System C

```
Session A - [24 x 80]                                                    _ □ ×
File  Edit  View  Communication  Actions  Window  Help
□  ▣▣  ▣▣  ▣▣  ▣▣  ▣  ▣▣  ▣▣  ▣  ▣▣
                        Work with Media Library Status
                                                        System:
   Type options, press Enter.
     1=Vary on     2=Vary off     3=Reset resource        4=Allocate resource
     5=Allocate unprotected    6=Deallocate resource    8=Work with description

           Device/                                                    Job
   Opt     Resource      Status              Allocation              name
    __     TAPMLB01      VARIED ON
    __       TAP02       OPERATIONAL         UNPROTECTED




                                                                      Bottom
   Parameters or command
   ===>
   F3=Exit    F4=Prompt    F5=Refresh    F9=Retrieve    F12=Cancel    F17=Position to
   F23=More options
   (C) COPYRIGHT IBM CORP. 1980, 2003.
MA        a                                                           09/002
```

Here are three possible values for the allocation of each resource. Each value assumes that the tape library is varied on.

ALLOCATED

An allocated resource is assigned to a particular system and no other system can access it. The allocated state is analogous to a stand-alone device that is varied on with the value ASSIGN(*YES).

UNPROTECTED

An unprotected tape resource is not assigned to a particular system and is available to respond to requests to its tape library device. This unprotected state is analogous to a stand-alone device that is varied on with the value ASSIGN(*NO). If a request is made to the tape library device and the tape resource is selected by the tape library device resource manager, the tape resource is assigned while it is being used.

DEALLOCATED

A deallocated tape resource is not assigned to a particular system and is unavailable to respond to requests to its tape library device. If the tape library is varied off, all of its tape resources are deallocated. The deallocated state allows the use of a tape resource in stand-alone mode. It also allows temporary use of a tape resource if a malfunction occurs with the robotic components of the tape library.

When a tape resource that is shared between systems is not in use, it should remain in an unprotected state with the tape library device varied on. If the tape resource is left in an allocated or deallocated state, a command request to use the resource might result in an error stating that no resources are available.

If you are using backup and recovery media services (BRMS), you should not use SHARED *YES for media libraries. Use UNPROTECTED to share your resources. You can also use a combination of UNPROTECTED and ALLOCATED on the network to ensure that each system has the correct device that is required for backup operations. Leave the tape libraries varied on at all times, and use the allocation status to control use.

One problem to consider in the example is the problem of cable limitations. One system can potentially prevent another from accessing tape resources even when one is available. The difference is in how a user can force a system to use a specific resource.

One method of resolving this problem is to manipulate the start times of save operations on each system. In the example, system A and system B are contending for tape resource TAP01. Start the save operation on system B to ensure that system B has access to a tape resource.

The following table shows how the strategy chart appears if this method is used in the example.

Table 17. Schedule to meet system and device constraints using time management

Start time	Approximate complete time	Backup group	System	Device	Tape resource forced
10:05 p.m.	1:00 a.m.	2	A	TAPMLB01	TAP01 (TAP02 is busy on system C)
10:00 p.m.	11:00 p.m.	5	C	TAPMLB01	TAP02
11:00 p.m.	1:00 a.m.	6	C	TAPMLB01	TAP02
1:05 a.m.	6:00 a.m.	1	A	TAPMLB01	TAP02 (TAP01 is busy on system B)
1:00 a.m.	4:00 a.m.	3	B	TAPMLB01	TAP01
4:00 a.m.	6:00 a.m.	4	B	TAPMLB01	TAP01

Because ALLOCATED resources are selected for use before UNPROTECTED resources, you can use this aspect to your advantage. A user exit (the *EXIT special value) is a user-defined CL command that permits automatic processing of predefined user routines. On system A in the example, you can use the *EXIT special value in the BRMS control group to change TAP02 from UNPROTECTED to ALLOCATED. The next save request then attempts to access TAP02 first. When the save operation is completed, you use the *EXIT special value at the end of the control group to change the resource back from ALLOCATED to UNPROTECTED. For more information about the *EXIT special value, see Backup Recovery and Media Services.

In order to accomplish this in the example, keep all the resources in UNPROTECTED status and change two backup groups. In this situation, you are only concerned about systems that are attached to more than one resource. Only systems that are attached to more than one resource can produce a resource access conflict. In this example, the system that is attached to more than one resource is system A. System A belongs to backup group 1 and backup group 2.

1. Change Save backup group 2:

    a. Change TAP01 from *UNPROTECTED to *ALLOCATED by specify the following command for the *EXIT special value:

    ```
    VRYCFG CFGOBJ(TAPMLB01) CFGTYPE(*MLBRSC) STATUS(*ALLOCATE) RSRCNAME(TAP01)
    ```

    b. Perform the save operation.

    c. Change TAP01 from *ALLOCATED to *UNPROTECTED by specifying the following command for the *EXIT special value:

    ```
    VRYCFG CFGOBJ(TAPMLB01) CFGTYPE(*MLBRSC) STATUS(*UNPROTECTED) RSRCNAME(TAP01)
    ```

2. Change Save backup group 1:

    a. Change TAP02 from *UNPROTECTED to *ALLOCATED by specifying the following command for the *EXIT special value:

```
VRYCFG CFGOBJ(TAPMLB01) CFGTYPE(*MLBRSC) STATUS(*ALLOCATE) RSRCNAME(TAP02)
```

   b. Perform the save operation.
   c. Change TAP02 from *ALLOCATED to *UNPROTECTED by specifying the following command for the
      *EXIT special value:

```
VRYCFG CFGOBJ(TAPMLB01) CFGTYPE(*MLBRSC) STATUS(*UNPROTECTED) RSRCNAME(TAP02)
```

The following table shows how the strategy table appears if this method is used in the example.

Table 18. Schedule to meet system and device constraints using ALLOCATE before UNPROTECT

Start time	Approximate complete time	Backup group	System	Device	Tape resource forced
10:00 p.m.	1:00 a.m.	2	A	TAPMLB01	TAP01
10:00 p.m.	11:00 p.m.	5	C	TAPMLB01	TAP02
11:00 p.m.	1:00 a.m.	6	C	TAPMLB01	TAP02
1:00 a.m.	6:00 a.m.	1	A	TAPMLB01	TAP02 (TAP01 is busy on system B)
1:00 a.m.	4:00 a.m.	3	B	TAPMLB01	TAP01
4:00 a.m.	6:00 a.m.	4	B	TAPMLB01	TAP01

You can also use the multiple tape library device descriptions that are created when a tape library is
configured. As each tape resource in a tape library reports to a system, a separate tape library description
might be created. Typically, you should use one TAPMLB xx and assign all the tape resources to it.
However, system A in the example differs from this. The following display shows the configuration that is
generated on system A.

Figure 14. Work with Media Library Status window

```
Session A - [24 x 80]                                              ☐ ☐ ✕

File  Edit  View  Communication  Actions  Window  Help

☐  ☐☐  ☐☐  ☐☐  ☐  ☐☐  ☐☐  ☐☐  ☐☐  ☐☐  ☐  ☐ ☐

                    Work with Media Library Status
                                                    System:
Type options, press Enter.
  1=Vary on    2=Vary off    3=Reset resource      4=Allocate resource
  5=Allocate unprotected    6=Deallocate resource  8=Work with description

        Device/                                              Job
Opt       Resource        Status            Allocation        name
  __    TAPMLB01        VARIED OFF
  __    TAPMLB02        VARIED OFF

                                                              Bottom
Parameters or command
===>
F3=Exit    F4=Prompt    F5=Refresh    F9=Retrieve    F12=Cancel    F17=Position to
F23=More options
(C) COPYRIGHT IBM CORP. 1980, 2003.
MA                a                                              09/002
☐
```

After the command CFGDEVMLB(TAPMLB01) is completed, you can see both resources under
TAPMLB01, even though TAP02 actually generated TAPMLB02. Both resources are set to UNPROTECTED.

Figure 15. Work with Media Library Status window

```
┌─────────────────────────────────────────────────────────────────────────────┐
│ ▣▐ Session A - [24 x 80]                                       _ □ ✕       │
├─────────────────────────────────────────────────────────────────────────────┤
│ File  Edit  View  Communication  Actions  Window  Help                      │
│  ▢   ▤▤  ▤▤  ▥▥ ▥▥   ▦▦ ▦    ▨   ▨▨ ▨▨   ▨▐ ▨▪   ▣   ▨ ▨                      │
│                        Work with Media Library Status                       │
│                                                   System:                   │
│   Type options, press Enter.                                                │
│     1=Vary on    2=Vary off    3=Reset resource       4=Allocate resource   │
│     5=Allocate unprotected   6=Deallocate resource   8=Work with description │
│                                                                             │
│          Device/                                                Job         │
│   Opt      Resource        Status              Allocation       name        │
│    __    TAPMLB01        VARIED ON                                           │
│    __     TAP01          OPERATIONAL           UNPROTECTED                   │
│    __     TAP02          OPERATIONAL           UNPROTECTED                   │
│    __    TAPMLB02        VARIED OFF                                          │
│                                                                             │
│                                                                             │
│                                                                  Bottom     │
│   Parameters or command                                                     │
│   ===>                                                                      │
│   F3=Exit   F4=Prompt   F5=Refresh   F9=Retrieve   F12=Cancel   F17=Position to │
│   F23=More options                                                          │
│   (C) COPYRIGHT IBM CORP. 1980, 2003.                                       │
│ MA▮    a                                                         09/002      │
│ ▱                                                                           │
└─────────────────────────────────────────────────────────────────────────────┘
```

If you varied on TAPMLB02, it also recognizes TAP01 and TAP02. However, because only one tape library can use a resource, TAP01 and TAP02 must to be set to DEALLOCATED in TAPMLB02, as is shown on the following display.

Figure 16. Work with Media Library Status window

```
┌─────────────────────────────────────────────────────────────────────┐
│ ▣ Session A - [24 x 80]                                    _ □ ✕     │
│  File  Edit  View  Communication  Actions  Window  Help              │
│  ▢  ▣▣  ▣▣   ▣▣   ▣ ▣   ▣   ▣ ▣   ▣ ▣   ▣   ▣ ▣                      │
│                 Work with Media Library Status                        │
│                                              System:                  │
│   Type options, press Enter.                                          │
│    1=Vary on    2=Vary off    3=Reset resource     4=Allocate resource│
│    5=Allocate unprotected    6=Deallocate resource  8=Work with description│
│                                                                        │
│         Device/                                              Job       │
│   Opt     Resource      Status            Allocation         name      │
│   __    TAPMLB01       VARIED ON                                        │
│   __      TAP01        OPERATIONAL        UNPROTECTED                   │
│   __      TAP02        OPERATIONAL        UNPROTECTED                   │
│   __    TAPMLB02       VARIED ON                                        │
│   __      TAP01        OPERATIONAL        DEALLOCATED                   │
│   __      TAP02        OPERATIONAL        DEALLOCATED                   │
│                                                                        │
│                                                                        │
│                                                            Bottom       │
│   Parameters or command                                                │
│   ===>                                                                 │
│   F3=Exit    F4=Prompt    F5=Refresh    F9=Retrieve   F12=Cancel    F17=Position to│
│   F23=More options                                                    │
│   (C) COPYRIGHT IBM CORP. 1980, 2003.                                 │
│  MA▮     a                                                    09/002   │
│  ▣                                                                    │
└─────────────────────────────────────────────────────────────────────┘
```

In order to use the TAPMLB02 device description, you set TAP01 to UNPROTECTED in TAPMLB01 and you
set TAP02 to UNPROTECTED in TAPMLB02, as is shown in the following display.

Figure 17. Work with Media Library Status window

```
Session A - [24 x 80]
File  Edit  View  Communication  Actions  Window  Help

                    Work with Media Library Status
                                            System:
Type options, press Enter.
  1=Vary on    2=Vary off    3=Reset resource       4=Allocate resource
  5=Allocate unprotected    6=Deallocate resource   8=Work with description

       Device/                                              Job
Opt      Resource      Status          Allocation          name
  __    TAPMLB01      VARIED ON
  __      TAP01       OPERATIONAL      UNPROTECTED
  __      TAP02       OPERATIONAL      DEALLOCATED
  __    TAPMLB02      VARIED ON
  __      TAP01       OPERATIONAL      DEALLOCATED
  __      TAP02       OPERATIONAL      UNPROTECTED




                                                          Bottom
Parameters or command
===>
F3=Exit    F4=Prompt    F5=Refresh    F9=Retrieve    F12=Cancel    F17=Position to
F23=More options
(C) COPYRIGHT IBM CORP. 1980, 2003.
MA       a                                                       09/002
```

The following table shows how the strategy chart appears if you use this method in the example.

Table 19. Schedule to meet system and device constraints using multiple tape library descriptions

Start time	Approximate complete time	Backup group	System	Device	Tape resource forced
10:00 p.m.	1:00 a.m.	2	A	TAPMLB01	TAP01
10:00 p.m.	11:00 p.m.	5	C	TAPMLB02	TAP02
11:00 p.m.	1:00 a.m.	6	C	TAPMLB02	TAP02
1:00 a.m.	6:00 a.m.	1	A	TAPMLB02	TAP02
1:00 a.m.	4:00 a.m.	3	B	TAPMLB01	TAP01
4:00 a.m.	6:00 a.m.	4	B	TAPMLB01	TAP01

Related reference
Work with Media Library Status (WRKMBLSTS) command
Related information
Backup, Recovery, and Media Services

Tape encryption

Tape encryption provides security and reduces the risk of data being misused. After a tape is encrypted, data is unreadable to people without a key.

Software tape encryption
Use the products and applications that are described to encrypt your data.

In order to perform software tape encryption it is necessary to have the following products and applications installed and licensed on your partition:

• i5/OS option 18 - Media and Storage Extensions
• i5/OS option 44 - Encrypted Backup enablement

You will also need a tape management application to specify encryption keystore file and record label information for each file that is to be encrypted.

For more information about using a tape exit interface, refer to Tape Management Exit Program.

Refer to the Creating a media policy topic for additional details about setting up encryption using BRMS.

Refer to the Cryptographic Services Key Management topic for more details about encryption keystore files.

Related information
Creating a media policy
Tape Management Exit Program
Cryptographic Services Key Management

Hardware tape encryption
Hardware tape encryption uses tape devices with data encryption capabilities and the IBM Security Key Lifecycle Manager to encrypt your data. IBM i only supports library managed encryption.

For more information about hardware tape encryption, refer to IBM Security Key Lifecycle Manager.

Related information
IBM Security Key Lifecycle Manager

Decrypting your data
There are two methods available to read or restore tape data that was previously encrypted.

1. If the products and applications used for software tape encryption are installed on your partition, your tape management application can specify the encryption keystore file and record label information for each file that is to be decrypted.

2. Use a decryption data area to specify the encryption keystore file and record label information to be used to decrypt your tapes. The data area must be named QTADECRYPT and can be created in either library QTEMP or QUSRSYS. The data area must provide the following information

   • Char(10) Device name (Decryption will only be run for tapes in this device)
   • Char(10) Encryption keystore file name
   • Char(10) Encryption keystore library
   • Char(32) Encryption record label

   Here is an example of how to create a decryption data area in QTEMP:

   a. ```
   CRTDTAARA DTAARA(QTEMP/QTADECRYPT) TYPE(*CHAR) LEN(62)
   ```

   b. ```
   CHGDTAARA DTAARA(QTEMP/QTADECRYPT) VALUE('TAPMLB01  KEYFILE   KEYLIB')
   ```

   c. ```
   CHGDTAARA DTAARA(QTEMP/QTADECRYPT (31 32)) VALUE('RECORD1')
   ```

   **Note:**

- The data area values can be overridden by a tape management application.
- The encryption key type must be AES.

## Troubleshooting tape resources

These topics provide information for troubleshooting your tape resources.

### Verifying that your tape unit works correctly

Perform that steps indicated to clean your tape cartridge and verify that your tape unit is working correctly.

1. Remove the cartridge from the tape unit.
2. Type WRKCFGSTS *DEV *TAP on a command line and make the tape unit unavailable to the system (vary off).
3. Clean the tape unit. See the cleaning instructions for the tape unit you are using.
4. Type the Verify Tape (VFYTAP) command on a command line and press Enter.

### Collecting library information for problem analysis

Collect the library data that a service representative needs to repair your tape library.

When problem analysis or problem isolation is required, collect and send the following information to the appropriate service representative:

- The information.
- The information.
- The for a 3494 tape library.

### Tape flight recorder

Use the following command to collect the tape flight recorder information for your tape library:

