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IBM Spectrum Archive Single Drive Edition and Library Edition
Installation and Configuration Guide

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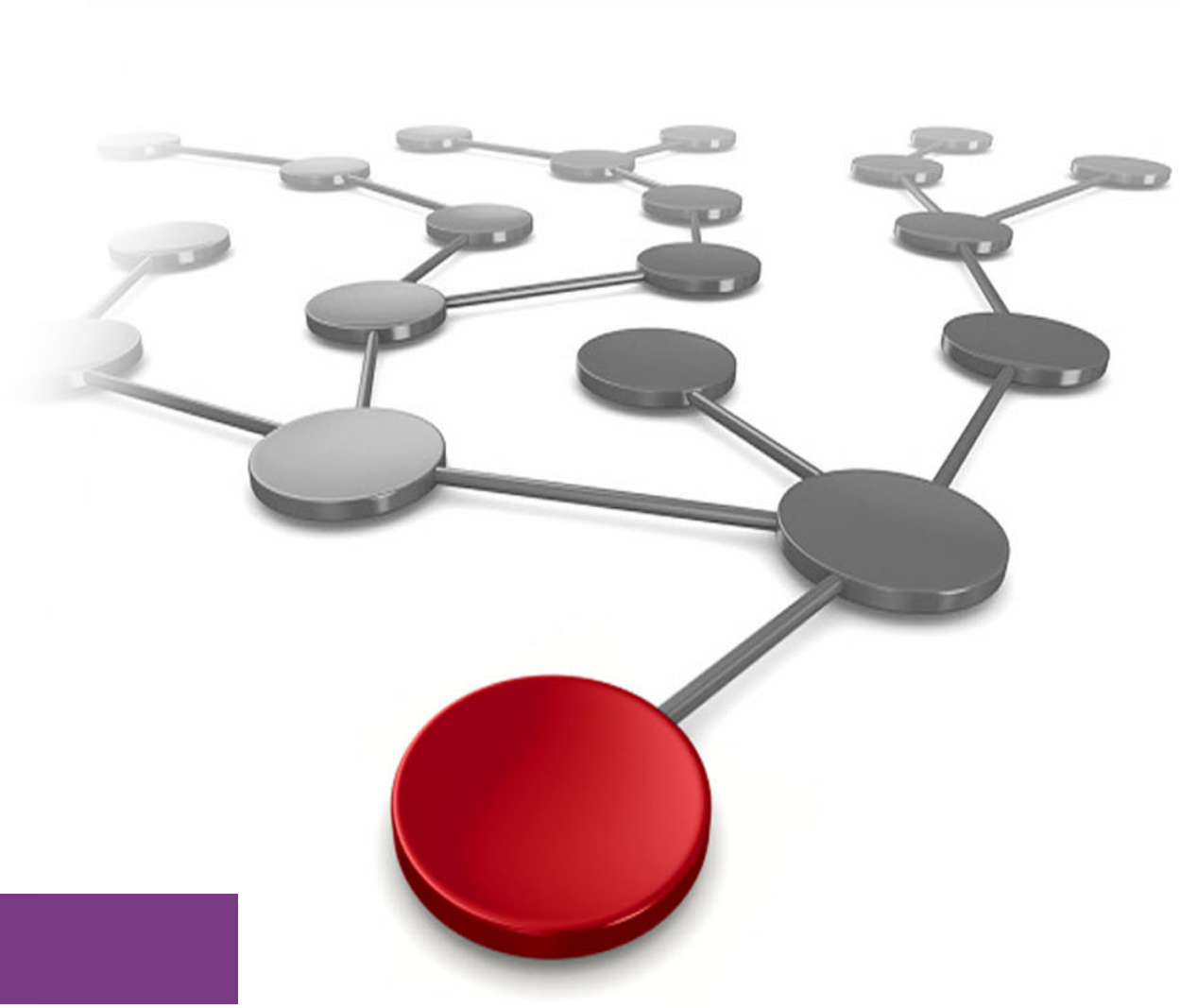

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IBM Spectrum Archive SDE and LE: Installation and Configuration Guide

March 2018

SG24-8090-01

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

Second Edition (March 2018)

This edition applies to IBM Spectrum Archive Single Drive Edition V2.4.0 and IBM Spectrum Archive Library Edition V2.4.0.