```
CALL QTADMPDV device_name
```

Substitute the name of your tape library for *device_name*.

BRMS flight recorder

Use the Dump BRMS (DMPBRM) command to collect the BRMS flight recorder information.

Library manager transaction logs

Copy the transaction logs, the time and date of the failure, and information about the volumes in question:

1. Insert a blank diskette in drive A of the personal computer.
2. Select **Service** > **Copy files** > **the transaction logs to be copied** > **OK** > **drive A**.
3. Type the file name and description of the problem.
4. Select **Copy files**.

Problem handling for tape libraries

Read these instructions for problem handling for the IBM System Storage Enterprise Tape Library 3494.

Under typical operational conditions, the operator does not use the Library Manager often. The software manages the 3494 from requests sent from a system. For most purposes, the best function to have active on the display of the Library Manager is the System Summary window. The system summary gives you indications of the 3494 status, including whether operator intervention is required in case of errors. If the Intervention Required LED on the front operator panel is flashing, check the System Summary window. If intervention is required, the Intervention field on the lower right side of the display shows Required instead of None.

To check and respond to errors, do the following:

1. To check for errors and problems, click **Commands** and select the Operator Intervention command.

   Problems are likely when a condition occurs from which the 3494 cannot recover on its own. Depending on the type of error or exception condition experienced, some or all of the 3494 operations are suspended until the problem is corrected.

2. To respond to an error, select the condition from the list on the Operator Intervention window and select the items.

3. Select **OK** after the problem has been resolved (often by manual intervention that might require you to open the front door of the 3494).

4. Repeat these steps until all error conditions are resolved.

Removable Mass Storage (RMS)

RMS is a type of device and media that is high capacity, random access, and interchangeable between systems and partitions.

RMS devices and media are similar to optical storage in regard to behavior and access interfaces. They are managed and used with existing optical device functions and commands. See "Optical storage" on page 75 as a reference guide for use of these devices and media. RMS media are handled the same as optical volumes, and as such are also accessible through the QOPT file system by using the hierarchical file system (HFS) and integrated file system (IFS) APIs. RMS media are formatted with the industry standard Universal Disk Format (UDF) version 2.5.

Two types of RMS devices and media are supported. Removable disk (RDX) cartridges are media that contain a spinning disk. The other is flash drive, which reports as Device Specific Media or *DEVICE mass storage. The media and devices are used as a backup and recovery solution for IBM i systems that can take advantage of the moderate throughput and the lower price of removable disk or flash drives.

RDX devices can be attached with SATA or USB interfaces and can be hosted to a virtual client partition. Devices that report as *DEVICE must be attached to the USB interface and can also be hosted to a virtual client partition.

Table 20. Supported hardware for removable mass storage	
Hardware resource type and model	**Device type**
63B8-004	RDX SATA
63B8-005	RDX USB
63B8-0D2	RDX (virtual client partition)
63BC-005	Device-specific USB
63BC-0D2	Device-specific (virtual client partition)

RMS Media Types

RDX capacities range from 160 GB to 2.0 TB. RDX media displays with media type *RDX.

IBM i allows the use of any flash drive that complies with the Universal Serial Bus Mass Storage Class. Flash drives display with media type *DEVICE.

The following types of flash drive configurations are allowed:

• A USB 2.0 device (up to 32 GB in capacity) attached to a USB 2.0 system unit port.

• A USB 3.0 device attached to a USB 3.0 port (adapter or system unit) with up to 256 GB capacity.

   Note: Support for a USB 3.0 flash drive with a capacity greater than 32 GB requires 7.2 PTF MF63610 or 7.3 PTF MF63611.

RMS Media Formats and Interchange

RMS media is formatted by the IBM i operating system with industry standard Universal Disk Format (UDF) version 2.5. Media that are recorded with UDF version 2.0 and 2.01 are also accessible for read or write. Media that are recorded with prior UDF versions are accessible as read-only.

Removing USB Storage Devices

Devices with an eject button, DVD, RDX, and tape drives, ensure that the media is properly quiesced and all the data is stored on the media before the device is ejected. Flash drives need an operation that is performed to ensure that the data is written to the media to allow the device to be safely removed. On IBM i use **VRYCFG STATUS(*OFF)**, or use **RMVOPTCTG** or option 4 on **WRKOPTVOL** to eject the media. If the media is logically ejected, a flash drive reports that it is empty until the RMS device description is varied off/on or the Add Optical Cartridge command **(ADDOPTCTG)** is used to logically add the media back to the flash drive.

Container Media

With 7.2 TR5 and later releases, support is added for optical container media. Container media allows optical image catalog entries to be stored on physical optical media within a RDX or flash drive.

Container media is created by using the Initialize Optical (**INZOPT**) command with a Volume type parameter value of ***CONTAINER.**

When optical container media is created, a virtual optical device of type/model 632B-011 is automatically created and associated with the physical RDX or flash drive device. This virtual optical device is used to work with any image catalog entries within the container media. If the automatically created virtual device is named **OPTVRT01**, the following command would be used to work with the image catalog entries: **WRKIMGCLGE *DEV OPTVRT01**

The new **QMOCRTCV** API can be used to add image catalog entries to the container media. See the QMOCRTCV API for more information.

For more information about container media support, see IBM Removable Media on IBM i.

Optical storage

Use the information that is described as an overview and reference guide for IBM optical support to a system with the IBM i operating system. *Optical storage* is any storage method that uses a laser to store and retrieve data from optical media.

Examples of this media are compact disk read-only memory (CD-ROM), digital versatile disk read-only memory (DVD-ROM), digital versatile disk random access memory (DVD-RAM), write-once read-many (WORM) cartridges, erasable optical cartridges, and Removable Mass Storage (RMS) media which are removable disk (RDX) and flash drives.

These functions are unique to optical support:

- CD-ROM devices
- DVD devices
- Directly attached optical media library devices
- LAN-attached optical media library devices
- Virtual optical devices
- RDX
- Flash drives

RMS devices and media are considered optical storage class for the purposes of supporting commands and functions on IBM i. All references to DVD devices and media in the optical storage section can be considered to also include RMS devices and media. For more information about RMS media and devices, see "Removable Mass Storage (RMS)" on page 74.

This information is intended for the following users:

- System operators and users can use this information as their primary reference for CD-ROM, DVD, optical media libraries, and virtual optical support.
- Service representatives can use this information to perform activities as directed by the appropriate optical device service guides.

Optical storage on the system provides an economical and efficient way to store and retrieve large amounts of information at a high performance level. Optical storage devices offer significant advantages over other high-capacity storages devices, such as tape and microfilm, with faster access times and a hierarchical-type file organization. IBM i optical storage uses files that are stored in directories and files that are stored in subdirectories similar to UNIX or PC-based file systems.

The capacity, price, and performance of optical storage continually improve, and IBM remains committed to providing its customers with these improvements over time. Even as new devices are introduced, the basic methods of accessing optical information remain consistent, as these new storage devices are being added under the current file system interfaces that optical storage programs have used for years.

These are some considerations in the use of optical storage media:

Consideration	Reason for use
Durability	Optical media can have a shelf life in excess of 50 years.
Archive storage	Write-once read-many (WORM) optical media can be used to archive large amounts of data. Each sector on the media is only written once when creating and updating files and directories. When a file is changed or deleted, a new version of the file gets written, but the old version still exists on the media. All previous versions of the file remain recorded on the media. This capability also exists on erasable media, but the entire disk can be erased and reused.
Transportability	Universal Disk Format (UDF) optical media can be read with any other industry operating system platform that supports UDF, which is an industry standard file system. Optical Media written with High Performance Optical File System (HPOFS) format can be interchanged with other optical media libraries attached to a system.
Random access	Optical devices are random access devices. This facilitates the retrieval of relevant data on demand. File access is independent of the order in which the data was stored. Also, multiple users can access the same volume at the same time.

When you use virtual optical storage, you create and use optical images that are stored on your disk units. These optical images are treated as if they were real optical disk media by the internal file system functions. The term virtual applies to the emulation of the optical media sectors when used by read and write functions.

Related concepts

Comparing offline storage
It is important that you understand the differences among different forms of media when you decide which one is right for you. Use the table provided to determine your preferred form of media.

Related information

Tape and Optical Storage

Supported hardware for optical storage

Various stand-alone optical devices are available as optical storage.

A variety of hardware configurations for CD-ROM, DVD-ROM, DVD-RAM, RDX and Flash drives are supported on a system. The table lists the stand-alone optical devices available. To see the supported media capability of a device, enter Display Device Description (DSPDEVD) on the command line.

Table 21. Supported stand-alone optical type devices

Device type	Hardware resource type and model	Device
632A	632A-005	Standalone USB DVD drive
632B	Virtual device backed up by the integrated file system (632B-001) or network file system (632B-003), or contained in a RMS device (632B-011)	Virtual device
632C	632C-002	Virtual device hosted by another partition
6320/6321	6320-002/6321-002	CD-ROM
6330 HH DVD-RAM	6330-002	DVD-RAM
6331 Slim DVD RAM	6331-0xx	Slim multi-recorder
6333 HH DVD RAM	6333-002	HH multi-recorder
6336 HH DVD-ROM	6336-002	DVD-ROM
6337 Slim Line DVD-ROM	6337-00x	DVD-ROM
63B8	63B8-004 SATA RDX drive 63B8-005 USB RDX drive 63B8-0D2 RDX drive hosted by another partition	Removable disk (RDX) dock. For more information, see the Removable Mass Storage (RMS) topic.
63BC	63BC-005 USB flash drive 63BC-0D2 USB flash drive hosted by another partition	Removable Mass Storage (RMS) device that is not an RDX device. A USB flash drive is an example of this type of device. For more information, see the Removable Mass Storage (RMS) topic.
7210-020	6321-002	CD-ROM Bridgebox external device
7210-025	6330-002	DVD-RAM Bridgebox external device
7210-030	6333-002	External device
7212-102	6330 6333 6336	
7214	6331 6337	Storage device enclosure
7226	6331 or 63B8	Storage device enclosure with DVD-RAM or RDX feature.
5720	6331 6337	Storage device enclosure

Note: The 632C-002 client virtual optical device now supports an embedded media changer when the virtual storage server partition is an IBM i. For example, if the backing optical device is a 632B-001 or 632B-003, then the client 632C automatically changes media for installation and save restore operations. For enablement and usage information, see the optical storage website or review the latest PSP information.

Optical media libraries come in a variety of configurations that are designed around the different forms of media and different connection options. Optical media libraries range from the single cartridge stand-alone model through models capable of holding 638 optical cartridges and twelve disk drives. Optical media libraries may be directly connected to the system for best functionality and performance, or may be connected through a LAN to allow independent access by PCs or other systems. Verify which adapter is appropriate for your model system and device interface.

Table 22. Currently supported optical storage devices				
Model	**Drive Type**	**Connection**	**Cartridge Capacity**	**Number of Drives**
3431-705	Multi-Function	LAN	1	1
3995-A23	Multi-Function	LAN	16	1
3995-022	WORM	LAN	32	2
3995-023	Multi-Function	LAN	32	2
3995-122	WORM	LAN	144	4
3995-123	Multi-Function	LAN	144	4
3995-C20	Multi-Function	LAN	20	1 or 2
3995-C22	Multi-Function	LAN	52	2
3995-C24	Multi-Function	LAN	104	2 or 4
3995-C26	Multi-Function	LAN	156	4 or 6
3995-C28	Multi-Function	LAN	258	4 or 6
3995-C40	Multi-Function	Direct	20	1 or 2
3995-C42	Multi-Function	Direct	52	2
3995-C44	Multi-Function	Direct	104	2 or 4
3995-C46	Multi-Function	Direct	156	4 or 6
3995-C48	Multi-Function	Direct	258	4 or 6
3996-032	Multi-Function	Direct	32	2
3996-080	Multi-Function	Direct	72 or 80	2 or 4
3996-174	Multi-Function	Direct	166 or 174	2 or 4
399F-100	Multi-Function	Direct	24-80	1-4
399F-200	Multi-Function	Direct	104-638	2-12

Optical devices

Your system comes with a rack-mounted CD-ROM or DVD-ROM drive.

As an option, you can order a DVD-RAM drive as a feature to replace your internal drive or to have it in addition to your internal drive. All optical drives are devices that multiple users can access concurrently.

Note: Optical drives on the system are not enabled for the digital audio disk.

To load and unload an optical disk, take the following steps.

1. Look at the following figure and remove the disk from the protective case.

2. Slide the disk into the tray with the label side showing. If your optical device is vertically positioned, make sure that the disk is secured by the two tabs at the bottom of the tray as shown on the left in the following figure.

3. When you have properly positioned the disk in the tray, press the Eject button or push the tray into the drive as shown in the following figure.

4. To remove the disk from the drive, look at the following figure and press the Eject button.

No preventive maintenance is necessary for the optical drive. Always handle optical disks by the edges to avoid finger prints. Optical disks can be wiped with a soft lint-free cloth or lens tissue. Always wipe in a straight line from the inner hub to the outer rim.

The system supports both directly attached small computer system interface (SCSI) and LAN-attached optical media library devices. These devices are an excellent alternative to storing data traditionally kept on paper, diskette, microfilm, microfiche, and tape. Optical libraries are high capacity, random access devices that provide fast access to a large amount of data. In addition, optical storage provides permanent, long-term archive characteristics unmatched by other storage mediums.

The system supports attachment of the IBM 3995 and 3996 Optical libraries as well as non-IBM optical library devices.

Related information

Optical Drives

Optical media types
Six categories of optical media are available to meet most storage requirements: CD-ROM, DVD-ROM, DVD-RAM, recordable media, write-once read-many (WORM) optical cartridges, and erasable optical cartridges.

- CD-ROM is a read-only format that is optimized for read performance. CD-ROMs are ideal for wide-scale distribution of programs and data. The CD-ROM data format is identical to the one that is used with personal computers. This format makes it possible to develop CD-ROMs for use in both personal computers and the system. You can read CD-ROMs in either a CD-ROM or DVD drive.
- DVD-ROM is a read-only format that provides a higher capacity than CD-ROM. Like CD-ROM, DVD-ROMs are excellent for wide-scale distribution of programs and data. You can only read DVD-ROMs in a DVD drive.
- DVD-RAM is writable optical media that is available in both double-sided (Type I) and single-sided (Type II) formats, ranging from 2.6 GB per cartridge to 9.4 GB per cartridge. Both types can be accessed in a DVD-RAM drive, and Type II media can be read in a DVD-ROM drive when the media is removed from the cartridge.
- CD-R, CD-RW, DVD-R, DVD+R, DVD-RW, and DVD+RW are recordable media. The Duplicate Optical (DUPOPT) command can be used with the recordable media if the source volume is part of an image catalog and the target device supports recording. Recording is only possible with 6331 and 6333 devices without an IOP. Use the Display Device Description (DSPDEVD) command to see whether your device can record.
- Removable disk (RDX) is a removable hard disk cartridge and is available in capacities from 160 GB to 2 TB.
- When the device type is a USB attached device that is not an RDX device, the media type that is displayed on commands like **WRKOPTVOL** is *DEVICE. IBM i does not try to identify the media more specifically for this device type. A USB flash drive is an example of this type of device.
- WORM storage is an economical way to archive data, yet still have it quickly and easily accessible. WORM media is available in 1x (650 MB), 2x (1.3 GB), 4x (2.6 GB), 8x (5.2 GB), and 14x (9.1 GB or 8.6 GB) capacities. It is also available in 30 GB and 60 GB Ultra Density Optical (UDO).
- An erasable cartridge offers the most flexibility with similar capabilities as magnetic storage. Erasable media is available in 1x (650 MB), 2x (1.3 GB), 4x (2.6 GB), 8x (5.2 GB), and 14x (9.1 GB or 8.6 GB) capacities. It is also available in 30 GB and 60 GB Ultra Density Optical (UDO).

Both WORM and erasable cartridges must have a sector size of 1024 bytes per sector for 1x, 2x, and 4x media. For 8x media, permanent WORM must have a sector size of 2048. Continuous composite write-once (CCW), WORM, and erasable media can either be 1024 or 2048 bytes per sector. 14x media is available in CCW and erasable in 2048 or 4096 bytes per sector. UDO media is available in 8192 bytes per sector.

Directly attached optical media libraries
One method of connecting optical media libraries is to directly connect the optical media library to your system. A multiwire cable connects the library to an IOP or I/O adaptor card.

Directly attached optical media libraries support the following functions:

- Hierarchical file system (HFS) application programming interfaces (APIs).
- Most integrated file system commands.
- Many IBM i save and restore commands.
- Other LAN-connected systems can access the optical media libraries by using the integrated file system.

Optical system configurations

All systems include a rack-mounted CD-ROM or DVD drive that is ideal for program and data distribution.

The CD-ROM or DVD drive is primarily intended as a program and data delivery device. Even though many users can potentially access it simultaneously, it can access only one medium at a time.

A DVD-RAM drive is available to replace the existing read-only drive or to be added as another internal drive. This drive can read CD-ROM or DVD media, and can read or write DVD-RAM media. The CD and DVD drives supported on the system cannot be used to write to CD-R, CD-RW, DVD-R, DVD-RW, or DVD+RW media using Hierarchical File System APIs or Integrated File System APIs. However, certain DVD-RAM drives are recordable with the Duplicate Optical (DUPOPT) command. Use the Display Device Description (DSPDEVD) command to see the recording capabilities of your drive

An optical media library is a device that contains at least one optical disk drive and may contain many optical cartridges. Optical media libraries can manage large numbers of optical cartridges and users.

Optical media libraries connect directly to your system. A multiwire cable connects the library to an input/output processor (IOP) or input/output adaptor (IOA) card. Optical media libraries support all of the following functions:

- Hierarchical File System (HFS) application programming interfaces (APIs).
- Most integrated file system commands.
- Many IBM i save and restore commands.
- Other LAN-connected systems can access the optical media libraries by using the integrated file system.

Concepts for optical storage

This section discusses optical volumes, optical directories and files, and volume identifiers.

You can display the primary menu for optical support by entering GO OPTICAL on the IBM i command line. System administrators and programmers can access most optical commands through this menu. It is also convenient to enter many of the optical commands directly on the command line. These commands offer the following functions:

- Display optical volumes in an optical media library device (MLD), CD device, DVD device, or virtual optical device.
- Display files and directories that are contained in any directory in any optical volume.
- Display the file attributes of any optical file.
- Import or export media in a directly attached optical media library, CD-ROM device, DVD device, or virtual optical device.
- Make backup copies of volumes, directories, files that are contained in a directly attached optical device, or virtual optical device.
- Initialize a volume that is contained in a DVD-RAM drive, in a directly attached optical media library, or in a virtual optical device.
- Work with devices that represent optical media libraries, optical systems, CD drives, DVD drives, and virtual optical drives.
- Add, remove, or check the status of any LAN-attached optical system.
- Display active LAN-attached system conversations.
- Duplicate one optical volume to another.
- Copy files and directories from one optical volume to another.
- Check a volume for damaged directories and files.

When you enter GO CMDOPT on the command line, a complete list of optical commands appears. Many of these commands are accessible through the previous GO OPTICAL menu.

Optical volumes

All optical data is stored on a unit that is called a *volume* regardless of the type of media, the type of optical storage device, and the way the storage device connects to your system.

A single CD-ROM or DVD-ROM disk contains one volume. WORM and erasable optical cartridges are two sided and contain two volumes per cartridge (one per side). DVD-RAM can be either one sided or two sided. Virtual optical media contains one volume.

Each volume has its own name that is chosen by the person who initializes the volume. The name chosen must be unique from the names of all other volumes on the system. Two volumes with the same name cannot be active at the same time. The volume name typically never changes after the volume is generated, although volume renaming is supported. The creator of the CD-ROMs and DVD-ROMs chooses the names, and the names cannot be changed.

The hierarchical file system (HFS), the integrated file system, and the save and restore functions all use volume names to access or create data on the volume.

You can display and manage the optical volumes from the IBM i operating system by using the Work with Optical Volumes (WRKOPTVOL) command. The hierarchical file system and integrated file system include the volume name in their path name to select which volume to use. A typical optical path looks like the following:

`/QOPT/VOLUMENAME/MYDIR/MYFILE.EXT`

Where:

- `/QOPT` is the name of the optical file system.
- `/VOLUMENAME` is the volume name that is chosen for the volume.
- `/MYDIR` is the name of a directory on the volume.
- `/MYFILE.EXT` is the name of a file in the directory.

Optical directories and files

information about an optical volume is organized into units called directories and the basic element of optical storage is the optical file.

A directory is a logical partition that can contain files and other directories called subdirectories. Every volume contains at least one directory called the root directory. You are not required to have other directories below the root directory. Directories are a convenient way to keep files organized.

Any data that is available to application programs can be stored in or retrieved from optical files in the form of a data stream. Optical files have the following characteristics:

- Data is stored in a stream-file format.
- Data is independent of format and record structures.
- Data is accessed through byte offsets and lengths.
- Data is recognized and managed by the application that creates the file.

Volume identifiers

Loading CD-ROM or DVD media into a drive causes automatic reading of the information from the media. Part of this information is the volume identifier.

The *volume identifier* is a name that is given to an optical volume when it is created or initialized. Depending on the media format, the volume identifier can be up to 32 characters in length. On the system, applications accessing data from the optical volume often refer to it by its volume identifier. For example, a CD-ROM volume identifier might be VOLID01.

Applications that need to access file data from any optical media need to refer to the volume identifier. For example, you can write a C program to use the integrated file system APIs to read file `/DIR1/FILE` on the optical volume VOLID01. In this case, the application specifies path `/QOPT/VOLID01/DIR1/FILE` on the open request.

Optical media formats

There are several optical media types and media formats used for the IBM i operating system.

The media format is the file system architecture that exists on the media to manage file, directory, and volume information.

Writable optical media (such as WORM, erasable, DVD-RAM) is initialized on IBM i using the Initialize Optical (INZOPT) command. WORM media must use the High Performance Optical File System (HPOFS) format. DVD-RAM media must use Universal Disk Format (UDF). Erasable media can use either HPOFS or UDF depending on the requirements of the user. You can specify the format by using the MEDFMT keyword on the Initialize the optical volume (INZOPT) command. The following topics provide information about the different media formats and a comparison so you can select the media format that best meets your requirements.

Related concepts

Initializing optical volumes
You must initialize the writable optical media before the system can create directories and files.

Managing directory- and file-level security
Directory- and file-level security is available for Universal Disk Format (UDF) volumes.

Saving and restoring using optical media
Optical media is a cost effective long-term storage solution. You can save and restore your data using optical media in multiple ways. You can perform saves using BRMS, save operations and restore commands, and the Load Run command.

ISO 9660
This industry standard media format was originally designed to specify the volume and file structures of compact-disk read-only memory (CD-ROM) optical disks, and is a read-only media format.

The ISO 9660 format is used currently on CD and DVD read-only media. ISO 9660 media that is created using the primary volume descriptor (PVD) is supported. ISO 9660 extensions that use the supplementary volume descriptor (SVD) is not supported.

In addition, there is some support for ISO 9660 extensions defined as the IEEE P1281 (System Use Sharing Protocol) and P1282 (Rock Ridge Interchange Protocol) specifications. These extensions are also known as Rock Ridge. The Rock Ridge alternate name structures through the PVD are supported. This support provides recognition and handling of mixed case and long file names, similar to a UNIX system. Other structures defined by Rock Ridge are not supported in the IBM i operating system. To enable support to read Rock Ridge alternate name structure (if it exists), enter CHGOPTA EXTMEDFMT(*YES) before importing the media. If the Rock Ridge alternate name structures do not exist, entering this command will have no effect.

Volume, directory, and file names
The volume identifier for the primary volume descriptor can be a maximum of 32 characters. The volume identifier must contain only alphabetic characters (A through Z), numeric characters (0 through 9), or the underscore (_).

Although not required, you can include one or more directories in the path name. Each element of the path can be a maximum of 32 characters with the total maximum path length of 256 characters. A path name can consist of any alphabetic characters (A through Z), numeric characters (0 through 9), or the underscore (_).

For ISO 9660 media containing Rock Ridge extensions, the length of each element name is not restricted, but the total maximum path length is still 256 characters. The path name characters are not restricted, but are recommended to consist of the POSIX portable file name character set (A through Z, a through z, 0 through 9, period (.), underscore (_), or hyphen (-)).

For ISO 9660 media containing Rock Ridge extensions, file searches are case-sensitive. If no case-sensitive match is found, a mixed case match is returned if it exists. If multiple mixed case matches exist on the volume, an error will be returned indicating that ambiguous names exist on the media. Some optical commands, such as Copy Optical (CPYOPT), are not supported when duplicate, ambiguous file

names exist. For example Rock Ridge allows files ABC.ext and abc.EXT to exist in the same directory. This is not supported by CPYOPT and may produce unpredictable results.

File name searches are not case sensitive, meaning that you can use either uppercase or lowercase characters to access existing files.

Directory and file security

There is no directory-level and file-level security for ISO 9660 media. Volume-level security is available through authorization lists.

Programming interfaces for ISO 9660
The system can read files on ISO 9660 media by using either the hierarchical file system (HFS) application programming interface (API) or the integrated file system application programming interface (API).

High performance optical file system
High Performance Optical File System (HPOFS) is an IBM-developed media format architecture available to use when initializing optical media.

Use the WORM-based version of HPOFS. This media format is designed (and required) for WORM media, but you can use it (and it is the default) when initializing erasable optical media. HPOFS is a WORM media format. You can write each sector of the media only once when creating and updating files and directories. This unique characteristic of never rewriting the same sector allows all previous versions of every file to remain on the media. One drawback of this is that media consumption continues to grow as you update and even delete files.

This section contains detailed information about HPOFS for directly attached optical media libraries. This section does not discuss HPOFS characteristics for LAN-attached optical media libraries.

Detailed information about the implementation of HPOFS for directly attached optical media libraries is available in the command support for media formats.

Related concepts
CL command support for media formats
Use these commands to save and restore data. And, read about the restrictions for the ISO 9660, High Performance Optical File System (HPOFS), and Universal Disk Format (UDF) media.

Volume, directory, and file names for HPOFS
High Performance Optical File System (HPOFS) volume identifiers can be a maximum of 32 characters and must contain only alphabetic characters (A through Z), numeric characters (0 through 9), a hyphen (-), or a period (.).

The first character of the volume identifier must be alphabetic or numeric and the identifier cannot contain imbedded blanks. Although not required, you can include one or more directories in the path name. Each element of the path can be a maximum of 255 characters with the total maximum path length of 256 characters. A path name can consist of any of the EBCDIC characters except hexadecimal 00-3F, hexadecimal FF, quotation marks ("), apostrophe ('), greater than symbol (<), less than symbol (>), question mark (?), and backward slash (\).

The system stores all alphabetic characters for directory and file names to the media in uppercase. File name searches are not case sensitive.

Directory and file security

There is no directory-level and file-level security for High Performance Optical File System (HPOFS) media. Volume-level security is available through authorization lists.

Space reclamation

You can update or delete files even though High Performance Optical File System (HPOFS) is a write-once read-many (WORM) media format.

When a file is changed or deleted, a new version of the file is written, and the old version still exists on the media. This is true for both WORM and erasable media. The old file versions will always exist on WORM and will exist on erasable media until the entire volume is reinitialized. When you change or delete a file, the system does not reclaim the space that was used by the old file. Media consumption continues to increase on HPOFS media until you reinitialize the volume (for erasable media). You can never reclaim deleted space for WORM media.

Programming interfaces (HPOFS)

You can create or read files on High Performance Optical File System (HPOFS) media by using either the hierarchical file system (HFS) application programming interface (API) or the integrated file system application programming interface (API).

The following are items specific to the implementation of the HPOFS media format that application developers need to know.

National Language Support

The integrated file system interfaces assume that the coded character set identifier (CCSID) represents the path in effect for the job. The system then converts the path from the job CCSID to an internally used CCSID. The HFS interface makes no assumption about the CCSID of the path; therefore, the system performs no character set conversion on the path. This can produce undesirable side effects, such as reading the wrong file or directory, if an application used the two API sets interchangeably or if the application changed from using one API set to the other.

A program should not create files through HFS and then try to read them by using the integrated file system APIs. Depending on the characters that are used in the path name, this can result in a `File not found` error. This type of problem can be avoided if the application uses only invariant characters (for example letters (A-Z), numbers (0-9), plus sign (+), equal sign (=), percent sign (%), ampersand (&), blank space( ), comma (,), underscore (_), period (.), colon (:), and semicolon (;) for path names. *Invariant characters* are graphic characters that map to the same code point in all character sets.

Held optical files

When the system writes an optical file that it cannot close normally, the system may create a held optical file. The held file exists on IBM i internal disk storage and contains the data written to the file. You can then save or release the held file through an API or command interface. The system creates held files only when files fail to archive on HPOFS media.

Synchronous write operations

You can open files on HPOFS through HFS by specifying that all write operations be synchronous. When specified, write operations will be synchronous to IBM i internal disk storage, not to the optical media. In the event of a power failure, the data is recoverable from a held optical file.

Similarly for the HFS `Force Buffered Data` API and the `integrated file system fsync()` API, data is forced to IBM i internal disk storage, not to optical media. Again, in the event of a power failure, the data is recoverable from a held optical file.

File sharing

Multiple jobs or threads can share files. The system fully recognizes files that share modes as specified on the open request. For example, assume that a job opens a file that specifies it to share only with readers. This means that you can perform other open operations only as long as the access requested remains read-only.

Extended file attributes

The system supports extended file attributes for files on HPOFS media. Extended attributes can be written to files using the HFS Change Directory Entry Attributes API as well as through some integrated file system interfaces.

Directory structure and performance (HPOFS)

High Performance Optical File System (HPOFS) volumes have a dual directory structure to access files. Both a hash and hierarchical structure exist to provide a primary and secondary path to the file data. If the primary directory structure becomes damaged, the secondary path is used.

The hash directory structure is designed to reduce the amount of media I/O required, which improves performance for file access. Because of this hash directory structure, directory depth has less effect on performance than if the directory were searched hierarchically. For example, if /DIRECTORY1 contains 1000 files and /DIRECTORY2 contains 100 files, file search times for files in /DIRECTORY1 will generally take no longer than file searches in /DIRECTORY2. This is because the system performs the searches by using the hash structure, not the hierarchical structure.

Directory depth has less effect on performance for a hash search than for a hierarchical search. However, the overall directory depths and total number of files on a volume will affect performance. In general, a volume with fewer files on it will result in better file performance than a volume with more files.

Media interchange between LAN and directly attached libraries

Discover how High Performance Optical File System (HPOFS) optical media created in a LAN-attached optical library can be accessed.

HPOFS formatted optical media created in a directly attached optical library can be accessed in a LAN-attached optical library assuming that the media type is supported. Conversely, optical media created in a LAN-attached optical library can be accessed in a directly attached optical library if the media type is WORM or rewritable. Rewritable optical volumes initialized as rewritable media are not interchangeable between LAN and directly attached libraries. Universal Disk Format (UDF) media created in a directly attached optical library cannot be accessed in a LAN-attached optical library device.

Universal Disk Format

Universal Disk Format (UDF) is the Optical Storage Technology Association (OSTA) supported group of ISO/IEC 13346.

UDF also addresses ECMA-167, which is equivalent to ISO 13346. UDF is a writable file format that provides true space reclamation capabilities as well as file and directory-level security. This section contains detailed information about the implementation of UDF for directly attached (C4x) 3995 optical media libraries as well as for a DVD-RAM device.

Note: Although not accessible through IBM i operating system, CD and DVD media that are created using the supplementary volume descriptor of ISO 9660 may be accessible in a system. You can access them through an integrated system.

Media formatted with UDF supports the concept of time zones. Before V6R1, i5/OS stored the file and volume dates on optical media using machine time, with no reference to the time zone. Beginning in V6R1, Coordinated Universal Time (UTC) is recorded on optical media with the UDF media format, and times stored in releases before V6R1 are interpreted as UTC. As a result, those times stored in previous releases on UDF media might be off by up to 23 hours.

Related information

Windows environment on System i

Volume, directory, and file names

Volume identifiers can be a maximum of 30 characters and must contain only alphabetic characters (A through Z), numeric characters (0 through 9), a hyphen (-), or a period (.). The first character must be alphabetic or numeric, and the identifier cannot contain embedded blanks.

Although not required, you can include one or more directories in the path name. Each element of the path can be a maximum of 254 characters with a total maximum path length of 256 characters. A path name can consist of any of the EBCDIC characters except x00-x3F, xFF, quotation marks ("), asterick (*), less than (<), greater than (>), question mark (?), and backward slash (\).

The system stores all alphabetic characters for directory and file names to the media in uppercase when created through HFS or the IBM i save interfaces. The system stores all alphabetic characters for directory and file names to the media in mixed case when created through the integrated file system

interfaces. File name searches are not case sensitive, meaning that you can use either uppercase or lowercase characters to access existing files.

File names ending with #hhhh, where # is hexadecimal value x7B and h is a hexadecimal number (0 through F), are not allowed because the Universal Disk Format (UDF) standard recognizes that data pattern as a File Identifier CRC.

File searches on Universal Disk Format (UDF) volumes created by IBM i are not case sensitive. For UDF media created or updated by another operating system platform, a case sensitive search is performed. If no case sensitive match is found, a match that is not case sensitive is returned if it exists. If multiple matches exist on the UDF volume that are not case sensitive, an error is returned indicating that ambiguous names exist on the media. Some optical commands, such as Copy Optical (CPYOPT), are not supported when duplicate, ambiguous file names exist. For example, a UDF that is created on another operating system might allow files ABC.ext and abc.EXT to exist in the same directory. This is not supported by the CPYOPT command and might produce unpredictable results.

Programming interfaces (UDF)
You can create files or read files on Universal Disk Format (UDF) media by using either the Hierarchical File System (HFS) application programming interfaces (APIs) or the Integrated File System APIs. There are things specific to the IBM i implementation of the UDF that application developers need to know.

National language support
    The integrated file system interfaces assume that the coded character set identifier (CCSID) represents the path in effect for the job. The system then converts the path from the job CCSID to an internally used CCSID. The HFS APIs make no assumption about the CCSID of the path; therefore, the system performs no character set conversion on the path. This can produce undesirable side effects if an application used the two API sets interchangeably or if the application changed from using one API set to the other.

    Do not create files through HFS and then try to read them by using the Integrated File System APIs. Depending on the characters that are used in the path name, a `File not found` error might result. This type of problem can be avoided if the application uses only invariant characters (for example, letters (A-Z), numbers (0-9), plus sign (+), equal sign (=), percent sign (%), ampersand (&), ( ), comma (,), underscore (_), period (.), colon (:), and semicolon (;)) for path names. Invariant characters are graphic characters that map to the same code point in all character sets.

    Since UDF is an industry-standard media format, NLS compliance can be important because of the increased opportunity for media interchange across different operating system platforms. This causes the system to limit HFS interfaces to UDF media. Additionally, the system uses invariant characters to reduce the chance of media interchange problems that are related to file names. Assume that an HFS-based application absolutely requires the use of variant characters. You can use the Change Optical Attributes (CHGOPTA) CL command to allow variant characters through the HFS interface by specifying CHGOPTA ALWVRNT(*YES). After the system allows variant characters through HFS, there is no guarantee that path names will interchange correctly if accessed from another operating system. There is also no guarantee that path names will be consistent between the HFS and integrated file system interfaces.

Held optical files
    The system does not create held files for UDF media. When a file fails to close on UDF, the system signals an error to the application. This error then closes the file without writing the data to optical disk. The application must rewrite the file (open, write, close) to ensure that the data is on optical disk. The exception to this is if the application performs a `Force Buffered Data (QHFFRCSF)` or `fsync()` API before the close operation.

    These APIs force the writing of the data to the optical disk.

File sharing
    Multiple jobs or threads can share files for a read operation, but writers are always exclusive. If one job or thread is writing to a file on UDF, you cannot use any other jobs or threads to open that file.

    Therefore, when using the integrated file system open() or open64() API, the sharing modes O_SHARE_RDONLY, O_SHARE_WRONLY, and O_SHARE_RDWR do not provide the requested level of

sharing when the access mode is O_RDWR or O_WRONLY. When the access method is O_RDWR or O_WRONLY, the resulting sharing mode will be equivalent to O_SHARE_NONE.

When using the HFS Open Stream File API, the lock modes deny none, deny write, and deny read do not provide the requested level of sharing when the access mode is write only or read/write. When the access method is write only or read/write, the resulting lock mode is deny read/write.

Mixed-case file name

When created through the integrated file system interfaces, files and directories created on UDF volumes preserve the case specified on the create operation. For example, if file Abc is specified on the open() API, Abc will be created on the media in the mixed-case form. Even though the system preserves case of the file name, file searches are not case sensitive, meaning that the system can read the file that uses any case, such as ABC or abc.

When created through the HFS or save and restore interfaces, the system stores files and directories that are created on the UDF volumes in uppercase. For example, if you specify file Abc on the Open Stream File (QHFOPNSF) API, the system creates ABC on the media. Again, file searches are not case sensitive, so you can specify any case to read the file.

File searches on UDF volumes created by IBM i are not case sensitive. For UDF media created or updated by another operating system platform, a case-sensitive search is performed. If no case-sensitive match is found, a match that is not case sensitive is returned if it exists. If multiple matches exist on the UDF volume that are not case sensitive, an error is returned indicating that ambiguous names exist on the media.

Directory and file security
Directory-level and file-level security is available for Universal Disk Format (UDF) volumes. The system maintains the data authorities of optical directories and files for three groups of users: owner, group, and public. Volume-level security is also available through authorization lists.

Directory-level and file-level security is not guaranteed when volumes are removed and transported to and from other systems. Security information recorded in the UDF structures on the media might not have the same meaning on another system as it does on the system where it was written.

Related concepts

Managing optical security and auditing
You can secure information about optical media by using IBM i security functions.

CL command support for media formats
Use these commands to save and restore data. And, read about the restrictions for the ISO 9660, High Performance Optical File System (HPOFS), and Universal Disk Format (UDF) media.

Media interchange
Universal Disk Format (UDF) media created on the IBM i operating system is UDF Version 2.01. This media can be interchanged to other operating systems that support this version of UDF.

UDF-compliant media that is created with UDF Version 1.5 or earlier is accessible as read-only. Media created with UDF Version 2.0 and UDF 2.01 is accessible for read and write. Optical media created with UDF version 2.5 are accessible as read-only. Removable Mass Storage (RMS) media created with UDF version 2.5 are accessible for read and write.

Directory structure and performance (UDF)
Universal Disk Format (UDF) volumes have a single (hierarchical) directory structure to access files. Because of this hierarchical directory structure, the depth of a directory tree has a direct affect on file performance. For example, if /DIRECTORY1 contains 1000 files and /DIRECTORY2 contains 100 files, file search times for files in /DIRECTORY1, in general, take longer than file searches in /DIRECTORY2. This is because the system performs file searches hierarchically, which may require looking at every entry in the directory.

In general, file performance is better for UDF if you evenly distribute files across several directories and subdirectories.

CL command support for media formats

Use these commands to save and restore data. And, read about the restrictions for the ISO 9660, High Performance Optical File System (HPOFS), and Universal Disk Format (UDF) media.

ISO 9660

You can use IBM i restore commands to restore data from ISO 9660 media. This is true only when the media was correctly mastered from a save image on tape. There are some restrictions on which optical commands are supported for ISO 9660 media.

HPOFS

IBM i save and restore commands can be used to save and restore data on HPOFS optical media. Refer to "Saving and restoring using optical media" on page 136 for more information about save and restore operations to HPOFS volumes. There are no restrictions on which optical commands the system supports for HPOFS media.

UDF

IBM i save and restore commands can be used to save and restore data on UDF optical media. There are some restrictions on which optical commands are supported for UDF volumes. For example, the system does not support Work with Optical Directories (WRKOPTDIR) and Work with Optical Files (WRKOPTF) commands. The Display Optical (DSPOPT) command has some restrictions when used for UDF volumes. You should use the integrated file system commands Work with Object Links (WRKLNK) and Display Object Links (DSPLNK) instead of the optical commands.

Some optical commands have no meaning when used with certain optical media formats. No support exists for other commands with certain optical media formats. This table lists all of the volume-related optical commands and the media formats to which they apply.

Command	ISO 9660	UDF	HPOFS Directly-attached device	HPOFS on LAN-attached device
CHGOPTVOL	Partially supported 1	Partially supported	Supported	Partially supported
CHKOPTVOL	Supported	Supported	Supported	Not supported
CPYOPT	Supported	Supported	Supported	Not supported
CVTOPTBKU	Not applicable	Not applicable	Supported	Not applicable
DSPOPT	Supported	Partially supported	Partially supported	Partially supported
DSPOPTLCK	Supported	Supported	Supported	Partially supported
DUPOPT	Not supported	Supported	Supported	Not supported
INZOPT	Not applicable	Supported	Supported	Not supported
WRKHLDOPTF	Not applicable	Not applicable	Supported	Not applicable
WRKOPTDIR	Supported	Not supported	Supported	Partially supported
WRKOPTF	Supported	Not supported	Supported	Partially supported
WRKOPTVOL	Supported	Supported	Supported	Partially supported
Partially supported indicates that some command parameters might not apply when used with the indicated device.				

Related concepts

High performance optical file system
High Performance Optical File System (HPOFS) is an IBM-developed media format architecture available to use when initializing optical media.

Directory and file security

Directory-level and file-level security is available for Universal Disk Format (UDF) volumes. The system maintains the data authorities of optical directories and files for three groups of users: owner, group, and public. Volume-level security is also available through authorization lists.

Configuring optical devices

Configure your CD-ROM, DVD-ROM, and DVD-RAM devices, and optical medial libraries. The systems come with a rack-mounted CD-ROM or DVD-ROM drive.

As an option, you can order a DVD-RAM drive as a feature to replace your internal drive or to have it in addition to your internal drive. All optical drives are multi-user devices that multiple users can access concurrently.

Directly attached optical media libraries are attached to the system through the small computer system interface (SCSI). On IBM i, multiple users can access data on optical media libraries concurrently. These interfaces are available to access the data on the CD and DVD devices and optical media libraries:

- Save and restore interface
- Hierarchical file system (HFS)
- Application programming interface (API)
- Integrated file system interfaces
- Optical commands and utility displays

Note: The CD-ROM and DVD-ROM drives on the system are not enabled for the digital audio disk format.

Connectivity of non-IBM library devices

In addition to IBM optical libraries, you can now attach some non-IBM optical library devices to the system. For more information about which devices are supported and system configuration requirements, see the Optical Storage Web site.

Related information

Optical Storage Web site

Configuring your optical drive

Depending on the model of your system, you can position the CD-ROM or DVD drive either horizontally or vertically in the system.

Before you use the CD-ROM or DVD drive, you must have a device description for it. The system can create the device description automatically during an IPL if auto-configuration is on. Alternatively, you create it manually by using the Create Device Description Optical (CRTDEVOPT) command. After you create the device description, you can vary on the configuration by using the Vary Configuration (VRYCFG) command. The configuration description for the CD-ROM or DVD device is *OPT. When the device description is varied on, it displays a status of ACTIVE.

Configuring directly attached optical media libraries

To create a device description for an optical media library device, use the Create Device Description (Media Library) (CRTDEVMLB) command.

Specify the device class as *OPT. For example:

```
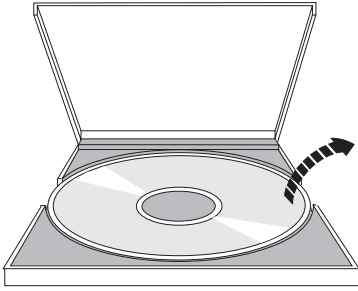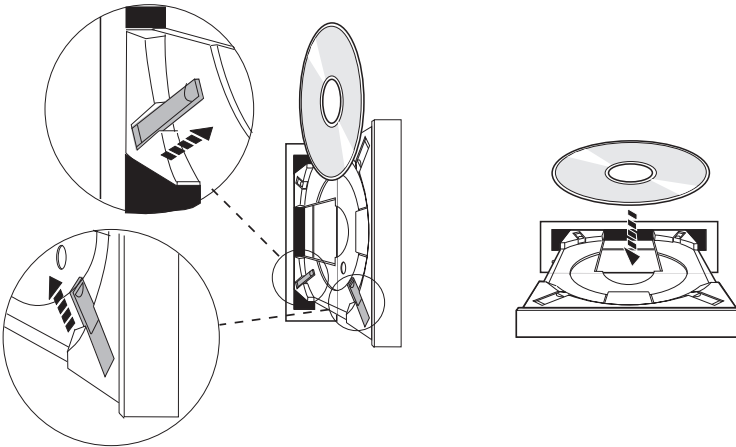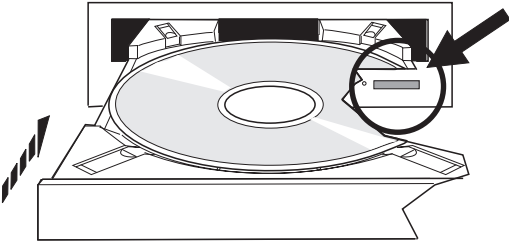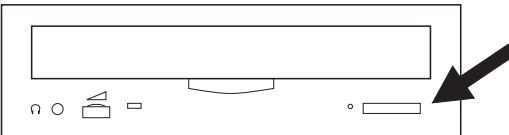CRTDEVMLB DEVD(OPTMLB01) DEVCLS(*OPT) RSRCNAME(OPTMLB01)
```

The configuration description for an optical media library device (MLD) is *OPTMLB. In addition, you can use the following commands to work with device descriptions:

- To change the device description, use the Change Device Description (Media Library) (CHGDEVMLB) command.
- To vary on or off the device description, use the Vary Configuration (VRYCFG) command.
- To delete the device description, use the Delete Device Description (DLTDEVD) command.
- To work with the configuration status, use the Work with Configuration Status (WRKCFGSTS) command.

Labeling optical cartridges

Each optical disk cartridge contains two sides. Each side corresponds to an optical volume. There are two techniques to associate a volume ID label with the correct side of the optical cartridge. This is important to know when you set the write-protect switch.

The optical cartridge should be labeled the first time the cartridge is added to an optical media library. This prevents any confusion in the future when you are attempting to determine which volume goes with which side.

Related concepts

Example: Adding optical cartridges to an optical media library
This example provides information about adding optical cartridges to an optical media library.

Labeling a new optical cartridge with uninitialized volumes

Several steps are necessary to label a cartridge that is new (both volumes are uninitialized). The options are selected from the Work with Optical Volumes display.

1. Label sides A and B with the volume names you will use when initializing them.
2. Place the cartridge in the input/output station with side A facing up.
3. Select Option 1 (Add).

   After you have added the cartridge, the volume names appear on the Work with Optical Volumes display as system-generated IDs that consist of the system date and time.

   The earlier time corresponds to the side that was facing up in the input/output station. Therefore, if side A was facing up in the input/output station, then side A will have the earlier date and time of the two volumes.

4. Initialize the volume that corresponds to side A by choosing option 10 (Initialize) next to the system-generated volume ID. Use the labeled name. Repeat this step for side B.

Labeling an optical cartridge with an initialized volume

To label a cartridge that has at least one initialized volume on it, follow these steps. The options are selected from the Work with Optical Volumes display.

1. If the cartridge resides in an optical media library, remove it by selecting **Remove** next to the volume ID.
2. After the cartridge is removed, set one side of the cartridge to write-protected and the other side to write-enable.
3. Add the cartridge to an optical media library by selecting **Add**.
4. Press F11 (View 2) to see the write-protected status of the newly added volumes.
5. Determine which volume is write-protected and make a record of this volume ID.
6. Remove the optical cartridge by typing selecting **Remove** next to the volume ID.
7. Label the write-protected side of the cartridge to the volume ID you previously recorded.

Related tasks

Setting write protection
The write-protect function prevents writing to disk. A write-protect window shows when write protection is on or off.

Getting started with optical cartridges and volumes

Read about the optical support functions and familiarize yourself with using optical cartridges and volumes.

Through these examples you can perform the following tasks:

- Work with optical volumes
- Add optical cartridges to an optical media library
- Initialize optical volumes
- Remove optical cartridges from an optical media library

Note: The device, volume, and directory names that are used in these examples are for illustrative purposes only. Your applications may require different volume names or different directory names. Additionally, your optical devices might have different names.

Only some of the available optical commands are discussed here. Do not use these topics as the primary reference for these commands because they do not describe all of the functions that are available. These topics provide a tutorial on getting started by using the optical utilities.

The following examples assume that you have a new optical disk cartridge available to use and that your optical media library is empty.

Example: Adding optical cartridges to an optical media library
This example provides information about adding optical cartridges to an optical media library.

To add an optical cartridge to the optical media library that you have attached to your system, place the optical cartridge with side A up in the input/output station of the optical library dataserver. Make sure the cartridge is seated properly. Use a new optical cartridge if one is available.

1. Type 1 (Add) in the Options field and press the Enter key. The Add Optical Cartridge display appears.
2. Type the name of the optical media library to which you want to add the cartridge. This is the name of the library description that was created during installation. If you have more than one library attached, you need to know the optical media library association and configuration. To view your optical configurations, type WRKMLBSTS MLB(*OPTMLB).
3. When all parameters are entered, press the Enter key.

Related concepts
Labeling optical cartridges
Each optical disk cartridge contains two sides. Each side corresponds to an optical volume. There are two techniques to associate a volume ID label with the correct side of the optical cartridge. This is important to know when you set the write-protect switch.

Example: Initializing optical volumes
This example provides information about initializing optical volumes in an optical media library.

If the cartridge you added is a new cartridge, the optical cartridge has two uninitialized volumes on it.

An uninitialized volume is an optical volume that has never been formatted or initialized. It is similar to a new diskette that needs to be formatted. If a volume has not been initialized, it has a volume type of *UNFORMATTED (uninitialized).

An uninitialized volume does not have a volume name written to it. When an uninitialized volume is added to an optical media library, a volume name that consists of a date and time (YYMMDDHHMMSS) is assigned to it. Optical volumes cannot be written to or read from until they are initialized.

On the Work with Optical Volumes display, you see that two volumes were added, one for each side of the optical disk cartridge. If either of the volumes are initialized, the volume type indicates *PRIMARY or *BACKUP, and most likely the volume ID will be different from the ones in the example. An optical disk can contain one volume that is initialized and one volume that is uninitialized. The volumes are treated independently even though they exist on the same cartridge.

If both volumes are uninitialized, the earlier date and time for the volume names indicate the volume that was facing up in the input/output station. In this example, because side A was facing up when the add operation was performed. This is important to know so the volume can be properly labeled when removed from the library.

To initialize the volume you determined to be side A, enter option 10 (Initialize) in the Opt field beside that volume. Press the Enter key.

Note: Initializing a previously initialized volume makes all existing data on that volume inaccessible. If you typed 10 next to a volume that is already initialized and you do not want to lose the data on that volume, do not continue with this function. Use a volume that is uninitialized.

Complete the following fields on the Initialize Optical Volume display:

Volume identifier
This is the existing volume ID of the volume that you are going to initialize. For uninitialized volumes, this name is a system-generated name that consists of the date and time. This is only a temporary name until the volume is initialized.

Volume identifier
Type the new name for the specified volume. This is the name that users and applications will use when referring to the volume.

Volume-full threshold
Leave this set to the default value. Use this value to give the volume a logical volume-full threshold.

Check for active volume
Leave this set to *YES to verify that the optical volume was previously initialized.

Clear
Leave this set to *NO. This specifies if existing data on the volume will be cleared during the initiating process. This parameter only applies when the volume media type is *DVD-RAM. Specifying CLEAR(*YES) can cause this operation to take up to one hour.

Text description
Enter a short description of the volume. Fifty characters are available for this field.

Press the Enter key to initialize the volume.

Note: Initializing an erasable optical volume can take up to 30 minutes.

After the volume is initialized, the Work with Optical Volumes display reappears and the previously uninitialized volume is now initialized. The type has changed from *UNFORMATTED to *PRIMARY, and the volume is now available for reading and writing files and directories.

From this display, you can select the following options:

1. Add an optical cartridge
2. Change the volume attributes
3. Copy a volume
4. Remove an optical cartridge
5. Display volume information
6. Print volume information
7. Rename a volume
8. Work with directories on the volume
9. Delete volume information for a previously removed volume
10. Initialize or reinitialize a volume
11. Work with directories and files on the volume
12. Duplicate a volume to another optical media
13. Check the volume for damaged files and return a count of the directories and files

Example: Removing an optical disk cartridge
This example shows how to remove the optical disk cartridge from the optical media library.

Because there are two volumes on a cartridge, removing a cartridge actually removes two volumes. Therefore, specifying **Remove** on any of the volumes shown in the example produces the same result.

Before removing a cartridge, make sure that the input/output station is empty. The optical media library cannot remove a cartridge if the input/output station is occupied by another cartridge.

1. Type 4 (Remove) in the Option field next to the cartridge you want to remove and press the Enter key. The Remove Optical Cartridge display appears. Complete the fields of the Remove Optical Cartridge display as follows:

Volume identifier
This is the volume you selected on the Work with Optical Volume display.

Volume description option
Specify *REMOVE for this field to remove the volume descriptions from the optical index database files after the cartridge has been removed.

Specify *KEEP for this field to save the volume descriptions for initialized volumes in the optical index database files. This causes the system to consider the volumes as *REMOVED.

2. Press the Enter key to remove the optical disk cartridge. The optical disk cartridge has now been moved to the input/output station of the optical library dataserver.

3. Press F3 (Exit) to return to the optical support main menu. The resulting display shows that the optical disk cartridge is no longer available.

4. Press F3 again to return to the IBM i command line.

Using optical devices

You can display the primary menu for optical support by entering GO OPTICAL on the IBM i command line. System administrators and programmers can access most optical commands through this menu. It is also convenient to enter many of the optical commands directly on the command line.

These commands offer the following functions:

- Display optical volumes in a directly attached or LAN-attached optical media library device (MLD), CD device, DVD device, or virtual optical device.
- Display files and directories that are contained in any directory in any optical volume.
- Display the file attributes of any optical file.
- Import or export media in a directly attached optical media library, CD-ROM device, DVD device, or virtual optical device.
- Make backup copies of volumes, directories, or files that are contained in directly attached optical devices or virtual optical devices.
- Initialize a volume that is contained in a DVD-RAM drive, a directly attached optical media library, or a virtual optical device.
- Work with devices that represent optical media libraries, optical systems, CD drives, DVD drives, and virtual optical drives.
- Add, remove, or change the status of any LAN-attached optical system.
- Duplicate one optical volume to another.
- Copy files and directories from one optical volume to another.
- Check a volume for damaged directories and files.

When you enter GO CMDOPT on the command line, a complete list of optical commands appears. Many of these commands are accessible through the previous GO OPTICAL menu.

The following topics provide information about configuring your CD-ROM, DVD-ROM, or DVD-RAM device as well as tips for loading and unloading media.

Loading, unloading, and varying on optical devices
Loading a CD-ROM, DVD, or RDX media into a drive, inserting a USB flash drive, or varying on an optical device causes the system to read the media to retrieve the volume identifier.

The system stores this volume identifier in an optical index database file to expedite future access to the media. After the volume identifier is in the optical index, you can access the media through save and restore options, as well as the application programming interfaces. Unloading the media from the drive removes the volume identifier from the optical index. The system adds the volume identifier to the optical index database in one of two ways:

- When the optical media is loaded into a varied-on device.

Note: Optical media can also be loaded into a varied off device. However, the optical index is not updated until you vary on the device description.

- When the user varies on the device description for an optical device with media in it.

It can take an extended amount of time before an optical device is ready to use after media is loaded or it is varied on. For CD-ROM or DVD devices, it can take up to 1 minute before the device is ready to use. For RDX and USB flash drives, it can take up to 10 seconds before the device is ready to use.

When the user successfully loads optical media into a drive, the system sends the following message to the QSYSOPR message queue:

```
Volume VOLID01 added to optical device.
```

When optical media is successfully removed from a drive, the system sends the following message to the QSYSOPR message queue:

```
Volume VOLID01 removed from optical device.
```

You can use the Work with Optical Volumes (WRKOPTVOL) command to verify the successful adding or removing of the optical media.

You can also use the Display Optical (DSPOPT) command to display optical volume information.

Occasionally media might fail to load successfully into the drive. The following list shows some of the possible causes for an unsuccessful load:

- Media or drive error occurred.
- The media format is not supported (digital audio CD-ROM).
- The system encountered a duplicate volume identifier.

Depending on the error, the tray might or might not eject if a CD-ROM or DVD fails to load. A failure to load the CD-ROM or DVD might not be obvious. Your first indication might be that you received one of the following messages when trying to access the CD-ROM:

```
Optical volume format not recognized.
```
```
Optical volume not found.
```

If an error does occur when loading media or varying on the drive, the system signals an error message to the QSYSOPR message queue. This message describes the reason for the failure.

The processing for the load, unload, and vary-on operations runs in job QJOBSCD. If errors occur during these operations, view the job log of QJOBSCD to see the detailed messages.

Allocating the device description
The process of loading the CD-ROM or DVD media requires shared update (*SHRUPD) use of the device description.

The QJOBSCD job must be able to obtain a *SHRUPD lock on the device description for the load to complete successfully. If another job is holding a conflicting lock on the device description, the load processing will fail with the following errors in the QJOBSCD job log.