Contents

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Preface

The IBM® Linear Tape File System™ (LTFS) is the first file system that works along with Linear Tape-Open (LTO) tape technology to set a new standard for ease of use and portability for open systems tape storage. In 2011, LTFS won an Engineering Emmy Award for Innovation from the Academy of Television Arts & Sciences.

This IBM Redbooks® publication helps you install, tailor, and configure the IBM Spectrum™ Archive Single Drive Edition (SDE) and the IBM Spectrum Archive™ Library Edition (LE) products.

LTFS is a file system that was originally implemented on dual-partition linear tape (IBM LTO Ultrium 5 tape drives (LTO-5) and IBM TS1140 tape drives). Now IBM Spectrum Archive SDE and LE support IBM LTO Ultrium 8, 7, 6, or 5 tape drives, and IBM TS1155, IBM TS1150, and IBM TS1140 tape drives. IBM Spectrum Archive LE supports the IBM TS4500 tape library, IBM TS3500 tape library, IBM TS3310 tape library, IBM TS3200 tape library express, IBM TS3100 tape library express, and IBM TS2900 tape autoloader express.

IBM Spectrum Archive makes tape look and work like any removable media, such as a USB drive. Files and directories appear on the desktop as a directory listing. It is now simple to drag files to and from tape. Any application that is written to use disk files works with the same files on tape. IBM Spectrum Archive SDE supports stand-alone drives only. IBM Spectrum Archive LE supports tape libraries. IBM Spectrum Archive LE presents each cartridge in the library as a subdirectory in the LTFS file system. With IBM Spectrum Archive LE, you can list the contents and search all of the volumes in the library without mounting the volumes by using an in-memory index.

This publication is intended for anyone who wants to understand more about IBM Linear Tape System products and their implementation. This book is suitable for IBM clients, IBM Business Partners, IBM specialist sales representatives, and technical specialists.

Authors

This book was produced by a team of specialists from around the world working at the IBM Tokyo and IBM Tucson development labs.

Larry Coyne is a Project Leader at the International Technical Support Organization, Tucson Arizona center. He has 35+ years of IBM experience with 23 in IBM storage software management. He holds degrees in Software Engineering from the University of Texas at El Paso and Project Management from George Washington University. His areas of expertise include client relationship management, quality assurance, development management, and support management for IBM Storage Software.

Khanh Ngo is an IBM Senior Technical Staff Member (STSM) in Tucson, Arizona serving as the Tape Storage Test Architect. He sets test strategies, designs tests, and tests solutions for the tape drive, tape library, and IBM Spectrum Archive product lines. He joined IBM in 2000 with a Bachelor of Science degree in Electrical Engineering and a Bachelor of Science in Computer Science. Later, he received a Master of Science degree in Engineering Management. He is also an IBM Master Inventor and on his IBM 5th patent plateau. Because of his work with various IBM Spectrum Archive Enterprise Edition (EE) customers across multiple industries, Khanh is often sought out for his expertise to lead, execute, and successfully complete proof of concepts and custom engineering solutions to integrate IBM Spectrum Archive EE into customers' production environments.

Illarion Borisevich is an IBM software developer in Tucson, Arizona as an FVT engineer for both IBM Spectrum Archive and IBM's next generation of storage management system, the IBM TS4500 tape library. He assists customers with setting up the IBM TS4500 and is a customer advocate for IBM Spectrum Archive. He has a bachelor's degree in computer science from the University of Arizona. Illarion works on the TS3500 CLI and develops scripts to stress both IBM Spectrum Archive EE and the TS4500 tape library solution systems.

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

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IBM Systems

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- Authors of the first edition, IBM Spectrum Archive SDE and LE: Installation and Configuration Guide:

  Larry Coyne, Sandor Alavari, Simon Browne, Chris Hoffmann, Leticia Munoz, Markus Schaefer

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Summary of changes

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

Summary of Changes
for SG24-8090-01
for IBM Spectrum Archive SDE and LE: Installation and Configuration Guide
as created or updated on March 22, 2018.

March 2018, Second Edition

This revision includes the following new and changed information.

New information for IBM Spectrum Archive Single Drive Edition

- Added support for the Linear Tape File System (LTFS) Format Specification Version 2.4.0.

  New support includes:

  - Support for some special characters, such as the colon (:), in file, directory, and volume name encoding.
  - Support for additional virtual extended attributes.

    The new attributes support the ability to change a tape volume's advisory lock status, and also to write certain data to MAM only (and bypass writing to the tape's index), saving processing time.
- Added LTO-8 and TS1155 tape drive support.
- Added support for the new LTO 8 Type M cartridge (M8).
- Added information about how tape write errors are now handled.

New information for IBM Spectrum Archive Library Edition

- Added support for the LTFS Format Specification Version 2.4.0.

  New support includes:

  - Support for some special characters, such as the colon (:), in file, directory, and volume name encoding.
  - Support for additional virtual extended attributes.

    The new attributes support the ability to change a tape volume's advisory lock status, and also to write certain data to MAM only (and bypass writing to the tape's index), saving processing time.
- Added LTO-8 and TS1155 tape drive support.
- Added support for the new LTO 8 Type M cartridge (M8).
- Added TS4300 tape library support.
- Added information about how tape write errors are now handled.

- Added a new administrative command **leadm** to handle the administration functions. The **leadm** command replaces the **ltfsadmintool** command.
- Added a list of new tape severity and status combined codes.

Changed information

- Updated LTFS terminology to Spectrum Archive
- Removed Storage Manager
- Updated commands

1

IBM Spectrum Archive overview

This chapter provides an overview of the IBM Spectrum Archive product family and the individual components of the IBM Spectrum Archive Enterprise Edition (EE).

This chapter includes the following topics:

- Introduction to IBM Spectrum Archive and LTFS
- IBM Spectrum Archive products
- IBM Spectrum Scale
- OpenStack SwiftHLM
- IBM Spectrum Archive EE Dashboard
- IBM Spectrum Archive EE REST API
- Types of archiving

1.1 Introduction to IBM Spectrum Archive and LTFS

LTFS is the first file system that works with LTO tape technology and IBM Enterprise tape drives, providing ease of use and portability for open systems tape storage.

With this application, accessing data that is stored on an IBM tape cartridge is as easy and intuitive as the use of a USB flash drive. Tapes are self-describing and you can quickly recall any file from a tape cartridge without having to read the whole tape cartridge from beginning to end. Furthermore, any LTFS-capable system can read a tape cartridge that is created by any other LTFS-capable system (regardless of the operating system platform). Any LTFS-capable system can identify and retrieve the files that are stored on it. LTFS-capable systems have the following characteristics:

- Files and directories are shown to you as a directory tree listing.
- More intuitive searches of tape cartridges and library content are now possible because of the addition of file tagging.
- Files can be moved to and from LTFS tape cartridges by using the familiar drag method that is common to many operating systems.
- Many applications that were written to use files on disk can now use files on tape cartridges without any modification.
- All standard File Open, Write, Read, Append, Delete, and Close functions are supported.
- No need for an additional, external tape management system or database tracking the content of each tape.

Archival data storage requirements are growing at over 60% annually. The LTFS format is an ideal option for long-term archiving of large files that must be easily shared with others. This option is especially important because the tape media that it uses (LTO and 3592) are designed to have a 15-year to 30-year lifespan (depending on the number of read/write passes).

Industries that benefit from this tape file system are the banking, digital media, medical, geophysical, and entertainment industries. Many users in these industries use Linux or Macintosh systems, which are fully compatible with LTFS.

LTO Ultrium tape cartridges from earlier LTO generations (that is, LTO-1 through LTO-4) *cannot* be partitioned and be used by LTFS/IBM Spectrum Archive. Also, if LTO Ultrium 4 tape cartridges are used in an LTO Ultrium 5 tape drive to write data, the LTO-4 tape cartridge is treated as an unpartitioned LTO-5 tape cartridge. Even if an application can manage partitions, it is not possible to partition the LTO-4 media that is mounted in an LTO Ultrium 5 drive.

Starting with the release of IBM Spectrum Archive EE V1R2, corresponding Write Once, Read Many (WORM) tape cartridges are supported in an IBM Spectrum Archive EE solution operating supported IBM Enterprise tape drives. With the same release, tape drives in mixed configurations are supported.

Although LTFS presents the tape cartridge as a disk drive, the underlying hardware is still a tape cartridge and is therefore sequential in nature. Tape does not allow random access. Data is always appended to the tape, and there is no overwriting of files. File deletions do not erase the data from tape but instead erase the pointers to the data. So, although with LTFS you can simultaneously copy two (or more) files to an LTFS tape cartridge, you get better performance if you copy files sequentially.