```
Optical device xxxxx in use.
```
```
Add optical disk cartridge failed to complete successfully.
```

As an example, assume that some job allocates OPT01 with an Exclusive Allow Read lock as follows:

```
ALCOBJ OBJ((OPT01 *DEVD *EXCLRD))
```

As long as the system holds this lock, CD-ROM and DVD loads will fail in the QJOBSCD job.

Allocating and deallocating an optical drive
You can allocate or deallocate a drive within a media library.

Optical media libraries range from a model that has a single drive to a model that has twelve drives. Use the Work with Media Library Status (WRKMLBSTS) command to see the allocation status of each drive within a media library. The allocation status for a drive can be ALLOCATED, DEALLOCATED or *UNKNOWN.

The default allocation status for an optical drive is ALLOCATED, which means that the drive is available for use by the optical media library. The system sets this default value at IPL time. You can only change it using the Work with Media Library Status (WRKMLBSTS) command. DEALLOCATED means that the drive becomes unavailable for use by the optical media library. The allocation status for drives in an optical media library that is varied off is *UNKNOWN.

There are times when a drive should be removed from serving the optical media library such as when it is suspected of needing repair. To do this, you need to change the drive allocation status to DEALLOCATED. This will make the drive unavailable for use by the optical media library.

To deallocate a drive, select option 6 (**Deallocate resource**) on the device or resource.

The device allocation status of deallocated remains in effect until the drive is allocated again or an IPL of the system occurs.

Using optical volumes

These topics describe the Work with Optical Volumes options on the Optical Support Utilities main menu.

These options are organized hierarchically, with volumes as the highest in the order and files as the lowest in the order. You can use the appropriate "Work with..." command to access these panels directly without having to go through the Optical Support Utilities main menu. Each display presents the selected information and the options that are available. Some options might not apply to all optical devices or volumes.

The primary menu for working with optical volumes is the Work with Optical Volumes display. There are several variations of the display to accommodate alternative formats and extended attribute information.

You can select the Work with Optical Volumes display by choosing **Work with optical volumes** on the Optical Support Utilities menu. You can also run the Work with Optical Volumes (WRKOPTVOL) command on the command line.

The Work with Optical Volumes (WRKOPTVOL) command applies to the following volumes:

- Volumes in CD-ROM, DVD, or RMS devices
- Volumes in optical media library devices
- Volumes in virtual optical devices
- Volumes in LAN-attached optical library devices

Displaying optical volumes
When the Work with Optical Volumes display first appears, it includes a list of all volumes in all CD-ROM devices, DVD devices, RMS devices, optical media libraries, and LAN-attached devices.

The volume names that are displayed are determined by what you type in the device (DEV) and CSI parameters. The following options are valid for the DEV parameter:

Name
    The name of a specific device. This lists all volumes in the specified device.

*ALL
    The list of all volumes in all devices. The volumes are displayed in alphabetical order regardless of the device they are in. You can press F11 (View 2) on the Work with Optical Volumes display to view the text variation of the display.

Press F11 (View 1) to return to the status variation.

A third variation of the Work with Optical Volumes display is the extended information display. To view this display, press F14 (Show extended information) on the Work with Optical Volumes display, or use the **Work with Optical Volumes (WRKOPTVOL)** command and set the extended information parameter to *YES.

Unlike the status and text variations, this display requires that the optical device be varied on. If an optical device is not varied on, the following message is returned.

```
OPT1520, Data displayed may not be current
```

Initializing optical volumes

You must initialize the writable optical media before the system can create directories and files.

When you initialize a volume, a new volume identifier must be given, which is then written to the media.

You initialize an optical volume by using the Initialize Optical (INZOPT) command. To select this command from the Work with Optical Volumes display, select option 10 (Initialize) in the Opt (Option) column next to the volume you want to initialize. The Initialize Optical Volume display appears and prompts you for required information.

The Media format parameter determines the media format of the volume. *MEDTYPE is the default, which means that the media type determines the media format. The two media formats available are Universal Disk Format (UDF) and High Performance Optical File System (HPOFS).

The Volume type parameter specifies the type of optical volume that is being initialized. Optical volumes for user applications are initialized as primary volumes. Backup optical volumes can be written to by using the following set of optical backup commands: **CVTOPTBKU**, **CPYOPT**, and **DUPOPT**. Container volumes are primary volumes that can be used to store optical image catalog entries for virtual optical devices. They are created by specifying a volume type of ***CONTAINER**.

> ⚠️ **Attention:** When you initialize an optical volume, all information previously written on the volume becomes inaccessible.

The INZOPT command applies to the following volumes:

- Volumes in directly attached optical media libraries
- Volumes on writable media in DVD devices
- Volumes in virtual optical devices.

Renaming optical volumes

You can rename an optical volume without losing the information about the volume.

To rename a volume, select **Rename** in the Opt (Option) column on the Work with Optical Volumes display. The fields on this display show the following information for renaming optical volumes:

- *Volume:* The current name of the optical volume for renaming appears in this field.
- *New Name:* Specify the new name of the optical volume. The new name automatically becomes the current volume name.

Note: You can rename unformatted (uninitialized and unknown) volumes. When an unformatted volume is renamed, the new name acts as an alias to the unformatted volume. The new name will not be written to the media and will not be preserved if the volume is exported from the device. The name is only a temporary volume identifier used to refer to this volume.

Adding optical disk cartridges

Use this procedure to add an optical disk cartridge to an optical volume.

To add an optical disk cartridge, perform the following steps:

1. On the Work with Optical Volumes display, select **Add** in the Opt column next to the blank volume name.

2. On the Add Optical Cartridge display, enter:

    - Optical media library device (required)
    - Authorization list
    - Rebuild directory index
    - Media location

    Note:

    - Specifying *NO for the Rebuild directory index prompt can improve the performance of the **Add Optical Cartridge (ADDOPTCTG)** command by deferring the rebuilding of the optical directory index until a later time.

- Some 399F models support adding multiple media through the bulk magazine. *MAGAZINE can be specified to use this feature if available for the device.

You do not need to provide a volume identifier. The system supplies a date and time stamp as the volume identifier. The date and time stamp is used to track each volume until it is read. If the volume is not initialized, the date and time stamp serves as its identifier until the volume is initialized with a user-supplied name.

Note: The **Add Optical Cartridge (ADDOPTCTG)** command applies to:

- Directly attached optical media libraries
- CD and DVD devices
- Virtual optical devices

Copying optical volume data
Optical files can be copied from one or more volumes or directories to other volumes or directories.

To copy optical files in one or all of the directories on a volume to another volume or directory, select **Copy** in the Opt column on the Work with Optical Volumes display next to the volume with the directory you want copied.

This command is not allowed for LAN-attached optical devices. If you attempt to use a LAN-attached optical device, an error message is issued.

The name of the volume appears on the display. You must specify the name of the directory to be copied from and the volume to receive the copy.

Note: The volume must be initialized before copying.

For copying IPL capable media, see "Duplicating optical volumes" on page 106.

If you are copying a full volume, specify an unused volume to receive the copied files to be sure that enough space is available.

This command does not delete files for you. Therefore, if you use this command to make additional copies, you must delete files from the target volume that have been deleted from the source volume.

When the copy request is completed, a message is added to the job log stating the number of files that were copied successfully and the number of files that were not copied. For each file that is not copied, a message stating the full file name is added to the job log. For each directory that is processed, a message is added to the job log stating the number of files that were copied successfully and the number of files that were not copied successfully.

Select files to copy (SLTFILE) parameter

The Select files to copy (SLTFILE) parameter indicates how files are to be selected for copying. You can select whether to replace files that already exist on the volume to which you are copying. A value of *CHANGED specifies that a file is copied if it does not exist on the target volume, or if the file is more current than the one on the target volume. A value of *NEW specifies that only files that do not already exist in the **To volume identifier** field are copied. A value of *ALL specifies that all files are copied, even if they exist with the same creation date.

Copy option (COPYTYPE) parameter

The Copy option (COPYTYPE) parameter indicates which resources are used to perform the copy operation. A value of *IOP specifies that the copy operation will have better performance but will slow down other requests to the optical media library. A value of *SYSTEM specifies that the copy request will share the optical media library resources with other requests but will cause the copy request to take longer.

Starting date and time (FROMTIME) parameter

The Starting date and time (FROMTIME) parameter is optional and can be used to further restrict the number of files that are copied. Files from the source volume that have a creation or modification date and time greater than or equal to the date and time entered on this parameter are selected to be copied.

Example: Copying optical volume data

To make a complete copy of VOLA on VOLB, use the following command:

```
CPYOPT FROMVOL(VOLA) FROMDIR('/') TOVOL(VOLB) TODIR(*FROMDIR) SLTFILE(*CHANGED)
CPYSUBDIR(*YES) CRTDIR(*YES) ALWCPYOPP(*NO) COPYTYPE(*IOP)
```

The Copy Optical (CPYOPT) command applies to:

- Volumes in directly attached optical media libraries
- Volumes in CD-ROM or DVD devices
- Volumes in virtual optical devices

Output file support structures

There are three possible record formats that are created by the Display Optical (DSPOPT) command when output is directed to either an output file or user space.

Only the fields that are set for a LAN volume (volume type 9) are indicated with an asterisk (*). The Volume Capacity and Volume Space Available fields have a different meaning for LAN volumes; this is because the Volume Full Threshold field is not available. The Volume Capacity field contains the current total free space on the volume. Total free space equals the free space available for the user's application plus the space reserved by the volume full threshold.

The Volume Space Available field contains the user free space on the volume. The user free space equals the total free space less the amount of space reserved by the volume-full threshold.

Output file structure for volume attributes

Record format for QAMODVA (a * indicates a LAN or type 9 volume)		
	Attribute name	Attribute length
*	CENTURY	CHAR(1)
*	DATE	CHAR(6)
*	TIME	CHAR(6)
*	VOLUME NAME	CHAR(32)
	OPTICAL DEVICE	CHAR(10)
*	CSI	CHAR(8)
	CSI LIBRARY	CHAR(10)
*	AUTHORIZATION LIST	CHAR(10)
	INTERNAL VOLUME ID	CHAR(32)
	VOLUME SERIAL NUMBER	PACKED(11,0)
*	VOLUME TYPE	PACKED(3,0)
	VOLUME CCSID	CHAR(2)
*	MEDIA TYPE	PACKED(3,0)
	MEDIA FORMAT	PACKED(3,0)

Record format for QAMODVA (a * indicates a LAN or type 9 volume)		
	VOLUME FULL THRESHOLD	PACKED(5,0)
	VOLUME SEQUENCE NUMBER	PACKED(9,0)
	VOLUME CREATION DATE	CHAR(7)
	VOLUME CREATION TIME	CHAR(6)
	VOLUME DESCRIPTION TEXT	CHAR(50)
	VOLUME LAST REFERENCE DATE	CHAR(7)
*	OPPOSITE SIDE VOLUME NAME	CHAR(32)
	VOLUME BLOCK SIZE	PACKED(9,0)
*	VOLUME CAPACITY	PACKED(13,0)
*	VOLUME SPACE AVAILABLE	PACKED(13,0)
	VOLUME LOCATION	CHAR(1)
	VOLUME OFFLINE LOCATION	CHAR(50)
	VOLUME ACCESS	CHAR(1)
	VOLUME MEDIUM	CHAR(1)
	DOUBLE-SIDED MEDIUM	CHAR(1)
	IPL-CAPABLE	CHAR(1)
	LAST VOLUME OF SET	CHAR(1)
	RESERVED	CHAR(23)

When the volume type is backup, the following fields are used:	
PRIMARY VOLUME NAME	CHAR(32)
PRIMARY VOLUME SERIAL #	PACKED(11 ,0)
CMPLT RANGE START DATE	CHAR(7)
CMPLT RANGE START TIME	CHAR(6)
CMPLT RANGE END DATE	CHAR(7)
CMPLT RANGE END TIME	CHAR(6)
VOLUME CHANGED END DATE	CHAR(7)
VOLUME CHANGED END TIME	CHAR(6)

When the volume media is CD-ROM, the following fields are applicable:	
MODIFICATION DATE	CHAR(7)
MODIFICATION TIME	CHAR(6)
EXPIRATION DATE	CHAR(7)
EXPIRATION TIME	CHAR(6)
EFFECTIVE DATE	CHAR(7)
EFFECTIVE TIME	CHAR(6)

When the volume media is CD-ROM, the following fields are applicable:	
COPYRIGHT INFORMATION	CHAR(37)
ABSTRACT INFORMATION	CHAR(37)
BIBLIOGRAPHIC INFO	CHAR(37)
PUBLISHER KEY	CHAR(1)
PUBLISHER	CHAR(128)
PREPARER KEY	CHAR(1)
PREPARER	CHAR(128)
DATA SPECIFICATION KEY	CHAR(1)
DATA SPECIFICATION	CHAR(128)

When the volume type is container, the following fields are applicable:	
ASSOCIATED CONTAINER VOLUME ID	CHAR(32)
IPL IMAGE CATALOG DIRECTORY	CHAR(256)

VOLUME LOCATION			
	The following fields are not currently used:		
	OFFLINE	CHAR(1)	CONSTANT("0")
	SLOT	CHAR(1)	CONSTANT("1")
	DRIVE	CHAR(1)	CONSTANT("2")
	MOVING	CHAR(1)	CONSTANT("3")
	REMOVED	CHAR(1)	CONSTANT("4")

VOLUME ACCESS			
	read-only	CHAR(1)	CONSTANT("1")
	WRITE PROTECTED	CHAR(1)	CONSTANT("2")
	WRITABLE	CHAR(1)	CONSTANT("3")

DOUBLE VOLUME MEDIUM			
	NO	CHAR(1)	CONSTANT("0")
	YES	CHAR(1)	CONSTANT("1")

DOUBLE-SIDED MEDIUM			
	NO	CHAR(1)	CONSTANT("0")
	YES	CHAR(1)	CONSTANT("1")

IPL-CAPABLE			
	NO	CHAR(1)	CONSTANT("0")
	YES	CHAR(1)	CONSTANT("1")

LAST VOLUME OF SET

	NO	CHAR(1)	CONSTANT("0")
	YES	CHAR(1)	CONSTANT("1")

KEY (PUBLISHER, PREPARER, DATA SPECIFICATION)

	CONTAINS DATA	CHAR(1)	CONSTANT("0")
	CONTAINS FILE NAME	CHAR(1)	CONSTANT("1")

VOLUME TYPE

	PRIMARY	PACKED(3,0)	CONSTANT(000.)
	BACKUP	PACKED(3,0)	CONSTANT(001.)
	CONTAINER	PACKED(3,0)	CONSTANT(002.)
	MIRROR	PACKED(3,0)	CONSTANT(003.)
	UNFORMATTED	PACKED(3,0)	CONSTANT(004.)
	UNKNOWN	PACKED(3,0)	CONSTANT(005.)
	SERVER VOLUME	PACKED(3,0)	CONSTANT(009.)

MEDIA TYPE

	WORM	PACKED(3,0)	CONSTANT(000.)
	ERASABLE	PACKED(3,0)	CONSTANT(001.)
	CD-ROM	PACKED(3,0)	CONSTANT(002.)
	DVD_ROM	PACKED(3,0)	CONSTANT(003.)
	DVD_RAM	PACKED(3,0)	CONSTANT(004.)
	CD-R	PACKED(3,0)	CONSTANT(005.)
	CD-RW	PACKED(3,0)	CONSTANT(006.)
	DVD-R	PACKED(3,0)	CONSTANT(007.)
	DVD+R	PACKED(3,0)	CONSTANT(008.)
	UNKNOWN	PACKED(3,0)	CONSTANT(009.)
	DVD-RW	PACKED(3,0)	CONSTANT(010.)
	DVD+RW	PACKED(3,0)	CONSTANT(011.)
	RDX	PACKED(3,0)	CONSTANT(012.)
	DEVICE	PACKED(3,0)	CONSTANT(013.)

MEDIA FORMAT

	UNITIALIZED	PACKED(3,0)	CONSTANT(000.)
	HPOFS	PACKED(3,0)	CONSTANT(001.)
	ISO 9660	PACKED(3,0)	CONSTANT(002.)
	UNKNOWN	PACKED(3,0)	CONSTANT(003.)

MEDIA FORMAT			
	UDF	PACKED(3,0)	CONSTANT(004.)
	UDF PARTIAL	PACKED(3,0)	CONSTANT(005.)
	CE CARTRIDGE	PACKED(3,0)	CONSTANT(0254.)

Output file structure for directory attributes

Record format for QAMODPA:	
Attribute name	Attribute length
CENTURY	CHAR(1)
DATE	CHAR(6)
TIME	CHAR(6)
DIRECTORY NAME	CHAR(256)
VOLUME NAME	CHAR(32)
OPTICAL LIBRARY	CHAR(10)
DIR CREATION DATE	CHAR(7)
DIR CREATION TIME	CHAR(6)
RESERVED	CHAR(25)

Output file structure for file attributes

Record format for QAMODFA:	
Attribute name	Attribute length
CENTURY	CHAR(1)
DATE	CHAR(6)
TIME	CHAR(6)
PATH NAME	CHAR(256)
VOLUME NAME	CHAR(32)
OPTICAL DEVICE	CHAR(10)
FILE SIZE	PACKED(9,0)
FILE CREATION DATE	CHAR(7)
FILE CREATION TIME	CHAR(6)
FILE MODIFICATION DATE	CHAR(7)
FILE MODIFICATION TIME	CHAR(6)
FILE EXPIRATION DATE	CHAR(7)
FILE EXPIRATION TIME	CHAR(6)
CONT FROM PREVIOUS VOL	CHAR(1)
CONT ON NEXT VOLUME	CHAR(1)
STARTING VOLUME ID	CHAR(32)

Record format for QAMODFA:	
ATTRIBUTE NAME	CHAR(25)
ATTRIBUTE DATA	CHAR(75)
FILE SIZE2	PACKED(15,0)
RESERVED	CHAR(17)

Notes:

1. If the file size is 999 999 999 bytes or less, FILE SIZE and FILE SIZE 2 will both contain the correct size of the file. If the file size is larger than 999 999 999 bytes, FILE SIZE is set to 999 999 999 and FILE SIZE 2 contains the correct file size.

2. If a file has extended file attributes, there will be one record per extended attribute until all attributes of the file have been listed.

Constants used in the status fields:

CONTINUATION INDICATOR		
	NO	CHAR(1)
	YES	CHAR(1)

Changing optical volume attributes

You can change the optical volume attributes with the Change Optical Volume (CHGOPTVOL) command.

You can also change the attributes of a volume by typing a 2 (Change) in the Opt (Option) column of the Work with Optical Volumes display.

You can change the following attributes with this command:

- Volume-full threshold percentage for volumes in directly attached media libraries
- Authorization list that is used to secure the volume

  Note: If the volume is in a stand-alone device (CD-ROM or DVD drive), the authorization list secures the volume for the duration that the media is in the device. Ejecting the media from the device and immediately reinserting it again resets the authorization list to the QOPTSEC default. The system does not maintain the authorization list for volumes that are removed from a stand-alone optical device. For volumes in an optical media library device (MLD), you can only maintain the authorization list when removing the media by specifying VOLOPT(*KEEP) on the Remove Optical Cartridge (RMVOPTCTG) command. The authorization list is not written to the optical disk but instead is maintained internally on the system.

- Volume description of the volume for DVD-RAM volumes and volumes in directly attached media libraries

Displaying and printing optical volume attributes

These topics provide information about viewing and printing the attributes of a volume.

Optical volume attributes

Figure 18. Display Optical Volume Attributes (window 1)

Figure 19. Display Optical Volume Attributes (window 2)

You cannot change any information about either of these displays.

A third display is possible if the optical volume type is *BACKUP. If the display indicates More in the bottom right corner, press the Page Down key to view the third display.

Note: This display shows information that is unique to optical backup volumes.

Press F14 to see the Additional Volume Attribute displays.

Printing optical volume attributes

You can print volume attributes by typing 6 (Print) in the Opt column next to a volume listed on the Work with Optical Volumes display.

The output is written to a spooled file, which can be found in the output queue for the job.

The Display Optical (DSPOPT) command applies to:

- Volumes in optical CD-ROM or DVD media devices
- Volumes in directly attached optical media libraries
- Volumes in virtual optical devices
- Volumes in LAN-attached optical media libraries

Duplicating optical volumes

An efficient method to create a backup of an optical volume is to use the Duplicate Optical (DUPOPT) command. This command copies sectors to create a volume that is identical to the source except for the volume identifier and creation date and time.

In release v7r2 with PTF SI57188 applied and in later releases, IPL capable media can be duplicated to media with different physical characteristics.

You can enter the information for the following fields on the Duplicate Optical display:

- From volume identifier
- To volume identifier
- Volume identifier
- Clear

For media that is not IPL capable

The target media must be at least as large as the source media when the media is duplicated.

If the source media is formatted with *UDF, the **DUPOPT** command attempts to make more space available on the target media when the target media is larger than the source. The usable size of the target media after the duplication is the smaller of:

- The usable size of the target media.
- Two times the size of the source media.
- Two times the size of the original media where the source volume was first formatted.

For example, when a 1-GB media is duplicated to a 2-GB media, the usable size of the target media after the duplication is 2 GB. When a 1-GB media is duplicated to a 2-GB media, and the 2-GB media is then duplicated to a 4-GB media, the usable size of the final target media after the duplication is 2 GB.

Note: The source media and the target media must use the same block size.

For IPL capable media

A new special value of *BOOT* is valid for the **DUPOPT** command To Volume parameter (**TOVOL**) in release v7r2 with PTF SI57188 applied and in later releases.

The target media must be large enough to contain the boot area and all of the files on the source media. The block size on the source volume must be greater than or equal to the block size on the target volume.

Specifying a value of *BOOT* for the To Volume parameter on the **DUPOPT** command indicates that the boot area and all files from the source media are to be copied to the mounted target media. The copy is done even if the physical characteristics of the target optical volume do not match the physical characteristics of the source optical volume. This *BOOT* value enables duplicating an existing IPL capable DVD or distributed media image to Removable disk (RDX) or flash media.

The following example of the **DUPOPT** command shows how to copy IPL capable media that is mounted in a DVD device that is named OPT01 to RDX media that is already initialized and mounted in device RMS01.

```
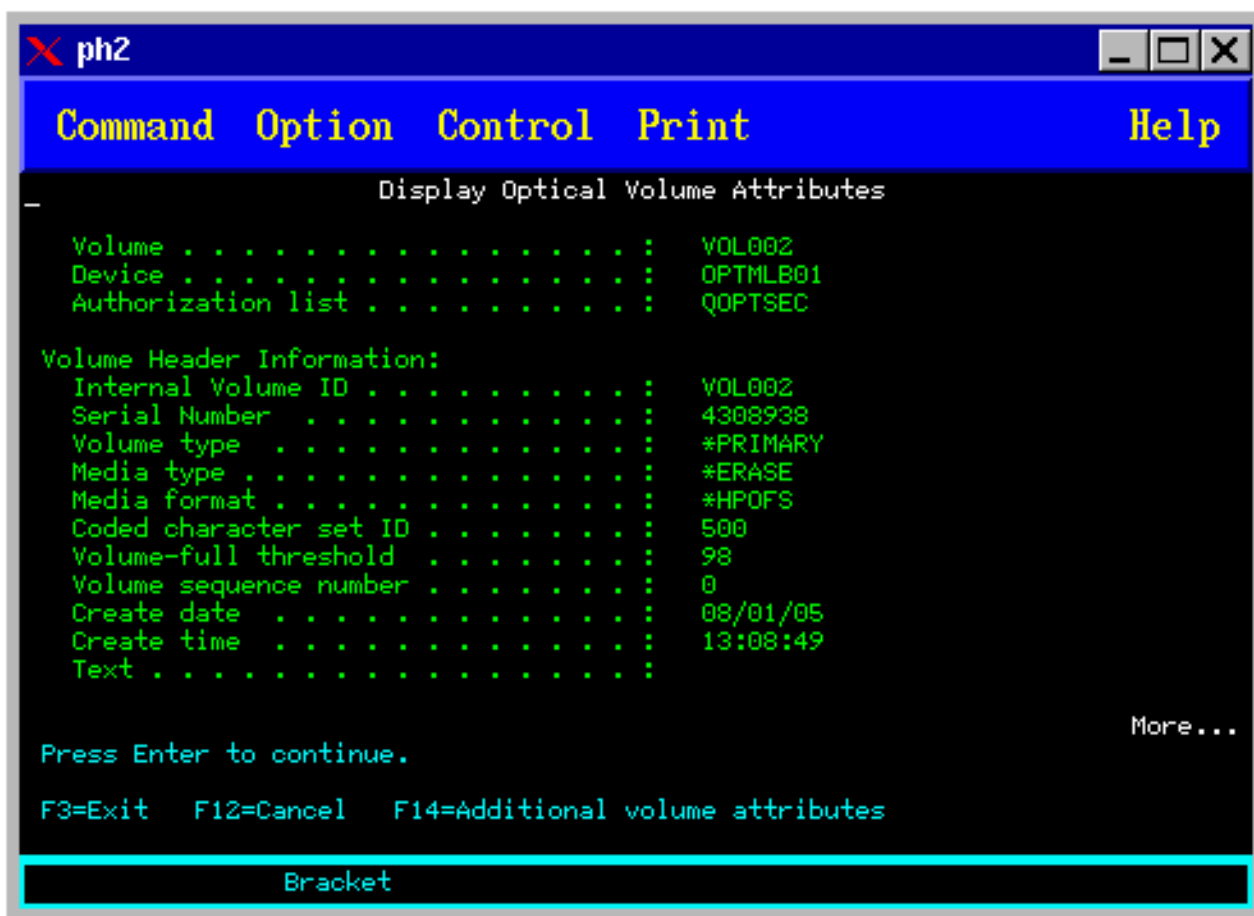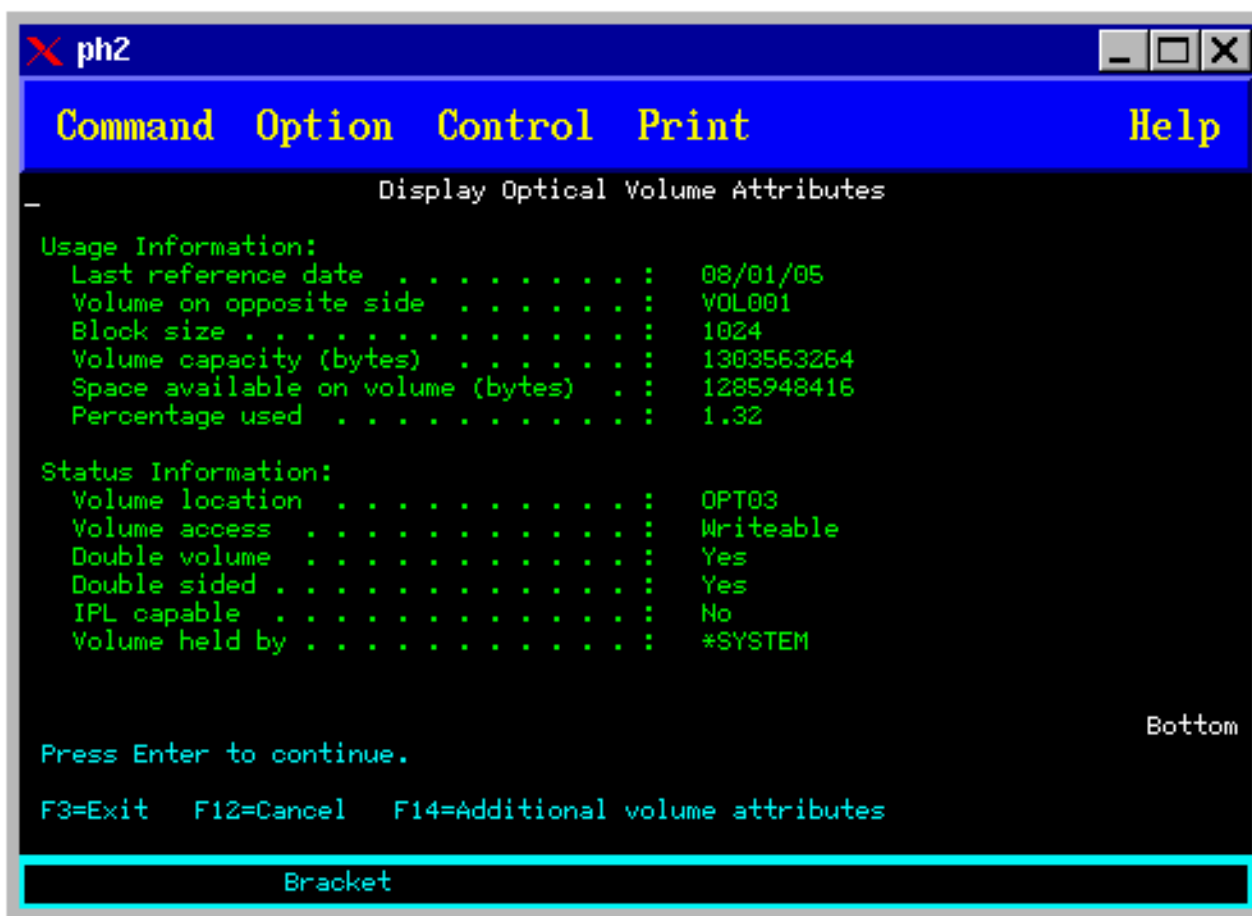DUPOPT FROMVOL(*MOUNTED) TOVOL(*BOOT) CLEAR(*YES) FROMDEV(OPT01) TODEV(RMS01)
```

The command in this example duplicates the mounted optical volume in device OPT01 to the mounted optical volume in device RMS01. The optical volume in device RMS01 is initialized before the duplication process. The volume in device RMS01 will be IPL capable after the duplication process completes.

Note: The special value of *BOOT* is only valid when the source volume contains IPL capable media.

Viewing directory and file information
There are two commands that you can use to view directory and file information through the optical support panels: the Work with Object Links (WRKLNK) command and the Work with Optical Directories (WRKOPTDIR) command.

WRKLNK

The WRKLNK command works with directories and files. This command gives a PC-like hierarchical view of the directories and files on the volume. Both directories and files at the given level in the path hierarchy are shown in the Work with Object Links display. The system shows directories as type DIR and files as type DSTMF.

The WRKLNK command applies to the following conditions:

- Volumes in CD-ROM or DVD devices
- Volumes in directly attached optical media library devices
- Volumes in virtual optical devices

WRKOPTDIR

The WRKOPTDIR command works only with directories. You can display all directories and subdirectories, or just display certain levels. This command requires creating the optical directory index if it was not created while adding an optical cartridge. The Work with Optical Files (WRKOPTF) command works with optical files.

The WRKOPTDIR command and WRKOPTF command apply to the following conditions:

- Volumes in directly attached optical media library devices
- CD-ROM volumes in either CD-ROM or DVD devices
- Volumes in LAN-attached optical media library devices
- WORM and ERASE volumes in virtual optical devices

Note: Volumes that are created in Universal Disk Format (UDF) do not support the WRKOPTDIR and WRKOPTF commands.

Removing and deleting optical volumes
You can remove optical volumes from an optical disk cartridge and then delete removed volumes from the optical index database.

To remove a volume, select (Remove) in the Opt (Option) column next to the volume you want to remove on the Work with Optical Volumes display.

You can then remove an optical volume by physically removing the optical disk cartridge from the optical library dataserver. The Remove Optical Cartridge display appears and prompts you for additional information.

Enter the information for the following fields:

- Volume identifier
- Volume description option
- Removed cartridge location

  Note: If the *KEEP option is specified, the record is kept when the volume is removed.
- Media location: Some 399F models support removing media to the bulk magazine. *MAGAZINE can be specified to use this feature if it is available for the device. The magazine can be removed by specifying VOL(*MAGAZINE) on this command.

Because there are two volumes on each optical disk, the options selected on the Remove Optical Cartridge display apply to both volumes.

The Remove Cartridge (RMVOPTCTG) command applies to:

- Volumes in directly attached optical media libraries
- Volumes in CD-ROM and DVD devices
- Volumes in virtual optical devices
- RMS media devices

Deleting removed volumes from the optical index database

If you removed (*REMOVED) the volume but saved the volume description information, you can later delete that information by selecting option 9 (Delete). The delete option can also be used if a volume has been marked as being in an offline device. The delete option removes a single volume, and not both volumes of an optical cartridge.

The delete option applies to:

- Removed volumes from optical media libraries
- Volumes in offline optical media libraries
- Volumes in offline optical LAN devices

Checking optical volume
You can use the Check Optical Volume (CHKOPTVOL) command to validate the integrity of the directories and files on a volume.

You can use the CHKOPTVOL command to verify that all files can be read. The command prints a list of damaged files if any. In addition, depending on the value of the OUTPUT parameter, the command can display a count of damaged and undamaged files.

Enter information for the following fields on the Check Optical Volume display:

- Volume identifier
- Optical device: Required only if the Volume identifier parameter is *MOUNTED

Note: The CHKOPTVOL command applies to the following volumes:

- Volumes in directly attached optical media libraries
- Volumes in CD-ROM, DVD, and RMS devices
- Volumes in virtual optical devices

Changing optical environment parameters
The Change Optical Attributes (CHGOPTA) command can be used to change specific optical configuration parameters that affect all jobs using the optical file system.

The following parameters can be set according to your configuration.

Copy attributes
 This parameter specifies whether to copy the file attributes of the source file when copying or moving files between the QDLS and the QOPT file systems using the HFS Copy or Move Stream File APIs. This parameter is ignored when copying or moving files within the optical file system and is not valid for LAN-attached optical libraries. This value should be set to *NO when applications do not require the file attributes to be maintained when copying between the QOPT and QDLS file systems. Using this option improves the performance of move and copy operations and reduces the optical storage requirements when writing to an optical disk.

Held file attribute
 This parameter specifies whether held optical file support is enabled or disabled for the QOPT file system. When held optical file support is disabled, it is up to the user to ensure that correct recovery procedures are followed when there is a close file error condition.

Allow variant characters
 This parameter indicates whether variant characters can be specified for path names when accessing files on optical volumes in Universal Disk Format (UDF) through the hierarchical file system (HFS) interfaces. The parameter does not affect access to optical volumes formatted in High Performance Optical File System (HPOFS) or ISO 9660 formats. It also has no effect on integrated file system interfaces for all optical media formats.

Support extended media formats
 This parameter indicates which media format to use when media is added to an optical device. Some media have both a primary and an extended media format. For instance, a UDF-Bridge Disk has ISO 9660 as the basic format and UDF as the extended format. Rock Ridge alternate name structures is another format that is supported. With this parameter, you can choose which format is to be used when media is added to a device.

Related concepts
Recovering held optical files

A held optical file is an optical file that cannot be closed normally.

Setting write protection
The write-protect function prevents writing to disk. A write-protect window shows when write protection is on or off.

To use the write-protect function, do the following:

1. Find the write-protect switch located on the cartridge.
2. Set the disk to read/write or read-only.

   - To make the disk read/write, move the write-protect switch to the off position. The write-protect window closes, and you can write data to disk.
   - To make the disk read-only, move the write-protect switch to the on position. The write-protect window opens, and data cannot be written to disk.

A separate Write-Protect switch exists for each volume (side) on the cartridge.
Related tasks
Labeling an optical cartridge with an initialized volume
To label a cartridge that has at least one initialized volume on it, follow these steps. The options are selected from the Work with Optical Volumes display.

Creating a master CD-ROM
The links provided will serve as a reference for instructions about CD premastering.

See Creating actual media from a virtual image or the Optical Storage Web page for instructions about CD premastering.

Related tasks
Creating actual media from a virtual image
Use these instructions to copy a virtual image to an optical disk.

Related information
Optical Storage

Optical volume backup

Use the information provided to define your backup strategy, learn about backup options, and learn backup commands.

Defining a backup strategy
There is no one perfect backup strategy that meets everyone's needs. Therefore, it is important to define your backup requirements before you decide on a backup strategy. Use the questions in this topic to help you determine your backup requirements.

- Do I need backups?

  – Can information be recreated easily?

  – If I do not have backups, how will that affect my business?

  – Am I legally required to have backups?

- How frequently should my backups be done?

  – Daily

  – Weekly

  – Monthly

  – Only when a volume is full

- How will backups be done?

  – Incremental backup

  – Partial or selective backups

- Complete backups
- When do I want the system to perform the backups?
  - During first, second, or third shift
  - On the weekend
  - Will there be other contentions for the optical drives?
- Will the target volume contain backups for one or multiple volumes?
- How long do I keep source information after a backup has been completed?
- What type of availability is needed for volumes?
  - In optical media library
  - Out of optical media library, but on-site
  - Out of optical media library, and off-site

This is not a complete list of items to consider when deciding on a backup strategy, but rather a foundation on which you can build.

Using the Duplicate Optical (DUPOPT) command
The Duplicate Optical (DUPOPT) command can be used to create a duplicate optical volume.

The created duplicate volume is identical to the original volume except for the volume identifier and the time created.

Performance improves significantly when you use DUPOPT instead of CPYOPT to back up an entire volume from scratch. The DUPOPT command has the following requirements:

- Two optical drives are required. One of the drives can be a virtual drive.
- Except for IPL capable media, the source and target volumes must have the same sector size. See "Duplicating optical volumes" on page 106 for more information.
- The source and target volumes cannot be on opposite sides of the same cartridge.
- Except for IPL capable media, the source and target device types must be the same type (for example, optical library to optical library or optical stand-alone device to optical stand-alone device). See "Duplicating optical volumes" on page 106 for more information.
- If the source media type is *WORM, the target media type can be either *WORM or *ERASE.
- If the source media type is *ERASE, the target media type must be *ERASE.
- If the source media type is *DVD-RAM, the target media type must be *DVD-RAM.
- If the target media type is *WORM, it must be uninitialized.
- If the target media type is *ERASE, all data currently on the target volume will be lost.
- Once the DUPOPT command begins operation, the system will not interrupt the process. The system will not schedule any other work in the drives until the command completes.
- If the source volume for the DUPOPT command is in an image catalog, the target media can be recordable. Recordable media types are CD-R, CD-RW, DVD-R, DVD+R, DVD-RW and DVD+RW.

Use the DUPOPT command when you want to copy the entire volume or for incremental backups of your source volume. For an entire backup, wait until your source volume is full before you use the DUPOPT command.

DUPOPT always makes a complete copy of your source volume. However, you can use it to make incremental backups of your optical volumes in the following manner:

1. Determine how often you want to back up your source and how many backup copies you want to keep.
2. Use DUPOPT to duplicate your source media to a target media that has a media type of *ERASE. This will give you an exact copy of the source media.
3. Continue making duplicates of your source volume as often as you want until your source volume becomes full.

4. Once the source media is full and you have a successful final copy, you can reuse all previous target media for backups of other source media.

5. If your source media type is *WORM, before your final backup determine whether your final target media type needs to be media type *WORM or *ERASE.

This command is an example of duplicating a virtual optical volume to a recordable optical volume. The optical volume *VIRTVOL* is duplicated on volume *DVDRW*. The volume in device OPT02 will be unloaded after the duplication process is completed and will have a volume identifier of *VIRTVOL*

```
DUPOPT   FROMVOL(VIRTVOL)  TOVOL(DVDRW)  NEWVOL(*FROMVOL)
 CLEAR(*YES)  TODEV(OPT02) TOENDOPT(*UNLOAD)
```

⚠️ **Attention:** If the DUPOPT command does not complete successfully or it ends for any reason while processing, the backup is unsuccessful. In addition, if the target media type is *WORM, the target volume may no longer be usable.

Related tasks

Creating actual media from a virtual image
Use these instructions to copy a virtual image to an optical disk.

Enhancements

Several enhancements have been made since the introduction of DUPOPT command.

- DUPOPT no longer requires the source and target volume to be in the same optical library.
- For target media with the *HPOFS media format, the target media capacity no longer has to be identical to the source media capacity. It can now be equal to or larger than the source media.
- For *WORM media the target media type no longer has to be *WORM. You can use either *WORM or *ERASE media.
- Improved device error recovery.
- Improved performance.
- The addition of the cross device support (library to library, stand-alone to stand-alone).
- The addition of the unload support for stand-alone devices.
- When duplicating a volume in a stand-alone or virtual device, you can create an exact copy with the same volume identifier as the source.

In the following example, the system duplicates the volume in optical device OPT01 to the volume in optical device OPT02. After completion, the target volume identifier will be MYBACKUP, and the system unloads the media from the device.

Note: The system only supports the unload option for stand-alone devices.

```
> DUPOPT FROMVOL(*MOUNTED) TOVOL(*MOUNTED) NEWVOL(MYBACKUP)
```

```
FROMDEV(OPT01) TODEV(OPT02) FROMENDOPT(*LEAVE) TOENDOPT(*UNLOAD)
```

Copy Optical (CPYOPT) command
Use the Copy Optical (CPYOPT) command to copy optical files and directories between optical volumes.

You can use CPYOPT command to copy any of the following:

- All files and directories for an entire volume
- All files and subdirectories for a directory
- All files for a directory
- A single file

The two optical volumes types are *PRIMARY and *BACKUP. *PRIMARY is the normal volume type, which can be written to by user applications. *BACKUP is a special volume type, which only can be written to by special optical commands. You can use CPYOPT to copy files between the following volume types:

From volume	To volume
*PRIMARY	*PRIMARY
*PRIMARY	*BACKUP
*BACKUP	*PRIMARY

Related concepts

Performance consideration for copying and duplicating optical volumes
There are several performance considerations to be aware of when copying and duplicating optical volumes.

Key parameters of the Copy Optical (CPYOPT) command
Several parameters must be specified to help you select the files that you want copied.

The parameters include:

- Select files to copy (SLTFILE)
- Copy subdirectories (CPYSUBDIR)
- Starting date and time (FROMTIME)

You can use CPYOPT to perform a backup of your optical volumes, but it is not the suggested way of doing so. Remember that CPYOPT works on a file basis; therefore, if you are copying a large number of files, your CPYOPT request can take hours to complete. The options you specify can also affect how long your copy request can run. Review the examples described below for a comparison of your options and how they might affect your copy request.

You can use the Select files to copy (SLTFILE) parameter to choose which files you want to copy. You have the following options:

- *CHANGED is the default option. The system determines if the source file already exists on the target volume. If so, the system copies the source file only if the source file has changed since performing the last copy operation. Two sets of dates and times determine if a file has changed: Either the date and time the file was last changed, or the date and time the file attributes were last changed. Specifying DATA(*FILATR) on the Display Optical (DSPOPT) command can display these dates and times.
- *ALL indicates that the system copies all files on the source volume. The system replaces any files that might already exist on the target media with a new copy from the source volume.
- *NEW indicates that the system copies only files that are not currently on the target volume.

If the target volume already contains files, choosing the *CHANGED or *NEW option might result in a longer running CPYOPT request. This is because the system has to make a list of files for both the source and target volumes, and then compare them. The time required to do this can become excessive when the volumes contain thousands of files.

You can also use the Copy subdirectories (CPYSUBDIR) parameter to indicate whether to process files in the subdirectories of the specified From path. Your options are as follows:

- *NO indicates that only files in the specified From path are eligible to be copied. This is the default option.
- *YES indicates that files in all subdirectories of the specified From path are eligible to be copied. The system creates subdirectories on the target volume if they do not already exist. The newly created subdirectories have the same name as they did on the source volume, even though the parent directory name can be different. A system makes a check before the copy operation to ensure that any resulting new path name does not exceed the maximum path name length. The system prevents you from copying the subdirectories of one directory to a subdirectory of that directory on the same volume.

The system uses the FROMTIME parameter to determine if a file is eligible for copying based on its creation or modification date. All files that were created, changed, or whose attributes have changed, on or after the starting date and time are eligible for copying. You can determine when a file was last created or changed by specifying DATA(*FILATR) on the Display Optical (DSPOPT) command. The default values *BEGIN for Starting date and *AVAIL for Starting time, indicate that all files meet the starting date and

time requirement. Specifying a starting date and time identifies only files that were created or changed since that date and time as eligible for copying. You can use this parameter to greatly limit the number of files that require processing by CPYOPT. This decreases the time that is required to process the files. You can combine this parameter and the SLTFILE parameter to limit the number of files that need to be checked before copying. You can select only files that were *CHANGED or *NEW after a specified starting date and time.

Here is an example showing how to copy all files from the source volume VOL001 to a volume that currently does not contain any files or directories. The system processes all subdirectories of the source volume, creates the subdirectories on the target volume, and copies all files.

Copy all files form the source volume since the last copy request:

```
CPYOPT FROMVOL(VOL001) FROMPATH(/) TOVOL(CPYVOL001) +
SLTFILE(*ALL) CPYSUBDIR(*YES) CRTDIR(*YES)
```

For this example you have options that may take different lengths of time.

- The first option is to issue the same request as the first examples but with a different target volume. The system copies all the files and directories to the new target volume.

- The second option is to use the *CHANGED option on the SLTFILE parameter.

```
CPYOPT FROMVOL(VOL001) FROMPATH(/) TOVOL(CPYVOL001) +
SLTFILE(*CHANGED) CPYSUBDIR(*YES) CRTDIR(*YES)
```

Note: Depending on how many files are currently on the source and target media, this request may take a long time to process. First, you must obtain a list of all files on the source media and the target media. Then compare the files to determine if any file has changed since the last CPYOPT request. Once that is done, the system copies only the files that have changed.

- The third option is to use the *NEW option on the SLTFILE parameter, provided that no existing files changed but were added to the source volume.

```
CPYOPT FROMVOL(VOL001) FROMPATH(/) TOVOL(CPYVOL001) +
SLTFILE(*NEW) CPYSUBDIR(*YES) CRTDIR(*YES)
```

Note: You must first build a list of all files that are on both the source and the target volume, and then compare the files before copying any new files.

- The fourth option is to use one of the SLTFILE options in combination with specifying a starting date and time.

```
CPYOPT FROMVOL(VOL001) FROMPATH(/) TOVOL(CPYVOL001) +
SLTFILE(*CHANGED) CPYSUBDIR(*YES) CRTDIR(*YES) FROMTIME('04/01/99' '00:00:00')
```

By specifying a starting time, the system copies only files that were created or changed after 1 April 1999 to the target volume.

Using the Copy Optical (CPYOPT) command to back up a volume
You can use the Copy Optical (CPYOPT) command to make a complete or partial copy of your volume.

The following describes the special processing of the CPYOPT command when the target is a *PRIMARY or *BACKUP volume. Refer to the following list to decide how to best use the command.

- Copy completely or partially. You can copy a file, a directory, a directory with all of its subdirectories, or an entire volume.

- Copy incrementally. You can copy only what has changed since the previous CPYOPT request.

- Copy by specifying a starting date for selecting files. Only files that are created or changed on or after the specified date are eligible for copying.

- Replicate the hierarchical structure of the source volume on the target volume.

CPYOPT requirements to volume type *PRIMARY

When the target volume is type *PRIMARY, the CPYOPT command has the following unique requirements:

- The source volume can be either type *PRIMARY or *BACKUP.
- Because the target volume is *PRIMARY, all API requests and most optical commands and utilities can access the volume.
- Because utilities and user programs can update the volume, you need to determine how to protect directories and files from unauthorized change or deletion.
- The target volume can contain information for one or multiple optical *PRIMARY volumes. An easy way to manage multiple volumes on a single target volume is to have a new first-level directory. That directory name can be the name of the source primary volume.
- You need a way of keeping track of when a volume or directory was last backed up. Use the CPYOPT command to do it automatically.
- The hierarchical structure on the target volume does not need to be identical to that of the optical volume.
- The creation date and time and change date and time of the file on the target volume will be different from their counterparts on the optical primary volume. The file creation data and time on the target volume is the date that the file was written.
- You can use directories and files on the target volume directly. You do not need to copy applications back to a optical volume.
- You can request that the system copy only new files on the source volume to the target volume. This might be useful if you never change files on your source volume but only create new ones.

*Copy Optical CPYOPT requirements to volume type *BACKUP*

When the target volume is type *BACKUP, the CPYOPT command has the following unique requirements:

- The source volume must be type *PRIMARY.
- Only the CPYOPT and Convert Optical Backup (CVTOPTBKU) commands can write to the target backup volume. APIs, utilities, and user programs cannot write to an optical backup volume.
- An optical back up volume can contain information for only one optical primary volume. This prevents two primary volumes from sharing the same optical backup volume.
- You cannot delete directories or files from an optical backup volume. This ensures data integrity of the optical backup volume.
- The system maintains the file creation date and time and the change date and time for the primary volume on the optical backup volume.
- A user application cannot directly use a file or directory on a backup volume. First, you must copy the file or directory to an optical primary volume by using the CPYOPT command.
- If the optical primary volume is damaged or lost, you can convert the optical backup volume to an optical primary volume. You can do this by using the CVTOPTBKU command.
- To maintain control information about the status of backup requests, optical backup volumes require additional media usage. Because of this, a primary volume that is 100% used may not fit on an optical backup volume.
- The system always initializes backup volumes with a 99% volume threshold.

Suggestions on which volume type to use with the CPYOPT command

Here is a list of items that you can use to determine if you should use a target volume type of *PRIMARY or *BACKUP.

- In general, using the CPYOPT command type *PRIMARY volume gives you more flexibility, but it requires more management of your backup volumes.
- The CPYOPT command for a type *BACKUP volume provides more management and security for your optical backup volumes, but it is less flexible.

- Use the CPYOPT command and specify a type *PRIMARY volume if you want to copy data from several volumes to a single volume.
- Use the CPYOPT command and specify a type *BACKUP volume if you want better security for your backup volumes. The system cannot write volumes with type *BACKUP to with normal optical commands or user programs.
- Use the CPYOPT command and specify a type *BACKUP volume to save information, such as when the system copies directories and volumes and the success status of those copies.
- The biggest advantage of using the CPYOPT command for a type *BACKUP volume is that the system stores the backup control information about the backup volume. This information includes the relationship between files on the backup volume and the files on the primary volume. This information can be useful if you ever need to recover the lost source data from the backup volume.
- Use the CPYOPT command and specify a type *BACKUP volume if you want the source and target file dates (creation and change) to be identical.
- One disadvantage in using the CPYOPT command to a type *BACKUP volume is that the system uses extra space on the backup volume to store control information. The amount that is used is approximately three times the sector size for each directory. Therefore, if the CPYOPT command copies 100 directories from a primary volume to a backup volume where the sector size on the backup volume is 2 KB, the backup volume uses an additional 600 KB of space. In this example 600 KB of space is used every time the command is run.

Volume type *BACKUP

This section discusses the *BACKUP volume type and the unique backup process that are associated with a *BACKUP volume.

Remember that using Copy Optical (CPYOPT) command to a *BACKUP volume is no longer the suggested way of backing up your volumes because of the time required. Duplicate Optical (DUPOPT) command is the recommended way of backing up your volumes.

The *BACKUP volume type supports the backing up and protection of information from optical primary volumes. The system does not allow user programs or APIs to write to optical backup volumes. Only a limited set of optical commands can update backup volumes. After the system creates a directory or file on an optical backup volume, the only way to delete it is to reinitialize the volume. Doing this prevents either accidental or intentional deletion.

Backup volumes and directories contain a Complete Backup Range file, which contains date information about prior copy requests to the optical backup volume. These dates are helpful in determining the contents of backup directories and volumes with respect to the contents of their primary counterparts. These control dates make it easier to recover by providing a time checkpoint. Each backup directory has its own control dates. Each backup volume also has its own control dates, which include:

- Complete starting date and time
- Complete ending date and time
- Last changed date and time

The system writes these dates to the backup volumes in a reserved file within each backup directory. Since the system writes the dates to the media, the backup volumes are self-contained. Not only is the backup data on the media, but the recovery information is there as well.

Completing backup range

When an optical primary volume is copied to an optical backup volume, a special file called a Complete Backup Range is written to the backup volume.

This file indicates the last time a backup was done. The system keeps backup control information for the volume as well as each directory on the volume. If the volume or directory was successfully backed up the Complete Backup Range file contains both a starting and ending date and time. When a range exists for an optical backup volume or directory, it has a specific meaning: The backup directory or volume has a copy of all the created or changed files within the date range that corresponds to the primary directory or volume.

For example, volume BVOL1 is an optical backup volume for primary volume PVOL1. BVOL1 contains directory /DIR1 that has a complete backup range as follows:

- Start date: 1/1/99
- Start time: 09:00:00
- End date: 1/30/99
- End time: 22:00:00

This means that the system backed up all the changed or created files in /DIR1 on PVOL1 since 9:00 a.m. on 1 January 1999. The system backed up files to /DIR1 on BVOL1 at 10:00 p.m. on 30 January 1999. Any files that were created or changed on primary volume PVOL1 in directory /DIR1 after 10:00 p.m. on 1/30/99 were not backed up.

Completing backup range for directories

The complete backup range for a directory does not encompass all subdirectories of the directory. In other words, each directory has its own unique complete backup range. For example, assume that directory /A has a complete backup range of 1 March 1999 through 1 May 1999. This does not necessarily mean that directory /A/B has the same complete range. In fact, /A/B might have no complete backup range at all. The complete range does not reflect a hierarchical range over all directories within that subtree.

The system updates the complete backup range for a backup directory after it copies all eligible files in the primary directory.

Note: Use the SLTFILE parameter on the CPYOPT command to determine if a file is eligible. If you use *ALL, all files are eligible to copy. If you use *CHANGED, only those files that were created or changed since the last CPYOPT command are eligible. If you specified *NEW, the system copies files only if they do not exist on the target volume.

For example, FILE.001 gets copied on 1 March 1999 as a result of a complete backup of directory /DIR1. At this time /DIR1 is given an ending range of 1 March 1999. On 1 April 1999, the user has the system back up directory /DIR1 again by specifying SLTFILE(*CHANGED). However, the back up affects only the files that have changed. If FILE.001 has not changed since the previous CPYOPT command, this file is not eligible to copy. However, the system updates the ending range for /DIR1 to 1 April 1999 if none of the eligible files fail to copy.

Complete backup range for optical volumes

The complete backup range for an optical volume is similar to that of an optical directory. The complete range for a directory represents the relationship between the files in a backup directory and those in the primary directory. Likewise, the complete range for an optical backup volume represents the relationship between the files on an optical backup volume and those on the primary volume. You must back up all eligible files on a volume to update the complete range of the volume.

You can update the complete range for a volume only if the CPYOPT command specifies the FROMPATH(/) and CPYSUBDIR(*YES) variables. This ensures that the system processes all files on the primary volume.

Completing backup range: Starting date and time
You can specify a starting date and time on the **Copy Optical (CPYOPT)** command.

The starting date and time of a complete backup range for an optical backup volume or directory is the earliest time that is specified on a CPYOPT command when all eligible files on the volume or directory were successfully copied.

The system uses time to select the files from the primary volume to be copied to the optical backup volume. The system copies any files that are created or changed on or after this time. First, the system must successfully copy all eligible files for a directory or volume. Then the system sets the starting date and time for the corresponding optical backup volume or directory to the specified time. The definition

indicates that this value is the earliest time that is specified on a CPYOPT command. Consider the following example.

Scenario: Starting date and time

A user issues the CPYOPT command for directory /DIR1 by specifying 1 May 1999 as the starting date. If all eligible files are successfully copied, then the system sets the complete starting date for the backup directory /DIR1 to 1 May 1999.

Now assume that the user issues the CPYOPT command again for /DIR1. This time the system sets the starting date to 1 April 1999. This request copies any files that have changed since the last CPYOPT command. Additionally, it copies any files that were created between 1 April 1999 and 1 May 1999 that were not selected on the previous request. If all eligible files are copied successfully, then the starting date for backup directory /DIR1 changes to 1 April 1999. Future copies specifying earlier starting dates will produce similar results.

Use *BEGIN and *AVAIL for the starting date and time on the CPYOPT command. This will copy all the files from a primary directory or volume, regardless of the create or change time for the file.

Completing backup range: Ending date and time
The CPYOPT command does not allow you to specify an ending date and time. The system always uses the date and time of the copy request as the ending date and time.

Therefore, the system uses the date and time of the request for the complete ending date and time for a backup directory or volume.

The ending date and time of a complete backup range for an optical backup volume or directory is one of the following conditions:

- The last time a CPYOPT command was completed
- When the system successfully copies all eligible files in that volume or directory
- When the starting date and time of the request is not after the existing complete range

The definition of the ending date and time field has two parts. First, this date is the last time a CPYOPT command was completed for the directory or volume with no failures. Second, the complete ending date and time is not updated if the range of the request does not overlap the existing range. This is true even if all eligible files are copied successfully.

Scenario: Ending date and time

On 1 July 1999, the user issued the CPYOPT command for directory /DIR1 that specifies 1 February 1999 as the starting date. If all eligible files are successfully copied, the system sets the complete starting date for the backup directory /DIR1 to 1 February 1999. The system sets the complete ending date to 1 July 1999.

Now, the system issues a second CPYOPT command for directory /DIR1 on 15 September 1999, specifying 1 June 1999 as the starting date. If all eligible files are successfully copied, the complete starting date for backup directory /DIR1 remains 1 February 1999. The complete ending date is moved out to 15 September 1999. This is the normal situation that takes into account only the first part of the definition above.

On 1 December 1999, the user issues the CPYOPT command again for the /DIR1 directory. This time the use specifies 1 October 1999 as the starting date. Even if all eligible files are copied successfully, the complete range does not change. The complete range cannot be expanded to include the new ending date. This is because the files that were created or changed between 15 September 1999 and 1 October 1999 are not accounted for.

Completing Backup Range: Last changed date and time
Using the CPYOPT command causes the system to write the last changed date and time of an optical backup volume or directory.

This includes any time that the system wrote files or directory attributes to the directory or volume.

The last changed date and time for that directory and volume always reflects the date and time of the request. This remains true even if the system writes a file to a backup directory.

Scenario 1: Last changed date and time

On 1 July 1999, the user issues the CPYOPT command for directory /DIR1 by specifying *BEGIN as the starting date. If the system successfully copies all the eligible files, then the dates are as follows:

- The system sets the complete starting date for backup directory /DIR1 to *BEGIN.
- The system sets the complete ending date to 1 July 1999.

If the system copies at least one file to /DIR1 as a result of this request, the last changed date is also 1 July 1999.

The system does not necessarily update the last changed date and time as the result of a successful copy. If the system did not write any files to the backup directory, the system may update the complete range, but not the last changed date.

Scenario 2: Last changed date and time

In "Scenario 1: Last changed date and time," the backup directory /DIR1 has the following dates after the request:

- A starting date of *BEGIN
- An ending date of 1 July 1999
- The last changed date of 1 July 1999

On 1 October 1999, the user issues the CPYOPT command again for directory /DIR1. This time the command specifies SLTFILE(*CHANGED) to copy only the files that have changed since the last CPYOPT request. Assume that no files have changed since the last backup on 1 July 1999. Since no files are eligible to copy, the system writes no files to the backup directory /DIR1. Therefore, the last changed date remains 1 July 1999. However, since no eligible files failed, the complete range for /DIR1 expands to have an ending date of 1 October 1999. The last changed date and time becomes most important when it is set beyond the complete range. This happens if some files are actually copied but other eligible files failed to copy for some reason.

Scenario 3: Last changed date and time

In "Last Changed Date and Time — Scenario Two," the backup directory /DIR1 has the following dates after the request:

- A starting date of *BEGIN
- An ending date of 1 October 1999
- A last changed date of 1 July 1999

On 1 December 1999, the user issues the CPYOPT command again for directory /DIR1. Assume that 10 files were changed or added to primary directory /DIR1 since the last CPYOPT request on 1 October 1999. Assume that only eight files are successfully copied to /DIR1 and that two of the eligible files failed. Since the system did not copy all eligible files, the complete range stays the same with a starting date of *BEGIN and an ending date of 1 October 1999. However, since /DIR1 changed, the last changed date gets updated to 1 December 1999. Since the last changed date is outside the complete range, a complete copy of /DIR1 from *BEGIN to 1 October 1999 may not exist. A more recent copy by the change on 1 December 1999 might have replaced one of those files.

*Example: Copying to optical type *BACKUP volue*
This example shows the system that backs up the primary volume VOL01 to the backup volume BKP-VOL01.

This will copy all the files in all the subdirectories. After the system writes to volume BKP-VOL01, the system will use the volume in one of the following ways:

- For further backups of volume VOL01
- For converting from backup volume BKP-VOL to *PRIMARY volume VOL01.

```
CPYOPT FROMVOL(VOL01) FROMPATH(/) TOVOL('BKP-VOL01' +
*BACKUP) SLTFILE(*ALL) CPYSUBDIR(*YES)
```

*Converting an optical type *BACKUP Volume*
Use the Convert Optical Backup (CVTOPTBKU) command to convert an optical *BACKUP volume to an optical *PRIMARY volume.

You typically use this function when the primary optical volume is either damaged or missing. The conversion eliminates the necessity of copying all information from the optical backup volume to a new primary volume. After the system converts the volume to a primary volume, it will allow all write requests to the volume.

After the system converts an optical backup volume to a primary volume, there is no way to convert it back to an optical backup volume. To convert backup volumes, select option 6 (Convert optical backup volume) from the Optical Backup/Recovery display or use the CVTOPTBKU command.

Before you attempt to convert, you should verify the name of the primary volume for which this volume is a backup. You can do this by displaying the volume attributes of the optical backup volume. You can do this by using the Display Optical Volume Attributes (DSPOPT) command or by selecting (Display) from the Work with Volumes display.

There may be previously deleted primary volume directories and files on the optical backup volume. Therefore, when converting the optical backup volume to a primary volume, it might be necessary to manually delete directories and files from the volume. You perform this function in order to accurately reflect what was on the primary volume. If you never delete directories and files from a primary volume, this should not be a concern.

Copy Optical (CPYOPT) command performance
Performance is a complex subject with many interdependent components.

By changing one component, you may adversely affect another. This interdependence and the other factors that affect performance prohibit providing a formula for computing the time required to copy a given number of files. It is a guideline to help you estimate how long your CPYOPT command might take.

You may need to estimate how long it takes to copy an entire optical volume when using the CPYOPT command. You can start by copying a single directory that contains a known number of average sized files. Then take the difference between the ending time and starting time to determine an elapsed time. Take the elapsed time and divide by the number of files that are copied to figure the average seconds per file. You can use this number as a basis to determine the amount of time that is required to copy the entire volume of average size files.

To maximize copy performance, use the following set of guidelines as a starting point:

- Having too few directories with too many files can affect performance. Having too many directories with too few files can affect performance also. Try to keep the number of files in a directory to less than 6000 files.
- Consider performance when determining file size.
- Avoid the use of extended attributes on files. When a file has extended attributes, they are stored separately from the data. When copying the data, the system must copy the attributes also. It is similar to copying a second file for each user file copied.
- Keep the source and target volumes in the same library.
- Avoid copying to the opposite side of an optical cartridge.
- If the copy processes can have dedicated use of the optical drives, use the COPYTYPE *IOP parameter on the CPYOPT command.
- Avoid optical drive contention from other optical processes.
- Dedicate the use of two optical drives for copy activity.

The following conditions can severely affect copy performance:

- Having only one drive available for use.
- Copying from one side of an optical cartridge to the opposite side.
- Having other optical processes that are running that attempt to use the available drives.
- A large number of files on the source volume.

The process of removing a volume, storing it in a slot, retrieving a new volume, and mounting it requires from 8 to 15 seconds. You should try to do your copy requests when the process can have dedicated use of the optical drives.

Do not try to copy a large number of files from one side of an optical cartridge to the other side. Optical drives have only one read/write head. The following conditions occur when copying from one side of an optical cartridge to another:

- The system mounts the source volume.
- A limited number of files that are to be copied are read and stored on IBM i temporary storage.
- The source volume is removed, and the system mounts the target volume by turning over the optical cartridge.
- Files are read from IBM i temporary storage and written to the target volume.
- If there are more files to copy, the system removes the target volume and mounts the source volume again by turning over the optical cartridge.
- The system repeats this process until it copies all the files. You may need to turn the optical cartridge over many times to copy all the files.

Copy performance is always better when both the source and target volumes are in the same library and when setting the COPYTYPE parameter for that library controller to *IOP. Two conditions exist that require an extra processing step. The first one is that the source and target volumes are in different libraries. The second involves setting the COPYTYPE parameter to *SYSTEM and having the volumes exist in the same library. This extra step requires moving the files you want to copy to temporary storage on the system before writing them to the target volume. You do not need to use temporary storage when the system meets both of the following conditions:

- Both optical volumes are in the same library.
- You set the COPYTYPE parameter on the CPYOPT command to *IOP.

This allows for the direct transfer of data between the two optical drives.

Save and restore commands
The save (SAV) command can be used to create a backup of an optical volume image. The volume image is restored using the restore (RST) command.

An optical volume image is a copy of the entire optical volume in *SAVRST format. Using SAV, the volume image can be saved to any supported save/restore device including tape, diskette, optical, or save file.

Subsequently, when the volume image is restored using the RST command, the entire image must be restored to an existing optical volume either in a stand-alone device or an optical media library.

An optical volume image has unique properties that require the entire volume image to be saved or restored in a single operation. Once saved you cannot restore individual files or directories.

Once an optical volume image is saved, it can be viewed with the Display Tape (DSPTAP), DSPDKT, Display Optical (DSPOPT), or Display Save File (DSPSAVF), depending on the save/restore device used. When the volume save/restore entry is displayed, option 8 can be used to display the additional information panel, which includes media specific information such as media type, volume capacity, sector size, and security attribute information. You cannot see the individual files and directories that make up the volume image.

Use of the generic SAV command to save optical data can be easily incorporated into an existing system backup strategy without requiring a separate command , such as DUPOPT, to perform the save operation. SAV provides a good alternative to DUPOPT because it allows a volume to be saved from a one-drive

optical media library or from a stand-alone device without requiring the allocation of a second optical device. SAV provides a viable incremental backup solution by periodically backing up volumes not yet at capacity to a save/restore device such as tape. When the volume is full it can be duplicated for archival purposes by either restoring the full volume to create a copy or by issuing the DUPOPT command to duplicate the volume.

Saving and then restoring an optical volume, image creates an exact copy of the saved volume including the volume name. DUPOPT creates a copy of the source volume but the volume name is changed.

To save and restore an optical volume, the following authority is required:

- *USE authority to the optical device.
- *SAVSYS special authority or *OBJEXIST authority through the optical volumes authorization list.
- If the media format is Universal Disk Format (UDF) *RWX authority is also required to the root directory of the volume. The device will be locked shared (LSRD) read while a SAV or RST is active.

Auditing records created during a SAV or RST request.

OR
Object restored

RZ
Change primary group during restore. Saved value different from target. Value on target remains unchanged. (UDF only)

RO
Change owner during restore. Saved value different from target. Value on target media remains unchanged. (UDF only)

O1
Successful open for save (S/R/S) Storage/Read/Save. Successful open for restore (S/U/R) Storage/Update/Restore.

Save (SAV) command support
The SAV command can be used to save High Performance Optical File System (HPOFS) formatted volumes or Universal Disk Format (UDF) volumes.

This function does not support the back up of ISO 9660 formatted media.

Select a volume or volumes to save. The SAV command prevents the implicit saving of all optical volume images in the QOPT file system when the OBJ parameter includes the entry '/*'. The file system QOPT cannot be saved; however, volumes below the file system can be saved. If you want to save all volumes within the QOPT file system, '/QOPT/*' must be explicitly specified on the OBJ parameter. If all volumes are selected, be aware that this SAV operation can take a long time to complete depending on the number of volumes being saved.

In order to specify that a volume image is to be saved, you must specify a value of *STG on the SUBTREE parameter.

Saving an optical volume image to another optical volume is allowed; however, the target volume cannot be the opposite side of the saved volume.

The performance of the SAV command is comparable to the DUPOPT command, although it depends on the target device chosen.

Parameters

OBJ
Specify a single or multiple path names. The path name cannot be extended beyond the volume level. Examples of invalid path names include '/QOPT/VOL/*' or '/QOPT/VOL/DIR/FILE'.

SUBTREE
This must be *STG when saving optical volume images.

CHGPRIOD
   The Start date, Start time, End date, and End time parameter must all be *ALL.

UPDHST
   This must be *NO.

SAVACT
   This parameter is ignored when attempting to save optical volume images.

PRECHK
   This must be *NO.

TGTRLS
   The value cannot precede V5R2M0.

Examples

- Save all volumes within the QOPT file system to a save file.