To operate the tape file system, the following components are needed:

- Software in the form of an open source LTFS package
- Data structures that are created by LTFS on tape

Together, these components can manage a file system on the tape media as though it is a disk file system for accessing tape files, including the tape directory tree structures. The metadata of each tape cartridge, after it is mounted, is cached in server memory. Therefore, metadata operations, such as browsing the directory or searching for a file name, do not require any tape movement and are quick.

Tape libraries, tape drives, and tape media supported by IBM Spectrum Archive

Throughout this book, the terms *supported tape libraries*, *supported tape drives,* and *supported tape media* will be used to represent the following tape libraries, tape drives, and tape media. For the IBM Spectrum Archive family, Table 1-1 describes the supported tape libraries, tape drives, and tape media.

Table 1-1 IBM Spectrum Archive supported tape libraries, tape drives, and tape media

	IBM Spectrum Archive Supported Tape Libraries and Tape Drives				
IBM Spectrum Archive product	**IBM tape drives/ tape libraries**	**IBM Enterprise tape drive support**	**IBM LTO tape drive support**	**IBM Enterprise tape media**	**IBM LTO tape media**
IBM Spectrum Archive Enterprise Edition	IBM TS4500 tape library IBM TS3500 tape library	IBM TS1155 IBM TS1150 IBM TS1140	LTO 8, 7, 6, 5	3592 JC, JB, JD, JK, JL	LTO 8, M8[a], 7, 6, 5
	IBM TS4300 tape library		LTO 8, 7, 6		LTO 8, M8, 7, 6
	IBM TS3310 tape library		LTO 8, 7, 6, 5		LTO 8, M8, 7, 6, 5
IBM Spectrum Archive Library Edition	IBM TS4500 tape library IBM TS3500 tape library	IBM TS1155 IBM TS1150 IBM TS1140	LTO 8, 7, 6, 5	3592 JC, JB, JD, JK, JL	LTO 8, M8, 7, 6, 5
	IBM TS4300 tape library		LTO 8, 7, 6		LTO 8, M8, 7, 6
	IBM TS3310 tape library IBM TS3200 tape library IBM TS3100 tape library IBM TS2900 tape autoloader		LTO 8, 7, 6, 5		LTO 8, M8, 7, 6, 5

	IBM Spectrum Archive Supported Tape Libraries and Tape Drives				
IBM Spectrum Archive product	**IBM tape drives/ tape libraries**	**IBM Enterprise tape drive support**	**IBM LTO tape drive support**	**IBM Enterprise tape media**	**IBM LTO tape media**
IBM Spectrum Archive Single Drive Edition	IBM TS1155 tape drive	3592 55F 3592 55G		JC, JK, JD, JL	
	IBM TS1150 tape drive	3592 E08 3592 EH8		JC, JK, JD, JL	
	IBM TS1140 tape drive	3592 E07 3592 EH7		JB, JC, JK	
	IBM TS2280 tape drive		LTO 8, 7		LTO 8, M8, 7
	IBM TS2270 tape drive		LTO 7, 6, 5 (read)		LTO 7, 6, 5
	IBM TS2360 tape drive IBM TS2260 tape drive		LTO 6, 5		LTO 6, 5
	IBM TS2350 tape drive IBM TS2250 tape drive		LTO 5		LTO 5

a. The LTO Program is introducing a new capability with LTO-8 drives. The ability of the LTO-8 drive to write 9 TB on a brand new LTO-7 cartridge instead of 6 TB as specified by the LTO-7 format. Such a cartridge is called an LTO-7 initialized LTO-8 Type M cartridge. For more information, see IBM Knowledge Center at https://www.ibm.com/support/knowledgecenter/en/STQRQ9/com.ibm.storage.ts4500.doc/ts4500_ipg_3584_lto_m8.html.

Table 1-2 lists the tape drives and media that are supported by LTFS. The table also gives the native capacity of supported media, and the raw capacity of the LTFS data partition on the media.

Table 1-2 Tape media capacity with IBM Spectrum Archive

Tape drive	**Tape media[a]**	**Native capacity[b, c]**	**LTFS data partition size[c, d]**
IBM TS1155 tape drive[e, f]	Extended type D data (JD)	15 TB (13.64 TiB)	14.562 TB (13.2 TiB)
	Extended type D WORM data (JZ)	15 TB (13.64 TiB)	14.562 TB (13.2 TiB)
	Advanced type C data (JC)	7 TB (6.36TiB)	6.757 TB (6.14 TiB)
	Advanced type C WORM data (JY)	7 TB (6.36 TiB)	6.757 TB (6.14 TiB)
	Advanced type D economy data (JL)	2 TB (1.81 TiB)	1.937 TB (1.76 TiB)
	Advanced type C economy data (JK)	900 GB (838 GiB)	869 GB (809 GiB)

Tape drive	Tape media[a]	Native capacity[b, c]	LTFS data partition size[c, d]
IBM TS1150 tape drive[g, h]	Extended type D data (JD)	10 TB (9.094 TiB)	9.687 TB (8.81 TiB)
	Extended type D WORM data (JZ)	10 TB (9.094 TiB)	9.687 TB (8.81 TiB)
	Advanced type C data (JC)	7 TB (6.36 TiB)	6.757 TB (6.14 TiB)
	Advanced type C WORM data (JY)	7 TB (6.36 TiB)	6.757 TB (6.14 TiB)
	Advanced type D economy data (JL)	3 TB (2.72 TiB)	2.912 TB (2.64 TiB)
	Advanced type C economy data (JK)	900 GB (838 GiB)	869 GB (809 GiB)
IBM TS1140 tape drive[g, h]	Advanced data type C (JC)	4 TB (3.63 TiB)	3.650 TB (3.31 TiB)
	Advanced data type C WORM (JY)	4 TB (3.63 TiB)	3.650 TB (3.31 TiB)
	Extended data (JB)	1.6 TB (1.45 TiB)	1.457 TB (1.32 TiB)
	Advanced type C economy data (JK)	500 GB (465 GiB)	456 GB (425 GiB)
IBM LTO Ultrium 8 tape drive	LTO 8	12 TB (11.176 TiB)	11.711 TB (10.65 TiB)
	LTO 8 Type M8 cartridge (M8)	9 TB (8.185 TiB)	8.731 TB (7.94 TiB)
IBM LTO Ultrium 7 tape drive	LTO 7	6 TB (5.46 TiB)	5.731 TB (5.21 TiB)
IBM LTO Ultrium 6 tape drive	LTO 6	2.5 TB (2.273 TiB)	2.408 TB (2.19 TiB)
IBM LTO Ultrium 5 tape drive	LTO 5	1.5 TB (1.364 TiB)	1.425 TB (1.29 TiB)

a. WORM media are not supported by IBM Spectrum Archive SDE and IBM Spectrum Archive LE, only with EE.
b. The actual usable capacity is greater when compression is used.
c. See the topic *Data storage values*, found at https://www.ibm.com/support/knowledgecenter/en/STQNYL_2.4.0/ltfs_data_storage_values.html
d. Values that are given are the default size of the LTFS data partition, unless otherwise indicated.
e. TS1155, TS1150, and TS1140 tape drives support enhanced partitioning for cartridges.
f. Media that are formatted on a 3592 drive must be read on the same generation of drive. For example, a JC cartridge that was formatted by a TS1150 tape drive cannot be read on a TS1140 tape drive.
g. TS1155, TS1150, and TS1140 tape drives support enhanced partitioning for cartridges.
h. Media that are formatted on a 3592 drive must be read on the same generation of drive. For example, a JC cartridge that was formatted by a TS1150 tape drive cannot be read on a TS1140 tape drive.

1.2 IBM Spectrum Archive products

The following sections give a brief overview of the IBM Spectrum Archive software products that are available at the time of writing. Their main features are summarized in Table 1-3.

Note: IBM LTFS Storage Manager (LTFS SM) was discontinued from marketing effective 12/14/2015. IBM support for the LTFS SM still continues.

Table 1-3 LTFS product comparison

Name	License required	Market	Tape Drive Support	Tape Library support	Internal database	Integrates with IBM Spectrum Scale™
IBM Spectrum Archive Single Drive Edition (SDE)	No	Entry - Midrange	Yes	No	No	No
IBM Spectrum Archive Library Edition (LE)	No	Midrange - Enterprise	Yes	Yes	No	No
IBM Spectrum Archive Enterprise Edition (EE)	Yes	Enterprise	Yes	Yes	No	Yes

1.2.1 IBM Spectrum Archive Single Drive Edition

The IBM Spectrum Archive SDE provides direct, intuitive, and graphical access to data that is stored with the supported IBM tape drives and libraries that use the supported Linear Tape-Open (LTO) Ultrium tape cartridges and IBM Enterprise tape cartridges. It eliminates the need for more tape management and software to access data. The LTFS format is the first file system that works with tape technology that provides ease of use and portability for open systems tape storage. With this system, accessing data that is stored on an IBM tape cartridge is as easy and intuitive as using a USB flash drive.