```
SAV DEV('/qsys.lib/xyz.lib/xzysavfile.file') +
OBJ(('/qopt/*')) SUBTREE(*STG)
```

- Save all volumes beginning with vola and volb to a save file.

```
SAV DEV('/qsys.lib/xyz.lib/xzysavfile.file') +
OBJ(('qopt/vola*') ('/qopt/volb*')) SUBTREE(*STG)
```

- Save one volume vol1 to a tape device.

```
SAV DEV('/qsys.lib/tap01.devd') OBJ(('/qopt/vol1')) SUBTREE(*STG)
```

Restore (RST) command support
The RST command can be used to select a volume or volumes to restore.

The RST command protocol requires that all physical file systems adhere to a certain set of predefined rules governing how restoring is handled, depending on whether the object exists on the system. For purposes of restoring an optical volume image, the target media must exist on the system, either mounted in a stand-alone device or imported into an optical media library. Also, it must be accessible by the name specified on the OBJ-New Path Name parameter. The OBJ-New Path Name must either match the name of the OBJ-Name parameter or be *SAME. This restriction will require that unformatted volumes be renamed before processing the RST command. Unformatted volumes can be renamed using option 7 from either the WRKOPTOL, WRKLNK display or by issuing the generic RNM command.

When an unformatted volume is renamed, the new name acts as an alias to the unformatted volume. The new name will not be written to the media and will not be preserved if the volume is removed from the device. The name is only a temporary volume identifier used to refer to this volume until the volume is restored.

Saved volumes can be restored to both unformatted and formatted volumes. If restoring to a formatted volume that contains active files and directories, an inquiry message is sent. If you proceed with the restore, all data on the target media will be lost.

Saved High Performance Optical File System (HPOFS) volumes can be restored to erasable media with matching sector sizes and a capacity equal to or greater than the saved volume.

Saved Universal Disk Format (UDF) volumes on DVD and erasable media can be restored onto DVD or erasable media, but media capacity and sector size must be identical to the saved volume.

WORM volumes can be restored to either WORM or Erasable media as long as the capacity of the target media is greater than or equal to the saved volume capacity and the sector size is identical to the saved volume. When restoring to WORM, the target volume must be unformatted.

The performance of the RST command is comparable to the DUPOPT command, although it depends on the target device chosen.

Parameters

OBJ name
The name of the optical volume image or images to be restored from a save/restore device.

OBJ New path name
Specify a single or multiple path names. The path name cannot be extended beyond the volume level. Examples of invalid path names include, '/QOPT/VOL/*' or '/QOPT/VOL/DIR/FILE'. Specify the names of existing volumes or *SAME.

SUBTREE
This must be *STG when restoring optical volume images.

OPTION
This must be *ALL or *OLD.

ALOWOBJDIF
Select *OWNER, *PGP, *AUTL, *NONE, *ALL. The selected value determines what differences will be tolerated between the saved volume and the formatted target volume. If changes are allowed, an attempt will made to preserve the security attributes UID, GID and PERMS of a the UDF target volume root directory. The *OWNER and *PGP values are not checked when restoring to an uninitialized volume or when restoring to an initialized HPOFS volume.

Examples

• Restore all volumes within the QOPT file system from a save file.

```
RST DEV('/qsys.lib/xzylib.lib/xzysavefile.file') OBJ((* *INCLUDE *SAME)) SUBTREE(*STG)
```

• Restore all volumes beginning with vola and volb from a save file.

```
RST DEV('/qsys.lib/xzylib.lib/xzysavefile.file') +
OBJ(('/qopt/vola*' *INCLUDE *same) ('/qopt/volb*' *INCLUDE *same)) SUBTREE(*STG)
```

• Restore one volume, vol1 to vol1.

```
RST DEV('/qsys.lib/tap01.devd') OBJ(('/qopt/vol1' *INCLUDE *same)) SUBTREE(*STG)
```

Note: The OBJ-New Path Name must either match the name of the OBJ-Name parameter or be *SAME. This restriction will require that unformatted volumes be renamed before processing the RST command.

Managing performance in optical media libraries

Several factors can affect the optical performance of both LAN-attached and directly attached optical media libraries.

Volume mounting and dismounting

Volume mounting and dismounting are important factors that affect optical performance. It takes approximately 8 to 15 seconds to remove a volume, store it in a slot, retrieve a new volume, and mount it. If you can minimize the number of volume mounts and dismounts that your application requires, optical performance will improve.

Drive contention

Performance can be severely affected by drive contention. The following conditions increase drive contention and should be avoided:

• Only one drive is available for use by applications libraries.

• Many optical processes are running that attempt to use different optical volumes at the same time.

Number of directories and files

Performance can be affected by having too few directories with too many files. Directories group related information to provide a means of quicker access. Typically, you get better performance from more directories with fewer files. Although there is no enforced limit on how many files there can be in a directory, you probably should not have more than 6000 for performance reasons.

File size

The size of a file has a direct effect on the amount of time it takes to read, write, or copy the file. In general, the larger the file, the longer the operation can be expected to take.

Add optical cartridge performance

Specifying *NO for the Rebuild Directory Index can improve the performance of **Add Optical Cartridge (ADDOPTCTG)** by deferring the build of the optical directory index until a later time.

Related information

Performance considerations
Volume, directory, and file considerations
Expanding buffer I/O through HFS

Performance considerations for directly attached optical media libraries
Read about the performance considerations that are specific to directly attached optical libraries.

When a file has extended attributes, they are stored separately from the data. When the data is written or copied, the attributes must also be written or copied. If file attributes are not required, attribute copying can be suppressed when copying between the QOPT and QDLS files systems by using the Change Optical (CHGOPTA) command. Setting the copy attributes (CPYATR) value on the CHGOPTA command to *NO suppresses the copying of attributes between the QOPT and QDLS file systems.

Expanding buffer I/O with the HFS API
Users of the HFS APIs can improve performance by taking advantage of the expanding buffer I/O option. Expanding the buffer I/O settings lets you control the amount of data that is read from the optical media when only parts of the entire file need to be read.
Related information
Expanding buffer I/O through HFS

Performance consideration for copying and duplicating optical volumes
There are several performance considerations to be aware of when copying and duplicating optical volumes.

Performance of the **Copy Optical (CPYOPT)** and **Duplicate Optical (DUPOPT)** commands is a complex subject with many interdependent components. By changing one component, you may adversely affect another.

Because of this interdependence and the other factors that affect copy and backup performance, refer to Optical Volume Backup, for additional information.

Related concepts
Copy Optical (CPYOPT) command
Use the Copy Optical (CPYOPT) command to copy optical files and directories between optical volumes.

Using the Duplicate Optical (DUPOPT) command
The Duplicate Optical (DUPOPT) command can be used to create a duplicate optical volume.

Volume mounting and dismounting schedule timers
Find out how a system manages work requests to the directly attached optical library devices.

You can use the Change Device Description (CHGDEVMLB) command to change the queuing and scheduling logic used by a system for directly attached optical media libraries.

Two timer values are associated with optical media libraries that affect the scheduling of volume mounting and preemptive dismounts. You can change both timer values by using the CHGDEVMLB command. The first timer value (UNLOADWAIT) is the unload wait time. This value determines how long the system waits for a new request for a mounted volume before removing it. The second timer value (MAXDEVTIME) is the maximum device wait time. This value determines how long a volume with active requests remains in a drive while other queued requests are waiting to use the drive.

By using these two timer values, you can adjust the volume mount scheduling that is used by the optical media library to match your application's use of optical volumes.

You can change these timer values at any time; however, the new timer values will not become effective until the next time the device is varied on.

System job priority and limit timers are used to schedule volume mounting. The maximum number of volumes that can be mounted is equal to the number of drives in the optical media library. Keep the following points in mind as you schedule volume mounting:

- A volume can remain mounted in an optical drive for the maximum device wait time if work requests with the same or lower job priority for a different volume have been received. An exception to this is when you are initializing a rewritable volume or using DUPOPT; the volume remains in the drive until the operation is completed.
- Work requests for mounted volumes are serviced before requests of the same or lower job priority for volumes not mounted.
- For a multiple job environment, volumes are mounted based on the job priority for the work request. A work request from a job with a higher system job priority causes the required volume to be mounted to handle that request. The volume remains mounted for the maximum device wait time if work requests continue, dismounts after unload wait time inactivity, or is overridden by a work request from a job with higher system priority. If you are initializing a rewritable volume or using DUPOPT, the volume remains mounted until the operation is completed.
- If the work on a drive is interrupted because of a higher priority request, the maximum device wait time timer for the currently mounted volume is canceled. All future requests for that volume are queued for normal processing by priority.
- If the volume needed for a work request is not mounted within the system timeout (typically 30 minutes), the job fails due to a timeout.

Change job priority on active jobs

Due to the work management method used by IBM i optical support, changing run priorities of an active optical job at the user level can result in loss of time allocation and, in some cases, causes jobs to time out.

Managing optical security and auditing

You can secure information about optical media by using IBM i security functions.

The level of security available depends on the optical media format of the volume. You can use an authorization list to secure all optical volumes. This includes all volumes in CD-ROM, DVD, LAN-attached, directly-attached, and virtual optical devices. Universal Disk Format (UDF) volumes provide directory- and file-level security in addition to authorization list security. Optical support provides ways to prevent unauthorized access and processing of data that is stored on optical volumes. Optical support does this by verifying a requester's rights to specific optical volumes before attempting the following requests:

- Open file or directory
- Create directory
- Delete file or directory
- Rename file
- Initialize or rename volume
- Remove cartridge

- Change or retrieve attributes
- Copy
- Backup or convert backup
- Save or release held files
- Read sectors
- Save optical volume storage
- Restore optical volume storage
- Check optical volume for damaged files

Along with security for optical volumes, directories, and files, auditing of access to optical objects is also available.

Related concepts

Directory and file security
Directory-level and file-level security is available for Universal Disk Format (UDF) volumes. The system maintains the data authorities of optical directories and files for three groups of users: owner, group, and public. Volume-level security is also available through authorization lists.

Using authorities required for optical functions
Specific authorities are required in order to perform specific optical functions. Refer to the descriptions to determine the level of authority that is needed.

You must have *USE authority to an optical volume to use the following optical functions:

- Open file for read
- Open directory
- Retrieve file or directory attributes
- Read sector
- List paths or files
- Check optical volume for damaged files

You must have *CHANGE authority to an optical volume to use the following optical functions:

- Open for write or read write
- Create or delete directory
- Create, delete, or rename file
- Change file or directory attributes
- Save or release held optical file

You must have *ALL authority to an optical volume to use the following optical functions:

- Initialize volume (requires *CHANGE for DVD-RAM media)
- Rename volume (requires *CHANGE for DVD-RAM media)
- Convert backup volume to primary
- Duplicate optical volume (requires *CHANGE for DVD-RAM media)

You must have *USE authority to the source optical volume and *CHANGE authority to the target optical volume to use the following optical functions:

- Copy file
- Copy directory

You must have *CHANGE authority to the source optical volume and *CHANGE authority to the target optical volume to use the move file function:

You must have *AUTLMGT authority to an optical volume to use the following optical functions:

- Change authorization list used to secure the volume
- Add optical cartridge (if overriding an existing authorization list)

You must have *OBJEXIST authority to the source volume to use save optical volume optical function.

You must have *OBJEXIST authority to the target volume to use the restore optical volume function.

Note: All programs are shipped with PUBLIC(*EXCLUDE) authority, and most of the commands are shipped with PUBLIC(*USE) authority. The following commands are shipped with PUBLIC(*EXCLUDE) authority.

- Add Optical Cartridge (ADDOPTCTG)
- Remove Optical Cartridge (RMVOPTCTG)
- Add Optical Server (ADDOPTSVR)
- Remove Optical Server (RMVOPTSVR)
- Reclaim Optical (RCLOPT)
- Change Optical Attributes (CHGOPTA)

Specifying an authorization list
Secure volumes with an authorization list during the import process.

The authorization list (AUTL) parameter on the Add Optical Cartridge (ADDOPTCTG) command allows the volumes being imported into an optical media library to be automatically secured with an authorization list as part of the import processing.

If no authorization list is specified for a new optical volume (one that has not been removed with the VOLOPT(*KEEP) option), the default optical authorization list (QOPTSEC) is used to secure the volume. If the volume was removed with the VOLOPT(*KEEP) option, the authorization list that previously secured the volume is used to secure the volume.

The user that adds the optical cartridge does not need to have any authority to the data on the volume being secured by the authorization list, as long as the user is not overriding the authorization list that previously secured a volume that was removed with the VOLOPT(*KEEP) option.

This method is different from the way authorization lists are used to secure system objects. For example, a system operator should be able to add the PAYROLL optical disk to the optical media library and secure it with the PAYROLL authorization list, but not be able to access the data on the PAYROLL optical disk.

To change the authorization list used to secure an optical volume that was previously removed with the VOLOPT(*KEEP) option, the user issuing the ADDOPTCTG command must have either *AUTLMGT authority to the authorization list that previously secured the volume or *ALLOBJ special authority.

Using the authorization list assignment and the Add Optical Server (ADDOPTSRV) command

The Add Optical Server (ADDOPTSRV) command secures all volumes in the system with the default optical authorization list (QOPTSEC). The default optical authorization list is used unless a volume was previously secured with a different authorization list and then removed using the VOLOPT(*KEEP) option on the Remove Optical Server (RMVOPTSVR) command.

Changing the authorization list to secure an optical volume
You can change the authorization list that is used to secure an optical volume in a CD-ROM device or an optical media library.

You can change the authorization list for an optical volume by using the Change Optical Volume (CHGOPTVOL) command.The user attempting to change the authorization list that is used to secure an optical volume must have either *AUTLMGT authority in the authorization list that is currently securing the volume or *ALLOBJ special authority. Specifying *NONE as the authorization list name causes access verification processing for the volume to be bypassed on the future access requests for the volume. If the new authorization list does not exist, the CHGOPTVOL command is rejected and a message is issued indicating that the new authorization list does not exist. Whenever the authorization list used to secure a

volume is changed to a different authorization list or to *NONE, an audit entry is logged if optical auditing is active.

Retaining the authorization list when removing optical volumes
The relationship between an optical volume and an authorization list is maintained in the optical index database.

This relationship is lost when a volume is exported with the *REMOVE option because the record is deleted. If the *KEEP option is specified when the volume is removed, the record is kept. By specifying *PREV on the Add Optical Cartridge (ADDOPTCTG) command, the authorization list that secured the optical volume before it was removed with the *KEEP option is used to secure the volume when it is re-added. The relationship between a CD-ROM volume and the authorization list securing it is lost when the CD-ROM is removed from the drive.

Mapping the authorization list to an optical volume
The name of the authorization list used to secure an optical volume is kept in an optical index database file.

If an authorization list used to secure an optical volume cannot be found when attempting to access the volume, the access is denied and a message is issued indicating that the authorization list for the volume cannot be found. IF *NONE is specified as the authorization list used to secure an optical volume, no access verification is performed. The authorization list that secures an optical volume can be determined by using the Work with Optical Volumes (WRKOPTVOL) command.

Managing directory- and file-level security
Directory- and file-level security is available for Universal Disk Format (UDF) volumes.

The system maintains the data authorities of optical directories and files for three groups of users: owner, group, and public. You can display, change, and manage these authorities by using the integrated file system authority commands Display Authority (DSPAUT), Change Authority (CHGAUT), and Work with Authority (WRKAUT). To change the owner and primary group for files and directories, use the integrated file system commands Change Owner (CHGOWN) and Change Primary Group (CHGPGP). You can also access these commands through the Work with Optical Volumes display by selecting option 11 (Work with object links) on the volume that you choose.

Related concepts
Optical media formats
There are several optical media types and media formats used for the IBM i operating system.

Optical auditing
Many optical operations can be audited.

To enable optical auditing, the system value QAUDCTL must be set to *AUDLVL, and *OPTICAL must be specified in the QAUDLVL system value.

Use the *SEC value on the SYSVAL parameter of the Work with System Values (WRKSYSVAL) command to change these system values. *AUDIT special authority is required to change these values.

The following optical operations can be audited:

- Create, copy, or delete a directory
- Open file, including access mode (read-only, write only, read and write)
- Copy, move, rename, or delete file
- Change or retrieve directory attributes
- Control file system (save or release held file, sector read) options
- Open a directory
- Back up optical volumes
- Initialize or rename an optical volume
- Convert a backup optical volume to a primary volume

- Add or remove an optical cartridge
- Change the authorization list, securing an optical volume
- Save an optical volume
- Restore an optical volume
- Check optical volume for damaged files

Related reference

Security reference

Reclaiming the optical index database

A system-level index, called the optical index database, keeps track of all optical volumes and directories known to the system.

The optical index database includes the optical volume index (QAMOVAR) and the optical directory index (QAMOPVR) physical files. You can use the Reclaim Optical (RCLOPT) command to re-create the optical index database if it is ever damaged or destroyed or whenever volumes that you know are in an optical media library, CD-ROM, or DVD device are reported as not found. To run the RCLOPT command, either select option 2 (Reclaim optical index) on the Optical Backup/Recovery display or enter the RCLOPT command. Doing either causes the Reclaim Optical (RCLOPT) display to appear.

Note: The RCLOPT command (shipped with a public authority of *EXCLUDE) applies to directly attached optical media libraries, CD-ROM, and DVD optical devices. You cannot issue the RCLOPT command to LAN-attached optical media libraries. To re-create the Optical Index Database for LAN-attached optical media libraries, use the Add Optical Server (ADDOPTSVR) command.

Reclaiming the optical index for a stand-alone optical device

The optical index database re-creates entries for CD-ROM and DVD devices each time the device is varied on with media in the device.

The easiest way to reclaim the optical index for a stand-alone optical device is to vary the device description off and on again using the Vary Configuration (VRYCFG) command. Ejecting and reinserting the media has the same effect. You can issue the Reclaim Optical (RCLOPT) command for stand-alone optical devices if you choose to do so.

Reclaiming types

There are three possible types to select: *SYNC, *UPDATE, and *RESET.

Each successive reclaim type described in these topics is more extensive and takes longer to run. The *UPDATE and *RESET reclaim types allow you to optionally reclaim the optical directory index. The type of index problem that you are experiencing determines which reclaim option should be run.

Related concepts

Choosing the reclaim type to use
Decide which reclaim type to use and when the different options should be used.

*Synchronizing volume index with internal library index (*SYNC)*
The synchronize option verifies that the entries in the optical index database are also in the internal library index.

Entries that are in both indexes are left unchanged. Only those optical volumes that are in the internal library index but not in the optical index database are mounted in an optical drive. If an entry is in the internal library index but not in the optical volume index, an entry is created for the volume in the optical volume index. Message OPT2105 `Optical index entries created for volume &2;` is issued, indicating that an optical volume index entry was created for the volume. If the volume is initialized, optical directory index entries are also created for each directory on the volume. If an entry is in the optical volume index but not in the internal library index, message OPT2115 `Optical volume &1; is marked removed` is issued. This indicates that the volume status for that volume has been changed to *REMOVED.

Updating volume index from an optical volume (*UPDATE)
The update option re-creates the optical volume index entries for all volumes in a media library or a specific volume by reading the volume data from the media.

In addition, you can optionally rebuild the optical directory index by using the DIR parameter. If *ALL is specified in the Volume identifier field, the optical volume index is reclaimed for all volumes in the optical media library. If a specific volume name is entered in the Volume identifier field, the optical volume index is reclaimed for that volume only. The optical volume index is updated only for those volumes and libraries that are selected. Index information for other volumes and libraries remains unchanged. Each optical volume whose index is reclaimed will be mounted in an optical drive.

If all of the volumes in an optical media library are specified and an entry is in the internal library index but not in the optical volume index, an entry is created for the volume in the optical volume index and message OPT2105 is issued. If the volume is initialized, optical directory index entries are also created for each directory on the volume.

If an entry is in the optical volume index but not in the internal library index, message OPT2115 is issued. This message indicates that the volume status for that volume has been changed to *REMOVED.

Resetting internal library index and reclaim volume index (*RESET)
The reset option performs basically the same processing as the update option, except that the internal library index is reclaimed before the optical volume index is reclaimed.

You can request that the internal library index and optical index database be re-created or updated either for a specific optical media library or for all optical media libraries. The optical volume index is updated only for those libraries that are selected. Index information for other libraries remains unchanged. Specifying the *RESET option will always reclaim the optical directory index. Each cartridge in the optical media library must be mounted at least once for you to use the *RESET option. The system does this to verify that the internal library index is correct.

If an entry is in the internal library index but not in the optical volume index, the system mounts and reads the volume again. The system creates an entry for the volume in the optical volume index and issues message OPT2105.

If an entry is in the optical volume index but not in the internal library index, the system issues message OPT2115. This message indicates that the volume was not located after rebuilding the internal library index, and that the volume status for that volume is changed to *REMOVED.

Using the reclaim optical directory index option

The reset option lets you reclaim the optical directory index (QAMOPVR) file. The following values are available for parameter DIR:

- *YES indicates that the optical directory index is reclaimed for each volume in the specified library.
- *NO indicates that the system does not reclaim the optical directory index for the volume.

The *RESET type requires exclusive use of all libraries that are being reclaimed. Also, when you use the *RESET type, the Volume identifier field is not used.

Time required to complete reclaiming the optical index
When either *RESET and VOLUME(*ALL) or *UPDATE and VOLUME(*ALL) together are selected, it may require several hours for the Reclaim Optical (RCLOPT) command to complete.

The time requirement is necessary because every volume in the optical media library that is specified must be mounted and then read. The requested databases are then updated before the next volume is mounted. The following factors affect how long it takes the command to complete:

- The number of libraries being reclaimed
- The number of volumes in each library
- Which type of reclaim is requested
- The number of directories on each volume

After a reclaim command has started, it should not be canceled before it has completed. If a reclaim command is canceled before it completes, it might be necessary to run the RCLOPT again before the optical media library is in a usable state.

Optical index information
Optical index information regarding which volumes are in a particular optical media library and which directories are on each volume is kept at different levels within the system.

Optical index files are used to enhance performance by eliminating the need to access the optical media library or physical media each time the location of a volume or directory is needed.

Failures, system upgrades, and physically moving optical library devices from one system to another can cause these index files to become out of synchronization with the actual contents of a particular optical media library or volume. When this happens, messages are sent indicating that the optical index needs to be reclaimed, such as OPT1245, OPT1825, or OPT1330. These messages direct you to run the Reclaim Optical (RCLOPT) command. The following topics describe the optical index files that are kept at the different levels of the system. An understanding of the different optical indexes is helpful when deciding which type of reclaim optical index to run.

Optical index database files
The optical indexes reside in the physical files QAMOVAR and QAMOPVR.

The QAMOVAR file is the optical volume index. It contains information about all optical volumes known to the system. This includes volumes that were previously removed from the optical media library with the volume description option of *KEEP. The QAMOPVR file is the optical directory index. It contains information about the directories on the volumes in directly attached optical media libraries or CD-ROM devices. This includes those volumes that were previously removed from directly attached libraries with the volume description option of *KEEP.

Information for volumes that are *OFFLINE or *REMOVED is retained by reclaim optical processing, but it cannot be rebuilt or verified because the physical volumes are no longer accessible. If the optical index database is ever destroyed, information about *REMOVED volumes can be recovered by adding the cartridge that contains the volumes to an optical media library using the Add Optical Cartridge (ADDOPTCTG) command.

Internal library index
Each optical media library keeps an internal library index of each volume that it contains.

The internal library index for each optical media library is controlled by the Licensed Internal Code. The information in this index is generally not accessible to users or application programs. However, this index must be kept synchronized with the optical index database. This index is re-created when the *RESET rebuild type is specified.

To select the optical media library or libraries that require rebuilding, enter the optical media library name in the Optical media library field on the Reclaim Optical (RCLOPT) display. The name that you enter must correspond to an optical media library that is currently configured on the system.

To reclaim more than one optical media library, issue separate RCLOPT commands for each device rather than using MLB(*ALL). Sequentially using the MLB(*ALL) command reclaims all of the optical media libraries one at a time. Issuing separate RCLOPT commands will allow the reclaiming operations to run in parallel, which will run faster.

Choosing the reclaim type to use
Decide which reclaim type to use and when the different options should be used.

Most optical support error messages that direct you to run the Reclaim Optical (RCLOPT) command specify the rebuild type you should use to recover from the error. However, occasionally you might suspect that the optical index needs to be reclaimed even though no error message has been issued. In this case, you need to determine which reclaim type should be run. If you are unsure which reclaim type you should use, run the RCLOPT command with the *SYNC option and then try the failing request again. If the request still fails, run the RCLOPT command with the *RESET option.

*SYNC

Use this option when you are getting messages indicating that a volume is not found (OPT1331 or OPT1330 - reason code 2) or that a volume is removed (OPT1460) when you feel that the volume is indeed in the optical media library. Use this option after you upgrade to a new release of IBM i or when you move a directly attached optical library device from one system to another.

*UPDATE

Use this option first if you see a message indicating that the optical tables are incorrect (OPT1825). You can also use this option if you are having problems with a particular volume not displaying all the directories when you use the Work with Optical Directories (WRKOPTDIR) command.

*RESET

Use this option when you get message OPT1330 with reason code 01. Unless otherwise instructed through an optical message, use this option as a last resort. It will generally take much longer to complete than either of the two previous options, but it will ensure that both the optical index database and the internal library index are correct. Specify DIR(*NO) unless you have a specific need to create the optical directory index. The only operations that require the directory index are Work with Optical Directories (WRKOPTDIR) and Display Optical (DSPOPT) when DATA(*DIRATR) is used. If you specify DIR(*NO), the directory index is built on demand when one of these functions is issued.

Recovering held optical files

A held optical file is an optical file that cannot be closed normally.

The file contains buffered data that cannot be written to the optical disk. If the open file handle is still valid, the file is still open; otherwise, it is considered closed.

Held optical files are only created for media format *HPOFS when the Change Optical Attributes (CHGOPTA) **Held file** attribute field is *YES. Held optical files are not created for media format *UDF or when the **Held file** attribute field for the CHGOPTA command is *NO.

Related concepts

Changing optical environment parameters
The Change Optical Attributes (CHGOPTA) command can be used to change specific optical configuration parameters that affect all jobs using the optical file system.

How optical files are used
An application can manipulate optical file data by using UNIX-type APIs or the hierarchical file system (HFS).

An application opens a file, operates on the file, and finally closes the file. When an application changes file data or attributes, the optical file system stores these changes in a temporary system object in IBM i storage. The optical file system does not update the optical disk until the application closes the file. When two or more applications concurrently change file data or attributes, the optical file system updates the optical disk when the last updating application closes the file. The application may force file and attribute data to optical disk by issuing either the HFS Force Buffered Data API or UNIX-Type `fsync()` functions.

Doing this process has the following benefits:

- Simulation of read and write access to optical files
- File locking and sharing
- Byte locking and sharing
- Random processing of optical file data
- Writing variable-length data buffers to the optical file
- Reduction of read and write to the optical disk

Related information

Application programming interfaces (APIs)

Held optical files

If the optical file system is unable to update the optical disk during a close function, the operation fails and the file is marked as held.

The optical file system might still consider the file to be open. If it considers the file open, the optical file system allows any application that already has the file open to continue operating. In any case, no new application can open a file while it remains held. If the system can correct the condition that caused the failure, and the file is still open, the application may attempt to close the file again. If the close function succeeds, the system no longer holds the file.

Notes:

1. If an HFS application specified an open type of normal, it cannot access the file through the HFS API any longer. See the online help information regarding the open types that concern the Open Stream File command.

2. The system does not create held files when files fail to close on Universal Disk Format (UDF) media.

Related reference

Application programming interfaces (APIs)

Recovering a held optical file

Read the provided instructions to learn how to recover a held optical file.

If a close operation fails for an open optical file and the file becomes held, the held file can be handled in one or both of the following ways:

• You can attempt a save request

• You can release the file to allow it to be opened again.

However, if the cause for the close failure has been corrected, the file can now be closed, without having to save or release it first. In this situation, the file is automatically saved and released, and the held status is lifted. After releasing a held file, you can close it if the open file handle is still valid.

Before saving or releasing a held optical file, you can view all of its open instances by selecting **Display Usage information** from the Work with Held Files Optical Files (WRKHLDOPTF) display. This can be an important step in determining the appropriate actions for the file. For example, before deciding not to save the latest version of a file, it is useful to know if other applications have been making concurrent updates to the same file. Updates need to be rolled back for all users if the file were only released and no further updates were made before the last updating application closed the file.

Saving a held optical file

Saving a held optical file physically writes the data and file attributes to the optical disk. You can choose to save to the original volume, directory, and file name that you specified at open time, or to a new optical file path.

In some situations, you can save the file at the original storage destination. For example, if the file has been opened with a normal open type, the file is now inaccessible through the HFS API, rendering the open file handle no longer valid. However, the condition that caused the file to become held might have been corrected, giving you the ability to save the data by specifying the held file as the destination.

If the application specifies a different file path as the destination, the file must not already exist. If appropriate, you can delete such a file before attempting to save to that volume, directory, and file name.

After a held optical file is saved, it should be released to allow the file to be used by future applications.

Releasing a held optical file

A held file can only be released if no locks are currently imposed on the file by other active jobs.

Releasing a held optical file clears the held status and allows new applications to open the file. It also releases the optical file system from its obligation to update the optical disk, unless some application makes further updates to the file. After the file has been released, it may be closed if the user's process is still active.

If one or more applications continue to change a file after it is released, the optical file system attempts to update the optical disk when the last updating application closes the file. However, if the cause for the close failure has not been corrected, the file can be expected to become held again.

A held file can be released after a save operation or without any save operation. If a successful save operation cannot be achieved, you can release the file to acknowledge that the data cannot be written to the disk and that this result is being accepted without taking further action aside from closing the file.

If you do not release the held optical file, it remains held even if the process ends, unless an automatic close operation is successful in saving the file at that time. For held files, this might only happen if the open type is permanent, and if the cause for the earlier close failure has been resolved.

Implementing held optical file functions
Before deciding whether to save or release a held optical file, you might want to view information that can influence save and release decisions.

The Work with Held Optical Files display provides this means, in addition to the ability to save and release held optical files. The save and release functions are also available as optical-specific functions of the HFS Control File System API.

The Work with Held Optical Files display provides a convenient way to list and manage any held optical files on the system. Use the Work with Held Optical Files (WRKHLDOPTF) command to access the Work with Held Optical Files display.

Options on the Work with Held Optical Files display are selected to display the use (open instances) of files, as well as to save and release held files. By default, using **Save** on the Work with Held Optical Files display causes the automatic release of a held file after it is saved.

The functions provided by **Save** and **Release** are also available as the optical-specific functions, Save Held Optical File and Release Held Optical File, of the Control File System API in the programming topic.

Unlike **Save**, the Save Held Optical File function of the Control File System API does not automatically release a held file after it is saved. Therefore, an explicit release request is needed afterward.

Related information

Programming

Disabling held optical file support
IBM i is shipped with held optical file support enabled. If you want, you may disable it by using the Change Optical Attributes (CHGOPTA) command.

When held optical file support is disabled, a held file is not created when a file fails to be archived to optical disk. When using this option, it is up to the user application to manage recovery procedures for files that fail to be archived. Consider the following scenarios:

Scenario 1

The application opens an optical file for a write operation, and then writes data to the file. When you attempt to close the file, it fails because the optical disk is full.

Held file support enabled
   The file is still open, but becomes held. The file closes when the job ends if it never closes successfully before the job ends. The file will remain held until it is released.

Held file support disabled
   The file is still open, but is not held. The file closes when the job ends if it never closed successfully before the job ends. The file will not become held, and all resources (virtual optical file) associated with the held file will then be freed up.

Scenario 2

The application opens an optical file for write, and then writes data to the file. The application then issues a Force Buffered Data API to ensure the data is safe on nonvolatile storage. The system then loses power.

Held File Support Enabled

After the internal program load (IPL) of the system is completed the file exists as a held optical file. All data that was successfully forced to disk is recoverable. In other words, when you save the held file to optical storage, all data written before the Force buffered data request will be saved.

Held File Support Disabled

After the IPL of the system is completed, the file does not exist as a held optical file. All data written to this file on the previous open instance is lost. The force data request had no effect.

It is important to note that when held optical file support is disabled, forcing data to nonvolatile storage is meaningless. This is because data is written to optical storage after the file closes successfully. The Force buffered data function will force the data to the IBM i disk, and you can use the held optical file to recover the data after a power loss. Held files are the only mechanism to recover data forced to nonvolatile storage after a power loss or other unexpected error. Held file support is needed to recover any data from an open instance that closes unsuccessfully. This affects the following application program interfaces.

- Force Buffered Data HFS (QHFFRCSF) API

  This API is allowed when held file support is disabled, but it will have no effect.

- Synchronize File Changes integrated file system fsync() API

  This API is allowed when held file support is disabled, but it will have no effect.

- Synchronous write-through flag on Open Stream File HFS (QHFOPNSF) API

  This value is allowed, but will be treated as an asynchronous write-through flag.

Use the Change Optical Attributes (CHGOPTA) command to enable, disable, or determine the current status of held optical file support. After held optical file support is disabled, it remains disabled for all optical users. You must enable held file support for it to become active again.

Related reference

Change Optical Attributes (CHGOPTA) command

Saving and restoring using optical media

Optical media is a cost effective long-term storage solution. You can save and restore your data using optical media in multiple ways. You can perform saves using BRMS, save operations and restore commands, and the Load Run command.

The IBM i Save and Restore commands support directly attached optical media library devices, CD-ROM, DVD-ROM, DVD-RAM stand-alone devices, and virtual optical devices. The best use of optical storage devices is for disaster recovery protection. The extraordinary long shelf life of optical media is well suited for the long-term storage of critical data. You can provide extra protection by using permanent WORM media because you cannot alter data on the media. Tape devices may provide the optimal day-to-day backup mechanism. This depends on the amount of data that you want backed up, and the amount of system time available for backup. CD-ROM and DVD-RAM media are also well suited for software distribution. The save/restore command interface can be used as a part of installation procedures for programs, data, and program fixes. CD-ROM and DVD-RAM stand-alone drive optical devices also support the Load Run (LODRUN) command.

Backup, Recovery and Media Services (BRMS) is a licensed program that helps you create a disciplined approach to manage your backups. Optical media is supported by BRMS. Refer to the BRMS topic for more details.

Related concepts

High performance optical file system
High Performance Optical File System (HPOFS) is an IBM-developed media format architecture available to use when initializing optical media.

Directory and file security

Directory-level and file-level security is available for Universal Disk Format (UDF) volumes. The system maintains the data authorities of optical directories and files for three groups of users: owner, group, and public. Volume-level security is also available through authorization lists.

Related reference
Save Restore (SAVRST) command
Related information
Backup, Recovery, and Media Services (BRMS)

Concepts for saving and restoring optical media
Optical devices support many of the most widely used IBM i Save and Restore commands.

The DVD-RAM stand-alone optical drive device is an economical alternative to magnetic tape for save/restore operations on entry-level systems. The DVD-RAM stand-alone drive device supports all major save/restore functions. The automated library device enhances ease of use of save and restore operations that require volume lists.

Optical media formats with saving and restoring operations
Save and restore volume list processing differs for each optical media format.

A volume list is used on a save or restore request when multiple optical volumes are required for the operation, thus creating a volume set. All volumes in a volume set must have the same optical media format. Volume sets are not supported for CD media formatted with ISO 9660.

You must initialize media of type permanent WORM and CCW WORM with the media format of High Performance Optical File System (HPOFS).

You can initialize media of type rewritable with HPOFS format or Universal Disk Format (UDF).

You must initialize the DVD type of media that is used by DVD-RAM stand-alone drive devices with UDF.

Organizing save and restore data on optical devices
Save and restore your data on an optical devices according to path name lengths, naming conventions, and directory levels.

The save data on optical media is uniquely identified by a path name. This path name has the form: /directory name/subdirectory name/../filename. You may create and specify as many directory levels as is necessary to organize your save data to suit your needs. If no directory levels are specified, the save data file is placed in the root directory of the specified optical volume.

The optical path name may be up to 256 alphanumeric characters in length. Optical volume names may be up to 32 alphanumeric characters in length. Some caution is necessary when using long names. Many IBM i save and restore displays, messages, reports, output files, and object descriptions, support a maximum of 6 characters for volume names, and 17 characters for path names. Longer names will appear truncated in these instances. Additionally, some automated data management software may not properly handle long volume names and long path names.

Saving a library to optical storage

You can save the IBM i library DEVLIB01 to the optical volume SRVOL1 that is contained in library device OPTMLB02. You do this by using the following command:

```
SAVLIB LIB(DEVLIB01) DEV(OPTMLB02) VOL(SRVOL1) ('/DEVLIB01')
```

An optical file containing the save data, with the name DEVLIB01, will be created in the root directory of volume SRVOL1.

Displaying save and restore file information about optical storage
You can use various commands to save and restore file information.

As an example, information concerning the save and restore files that are contained on a given optical volume can be displayed using the Display Optical (DSPOPT) command. The following command displays

the information for all save and restore files that are found in the root directory of the optical volume SRVOL1:

```
DSPOPT VOL(SRVOL1) DATA(*SAVRST) PATH(/)
```

Using the OPTFILE parameter

The OPTFILE parameter is used in save and restore commands to designate the optical file path name to be used to contain the save data. The system dynamically creates any specified directory names that do not exist.

The OPTFILE parameter has a default value of (*). By using the default parameter value, you will place the file in the root directory of the optical volume that is specified by the VOLUME parameter. Additionally, in commands other than SAV, the file name is the name of the IBM i library that contains the objects that are saved.

For the SAV command, OPTFILE(*) generates a file name of the form SAV*yyyymmddhhmmssmmm*, where *yyyymmddhhmmssmmm* is the current date and time.

Using the media eject option

For stand-alone drive devices that are attached by PowerPC® IOAs, you can automatically open the media tray at the conclusion of a save and restore operation. You can do this by specifying the ENDOPT(*UNLOAD) parameter. The system ignores this parameter for optical library devices. The ENDOPT(*LEAVE) or ENDOPT(*REWIND) parameters have no effect on optical stand-alone drive devices or optical media library devices.

Volume list contents
Volume lists allow a single save and restore operation to use many pieces of optical media to complete the requested operation.

Information relating to optical volumes that are a part of a save and restore volume list may be displayed using the Display Optical (DSPOPT) command.

Volume list information fields:

Continued from Previous Volume flag

- This field applies only to UDF media.
- This flag indicates that the save and restore file is continued from the previous volume in the volume list.
- Only one file on a given volume can have this flag set on.
- You can use the DSPOPT DATA(*FILATR) command to display this flag.

Continued on Next Volume flag

- This field applies only to UDF media.
- This flag indicates that the save and restore file is continued to the next volume in the volume list.
- Only one file on a given volume can have this flag set on.
- You can use the DSPOPT DATA(*FILATR) command to display this flag.

IPL Capable flag

- This flag indicates that the Save System (SAVSYS) command created this volume and that you can use it for D-Mode IPL.
- You can use the DSPOPT DATA(*VOLATR) command to display this flag.

Last Volume in Volume List flag

- This flag indicates that the volume is the final volume in a volume list.

- For High Performance Optical File System (HPOFS) format volumes, the system does not allow save files that are unrelated to the volume list on the final volume. The remaining capacity does not affect this situation. UDF volumes do allow unrelated save files on the volume if sufficient free space exists.
- You can use the DSPOPT DATA(*VOLATR) command to display this flag.

Starting Volume ID

- The volume ID of the first volume in a multiple volume set in a volume list is located in the starting volume ID field. For UDF volumes, the volume list might contain several different save files. Consequently, this field does not specify the starting volume of any given file that is contained in the set.
- You can use the DSPOPT DATA(*VOLATR) or DATA(*FILATR) command to display this flag.

Volume lists with HPOFS format media
Only one file in a multivolume set logically spans volumes. The last volume in the set does not accept additional save requests. The system does not maintain continued flags.

- Volume1 (Sequence#=1, Starting volid=Volume1, Last volume in set=No)

  - File1 (Continued from previous volume=NO, Continued on next volume=NO)
  - File2 (Continued from previous volume=NO, Continued on next volume=NO)
  - File3 (Continued from previous volume=NO, Continued on next volume=NO)
- Volume2 (Sequence#=2, Starting volid=Volume1, Last volume in set=No)

  - File3 (Continued from previous volume=NO, Continued on next volume=NO)
- Volume3 (Sequence#=3, Starting volid=Volume1, Last volume in set=Yes)

  - File3 (Continued from previous volume=NO, Continued on next volume=NO)

Notes:

- No more save operations are allowed to Volume1, Volume2, or Volume3. The system does not allow additional save files to Volume3, regardless of sufficient free space.
- Access to any previous save data is lost from Volume1, Volume2, and Volume3.
- All restore operations must begin on Volume1.

Volume lists with UDF media
More than one file in a multi-volume set can logically span volumes, but only one file per volume can span to the next volume in the volume list.

The last volume in the set accepts additional save requests if space is available. The system maintains the continued flags for spanned files.

- Volume1 (Sequence#=1, Starting volid=Volume1, Last volume in set=No)

  - File1 (Continued from previous volume=NO, Continued on next volume=NO)
  - File2 (Continued from previous volume=NO, Continued on next volume=NO)
  - File3 (Continued from previous volume=NO, Continued on next volume=YES)
- Volume2 (Sequence#=2, Starting volid=Volume1, Last volume in set=No)

  - File3 (Continued from previous volume=YES, Continued on next volume=NO)
  - File4 (Continued from previous volume=NO, Continued on next volume=NO)
  - File5 (Continued from previous volume=NO, Continued on next volume=YES)
- Volume3 (Sequence#=3, Starting volid=Volume1, Last volume in set=No)

  - File5 (Continued from previous volume=YES, Continued on next volume=YES)
- Volume4 (Sequence#=4, Starting volid=Volume1, Last volume in set=Yes)

  - File5 (Continued from previous volume=YES, Continued on next volume=NO)

– File6 (Continued from previous volume=NO, Continued on next volume=NO)

Note:

1. Space permitting, additional saves are allowed to Volume4.

2. A restore operation begins on the volume that contains the first occurrence of the specified file. For example, you can restore data from File4 on Volume2 without processing Volume1.

3. The volume set for UDF media described in this section is not related to the volume set or multi-volume support that is defined in format specifications for UDF (ECMA 167 3rd Edition or UDF Revision 2.01). Support for volume sets as defined by these specifications is not currently provided by IBM i.

Related concepts

Clearing media
By specifying CLEAR(*ALL), you clear all the files on the media.

Saving optical files to optical storage
You can save optical files to DVD-RAM, UDF, and HPOFS media.

Specifying optical file path names
Learn how to specify a path name for the optical file that is used for the save operation.

Optical storage operates in random mode and uses a hierarchical file structure when writing files to the media. Beginning with the root directory of the volume, you may specify a path name for the optical file that is used for the save operation. Specifying an asterisk (*) causes the system to generate an optical file name in the root directory (/). Specifying `optical_directory_path_name/*` causes the system to generate an optical file name in the specified directory of the optical volume. Specifying `optical_file_path_name` creates an optical file name. For example, specifying SAVLIB LIB(MYLIB) DEV(OPT01) OPTFILE('/mydir/*') creates an optical file name of mydir/MYLIB. If mydir directory does not exist, the system creates it.

When you use DVD-RAM media to save IBM i information, the system checks for active files by using the CLEAR parameter on the save commands. Specify CLEAR(*NONE) to have the system search the DVD-RAM volume for any active optical files that have the same name. If an optical file of the same name exists, the system displays an inquiry message. You may cancel the processing, write over the existing file on the volume, or insert a new cartridge. If no active files of the specified optical file exist and there is available space on your DVD-RAM volume, the system writes the file to your DVD-RAM media. If the system cannot find any available space on the media, it prompts you to insert a DVD-RAM volume in the device.

Clearing media
By specifying CLEAR(*ALL), you clear all the files on the media.

By specifying CLEAR(*AFTER), you automatically clear all media after the first volume. The system sends an inquiry message when it encounters the specified optical file on the first volume. This allows you to either end the save operation or replace the file. Specifying CLEAR(*REPLACE) automatically replaces the active data of the specified optical file on the media.

The only option on the CLEAR parameter that clears all the files is CLEAR(*ALL). Otherwise, the system sends an inquiry message for each specified optical file name it encounters. Specifying CLEAR(*NONE) sends an inquiry message for each specified optical file name it encounters, not just the first one.

To avoid receiving an inquiry message during the save operation, you can perform either of the following functions:

- Initialize the optical volume (INZOPT) first.
- Specify an option by using the CLEAR parameter on the save command.

Note: Do not use the CLEAR(*NONE) parameter, this sends an inquiry message. See the online help information regarding the use of the CLEAR parameter with the save commands.

Related concepts

Volume lists with UDF media

More than one file in a multi-volume set can logically span volumes, but only one file per volume can span to the next volume in the volume list.

Saving to multiple volumes
If the system writes data to a second DVD-RAM volume, the system considers this a DVD set.

A set includes two or more volumes. The system can only write information about the last volume in the set. In a three-volume DVD-RAM set, the system cannot write information to the first or second volume.

The table below provides command support information according to optical device.

Command	Supported by optical device
SAVSTG	None
SAVS36F	None
SAVS36LIBM	None
SAVUSFCNR	None
RSTS36F	None
RSTS36FLR	None
RSTS36LIBM	None
RSTUSFCNR	None
SAVLICPGM	DVD (No optical libraries)
SAVSYS	DVD (No optical libraries)
RSTLICPGM	DVD (No optical libraries)
SAVCHGOBJ of more than one library, including LIB(*ALLUSR)	DVD and optical library devices with Universal Disk Format (UDF) media
SAVDLO of more than one ASP	DVD and optical library devices with UDF media
SAVLIB of more than one library, including LIB(*ALLUSR), LIB(*IBM), AND LIB(*NONSYS)	DVD and optical library devices with UDF media
SAVCFG	All writable optical devices
SAVCHGOBJ of one library	All writable optical devices
SAVDLO of one ASP	All writable optical devices
SAVLIB of one library	All writable optical devices
SAVOBJ of one library	All writable optical devices
SAVSAVFDTA	All writable optical devices
SAVSECDTA	All writable optical devices
RSTCFG	All optical devices
RSTLIB	All optical devices
RSTOBJ	All optical devices
RSTUSRPRF	All optical devices
SAVAPARDTA	Not applicable, command does not use a device
RSTAUT	Not applicable, command does not use a device

Operating guidelines by optical device type
There are operational guidelines by device type for optical library data servers and CD-ROM, DVD-ROM, and DVD-RAM stand-alone optical drive devices.

Optical library dataservers

- You cannot use the default value, *MOUNTED, for the volume identifier.
- Volumes that are provided in a volume list must all be in the same library device.
- A single save data file may span several volumes in a volume list.
- For High Performance Optical File System (HPOFS) media, any volume used in a volume list becomes unusable by any save or restore operation other than the operation originally processing the volume list.

    For example:

    – Save command A writes save data fileA to volume volA.
    – Save command B writes save data fileB to volume list: volC, volB, volA.
    – Restore command A will not be able to restore from fileA on volume volA.
    – Restore command B will be able to restore from fileB on the volume list: volC, volB, volA.

CD-ROM and DVD-ROM stand-alone optical drive devices

- CD-ROM and DVD-ROM are read-only devices. The system does not support save commands for these devices.
- Save files cannot span multiple CD-ROM or DVD-ROM media that contain ISO 9660 media format.
- You can specify the default value, *MOUNTED, for the volume identifier. It will process the optical volume currently in the specified stand-alone device.

DVD-RAM stand-alone optical drive devices

- DVD-RAM devices are read and write devices. Save and restore commands are supported for DVD-RAM devices.
- You can specify the default value, *MOUNTED, for the volume identifier. It will process the optical volume currently in the specified stand-alone device.
- Multiple save data files may span several volumes in a specified DVD_RAM volume list.

Note: Software compression and decompression might increase the save and restore times. It uses considerable processing resources which may affect the overall system performance.

Troubleshooting optical storage

Get answers to several of the most common questions, steps to follow when a problem occurs, and information needed for problem analysis.

Optical support FAQ
Optical support FAQ provides information to help with some common problems and questions encountered with optical devices.

1. When writing objects, I receive a message indicating that there is not enough optical media space available. However, the volume is not full. What is wrong?
2. My backup volume is filling up before all objects from the primary have been stored. What is using up the extra space?
3. While backing up optical media, the task ends abnormally. When I restart the backup, I receive the OPT1210 message indicating that the directory already exists. However, the directory is not listed when I use the Work with Optical Directories (WRKOPTDIR) command. How can this be?
4. I received an OPT1115 message indicating that the file is not found when trying to retrieve an object. When I use the Work with Optical Files (WRKOPTF) command, the object is displayed. Why am I unable to retrieve the object?
5. My application appears to be storing objects correctly, but when I use the Work with Optical Files (WRKOPTF) command, not all of the objects are showing up. Where are the objects going?

6. My application program fails with message CPF1F83 indicating that the file system name /QOPT was not found when I attempt to copy a stream file using the CPYSF command. What is wrong?

7. There is a volume I want to use, but I cannot seem to access it. What can I do?

8. Messages are occurring which indicate that I should run Reclaim Optical (RCLOPT) command. A RCLOPT of type *RESET can take a long time. Is there a quicker way to recover?

9. What is the difference between volumes marked *OFFLINE and those marked *REMOVED?

10. When I add full optical volumes into my optical media library by using the Add Optical Cartridge (ADDOPTCTG) command, it takes a long time. Any suggestions?

11. I entered a CD-ROM volume into my CD-ROM device, but I received a message saying volume not found when I attempted to access it. I did not see any error messages. What went wrong?

When writing objects, I receive a message indicating that there is not enough optical media space available. However, the volume is not full. What is wrong?

Either the threshold is incorrectly set, the object being stored is bigger than the available space, or the spares area is full. Display the volume attributes of the volume that you are writing to using the Display Optical (DSPOPT) command. Verify that the threshold and space available values are valid. Also, verify that access to the volume access is writable, and not read-only. If it is read-only, then the spares area may be full. The spares area is a set of sectors to which data is written when the original sector is damaged.

My backup volume is filling up before all objects from the primary volume have been stored. What is using up the extra space?

Several situations can cause this to happen:

- Device errors may have occurred when only part of a file was written. When the backup operation was restarted, the complete file was rewritten.

- If the backup volume type is WORM, it might have been initialized multiple times before the backup operation, thus wasting some volume space.

- If you are performing an incremental backup operation, you might have selected the wrong option on the SLTFILE parameter (*ALL instead of *CHANGED).

- If you created the primary volume on a pre-Version 2 Release 3 Modification 0 system, and the primary volume is over 98% full, then the Duplicate Optical (DUPOPT) command may be the only choice to back up this volume.

- The primary volume is a 2X media and the backup volume is 1X.

While backing up a volume, the task ends abnormally. When I restart the backup, I receive the OPT1210 message indicating that the directory already exists. However, the directory is not listed when I use the Work with Optical Directories (WRKOPTDIR) command. How can this be?

When the task ended abnormally, the directory was created on the volume, but the internal optical index files had not been updated yet. Remove the backup volume using the Remove Optical Cartridge (RMVOPTCTG) command and add it back in using the Add Optical Cartridge (ADDOPTCTG) command and specifying DIR(*YES). The internal optical index will be updated with the new path.

I received message OPT1115 indicating that the file is not found when trying to retrieve an object. When I use the Work with Optical Files (WRKOPTF) command, the object is displayed. Why am I unable to retrieve the object?

The optical media may be dirty. Contact your next level of support (hardware) to get the media cleaned.

My application appears to be storing objects correctly, but when I use the Work with Optical Files (WRKOPTF) command, not all of the objects are showing up. Where are the objects going?

The files may be held optical files. Refer to Held optical files for more information about held optical files. In this case, the volume may have reached its threshold. Verify that your application is handling the OPT1345 message `Threshold reached on optical volume` or CPF1F61 message `No space available on media` correctly.

My application program fails with message CPF1F83 indicating that the file system name /QOPT was not found when I attempt to copy a stream file using the CPYSF command. What is wrong?

The file system portion of the path (/QOPT) must be specified in uppercase characters. The rest of the path can be in either uppercase or lowercase characters.

There is a volume I want to use, but I cannot seem to access it. What can I do?

Duplicate volume names might cause this. If the volume is in a LAN system, it may have the same name as a volume in a directly attached library or another system. If there are duplicate names, only the first volume found is usable.

Messages are occurring which indicate that I should run Reclaim Optical (RCLOPT) command. A RCLOPT of type *RESET can take a long time. Is there a quicker way to recover?

Yes. First read Reclaiming the Optical Index Database to gain a better understanding of the RCLOPT process. Then attempt one of the following:

- Run RCLOPT MLB *device_name* OPTION(*SYNC).
- Work with Optical Volumes (WRKOPTVOL) and press F14 (Show extended information). If any volumes show `moving` as the location, then do the following:

  1. Run RCLOPT MLB(device name) OPTION(*UPDATE) VOL *moving_volume_name*.
  2. Refresh the Work with Optical Volumes screen. If any volumes still show up as moving, repeat step 1.

- Run RCLOPT MLB *device name* OPTION(*RESET) DIR(*NO)

  Note: This choice takes longer than the first two, but by specifying DIR(*NO), it can cut the RCLOPT *RESET time in half.

What is the difference between volumes marked *OFFLINE and those marked *REMOVED?

*OFFLINE entries are volumes in optical devices that are either powered off, varied off, or no longer connected. *REMOVED entries are volumes that were removed from the optical media library with VOLOPT *KEEP specified.

When I add full optical volumes into my optical media library by using the Add Optical Cartridge (ADDOPTCTG) command, it takes a long time. Any suggestions?

When volumes are removed using the Remove Optical Cartridge (RMVOPTCTG) command, remove them specifying *KEEP on the VOLOPT parameter. The internal optical indexes save all information about these volumes, including the optical directory information. When volumes are added using the ADDOPTCTG command, specify *NO in the DIR parameter. The volumes are added and the directory index is not rebuilt. This speeds up the import process.

Note: This process should not be followed if changes were made to the removed volumes since the volumes were last removed from this system.

I entered a CD-ROM volume into my CD-ROM device, but I received a message saying volume not found when I attempted to access it. I did not see any error messages. What went wrong?

Refer to CD-ROM and DVD on IBM i for information about loading CD-ROM media. In this case, you probably attempted to access the CD-ROM before it was fully loaded (wait 10-20 seconds after the tray slides in), or an error occurred during the load operation. Refer to the QSYSOPR message queue to see if the CD-ROM volume loaded successfully.

Collecting information
If you need to call the next level of support, have the following information ready to help speed up the problem analysis process.

- Detailed description of problem, including each of the following items:

  1. Applications that are running
  2. Whether the system or application is newly installed or has been running

3. Can the problem be reproduced?

- Type and model number of the dataservers
- Up to date PTF level
- Number of dataservers
- Number of volumes

Other system commands

The following system commands can help in gathering pertinent information for analyzing problems.

- The Display Job Log (DSPJOBLOG) command shows commands and related messages for a job while it is still active and has not yet been written.
- Display Log (DSPLOG) command shows the system history log (QHST). The history log contains information about the operation of the system and the system status.
- The Trace Job (TRCJOB) command controls traces of program calls and returns that occur in the current program, or the job being serviced.
- The Start Service Job (STRSRVJOB) command starts the remote service operation for a specified job so that other service commands can be entered to service the specified job.
- The End Service Job (ENDSRVJOB) command ends the remote job service operation. This command stops the service operation that began when the Start Service Job (STRSRVJOB) command was entered.
- The Analyze Problem (ANZPRB) command allows you to analyze, create problem records for, or report problems that were not detected by the system. If the problem is valid, a fix can be supplied by matching the problem description to an already known problem for which a PTF exists, or an APAR can be created.

Related information

Programming

Virtual storage

This storage solutions topic covers only the IBM i virtual storage solutions that store media images on your disk units or in the network file system and client virtual devices. The following types of virtual storage solutions are available for IBM i.

- Virtual I/O Server (VIOS) partition owned physical tape devices, physical optical devices, and virtual optical devices can be used by IBM i partitions. See the PowerVM® Editions for information on how to set up these devices to be used from an IBM i partition.
- Virtual Tape Library devices. Virtual Tape Library devices are external devices that emulate a tape library device but store data on disk instead of on tape media. Check the documentation for your specific Virtual Tape Library device for information on how to set up these devices to be used by an IBM i partition.
- IBM i virtual storage. The IBM i operating system provides virtual tape and virtual optical solutions that imitate tape, CD, DVD, write-once read-many (WORM), and erasable optical media on your disk units, or in the network file system for virtual optical. The imitated media appear to the system to be actual media.
- Client virtual devices (optical and tape). An IBM i partition running on an IBM Power System, Power6 or later, can share a natively attached optical device, a natively attached tape device, or an IBM i virtual optical device (optical image catalog) with IBM i client partitions.

Concepts for IBM i virtual storage

Learn general information about IBM i virtual storage, including descriptions and instructions for use.

Virtual storage device

A virtual storage device is a device description that supports virtual storage, like an actual tape, or optical device description supports actual storage. One to 35 virtual storage tape device descriptions and one to 35 virtual storage optical device descriptions can be active at a time on the system.

You create a virtual tape device by selecting the RSRCNAME(*VRT) or TYPE(63B0) parameters on the Create Device Description (Tape) or (CRTDEVTAP) command.

You create a virtual optical device by selecting the RSRCNAME(*VRT) or TYPE(632B) parameters in Create Device Description (Optical) or (CRTDEVOPT) command.

Virtual optical devices of TYPE(632C) indicate that this device is being hosted by another IBM i or by a VIOS and are created automatically during auto-configuration. If the 632C device type is being hosted by a VIOS, then it requires that you manually change the media when required.

Image catalog

An image catalog is an object that can contain up to 256 image catalog entries. Each catalog is associated with one user-specified integrated file system directory. The system-recognized identifier for the object type is *IMGCLG. Image catalogs can have the following statuses:

Ready
All of the loaded and mounted image catalog entries are available for use by the virtual storage device. The image catalog can be made ready by using the Load Image Catalog (LODIMGCLG) command with the parameter OPTION(*LOAD).

Not Ready
None of the image catalog entries in the image catalog are available for use by the virtual storage device.

You can view or change image catalogs by using the Work with Image Catalogs (WRKIMGCLG) command.

Write protection

Write protection refers to whether you have enabled the write protection switch for an image catalog entry. The statuses for write protection are as follows:

Y
Write protection is set for the image catalog entry. You cannot write to the virtual image associated with the image catalog entry.

N
Write protection is not set for the image catalog entry. You can write to the virtual image associated with the image catalog entry.

For optical use only

Note: If the access for an optical image catalog entry is *READWRITE, you set the write protection switch to Y or N. If the access for the optical image catalog entry is *READONLY, the write protection switch is always set to Y.

You can view or change image catalog entries by using the Work with Image Catalog Entries (WRKIMGCLGE) command. The WRKIMGCLGE command indicates if the image catalog is in a Ready state or a not-ready state, and you can use this command to change image catalog entries whether the image catalog is in a ready state or a not-ready state.

You can change the status of the entries by using the Load/Unload/Mount IMGCLG Entry (LODIMGCLGE) command or by typing GO IMGCLG at a command line. To change other attributes of an entry, you need to use the Change Image Catalog Entry (CHGIMGCLGE) command.

Virtual image

A virtual image is an object that contains the data that is typically on physical media. The virtual image is a stream file that resides in the integrated file system. In a backup and recovery scenario, you can also span virtual images.

Related reference

Work with Image Catalogs (WRKIMGCLG) command
Work with Catalog Entries (WRKIMGCLGE) command
Load/Unload/Mount IMGCLG Entry (LODIMGCLGE) command

Related information

Security reference

Benefits of virtual storage

Virtual storage can help eliminate media errors and user intervention and can increase system availability.

Virtual storage also provides the following advantages:

Electronic distribution

You can use virtual storage to simplify software and data distribution by creating tape, CD or DVD images on your system. You can distribute these images electronically using file transfer protocol (FTP, FTP SSL) or other electronic methods. On the system that receives the images, you can mount the images in a virtual device for easy access. You can also receive or distribute programming temporary fixes (PTFs) electronically.

Object signing

You can secure a virtual image by giving it a digital signature, IBM i provides support for using digital certificates to digitally sign objects. A digital signature on an object is created by using a form of cryptography and is like a personal signature on a written document. You need to create a digital signature to use object signing and signature verification.

CD, DVD, and tape creation

You can use virtual storage to create actual media using the DUPOPT and DUPTAP commands to duplicate the virtual images to physical media.

Related information

Object signing and signature verification

Catalog shadowing

Use catalog shadowing to create a copy of an existing image catalog.

Use the Create Image Catalog (CRTIMGCLG) command to create a copy of an image catalog. The reference image catalog contains information about images. The dependent image catalog is a copy of the reference image catalog at a single point in time when the Create Image Catalog (CRTIMGCLG) command was performed.

Use this command to create a dependent image catalog of your reference catalog:

```
CRTIMGCLG IMGCLG(dependent) DIR(*refimgclg) REFIMGCLG(reference)
```

There can be up to 35 ready dependent catalogs pointing to one reference catalog. Each of the tape reference catalogs are read-only and write accessible. However, optical reference and all dependent image catalogs are read-only and can be used for restore operations.

In order to delete the reference catalog or to delete any one image file all of the dependent image catalogs must be deleted first. The volume name for the optical dependent catalogs has a 4-character prefix. The prefix is added after the optical dependent catalog is made ready. Use the Work with Image Catalog Entries (WRKIMGCLGE) to find the optical dependent volume name.

IBM i virtual tape

IBM i virtual tape provides many enhancements to your system. It provides higher availability, shorter backup times, and additional benefits. The virtual tape images are stored in stream files on your system disk units.

The benefits of virtual tape include the following:

- Virtual tape provides improved availability over previous forms of media.
- The backup time is quicker.
- If additional volumes are needed during a backup, they are automatically created.
- Virtual tape supports multiple, simultaneous read operations from the same virtual tape volume.

Virtual tape devices can perform the same tasks as physical tape except they cannot perform the Save Storage (SAVSTG) command.

Image catalog entry for virtual tape storage

An *image catalog entry* displays information about the virtual volume within an image catalog and contains information about a virtual image located in the image catalog directory.

Examples of image catalog entry information include a file name of the virtual image, a volume identifier, the index position in the catalog, access information, write-protection information, and a text description of the image.

Possible statuses of an image catalog entry are:

Mounted
The virtual image associated with the selected image catalog entry is active or loaded in the virtual device. The mounted virtual image is specified by selecting *MOUNTED in the using volume parameter. Only one virtual tape volume can be in mounted status at a time.

Loaded
The virtual tape volume associated with the selected image catalog entry is available for use by the virtual tape device.

Unloaded
The virtual image associated with the selected image catalog entry is not available for use by the virtual tape device.

Next
This image catalog entry is the next one mounted when a command specifying a volume of *MOUNTED is issued to use the virtual tape device.

If the image catalog is in a ready state, these statuses represent the current status of the image catalog entry. If the image catalog is in a not ready state, these statuses represent what the status of the image catalog entry is when the image catalog is put in a ready state.

Volume spanning for virtual tape storage

Spanning occurs when the volumes have files that continue from one volume to the next.

When a save operation spans a volume, it pauses the save process when the current piece of media you are using runs out of space and continues the save operation on the next piece of media. In the context of backup and recovery, a volume is the media that you are using to save your data.

When you perform a save operation and span virtual images, the multivolume set of virtual images behaves just like a multivolume set of any form of actual media.

Note: Volume spanning is not supported when the virtual tape device is being used by another partition.

One advantage of using virtual storage for a backup operation is that if you have enough disk space, you can perform unattended backups without the use of a media autoloader or a media library.

Similar to actual devices, when you span volumes of virtual images, you can specify a volume list or specify *MOUNTED for the VOL parameter on all of the save commands. If you specify a volume list, the

system mounts the volumes of virtual images when they are needed. In either case, you should allow for enough volumes to complete the save operation.

If *MOUNTED is specified, the volume that is mounted is used. If there are no volumes mounted, the next loaded volume in the image catalog is mounted automatically.

If *MOUNTED is specified for a save operation, a new volume is automatically created when the end of the image catalog is reached.

If a volume list is specified for a save operation, message CPA6798 is displayed when the volume list is completed. You can provide a new volume at that time.

Note: If the new volume specified in reply to message CPA6798 does not exist or if *GEN is specified, a new volume is automatically created.

If you allow the system to create a new volume for you, the system does the following:

- Adds a *NEW volume and inserts it at position 256 in the image catalog
- Mounts the volume in the virtual device
- Continues the save

When the system creates a new volume, the system gives the new virtual image a name. The system always inserts the new virtual image in position 256 of the image catalog. The size of the new virtual image is set to 1000000 MB with Allocate Storage (ALCSTG)(*MIN). The previous volume gets moved to an earlier position.

The following table shows an example of what happens when the system adds a new volume during a save operation to an image catalog where Vol001 and Vol002 existed before starting the save operation.

Index	Volume name	Virtual image name	Volume sequence number	Size	Description
1	Vol001	File1	1	1000 MB	My Save 1
2	Vol002	File2	2	1000 MB	My Save 1
256	GEN001	GEN001	3	1 000 000 MB	Created on 31 December 2007 15:38:29

Planning for virtual tape storage
There are requirements and preparation that need to be considered when using virtual tape.

To prepare to use virtual tape storage, you need to consider these items:

- Whether you have the authority to create virtual images
- How much disk space you have

  Because virtual images are stored on your disk units, they can quickly use disk space. It is essential that you determine whether you have enough disk space. The smallest allowable size for a tape image file volume is 48 MB. The largest allowable size is 1000000 MB.

  To determine how much disk space you have, follow these steps:

  1. From IBM Navigator for i, expand **Configuration and Service** > **Disk Pools**.
  2. Right-click the **Disk Pool** you want to view, and select **Properties**.
  3. Select the **Capacity** tab. The Capacity page displays the used space, free space, total capacity, threshold, and percentage of disk space used for the disk pool.

  Note: The default value of the **Catalog ASP threshold** is set to *CALC. This value sets the maximum allowed storage threshold for virtual tape to be the greater of 95% or 5 GB of free space remaining in

the ASP. The tape operation stops with an end of media error when the maximum allowed storage threshold for virtual tape is reached.

You can also use the Work with Disk Status (WRKDSKSTS) command to determine your free space. If you need to free up disk space, follow these steps:

1. Remove any unused virtual tape volumes by using Remove Image Catalog Entry (RMVIMGCLGE) KEEP(*NO).

2. Free up any unused space within an existing virtual tape volume by using Change Image Catalog Entry (CHGIMGCLGE) Allocate Storage (ALCSTG)(*MIN), or free up any unused space within all of the virtual tape volumes within an image catalog by using CHGIMGCLG ALCSTG(*MIN).

3. Delete any unused objects.

4. Save objects by specifying STG(*FREE).

5. Save the old log versions of QHST that are not currently used and then delete them.

6. Print or delete spooled files on the system.

- The number of virtual images volumes you need

  To determine how many volumes you need, follow these steps:

  1. Determine how much data you plan to store.

  2. Determine the size of each virtual image. Determine image size based on what you plan to do with the tape image file. Keep files small if you want to electronically transfer them to another system.

- The maximum block size supported by the physical tape device that the virtual tape volume will be saved to

- That the user profile that is used to create the virtual tape volumes has its maximum storage allowed attribute set to *NOMAX

Related information

Work with Disk Status (WRKDSKSTS) command

Cleaning up disk storage space

Setting up virtual tape storage

Follow these steps to set up your virtual tape storage.

If you do not already have virtual tape device type 63B0, create one and vary it on:

```
CRTDEVTAP DEVD(TAPVRT01) RSRCNAME(*VRT)
VRYCFG CFGOBJ(TAPVRT01) CFGTYPE(*DEV) STATUS(*ON)
```

Note: You can have up to 35 virtual tape devices active at one time.

Creating a virtual device using IBM Navigator for i

To create virtual devices using IBM Navigator for i, perform the following steps:

1. In IBM Navigator for i, expand **Configuration and Service** > **All Tasks** > **Tape Devices** > **Create Virtual Device**.

2. Follow the instructions to create a virtual device.

Creating an image catalog using IBM Navigator for i

To create virtual images using IBM Navigator for i, perform the following steps:

1. In IBM Navigator for i, expand **Configuration and Service** > **All Tasks** > **Tape Devices** > **Create Image Catalog**.

2. Follow the instructions to create an image catalog.

Creating an image catalog and add volumes using the IBM i command line

The following examples show how to create an image catalog and add volumes using the **CRTIMGCLG** command.

This example shows how to create an image catalog and multiple virtual volumes with different attributes.