For in-depth information about IBM Spectrum Archive Single Drive Edition, see Chapter 2., “IBM Spectrum Archive Single Drive Edition” on page 23.

Figure 1-1 shows the IBM Spectrum Archive SDE user view, which resembles standard file folders.

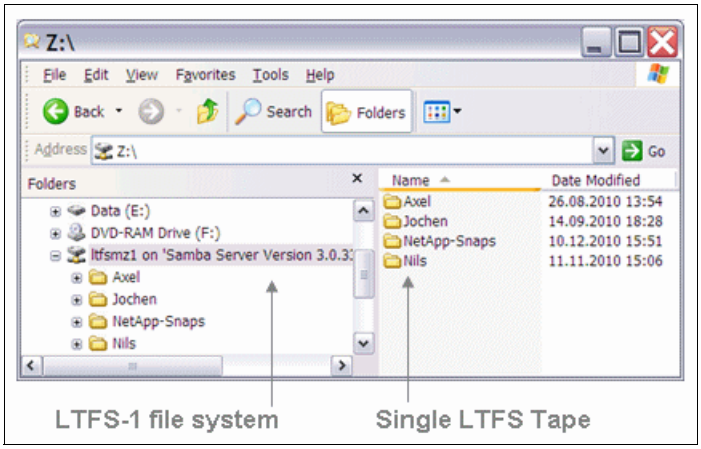

Figure 1-1 IBM Spectrum Archive SDE user view showing the file folders from the single LTFS tape cartridge

It runs on Linux, Windows, and MacOS, and with the operating system's graphical File Manager, reading data on a tape cartridge is as easy as dragging file data sets. Users can run any application that is designed for disk files against tape data without concern for the fact that the data is physically stored on tape. IBM Spectrum Archive SDE allows access to all of the data in a tape cartridge that is loaded on a single drive as though it were on an attached disk drive.

It supports existing stand-alone versions of LTFS, such as those running on IBM, HP, Quantum, FOR-A, 1 Beyond, and other platforms.

IBM Spectrum Archive SDE software, systems, tape drives and media requirements

The most current software, systems, tape drives and media requirements can be found at the IBM Spectrum Archive Single Drive Edition IBM Knowledge Center website:

https://www.ibm.com/support/knowledgecenter/en/STQNYL

Select the most current IBM Spectrum Archive SDE version and then select planning. The supported tape drives and media, system requirements, and required software topics will be displayed.

IBM Spectrum Archive SDE supports the use of multiple tape drives at one time. The method for using multiple tape drives depends on the operating system being used.

For Linux and Mac OS X users, it is possible to use multiple tape drives by starting multiple instances of the LTFS software, each with a different target tape device name in the **`-o devname`** parameter. For more information, see the topic *Mounting media by using the* **`ltfs`** *command*, found at:

https://www.ibm.com/support/knowledgecenter/en/STQNYL_2.4.0/ltfs_managing_command_line_ltfs.html

For Windows users, the LTFS software detects each of the installed tape drives and it is possible to assign a different drive letter to each drive by using the configuration window. For more information, see the topic *Assigning a drive letter to a tape drive*, found at:

https://www.ibm.com/support/knowledgecenter/en/STQNYL_2.4.0/ltfs_assigning_drive_letter.html

Note: A certain level of tape drive firmware is required to use fully IBM Spectrum Archive SDE functions. To find the supported firmware version and for more information about connectivity and configurations, see the IBM System Storage® Interoperation Center (SSIC) at the following website:

http://www.ibm.com/systems/support/storage/ssic/interoperability.wss

Migration path to IBM Spectrum Archive EE

There is no direct migration path from IBM Spectrum Archive SDE to IBM Spectrum Archive EE software. Any existing IBM Spectrum Archive SDE software should be uninstalled before IBM Spectrum Archive EE is installed. Follow the uninstallation procedure in Chapter 2., “IBM Spectrum Archive Single Drive Edition” on page 23.