- ```
  CRTIMGCLG IMGCLG(CLG1) DIR('/CLG1DIR')
  TYPE(*TAP)(Create an empty tape catalog.)
  ```

- ```
  ADDIMGCLGE IMGCLG(CLG1) FROMFILE(*NEW) TOFILE(VOL001)
  IMGSIZ(5000) VOLNAM(VOL001)  (Add 1 new tape volume with a size of 5GB.)
  ```

- ```
  ADDIMGCLGE IMGCLG(CLG1) FROMFILE(*NEW) TOFILE(VOL002)
  IMGSIZ(100000) VOLNAM(VOL002)  (Add 1 new tape volume with a size of 100GB.)
  ```

This example shows how to create an image catalog and multiple virtual volumes with the same attributes.

- ```
  CRTIMGCLG IMGCLG(CLG1) DIR('/CLG1DIR') TYPE(*TAP) ADDVRTVOL(10)
  PREFIX(VOL) IMGSIZ(5000)  (Create an image catalog with 10 5GB tape volumes.)
  ```

Related concepts

Formatting of virtual tape images
The density (format) parameter limits the block size that can be written to a virtual tape volume so that the volume is compatible for duplication to your physical tape device.

Related information

Tape media
Backing up your system
Recovering your system
Create Image Catalog (CRTIMGCLG)
Preparing a tape image catalog to install software

Managing virtual tape
Learn the necessary steps to manage your virtual tape.

Perform a save operation
To save to virtual tape storage, see Virtual tape media.

Perform a restore operation
To restore from virtual tape storage, see Recovering your system.

Duplicating virtual tape to physical media
When you duplicate virtual tape volumes to physical tape devices you need to make sure that the virtual tape volumes are created using a block size that is compatible with your physical tape device. The density (format) of the virtual tape volumes is used to control the maximum size for the blocks of data on the virtual tape volume. To determine the block size that your tape device supports, see Formatting of virtual tape images.

Using volumes in dependent image catalogs
A dependent catalog provides a read-only view of the virtual tape volumes that are within a reference image catalog. For example, if an image catalog existed named JOE, then the following command would be entered on the command line to create a dependent image catalog based on image catalog JOE:

```
CRTIMGCLG IMGCLG(JOEDEP) DIR(*REFIMGCLG) TYPE(*TAP) REFIMGCLG(JOE)
```

All of the volumes in the reference image catalog (JOE) are accessible when the dependent image catalog (JOEDEP) is mounted in a separate virtual tape device. The dependent image catalogs are not synchronized with additional changes that are made to the reference image catalog. Multiple dependent image catalogs can be created all pointing to the same reference catalog. The same virtual

tape volume can be mounted in several virtual devices at the same time through the use of dependent image catalogs. This mounting procedure enables the same virtual tape volume to be used for input operations by multiple users at the same time.

A volume cannot be mounted for both read-only and read-write at the same time. A volume that is already mounted in a device by a dependent catalog cannot be mounted in a different device by a reference catalog. A volume that is already mounted in a device by a reference catalog cannot be mounted in a different device by a dependent catalog.

Using virtual tape from other partitions or iSCSI attached server

A Linux guest partition or an iSCSI attached server can use the virtual tape devices and the currently mounted volume.

The IBM i host partition must mount the virtual tape volume before it can be used by another partition or iSCSI attached server.

1. Make sure that the virtual tape device description has the Unload device at vary off parameter set to *NO.
2. Mount the virtual volume in the virtual tape device using the image catalog commands.
3. Make sure that the virtual volume density is *VRT256K.
4. Vary off the virtual tape device.

   Note: The virtual volume is still mounted.

The other partition or iSCSI attached server can now use the previously mounted virtual tape volume through the virtual I/O to the virtual tape device. The other partition or iSCSI attached server can only use the mounted volume because volume spanning is not supported.

The virtual tape device is configured as a 3580 model 002 tape device to the other partitions or iSCSI attached servers.

Note: The image catalog commands should not be used to remove or change the virtual tape volumes while they are being used by other partitions.

Additional information.

IBM i integration with servers

Integrated server through iSCSI

Using virtual tape volumes in user ASPs

1. Create a User Defined File System for the user ASP that can be made visible to the rest of the integrated file system name space.

   • CRTUDFS UDFS('*/dev/qaspXX/aspXX.udfs*'), where XX is the ASP number

2. Add a new directory to the system that will be used as the mount point directory for the User Defined File System created in step 1.

   • MKDIR DIR('*/your-path*') to make a mount point directory

3. Make the objects in the User Defined File System accessible to the integrated file system name space. The mount point directory is assigned as the first part of the path name, which is used to access the objects.

   • MOUNT TYPE(*UDFS) MFS('/dev/qaspXX/aspXX.udfs') MNTOVRDIR(*your-path*)

   Note: Anything that is created in '*/your-path*' is created in the UDFS.

4. Use the CRTIMGCLG command to create an image catalog with the mount point in the first part of the path name.

   • CRTIMGCLG IMGCLG(USERASP) DIR('*/your-path/image-directory*') TYPE(*TAP)

Note: You cannot specify only the mount-point directory when you specify a path-name with the CRTIMGCLG command. The path name must include a directory below the mount-point directory.

Using virtual tape volumes in independent disk pool

To use a virtual tape volume in an independent disk pool, specify the disk pool device name as the first part of the integrated file system path name. The independent disk pool must be varied on before the virtual tape volumes are usable.

Image files *ALWSAV attributes

When the image catalog is in ready status, all of the image catalog's images have an *ALWSAV attribute value of *NO with the CHGATR command. This does not allow the images to be saved by the Save Object (SAV) command or the QsrSave API. When the image catalog is not in ready status, all of the image catalog's images have an *ALWSAV attribute value of *YES. This allows the images to be saved.

The CHGATR command would be used to change the allow save attribute of the virtual volumes in the integrated file system.

- CHGATR OBJ('/tape/catalog1') ATR(*ALWSAV) VALUE(*NO)

Related concepts

Formatting of virtual tape images

The density (format) parameter limits the block size that can be written to a virtual tape volume so that the volume is compatible for duplication to your physical tape device.

Related information

Recovering your system

Virtual tape media

Formatting of virtual tape images

The density (format) parameter limits the block size that can be written to a virtual tape volume so that the volume is compatible for duplication to your physical tape device.

- Volumes with a density of *VRT256K use an optimum and maximum block size of 256 KB.

- Volumes with a density of *VRT240K use an optimum and maximum block size of 240 KB.

- Volumes with a density of *VRT64K use an optimum and maximum block size of 64 KB.

- Volumes with a density of *VRT32K do not use an optimum and maximum block size and are compatible with all devices.

Note: The application using the tape device controls the actual block size used when data is written to a virtual tape volume. An application can write data blocks to virtual tape volumes that are smaller than the maximum block size.

You cannot copy your virtual tape media to physical media if you choose an incompatible block size. Ensure that you pick a virtual tape density with a block size that is compatible with the physical tape devices on your system by performing one of the following:

- For tape library devices in IBM Navigator for i, expand **Configuration and Service** > **All Tasks** > **Tape Devices** > **Tape Libraries** > **Tape Resources**. Next, right-click the device that you want to view and select **Properties** to display the supported block sizes for your tape device.

- For stand-alone tape devices in IBM Navigator for i, expand **Configuration and Service** > **All Tasks** > **Tape Devices** > **Stand-Alone Devices** . Next, right-click the device that you want to view and select **Properties** to display the supported block sizes for your tape device.

- Save a small library to your physical tape drive with the USEOPTBLK parameter set to *YES. Type DSPTAP DATA(*LABELS) on a command line, and see the Block Length field for the block size that was used.

Note: The Initialize Tape (INZTAP) command makes any pre-existing data on the virtual tape volume inaccessible by the virtual tape device. The INZTAP command with the parameter CLEAR(*YES) can be used to delete any existing data in a virtual tape volume, but this should only be used if you have security concerns with the existing data because this operation can take a long time and uses significant system resources.

Related concepts

Setting up virtual tape storage
Follow these steps to set up your virtual tape storage.

Managing virtual tape
Learn the necessary steps to manage your virtual tape.

Transporting virtual images to another system
Use these instructions to move virtual images between systems.

One benefit of using virtual tape and optical storage is that you can use copies of a virtual image on more than one system. To transport a virtual image across systems, use one of the following methods:

FTP

You can transfer a virtual image across systems by using File Transfer Protocol (FTP). To use FTP, you must have TCP/IP set up and running on your system.

This example shows how to transfer a virtual tape or optical image catalog with the images to a remote IBM i system.

On the remote system, create a directory for storing the virtual images.

```
CRTDIR myimgclgdir1
```

On the local system, perform the following steps.

```
ftp REMOTESYSTEM
```

```
binary
```

```
namefmt 1
```

```
cd /myimgclgdir1   (Navigate to the directory you created on the remote system to store the
virtual images.)
```

```
lcd /myimgclgdir1   (Navigate to the directory on the local system that contains the virtual
images that you want to transfer.)
```

```
mput * *   (Transfer all of the virtual images and the image catalog file to the remote
system.)
```

When the transfer completes, use the following command on the remote system to create a new image catalog with the transferred images.

```
CRTIMGCLG IMGCLG(NEWCLG) DIR('/myimgclgdir1') TYPE(*TAP) IMPORT(*YES)
```

System i Navigator

You can use System i Navigator to transfer files between systems by dragging the file from one system to another.

You can also use Management Central to move files. Management Central is a suite of functions that make managing multiple systems as easy as managing a single system.

Independent disk pool

Use an independent disk pool to share virtual images between systems. Enter the following command on a command line to create a new image catalog to access the virtual volumes that are stored in a directory within an independent disk pool:

```
CRTIMGCLG IMGCLG(MYCATALOG) DIR('/MYIASPNAME/mycatalogdir') TYPE(*TAP) IMPORT(*YES)
```

Related information

Transferring files with File Transfer Protocol
FTP

Changing the write protection for image catalog entries for virtual tape
Use this information to change the write protection for virtual tape media.

All image catalog entries include a write-protect switch, which functions identically to the write-protect switch located on the actual media. The default setting is that the image catalog entry is not write-protected.

Note: All image catalog entries in dependent catalogs are write protected.

When you add a new image catalog entry to an image catalog, the image catalog entry is not write-protected by default. After you add an image catalog entry to an image catalog, you can change whether it is write-protected with the Change Image Catalog Entry (CHGIMGCLGE) command.

To change an image catalog entry no be write-protected, type the following command, where the image catalog name is MYCAT and the image catalog index is 3:

```
CHGIMGCLGE IMGCLG(MYCAT) IMGCLGIDX(3) WRTPTC(*YES)
```

To change an image catalog entry to be not write-protected, type the following command where the image catalog name is MYCAT and the image catalog index is 3:

```
CHGIMGCLGE IMGCLG(MYCAT) IMGCLGIDX(3) WRTPTC(*NO)
```

Using virtual images in an image catalog
Use the Load or Unload Image Catalog (LODIMGCLG) command to associate an image catalog and its images to a virtual tape device.

To use virtual images in an image catalog, enter the following command to load the image catalog in the virtual device:

```
LODIMGCLG IMGCLG(MYCATALOG) DEV(TAPVRT01)
```

Adding virtual tape volumes
Use the Add Image Catalog (ADDIMGCLGE) command to add virtual tape volumes to an image catalog.

Add existing virtual tape files to an image catalog

To add images to an image file in an image catalog directory, enter the following information into a command line:

```
ADDIMGCLGE IMGCLG(MYCATALOG) FROMFILE(vol001) TOFILE(*fromfile)
```

Repeat this step for each file in your catalog directory.

Create new virtual tape volumes

To create new virtual tape volumes, enter the following information into a command line:

```
ADDIMGCLGE IMGCLG(MYCATALOG) FROMFILE(*NEW) VOLNAM(VOL001)
```

Virtual tape storage error messages
Typically, when an error occurs with virtual tape storage, the operation stops and you receive an inquiry or escape message. The message indicates that there is something wrong with the volume being processed and provides recovery instructions. Follow the instructions to recover from the inquiry or escape message.

The most common inquiry and escape messages that occur with virtual tape storage are:

Inquiry messages

CPA4262
    Volume &5 on device &4 is write protected (C R).

CPA6745

    Volume on device &4 is write protected (C R).

CPAB8E6

    Device &1 cannot be varied off at this time.

    This message is sent when an attempt is made to vary off an independent disk pool containing a virtual volume that is in use by an active virtual tape device. The Work with ASP Jobs (WKRASPJOB) command can be used to determine which jobs are using the independent disk pool.

Escape messages

CPF415B

    Device list not correct. Multiple device descriptions cannot be specified when virtual tape is used.

CPF41B0

    Incorrect image catalog name specified.

CPF41B3

    No more volumes to mount from catalog. You specified VOL(*MOUNTED) and the last accessible virtual tape volume in the catalog was already used and unloaded.

CPF41B4

    Virtual tape volume not available. The specified volume is in unloaded status.

CPF41B5

    Virtual tape volume not found.

CPF4371

    Device not operational.

    This message is sent when an unexpected error occurs. Possible causes are:

- The virtual volume stream file was removed while in use.
- A forced vary off operation was performed on an independent ASP containing a virtual tape volume that was in use.

    It is necessary to vary the virtual tape device description off and back on with the VRYCFG command with the RESET(*YES) parameter to clear the error.

CPF4373

    End of media on device.

    This message is sent when the storage threshold of the ASP containing the virtual tape volume exceeds the maximum allowed storage for virtual tape, or when the maximum storage allowed threshold of the user profile that owns the virtual tape volume is exceeded, and additional storage cannot be allocated to continue the operation. The default maximum allowed storage for virtual tape is the greater of 95% or 5 GB of free space remaining in the ASP. The catalog ASP threshold value can be used to change the maximum allow storage.

CPF6760

    Device &1 is not ready.

    This error is reported when the requested virtual volume cannot be mounted. Typically this error occurs when the requested virtual volume is already mounted in a different virtual device through a reference or a dependent image catalog, and the mount is not allowed.

CPF67F5

    Duplicate cartridge or virtual volume name found.

To see any of these messages, type DSPMSGD CPF*xxxx* at a command line and press Enter.

Diagnostic messages

CPDBC04

    Error on command &3 during virtual tape function &2. Reason code 26.

Reason code 26 is sent when a command to mount or change a virtual volume cannot be processed because the volume is currently mounted in a device. The volume needs to be unloaded or unmounted from the device it is currently in before the command can be completed.

Note: If the virtual volume was used by another partition and left mounted, then there may not be any image catalogs that show that the volume is in a mounted status. The CHKTAP command with ENDOPT(*UNLOAD) can be used to unload the virtual tape volume.

IBM i virtual optical storage

When you use IBM i virtual optical storage, you create images that exist on your system disk units or in the network file system.

You can use virtual optical images to perform the following tasks:

- Install software such as Licensed Internal Code, program temporary fixes (PTFs), IBM i, and licensed programs
- Distribute software
- Perform backups
- Create distribution media for Central Site
- Create Save Licensed Programs media
- Copy critical data to archive media

Image catalog mode
An image catalog can be loaded into a virtual optical device in standalone or library mode. In library mode, the virtual device can be used as a virtual optical library where all images in the image catalog are available and accessible concurrently.

The image catalog mode is specified with the **LIBMODE** keyword on the **LODIMGCLG** command. **LIBMODE(*NO)** is the default setting.

For image catalogs in Ready status, the current mode can be viewed using the **WRKIMGCLG** panel and F11=View relationships. See the **WRKIMGCLG** command for additional information.

Standalone mode
When the selected image catalog is loaded in standalone mode, the virtual image in mounted status is the only virtual image in the catalog that can be seen in the virtual device by using the Work with Catalog Entries **WRKIMGCLGE** or Work with Optical Volumes **WRKOPTVOL** command.

The following command is an example of loading the image catalog into the virtual optical device in standalone mode. **LODIMGCLG IMGCLG(MYIMAGECATALOG) DEV(OPTVRT01) LIBMODE(*NO).**

Library mode
When the selected image catalog is loaded in library mode, all virtual images in the catalog that are in mounted or available status can be seen in the virtual device by using the Work with Catalog Entries **WRKIMGCLGE** or Work with Optical Volumes **WRKOPTVOL** command.

The following command is an example of loading the image catalog into the virtual optical device in library mode. **LODIMGCLG IMGCLG(MYIMAGECATALOG) DEV(OPTVRT01) LIBMODE(*YES)**

Loading an image catalog into a virtual optical device in library mode requires an IBM Lab Services offering. See the optical storage website for more information about using optical image catalogs in library mode as a media library.

Image catalog entry for virtual optical storage
An image catalog entry is a position within an image catalog that contains information about a virtual image that is located in the image catalog directory.

Examples of image catalog entry information include a file name of the virtual image, a volume identifier, the index position in the catalog, access information, write-protection information, and a text description of the image.

The following are the possible statuses of an image catalog entry. The image catalog is in ready state when it is loaded into a virtual optical device. If the image catalog is in a ready state, these statuses represent the current status of the image catalog entry. If the image catalog is in a not-ready state, these statuses represent what the status of the image catalog entry will be when the image catalog is put in a ready state. There are exceptions for the loaded status and available status noted in the following descriptions.

Mounted
The virtual image associated with the selected image catalog entry is active or loaded in the active virtual device. When the selected image catalog is in stand-alone mode, the mounted virtual image is the only virtual image in the catalog that can be seen in the virtual device by using the Work with Catalog Entries (WRKIMGCLGE) or Work with Optical Volumes (WRKOPTVOL) commands. When the selected image catalog is in library mode, the mounted virtual image and other images in the catalog can be seen in the virtual device. Only one virtual image can be in mounted status at a time. The mounted virtual image can also back a virtual optical device in a client IBM i partition.

Available
The virtual image associated with the selected image catalog entry is active or loaded in the selected virtual optical device. The virtual image and other images in the catalog can be seen in the virtual device by using the Work with Catalog Entries (WRKIMGCLGE) or Work with Optical Volumes (WRKOPTVOL) commands. This status is associated with entries in an image catalog that is loaded in library mode. Images are in available status when the catalog is in ready state, and change to loaded status if the image catalog is unloaded.

Loaded
The virtual image associated with the selected image catalog entry is active or loaded in the selected virtual optical device. The virtual image cannot be seen in the virtual device, but is available to the device. Images are in loaded status when the catalog is in a not-ready state, and change to available status if the catalog is loaded in library mode.

Unloaded
The virtual image associated with the selected image catalog entry is not active or not loaded in the active virtual optical device. Only image catalog entries with a status of mounted, available, or loaded can be accessed through the virtual optical device.

Access
Access refers to whether an image catalog entry is read-only or if it is also writable.

With respect to access, an image catalog entry can have the following statuses:

*READONLY
The virtual image associated with the image catalog entry is read-only.

*READWRITE
You can both read and write to the virtual image associated with the image catalog.

*UNKNOWN
The access information for the virtual volume that is associated with the image catalog entry is unknown.

Volume spanning for virtual optical storage
When a save operation spans a volume, it pauses the save process when the current piece of media you are using runs out of space and it continues the save operation on the next piece of media. In the context of backup and recovery, a volume is the media that you are using to save your data. Spanning occurs when the volumes have files that continue from one volume to the next.

When you perform a save operation and span virtual images, the multivolume set of virtual images behaves just like a multivolume set of any form of actual media.

One advantage of using virtual storage for a backup operation is that if you have enough disk space, you can perform unattended backups without the use of a media autoloader or a media library.

Similar to actual devices, when you span volumes of virtual images, you can specify a volume list or specify *MOUNTED for the VOL parameter on all of the save commands. If you specify a volume list, the

system mounts the volumes of virtual images when they are needed. If you specify *MOUNTED, you must have the virtual images mounted when you start the command. In either case, you must provide enough volumes to complete the save operation.

Whether you specify *MOUNTED or a volume list, if you do not provide enough volumes to complete the save operation, the system sends you inquiry message OPT149F Load next volume on optical device &1. Inquiry message OPT149F provides you with the following options:

- Cancel the operation
- Allow the system to create a new volume for you
- Pause the operation and create a new volume manually

If you allow the system to create a new volume for you, the system does the following:

- Adds a *NEW volume and inserts it at position 256 in the image catalog
- Mounts the volume in the virtual device
- Initializes the new volume
- Continues the save operation

When the system creates a new volume, the system gives the new virtual image a name. The system uses a time stamp for the volume ID. The image name is a combination of the volume ID and the volume sequence number. The system inserts the new virtual image in position 256 of the image catalog. The size of the new virtual image is the same as the previous virtual image.

The following table shows an example of what happens when the system adds two new volumes during the save operation to an image catalog where volume 2 existed before starting the save operation.

Index	Volume ID	Virtual image name	Volume sequence number	Size	Description
1	Volume1	File1	1	1300 MB	My Save 1
2	Volume2	File2	2	650 MB	My Save 1
253	030311124115	030311124115 0003	3	650 MB	SET ID VOLUME1 SEQ 0003
254	030311124330	030311125532 0004	4	650 MB	SET ID VOLUME1 SEQ 0004
255	030311124545	030311125645 0005	5	650 MB	SET ID VOLUME1 SEQ 0005
256	030311124801	030311124801 0006	6	650 MB	SET ID VOLUME1 SEQ 0006

Consideration for full backups

If you are doing a full backup, with the Save System (SAVSYS) command for example, the first volume must be least 1489 MB. The first volume must be at least 1489 MB because the first volume must be large enough to save the Licensed Internal Code. The remaining volumes can be smaller than 1489 MB.

Limitations of virtual optical storage

You can use virtual optical storage for all operations that can write to actual media with the following exceptions.

Main storage dump in SST and DST
> System service tools (SST) and dedicated services tools (DST) provide the capability to perform a main storage dump to media. You cannot use virtual optical storage for a main storage dump to media.

Save Licensed Internal Code
> The Save Licensed Internal Code function is only available at the Initial Program Load (IPL) display or at the Install the Operating System display. Because the integrated file system is not available when these functions are used, the virtual optical device will not have any loaded media.

PTFs
> If you build a custom fix package and save it to a virtual image, you cannot span volumes. Your custom fix package must fit on one volume.

IBM Integrated System x for IBM i
> Integrated System x hardware does not support write operations to virtual images.

Backup and recovery
> You only perform a restore operation from virtual images if the system is already up and running. Installations done by using an image catalog require a command line to start an installation.

Related information

Custom fix package

Formatting of virtual optical images

For virtual optical, images are available in International Standards Organization (ISO) 9660 format, Universal Disk Format (UDF), and High Performance Optical File System (HPOFS) format.

ISO 9660

If a virtual image is in ISO 9660 format, it is read-only. Also, you cannot span virtual images that are in ISO 9660 format.

UDF

The virtual image is in UDF if you do one of the following:

- Create a virtual image by specifying FROMFILE(*NEW) on the Add Image Catalog Entry (ADDIMGCLGE) command and initialize the associated volume to UDF using the Initialize Optical (INZOPT) command.
- Create a virtual image from a device containing a CD or DVD formatted with UDF.
- Create a virtual image by specifying FROMDEV(*VOL) and VOL(volume ID of a physical volume that is formatted with UDF) using the Add Image Catalog Entry (ADDIMGCLGE) command.

HPOFS

The virtual image is in HPOFS if you do one of the following:

- Create a virtual image by specifying FROMFILE(*VOL) and VOL(volume ID of a physical volume that is formatted with HPOFS) on the Add Image Catalog Entry (ADDIMGCLGE) command.
- Create a virtual image by specifying FROMFILE(*NEW) on the Add Image Catalog Entry (ADDIMGCLGE) command and initialize the associated volume to HPOFS using the Initialize Optical (INZOPT) command.

Typically, you specify FROMFILE(*NEW) when you plan to save to a virtual image or plan to use a virtual image to distribute software. You can also span virtual images that are in UDF.

You can also specify FROMFILE(*NEW) when creating virtual images of media type WORM or ERASE for use in a library mode Image Catalog for archive applications.

If you want to create actual media from a virtual image that was created specifying FROMFILE(*NEW), you can send the virtual image to a PC or you can use the Duplicate Optical (DUPOPT) command to copy the virtual image directly to a DVD drive on your system.

Preparing for virtual optical storage
There are specific requirements that must be met when preparing and using virtual optical storage.

To prepare to use virtual optical storage, you need to consider these items:

- Whether you have the authority to create virtual images

  You must have security administrator (*SECADM) and all object (*ALLOBJ) special authorities to use the commands required to create virtual images.

- The amount of disk space available

  Because virtual images are stored on your disk units, they can quickly use disk space. You have to determine whether you have enough disk space. The smallest allowable size for an optical image file volume is 48 MB. The largest allowable size is 1 TB.

  To determine how much disk space you have, follow these steps:

  1. From IBM Navigator for i, expand **Configuration and Service** > **Disk Pools**.
  2. Right-click the disk pool you want to view, and select **Properties**.
  3. Select the Capacity page.

  The Capacity page displays the used space, free space, total capacity, threshold, and percentage of disk space that is used for the disk pool.

  You can also use the Work with Disk Status (WRKDSKSTS) command to determine your free space.

- The number of volumes of virtual images that you need

  To determine how many volumes you need, follow these steps:

  1. Determine how much data you plan to store.
  2. Determine the size of each virtual image. You can determine the size based on what you want to do with the optical image file. For example, if you copy the optical image files to a CD, the largest you can make the volumes is 650 MB.
  3. Divide the amount of data you are going to store by the size of your volumes. For example, if you plan to save 1 GB of data and you want to copy your volumes to a CD, you must create two volumes.

If you are doing a full backup, the first volume must be at least 1489 MB because the first volume must be large enough to store the Licensed Internal Code. The remaining volumes can be smaller than 1489 MB.

Related reference
Work with Disk Status (WRKDSKSTS) command
Related information
Security reference

Setting up virtual optical storage
Follow these instructions to set up virtual optical storage.

- To create virtual optical storage, take the following steps.

  1. Create the image catalog:

     ```
     CRTIMGCLG IMGCLG(MYCATALOG) DIR('/MYCATALOGDIRECTORY')
     ```

  2. Add the image from physical media or from image files that are received from another system. If you are adding a new blank image, type the following command:

     ```
     ADDIMGCLGE IMGCLG(MYCATALOG) FROMFILE(*NEW) TOFILE(NEWIMAGEFILE) IMGSIZ(16000)
     ```

     Repeat this step for each optical disk needed.

3. If you do not already have virtual optical device type 632B, create one and vary it on:

```
CRTDEVOPT DEVD(OPTVRT01) RSRCNAME(*VRT)
VRYCFG CFGOBJ(OPTVRT01) CFGTYPE(*DEV) STATUS(*ON)
```

4. Load the image catalog in the virtual device:

```
LODIMGCLG IMGCLG(MYCATALOG) DEV(OPTVRT01)
```

5. Initialize the virtual image:

```
INZOPT NEWVOL(MYVOLUMEID) DEV(OPTVRT01) CHECK(*NO) TEXT(MYTEXTDESCRIPTION)
```

- To create virtual storage from physical media in an optical device or from images that are received from another system, take the following steps.

  1. Create the image catalog:

  ```
  CRTIMGCLG IMGCLG(MYCATALOG) DIR('/MYCATALOGDIRECTORY') CRTDIR(*YES)
  ```

  2. Add the image from physical media or from image files that are received from another system.

     - To add images from physical media:

     ```
     ADDIMGCLGE IMGCLG(MYCATALOG) FROMDEV(OPTXX) TOFILE(*fromfile)
     ```

     Repeat for each optical disk.

     - To add images from an image file:

     ```
     ADDIMGCLGE IMGCLG(MYCATALOG) FROMFILE(SLIC_N) TOFILE(*fromfile)
     ```

     Repeat this step for each file in your catalog directory. This step assumes that your image is already in the image catalog directory. RMS media cannot be added to an image catalog because the physical sector size is incompatible with virtual media.

  3. Create and vary on the virtual device:

  ```
  CRTDEVOPT DEVD(OPTVRT01) RSRCNAME(*VRT)
  VRYCFG CFGOBJ(OPTVRT01) CFGTYPE(*DEV) STATUS(*ON)
  ```

  4. Load the image catalog in the virtual device:

  ```
  LODIMGCLG IMGCLG(MYCATALOG) DEV(OPTVRT01)
  ```

- To create virtual storage from physical media in an optical library device or by volume identifier, take the following steps.

  1. Create the image catalog:

  ```
  CRTIMGCLG IMGCLG(MYCATALOG) DIR('/MYCATALOGDIRECTORY') CRTDIR(*YES)
  ```

  2. Add the image from physical media specifying the volume identifier:

  ```
  ADDIMGCLGE IMGCLG(MYCATALOG) FROMDEV(*VOL) VOL(volumeidxx)
  ```

  Repeat this step for each optical volume.

  3. Create and vary on the virtual device

  ```
  CRTDEVOPT DEVD(OPTVRT01) RSRCNAME(*VRT)
  VRYCFG CFGOBJ(OPTVRT01) CFGTYPE(*DEV) STATUS(*ON)
  ```

  4. Load the image catalog in the virtual device:

  ```
  LODIMGCLG IMGCLG(MYCATALOG) DEV(OPTVRT01)
  ```

This usage of create virtual storage is typically used when optical library volumes are being migrated to virtual images. Upon completion of the **ADDIMGCLGE** from optical library media, the characters ""M_" is added to the beginning of the optical library volume identifier to indicate that the volume has been migrated. Adding the characters helps to avoid a duplicate volume name between the new virtual volume and the optical library volume.

- To create a library mode image catalog with Write Once Read Many (WORM) media, Erasable media, or RAM media for archive storage, take the following steps.

  1. Create the image catalog:

     ```
     CRTIMGCLG IMGCLG(MYLIBCATALOG) DIR('/MYLIBCATALOGDIRECTORY') CRTDIR(*YES)
     ```

  2. Add a new blank image of media type *WORM, *ERASE, or *RAM.

     ```
     ADDIMGCLGE IMGCLG(MYLIBCATALOG) FROMFILE(*NEW) TOFILE(MYIMAGEFILE1) MEDTYPE(*WORM)
     IMGSIZ(*DVD2600)
     ```

     or

     ```
     ADDIMGCLGE IMGCLG(MYLIBCATALOG) FROMFILE(*NEW) TOFILE(MYIMAGEFILE1) MEDTYPE(*ERASE)
     IMGSIZ(*DVD2600)
     ```

     or

     ```
     ADDIMGCLGE IMGCLG(MYLIBCATALOG) FROMFILE(*NEW) TOFILE(MYIMAGEFILE1) MEDTYPE(*RAM)
     IMGSIZ(*DVD2600)
     ```

     Repeat this step for each new optical media needed.

  3. Create and vary on the virtual device:

     ```
     CRTDEVOPT DEVD(OPTVRT01) RSRCNAME(*VRT)
     VRYCFG CFGOBJ(OPTVRT01) CFGTYPE(*DEV) STATUS(*ON)
     ```

  4. Load the image catalog in the virtual device in library mode:

     ```
     LODIMGCLG IMGCLG(MYLIBCATALOG) DEV(OPTVRT01) LIBMODE(*YES)
     ```

- To install upgrades from an image catalog, take the following steps.

  1. Create the image catalog:

     ```
     CRTIMGCLG IMGCLG(MYCATALOG) DIR('/MYCATALOGDIRECTORY')
     ```

  2. Add the image from physical media or from image files that are received from another system:

     - To add images from physical media:

       ```
       ADDIMGCLGE IMGCLG(MYCATALOG) FROMDEV(OPTXX) TOFILE(*fromfile)
       ```

       Repeat this step for each optical disk.

     - To add all images into the image catalog automatically:

       This step assumes that the images exist in the image catalog directory. This command can be useful for adding images that were downloaded from ESD.

       Ensure one of the following PTFs is applied.

       - If the current Operating system is V6R1 – SI40473
       - If the current Operating system is V7R1 – SI40971

       Call the Fill Image Catalog API to automatically add all files into your image catalog.

       ```
       CALL PGM(QVOIFIMG) PARM('MYCATALOG'  '*ALL'  0)
       ```

  3. Create and vary on the virtual device:

```
CRTDEVOPT DEVD(OPTVRT01) RSRCNAME(*VRT)
VRYCFG CFGOBJ(OPTVRT01) CFGTYPE(*DEV) STATUS(*ON)
```

4. Load the image catalog in the virtual device:

```
LODIMGCLG IMGCLG(MYCATALOG) DEV(OPTVRT01)
```

5. Verify the catalog:

```
VFYIMGCLG IMGCLG(MYCATALOG) TYPE(*UPGRADE) SORT(*YES)
```

For the verification operation, the following items are required:

– Licensed Internal Code for IBM i
– IBM i operating system
– IBM i - Library QGPL
– IBM i - Library QUSRSYS

6. Start the installation:

```
PWRDWNSYS OPTION(*IMMED) RESTART(*YES) IPLSRC(*IMGCLG) IMGCLG(MYCATALOG)
```

Note: Before you issue the **PWRDWNSYS** command to start an upgrade from the image catalog, review the Installing, upgrading, or deleting IBM i and related software topic and complete the appropriate planning and preparation tasks.

Related information
Distributing software
Virtual optical media
Backing up your system
Recovering your system

Managing virtual optical storage
Manage your virtual optical storage using the provided information.

Installing or replacing software
To install or replace software using virtual optical storage, see Preparing to upgrade or replace software using an image catalog.

Distributing software
To set up virtual optical storage for software distribution, see Preparing the central system for virtual images.

Installing fixes
To install fixes with virtual optical storage, see Installing fixes from an image catalog.

Performing a save operations
To save files to virtual optical storage, see Virtual tape media.

Note: When the image catalog is in ready status, all images in the catalog have an *ALWSAV attribute value of *NO. This does not allow the images to be saved by the Save Object (SAV) command or the QsrSave API. When the image catalog is not in ready status, all images in the catalog have an *ALWSAV attribute value of *YES. This allows the images to be saved.

Performing a restore operation
To restore files from virtual images, see Recovering your system.

Related information
Preparing to upgrade or replace software using an image catalog
Preparing the central system for virtual images
Installing fixes from an image catalog
Virtual tape media
Recovering your system

Changing the write protection for image catalog entries for virtual optical media
Use this information to change the access-mode for virtual optical media.

All image catalog entries include a write-protect switch, which functions identically to the write-protect switch located on the actual media. The initial position of this switch is on for read-only media and off for writable media. Virtual images in International Standards Organization (ISO) 9660 format are read-only while media in Universal Disk Format (UDF) can be writable or read-only.

When you add a new image catalog entry to an image catalog, the image catalog entry is not write-protected by default. After you add an image catalog entry to an image catalog, you can change whether it is write-protected with the Change Image Catalog Entry (CHGIMGCLGE) command.

To change an image catalog entry to be write-protected, type the following command, where the image catalog name is MYCAT and the image catalog index is 3:

```
        CHGIMGCLGE IMGCLG(MYCAT) IMGCLGIDX(3) WRTPTC(*YES)
```

To change a write-protected image catalog entry's write-protection status to not write-protected, type the following command where the image catalog name is MYCAT and the image catalog index is 3:

```
        CHGIMGCLGE IMGCLG(MYCAT) IMGCLGIDX(3) WRTPTC(*NO)
```

Creating actual media from a virtual image
Use these instructions to copy a virtual image to an optical disk.

One of the advantages to using virtual optical storage is that you can copy virtual images to actual media. If you plan to copy your virtual images to actual media, you must ensure that they are the correct format and the correct size.

The possible values for the Image size (IMGSIZ) parameter of the Add Image Catalog Entry (ADDIMGCLGE) command follows:

*CD650
   The size of the virtual image is 650 MB. Images created with this size can be written to any standard 650 MB media or larger.

*DVD2600
   The size of the virtual image is 2.6 GB. Images created with this size can be written to any 2.6 GB media.

*DVD4700
   The size of the virtual image is 4.7 GB. Images created with this size can be written to any 4.7 GB media.

Optical image files
   Images can be written to media ranging from 48-1000000 megabytes

Tape image files
   Images can be written to media ranging from 48-1000000 megabytes.

When you create a virtual image of media type *RAM, the image is a byte image. The system creates no headers in the image and uses no compression. When you create a virtual image of media type *WORM or *ERASE, the image is a byte image with a header added at the beginning.

A virtual image can be in one of three formats, ISO 9660, Universal Disk Format (UDF), and High Performance Optical File System (HPOFS). You can only use a virtual image in UDF or HPOFS to create actual media.

Creating actual media using a PC

To create actual media using a PC, you must use a method, such as File Transfer Protocol (FTP) or IBM Navigator for i to move the file to a PC that has software with image burning capability.

To create actual media, follow these steps:

 1. Move the image file to your PC.

To use FTP to move the image file to your PC, see [Transferring files with FTP](#).

To use IBM Navigator for i to move the image file, follow these steps:

  a. From IBM Navigator for i, expand **File systems** > **Integrated File System**.

  b. Navigate to the directory with your virtual image.

  c. Right-click the image and select **Download** to download the image file to your PC.

2. Use image burning software on your PC to burn the image to a CD or DVD. It is recommended that you use disk-at-once mode rather than track-at-once mode or session-at-once mode.

Creating actual media using the DVD drive on your system

You can use the Duplicate Optical (DUPOPT) command to create actual media from a virtual image. The target media can be DVD-RAM if you have a DVD-RAM drive on your system, or if you have a drive capable of recording you can create a recorded image. Use the Display Device Description (DSPDEVD) command to display the media types that can be recorded by the drive. If the media type of the virtual image is *WORM or *ERASE, the DUPOPT operation can only be used to create a recorded image. The target media cannot be DVDRAM media.

The size of your virtual image must be the same size or smaller than your media.

To create actual media, follow these steps:

1. Vary on your virtual optical device by typing the following command:

```
VRYCFG CFGOBJ(virtual-device-name) CFGTYPE(*DEV) STATUS(*ON)
```

2. Load your image catalog by typing the following command:

```
LODIMGCLG IMGCLG(catalog-name) DEV(virtual-device-name) OPTION(* LOAD)
```

3. Type WRKIMGCLGE (the Work with Image Catalog Entry command) to ensure that your image catalog entry is loaded and mounted. If it is not, follow these steps:

  a. If the image catalog entry is not loaded, type 8(LOAD) and press Enter.

  b. If the image catalog entry is not mounted, type 6(MOUNT) and press Enter.

4. Vary on your DVD-RAM drive by typing the following command:

```
VRYCFG CFGOBJ(DVD-device-name) CFGTYPE(*DEV) STATUS(*ON)
```

5. Verify that your media is loaded in your DVD device.

6. Duplicate the virtual image to the DVD by typing the following command.

```
DUPOPT   FROMVOL(*MOUNTED)  TOVOL(*MOUNTED)  NEWVOL(*FROMVOL)
         CLEAR(*YES)  FROMDEV(virtual-device-name)  TODEV(DVD-device-name)TOENDOPT(*UNLOAD)
```

Copying a virtual volume to an actual media using an optical library drive on your system

You can use the Duplicate Optical (DUPOPT) command to copy a virtual volume of type *WORM or *ERASE to an identical physical volume in your optical library.

Your virtual image must have been created previously using ADDIMGCLGE FROMDEV(*VOL) VOL(target volume id), where the target volume id identifies the physical volume that the virtual volume is copied to.

To copy the virtual volume to physical optical library media, follow these steps:

1. Vary on your virtual optical device by typing the following command:

```
VRYCFG CFGOBJ(virtual-device-name) CFGTYPE(*DEV) STATUS(*ON)
```

2. Load your image catalog by typing the following command:

```
LODIMGCLG IMGCLG(catalog-name) DEV(virtual-device-name) OPTION(* LOAD)
```

3. Type `WRKIMGCLGE` (the Work with Image Catalog Entry command) to ensure that your image catalog entry is loaded and mounted. If it is not, follow these steps:

    a. If the image catalog entry is not loaded, type `8` (`LOAD`) and press Enter.

    b. If the image catalog entry is not mounted, type `6` (`MOUNT`) and press Enter.

4. Vary on your optical library by typing the following command:

```
VRYCFG CFGOBJ(optical-library-device-name) CFGTYPE(*DEV) STATUS(*ON)
```

5. Duplicate the virtual image to the physical volume by typing the following command.

```
DUPOPT   FROMVOL(*MOUNTED)  TOVOL(*MOUNTED)  NEWVOL(*FROMVOL) CLEAR(*YES)
```

Transporting virtual images to another system
Use these instructions to move virtual images among different systems.

One benefit of using virtual tape and optical storage is that you can use copies of a virtual image on more than one system. To transport a virtual image to another system, use one of the following methods:

FTP
You can transfer a virtual image from one system to another by using File Transfer Protocol (FTP). To use FTP, you must have TCP/IP set up and running on your system.

This example shows how to transfer a virtual tape or optical image catalog with the images to a remote IBM i system.

On the remote system, create a directory for storing the virtual images.

```
CRTDIR myimgclgdir1
```

On the local system, perform the following steps.

```
ftp REMOTESYSTEM
```

```
binary
```

```
namefmt 1
```

```
cd /myimgclgdir1   (Navigate to the directory you created on the remote system to store the
virtual images.)
```

```
lcd /myimgclgdir1   (Navigate to the directory on the local system that contains the virtual
images that you want to transfer.)
```

```
mput * *    (Transfer all of the virtual images and the image catalog file to the remote
system.)
```

When the transfer completes, use the following command on the remote system to create a new image catalog with the transferred images.

```
CRTIMGCLG IMGCLG(NEWCLG) DIR('/myimgclgdir1') TYPE(*OPT) IMPORT(*YES)
```

System i Navigator
You can use System i Navigator to transfer files between systems by dragging the file from one system to another.

You can also use Management Central in System i Navigator to move files. Management Central is a suite of systems management functions that make managing multiple systems as easy as managing a single system. For instructions on moving a file with Management Central, see Packaging and sending objects with Management Central.

Independent disk pool

Use an independent disk pool to share virtual images between systems. Enter the following command in the command line to create a new image catalog to access the virtual volumes stored in a directory within an independent disk pool.

```
CRTIMGCLG IMGCLG(MYCATALOG) DIR('/IASP33/MYCATALOGDIRECTORY') TYPE(*OPT) IMPORT(*YES)
```

QFilesvr.400

The IBM i File Server file system (QFileSvr.400) is an integrated file system that provides transparent access to other file systems that reside on remote systems. The QFileSvr.400 size limit is dependent on the underlying file system in IFS.

Related information

FTP

Transferring files with FTP

i5/OS File Server file system (QFileSvr.400)

Virtual optical storage error messages

Typically, when an error occurs with virtual optical storage, the operation stops and you receive an inquiry or escape message. The message indicates that there is something wrong with the volume being processed and provides recovery instructions. Follow the instructions to recover from the inquiry or escape message.

The following is a list of the most common inquiry and escape messages that occur with virtual optical storage.

Inquiry messages

OPT1260 - Active file found on volume &1.

OPT1314 - Volume is write-protected or read-only.

OPT1321 - Error occurred processing volume &2.

OPT1486 - Load next volume on optical device &1.

OPT1487 - Load volume &2 on optical device &1.

OPT1488 - Volume &2 on optical device &1 is not initialized.

OPT1495 - Volume name list exhausted on device &1.

OPT1496 - Load volume with sequence number &5 on device &1.

OPT149B - Load volume with correct starting volume on device &1.

OPT149C - Load volume with correct continued file on device &1.

OPT149D - Optical volume is part of an existing volume set.

OPT149E - Found unexpected volume on device &1.

OPT149F - Load next volume on optical device &1.

OPT1503 - Optical volume contains active files.

OPT1504 - Optical device &1 is empty.

Escape messages

OPT1390 - Error with virtual volume image.

OPT1605 - Media or device error occurred.

To see any of these messages, type: DSPMSGD OPT*xxxx* at a command line and press Enter.

Virtual optical storage using the Network File System

The virtual optical device support of IBM i provides a method for using virtual optical images from a single image source that can be shared with other systems in a network.

A client with a virtual optical device type 632B model 003 can access images located on a server using the Network File System (NFS). In previous releases, it existed in a local system integrated file system directory. This device can be used to install and upgrade IBM i, distribute licensed programs, PTFs, or user data.

Requirements for virtual optical storage within a Network File System network
To share virtual optical images with the Network File System (NFS) network, you need to ensure that the client and server meet specific requirements.

Server requirements for sharing virtual optical images

To share virtual optical images through a network, the server must meet the following requirements:

- The server must be able to share virtual optical images using version 3 or later of the Network File System (NFS).
- A volume list (VOLUME_LIST) file containing the list of images to be loaded in the virtual optical device must exist in the image catalog directory. The VFYIMGCLG command is used to create the volume list file from the image catalog containing the images you want to share. Following is an example of the command:
  - VFYIMGCLG IMGCLG(PUBS) TYPE(*OTHER) NFSSHR(*YES)

  Note: The image catalog used must have an image catalog path name that is limited to 127 characters. Path name characters are limited to A-Z, a-z, 0-9, and / (slash). Each image file name is limited to 127 characters.

- A volume list has the following characteristics:
  - Must be called VOLUME_LIST
  - Each line is either an image file name or a comment
  - ASCII format
  - All entries are ended by the end of a line.
  - All characters following the pound sign '#' are considered comments until the end of the line
  - Comments can be added after # and must be followed by a EOL character
  - Provides the order that the image files will be processed on the client system
  - File names are limited to 127 characters
  - Can be created with the Verify Image Catalog Entry (VFYIMGCLG) with the NFSSHR(*YES) parameter or manually by using a ASCII editor
  - No tabs or line feeds can be used in the path name

Note: Changes to VOLUME_LIST file are not active until the next time the client device is varied off/on.

Client system requirements for sharing virtual optical images

To share virtual optical images through a network, the client system must meet the following requirements:

The 632B-003 optical device is created by using the Create Device Description Optical (CRTDEVOPT) command. The client must meet the following requirements.

- Either a service tools server or a LAN console connection must be configured
- The Internet Protocol (IP) must be Version 4
- Trivial File Transfer Protocol (TFTP) is required for installation and upgrade of IBM i

Refer to Preparing your console for software installation for more information.

Related tasks
Setting up the server to share virtual optical image files with the client system
The following directions show how to set up the server to share virtual optical image files with the client system. These steps are only for IBM i.

Setting up the server to share virtual optical image files with the client system for installation and upgrade

The following directions show how to set up the server to share virtual optical image files with the client system for installation and upgrade of IBM i.

Related information

Configuring the service tools server

Setting up a virtual optical device within a Network File System network
A virtual optical device can be used to distribute licensed programs, PTFs, or user data from a server to a client system.

Setting up the server to share virtual optical image files with the client system
The following directions show how to set up the server to share virtual optical image files with the client system. These steps are only for IBM i.

1. You must have previously creating an image catalog containing the images that you want to share. The image catalog used must have an image catalog path name of 127 characters or less. Path name characters are limited to A-Z, a-z, 0-9, and / (slash). Each image file name is limited to 127 characters.
2. After the image catalog has been created and loaded, you'll need to verify the image catalog to create a volume list file (VOLUME_LIST) that will be used by the virtual optical device on the client system. The following command is an example of how to create the volume list file:

   - VFYIMGCLG IMGCLG(PUBS) TYPE(*OTHER) NFSSHR(*YES)

   The volume list file can also be created by using an ASCII editor. There are specific guidelines that must be met when creating a volume. Refer to Requirements for virtual optical storage within a Network File System network for more information.
3. Ensure that the NFS file servers are running.

   Enter either one of the following Start Network File System Server (STRNFSSVR) commands:

   - Run all of these commands on your servers:

     – STRNFSSVR *RPC
     – STRNFSSVR *SVR
     – STRNFSSVR *MNT

   - Or start all of the servers with this command:

         STRNFSSVR *ALL
4. Export the image catalog directory.

   This example restricts access by all NFS clients because it is read-only. Ensure that the exported directory is in the public directory and that it is a subdirectory of the NFSROOT path.

   - CHGNFSEXP OPTIONS('-i -o ro') DIR('*directory-name*')
5. Specify the level of authority for the user id (UID), group id (GID), or *PUBLIC that owns or manages the image catalog directory and the image files. The minimum authority that is required is the following:

   - Execute (*X) data authority for the exported directory and any subdirectories
   - Read (*R) data authority for files in the exported directory and any subdirectories.

   The following example is for the use of the *PUBLIC authority:

   ```
   CHGAUT OBJ('/catalog_directory') USER(*PUBLIC) DTAAUT(*RX) SUBTREE(*ALL)
   ```

Note: The fully exported image catalog directory name is limited to 127 characters. The directory path name may only contain characters A-Z, a-z, 0-9, and / (slash).

Refer to the IBM i Network File System Support PDF for additional details.

Related concepts

Requirements for virtual optical storage within a Network File System network

To share virtual optical images with the Network File System (NFS) network, you need to ensure that the client and server meet specific requirements.

Related tasks

Setting up the virtual optical device on the client system
After you set up the Network File System server to share images, proceed with these steps to set up virtual optical device on the client.

Related information

i5/OS Network File System Support PDF

Setting up the server to share virtual optical image files with the client system for installation and upgrade
The following directions show how to set up the server to share virtual optical image files with the client system for installation and upgrade of IBM i.

1. You must have previously created an image catalog containing the images that you want to share. The images must contain Licensed Internal Code and base IBM i (which includes libraries QSYS, QGPL, and QUSRSYS). The image catalog used must have an image catalog path name of 127 characters or less. Path name characters are limited to A-Z, a-z, 0-9, and / (slash). Each image file name is limited to 127 characters.

2. After the image catalog has been created and loaded, you need to verify the image catalog to create a volume list file (VOLUME_LIST) that will be used by the virtual optical device on the client system. The following command is an example of how to create the volume list file:

   • VFYIMGCLG IMGCLG(INSTALL) TYPE(*UPGRADE) NFSSHR(*YES)

   Note: The VFYIMGCLG command creates the volume list file and adds a new subdirectory called BOOTP in the image catalog directory. The subdirectory contains files required to perform the IBM i install.

   The volume list file can also be created by using an ASCII editor. There are specific guidelines that must be met when creating a volume. Refer to Requirements for virtual optical storage within a Network File System network for more information.

3. Ensure that the NFS file servers are running.

   Enter either one of the following Start Network File System Server (STRNFSSVR) commands:

   • Run all these commands on your servers:

     – STRNFSSVR *RPC
     – STRNFSSVR *SVR
     – STRNFSSVR *MNT

   • Or start all the servers with this command:

     STRNFSSVR *ALL

4. Export the image catalog directory.

   This example restricts access by all NFS clients because it is read-only. Ensure that the exported directory is in the public directory and that it is a subdirectory of the NFSROOT path.

   • CHGNFSEXP OPTIONS('-i -o ro') DIR('*directory-name*')

5. Specify the level of authority for the user id (UID), group id (GID), or *PUBLIC that owns or manages the image catalog directory and the image files. The minimum authority that is required is the following:

   • Execute (*X) data authority for the exported directory and any subdirectories
   • Read (*R) data authority for files in the exported directory and any subdirectories.

   The following example is for the use of the authority *PUBLIC:

   ```
   CHGAUT OBJ('/catalog_directory') USER(*PUBLIC) DTAAUT(*RX) SUBTREE(*ALL)
   ```

6. Add the /CATALOG_DIR/BOOTP directory as the Trivial File Transfer Protocol (TFTP) alternate source directory by using CHGTFTPA command:
   - CHGTFTPA AUTOSTART(*YES) ALTSRCDIR('/catalog_directory/BOOTP')
7. Ensure QTFTP has *RX authority to all install files located in the TFTP alternate source directory:
   - CHGAUT OBJ('/catalog_directory/BOOTP') USER(QTFTP) DTAAUT(*RX) SUBTREE(*ALL)
8. Ensure that the TFTP servers are started and reflect the previous changes made by stopping/starting the servers:
   - ENDTCPSVR *TFTP
   - STRTCPSVR *TFTP

Note: The fully exported image catalog directory name is limited to 127 characters. The directory path name can only contain characters A-Z, a-z, 0-9, and / (slash).

More supporting details can be found in IBM i Network Install using network File System.

Refer to theIBM i Network File System Support PDF for additional details.

Related concepts
Requirements for virtual optical storage within a Network File System network
To share virtual optical images with the Network File System (NFS) network, you need to ensure that the client and server meet specific requirements.

Related tasks
Setting up the virtual optical device on the client system
After you set up the Network File System server to share images, proceed with these steps to set up virtual optical device on the client.

Related information
i5/OS Network File System Support PDF

Setting up the virtual optical device on the client system
After you set up the Network File System server to share images, proceed with these steps to set up virtual optical device on the client.

To set up the virtual optical device type 632B-003 on the client, follow these steps.

1. If you do not use Local Area Network (LAN) console, configure a service tools server for the virtual optical device to use. See Configuring the service tools server for DST for details.
2. Create a device description for the virtual optical device.

   ```
   CRTDEVOPT DEVD(NETOPT) RSRCNAME(*VRT) LCLINTNETA(*SRVLAN)
   RMTINTNETA('X.X.XXX.XXX') NETIMGDIR('/pubs')
   ```

   Note:
   - The RMTINTNETA is the remote internet address of the Network File system (NFS) server where this virtual optical device will look for virtual image files
   - The NETIMGDIR parameter specifies the network path on the Network File System (NFS) server containing the virtual image files that were prepared for use with this device. The path is limited to 127 characters. The character set is limited to A-Z, a-z, 0-9, and / (slash).
3. Vary on the virtual optical device. The virtual_device_name specified on the VRYCFG command should be the same as the name specified for DEVD on the CRTDEVOPT command.

   ```
   VRYCFG CFGOBJ(virtual_device_name)  CFGTYPE(*DEV) STATUS(*ON)
   ```

The virtual optical device is now ready for use with the shared image files.
Related tasks
Setting up the server to share virtual optical image files with the client system

The following directions show how to set up the server to share virtual optical image files with the client system. These steps are only for IBM i.

Setting up the server to share virtual optical image files with the client system for installation and upgrade
The following directions show how to set up the server to share virtual optical image files with the client system for installation and upgrade of IBM i.

Related information
Configuring the service tools server

Using images on the client system
The following commands on the client system allow you to work with image files.

- The Work with Optical Volumes (WRKOPTVOL) command shows a list of optical volumes that are known to the system.
- The Work with Image Catalog Entries (WRKIMGCLGE) command allows you to work with the entries for the specified virtual optical device. Following is an example of the command:

  Note: The name of the device used for the WRKIMGCLGE command should match the name of the device created with the CRTDEVOPT command.

  – WRKIMGCLGE IMGCLG(*DEV) DEV(*NETOPT*)
- The Load Image Catalog Entry (LODIMGCLGE) command can be use to mount a different volume within the virtual optical device in the network. This is an example of the command:

  – LODIMGCLGE IMGCLG(*DEV) DEV(OPTVRT01) IMGCLGIDX(1) OPTION(*MOUNT)
- Restore the licensed programs, PTFs, or user data.

  For instructions, refer to Installing fixes, Installing additional licensed programs, and Using restore menu options 21, 22, and 23.

Client virtual devices (optical and tape)

Client virtual device support allows multiple IBM i partitions to share the devices without needing to use dynamic logical partitioning.

An IBM i server partition that is running IBM i 6.1 or later on an IBM i Power® System, POWER6® or later, can share a natively attached optical device or an IBM i virtual optical device (optical image catalog) with multiple client partitions that are running IBM i 6.1 or later.

An IBM i server partition that is running IBM i 7.2 on an IBM Power system, POWER® 6 or later, can share a natively attached DAT or LTO tape device with multiple IBM i client partitions that are running IBM i 6.1.1 or later. The tape devices must be attached in an IOPless configuration on the server. If they are in a tape library device, the tape library device must be running in sequential mode. For the PTF levels required and more information, see Client Virtual Tape Devices

Note: IBM i virtual tape devices (tape image catalog) are not virtualized to IBM i client partitions. When a high-speed tape device (LTO5 or newer) is virtualized to an IBM i client partition, the client partition might not be able to run the tape device at full speed.

Optical and tape devices are configured to be used by IBM i client partitions by creating a virtual SCSI server adapter in the IBM i server partition and a virtual SCSI client adapter in the IBM i client partition. In addition to the virtual SCSI connections, a Network Server Description (NWSD) is needed in the IBM i server partition.

- Up to 16 optical devices available in the server partition are virtualized to the client partitions for each NWSD.
- Up to 4 tape devices available in the server partition are virtualized to the client partitions for each NWSD.

Note: The NWSD parameters **RSTDDEVRSC** (Restricted device resources) and **ALWDEVRSC** (Allowed device resources) can be used to restrict which virtualized devices the client partition can access. If you define multiple Network Server descriptions, then you must use the **RSTDDEVRSC** or **ALWDEVRSC**

parameters to prevent the same device from appearing multiple times on the client partitions. The **RSTDDEVRSC** and **ALWDEVRSC** parameters are limited to a maximum of 16 entries.

Note: An existing virtual SCSI server adapter and NWSD in the IBM i server partition can be used, but creating new ones to use for optical and tape is recommended.

A virtualized optical or tape device in the server partition can be used for a D-mode Initial Program Load (IPL) and install of the client partition, installing program temporary fixes (PTFs), for save/restore, and for any other I/O operations.

Note: When an IBM i server partition uses an image catalog to provide a virtualized optical device to an IBM i client partition, the next volume will not load automatically for the client partition unless the server and client partitions are running IBM i release 7.1 or later with the correct PTF levels and if the optical device was already varied on when the network server was varied on. For the PTF levels and additional information go to Embedded media changer.

Configuring an optical or tape device for use by an IBM i client partition

Use the following procedure to configure an optical or tape device to be used by an IBM i client partition:

1. Use the managing HMC to create new virtual SCSI adapters on the IBM i server and client partitions.

    - If you use the HMC Enhanced Interface, see "Creating virtual SCSI adapters with the HMC Enhanced Interface" on page 175.
    - If you use the HMC Classic Interface, see "Creating virtual SCSI adapters with the HMC Classic Interface" on page 176.

2. Create a Network Server Description (NWSD) on the IBM i server partition. Perform the following steps to do so:

    a. Determine the correct virtual SCSI server resource name by entering `WRKHDWRSC *CMN` command on the command line of the IBM i server partition. Look at the controller resources with type 290B. Use option 7 to display the resource details and look at the last digits of the location code. The controller resource which has a location code ending with the virtual SCSI adapter number or remote adapter ID you created in step "1" on page 174 is the controller resource name to be used when creating the NWSD. Record the controller resource name for later use. For example, if the virtual SCSI adapter number or remote adapter ID you created in step "1" on page 174 was 7, then the location code would have the following format:

    ```
    Location: U9409.E8A.10ABCDE-V1-C7
    ```

    b. At the IBM i command line on the IBM i server partition, enter `CRTNWSD` to create a network server description, and press F4 for prompts, then F9 to display all parameters. Enter the following values:

    Network Server Description: Provide a name for the Network server description. For example, if you plan to use partition 8 as the client partition you could use the name CLIENT8 for the NWSD.

    Resource Name: Provide the resource name recorded in step "2.a" on page 174.

    Network server type: *GUEST

    Server operating system: *OPSYS

    Online at IPL: *YES

    Code page: 437

    Restricted device resources: Use ***NONE** if you do not want to restrict any resources from being seen by the clients. You can also provide a list of up to 16 specific resource names to restrict, or you can use ***ALLOPT** or ***ALLTAPE** to restrict all optical or all tape devices.

    Allowed device resources: Use ***UNRSTD** if you do not want to restrict any resources from being seen by the clients. You can also provide a list of up to 16 specific resource names to allow, or you can use ***ALLOPT** or ***ALLTAPE** to allow all optical or all tape devices.

    Power Control: Specify ***NO**.

    This is an example of a command to create a Network Server Description that you intend to be used by partition 8, your controller resource name is CTL09, and you don't want the client partition to see tape resource TAP01.

```
CRTNWSD NWSD(CLIENT8) RSRCNAME(CTL09) TYPE(*GUEST *OPSYS) ONLINE(*YES) CODEPAGE(437)
RSTDDEVRSC(TAP01) PWRCTL(*NO)
```

This is an example of a command to create a Network Server Description that you intend to be used by partition 8, your controller resource name is CTL09, and you want the client partition to see only tape resource TAP01,

```
CRTNWSD NWSD(CLIENT8) RSRCNAME(CTL09) TYPE(*GUEST *OPSYS) ONLINE(*YES) CODEPAGE(437)
ALWDEVRSC(TAP01) PWRCTL(*NO)
```

3. Start the NWSD on the IBM i server partition by performing the following steps:

   a. Vary on any optical devices that you want the client partitions to use. Do not vary on the tape devices.

   b. Enter the **WRKCFGSTS *NWS** IBM i command.

   c. Use option 1=Vary on for the NWSD that you want to start and press Enter.

4. Enter the **WRKHDWRSC *STG** IBM i command to locate the virtual devices in the IBM i client partition. The virtual devices will be associated with a type 290A storage controller.

   a. Select option 7 to display resource detail next to each of the 290A storage controller resources listed.

   b. Look at the last digits for the location code Cxx where xx corresponds to the virtual adapter number you wrote down in step .

   c. When you find the correct storage controller resource, look for the DC0xx resource and select option 9 to work with resources.

   Note: A virtualized optical device resource will appear as one of the following device Type-models on the IBM i client partition.

   - RDX drives will appear as Type-model 63B8-0D2.
   - USB Flash drives will appear as Type-model 63BC-0D2.
   - All other physical optical device types, and IFS/NFS file backed virtual devices (632B-001 and 632B-003) will appear as Type-model 632C-002.

   A virtualized tape device resource shows the same device type and model on the client partition as on the server partition.

   For tape devices, the client partition might display the serial number in a different format than on the server partition. For example, a SAS tape device could have a serial number of YSA068000277 on the server partition and a serial number of 00-8000277 on the client partition.

5. Vary on the virtual devices from the IBM i client partitions.

   - For virtualized optical devices, the corresponding optical device on the server partition must be varied on before the client partitions can use the device.
   - For virtualized tape devices, the corresponding tape device on the server partition must be varied off before the client partitions can use the device. If you want multiple client partitions to be able to vary on the device at the same time, then the device description **Assign device at vary on** parameter must be set to ***NO** on the client partitions.

   Note: If you are virtualizing a RDX or USB Flash drive that contains optical container media, and there is a volume list file on the media that makes the child virtual volumes writable, then only one partition at a time can access the child virtual volumes. For all other partitions the child virtual device description must be varied off.

Creating virtual SCSI adapters with the HMC Enhanced Interface

Use the following procedure to create new virtual SCSI adapters on the IBM i server and client partitions with the HMC Enhanced Interface:

1. In the managing HMC navigation pane open **Systems Management** > **Servers**, and select the managed system on which the IBM i client partition resides.

2. For the client partition, select **Virtual I/O** > **Virtual storage**.

3. On the Virtual storage panel, press the **Adapter view** button to view the IBM i Hosted Virtual SCSI adapters.

4. Select the **Create Adapter** option to create new IBM i Hosted Virtual SCSI adapters. The Create Virtual SCSI Adapter panel will preselect a valid adapter ID and remote adapter ID to use. Record the remote adapter ID for later use in step "2" on page 174 and press **OK**.

   Note: The active partition profiles are automatically updated to include the new virtual SCSI adapters.

Creating virtual SCSI adapters with the HMC Classic Interface

Use the following procedure to create new virtual SCSI adapters on the IBM i server and client partitions with the HMC Classic Interface:

1. Create a new SCSI server adapter on the IBM i server partition.

   a. In the managing HMC navigation pane open **Systems Management** > **Servers**, and select the managed system on which the IBM i server partition resides.

   b. Select the IBM i server partition, click the **Tasks** button, and choose **Dynamic Logical Partitioning** > **Virtual Adapters**.

   c. Click **Actions** and choose **Create Virtual Adapter** > **SCSI adapter**.

   d. Use the default Adapter number or provide your own number. This number is the Server adapter ID, which you need to record for later use.

      - In the **Type of adapter** field, select **Server**.
      - Click **Only selected client partition can use** and select the client partition name.
      - Enter a Client adapter ID that is not already defined by the client partition. To see which client adapter IDS are already defined for the client partition, display the properties for the client partition and choose the **Virtual Adapters** tab to see which client adapter IDs are already defined. Record the client adapter ID for later use.
      - Select **OK** to create the adapter.

   e. Create the virtual SCSI adapter within the partition profile for the IBM i server partition so that the virtual SCSI adapter continues to exist after you restart the partition. To do this edit the partition profile, select the **Virtual Adapters** tab, and repeat steps "1.c" on page 176 and "1.d" on page 176 above.

2. Create the virtual SCSI client adapter in the IBM i client partition.

   a. In the managing HMC navigation pane, open**Systems Management** > **Servers**, and select the managed system on which the IBM i client logical partition resides.

   b. Select the IBM i client partition, click **Tasks**, and choose **Dynamic Logical Partitioning** > **Virtual Adapters**

   c. Click **Actions** and choose **Create Virtual Adapter** > **SCSI Adapter**.

   d. Enter the client adapter ID you recorded in step "1.d" on page 176 for the **Adapter number** and select client for the **type of adapter**.

   e. Select the IBM i server partition that owns the virtualized device as the server partition and specify the Server adapter ID that you recorded in step "1.d" on page 176. Select **OK**.

   f. Create the virtual SCSI adapter within the partition profile for the IBM i client partition so that the virtual SCSI adapter continues to exist after you restart the partition. To do this, edit the partition profile, select the **Virtual Adapters** tab, and repeat steps "2.c" on page 176, "2.d" on page 176, and "2.e" on page 176 above.

Storage area networks

Discover the advantages and disadvantages of storage area networks (SANs).

SANs are a newer development in the disk and tape attachment business. They consolidate the storage of multiple, storage devices into a single set of centrally managed resources. To do so, they employ a

combination of technologies, including hardware, software, and networking components. They support direct, high-speed data transfers between systems and storage devices in the following ways:

System to storage

This is the traditional model of interaction with storage devices. The advantage of a SAN in this case is that the same storage device may be accessed serially or concurrently by multiple systems.

System to system

A SAN may be used for high-speed, high-volume communications between systems.

Storage to storage

This SAN data movement capability enables data to be moved without system intervention, thereby freeing system processor cycles for other activities like application processing. Examples include a disk unit backing up its data to a tape device without system intervention or remote device mirroring across the SAN. This type of data transfer is not currently available on the system.

SANs provide many benefits in your IBM i network, including the following:

Scalability

Storage is independent of the system itself, so you are not limited by the number of disks you can attach directly to the system.

Improved availability of applications

Storage is independent of applications and is accessible through alternative data paths.

Better application performance

Storage processing is moved from the systems onto a separate network.

Centralized and consolidated storage

Storage capacity can be connected to systems at a greater distance, and storage resources can be disconnected from individual hosts. The results can be lower overall costs through better use of the storage, lower management costs, increased flexibility, and increased control.

Data transfer for storage at remote sites

You can keep a remote copy of data for disaster protection.

Simplified centralized management

A single image of storage media simplifies management.

Related information

Introduction to Storage Area Networks

iSeries in Storage Area Networks A Guide to Implementing FC Disk and Tape with iSeries

Related information for Storage solutions

Product manuals, IBM Redbooks publications, Web sites, and other information center topic collections contain information that relates to the Storage solutions topic collection. You can view or print any of the PDF files.

Manuals

- Backup, Recovery, and Media Services for IBM i

- Hierarchical Storage Management (943 KB)

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- Introduction to Storage Area Networks (4.1 MB)

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- Backup, Recovery, and Media Services

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