Data tapes that are used by IBM Spectrum Archive SDE version 1.3.0 or later can be imported into IBM Spectrum Archive EE. For more information about this procedure, see the importing section in the *IBM Spectrum Archive Enterprise Edition V1.2.5.1 Installation and Configuration Guide*, SG24-8333. Tapes that were formatted in LTFS 1.0 format by older versions of IBM Spectrum Archive are automatically upgraded to LTFS 2.0 format on first write.

1.2.2 IBM Spectrum Archive Library Edition

IBM Spectrum Archive LE uses the open, non-proprietary LTFS format that allows any application to write files into a large archive. It provides direct, intuitive, and graphical access to data that is stored on tape cartridges within the supported IBM tape libraries that use either LTO IBM Enterprise supported tape drives.

For in-depth information about IBM Spectrum Archive Library Edition, see Chapter 3, “IBM Spectrum Archive Library Edition” on page 115.

Figure 1-2 shows the user view of multiple IBM Spectrum Archive tapes appearing as different library folders.

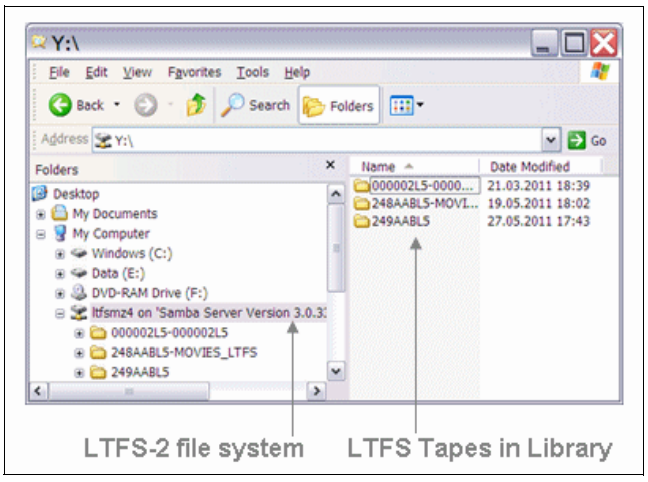

Figure 1-2 IBM Spectrum Archive LE user view of multiple LTFS tape cartridges

In addition, IBM Spectrum Archive LE enables users to create a single file system mount point for a logical library that is managed by a single instance of IBM Spectrum Archive, which runs on a single computer system.

The LTFS metadata of each tape cartridge, after it is mounted, is cached in server memory. So, even after the tape cartridge is ejected, the tape cartridge metadata information remains viewable and searchable, with no remounting required. Every tape cartridge and file is accessible through the operating system file system commands, from any application. This improvement in search efficiency can be substantial, considering the need to search hundreds or thousands of tape cartridges that are typically found in tape libraries.

IBM Spectrum Archive LE software, systems, tape drives and media requirements

The most current software, systems, tape drives and media requirements can be found at the IBM Spectrum Archive Library Edition IBM Knowledge Center website:

https://www.ibm.com/support/knowledgecenter/en/STZMZN

Select the most current IBM Spectrum Archive LE version and then select **Planning**. The Supported tape drives and media, system requirements, and required software topics will be displayed.

For more information about connectivity and configurations, see the SSIC website:

http://www.ibm.com/systems/support/storage/ssic/interoperability.wss

Migration path to IBM Spectrum Archive EE

There is no direct migration path from IBM Spectrum Archive LE to IBM Spectrum Archive EE software. Any existing IBM Spectrum Archive LE software should be uninstalled before IBM Spectrum Archive EE is installed. Follow the uninstall procedure that is documented in Chapter 3, “IBM Spectrum Archive Library Edition” on page 115.

Data tapes that were created and used by IBM Spectrum Archive LE Version 2.1.2 or later can be imported into IBM Spectrum Archive EE. For more information about this procedure, see the importing section in the *IBM Spectrum Archive Enterprise Edition V1.2.5.1 Installation and Configuration Guide*, SG24-8333.

1.2.3 IBM Spectrum Archive Enterprise Edition

As enterprise-scale data storage, archiving, and backup expands, there is a need to lower storage costs and improve manageability. IBM Spectrum Archive EE provides such a solution that offers IBM Spectrum Scale users a new low-cost, scalable storage tier.

IBM Spectrum Archive EE provides seamless integration of LTFS with IBM Spectrum Scale by providing an IBM Spectrum Archive tape tier under IBM Spectrum Scale. IBM Spectrum Scale policies are used to move files between online disks storage and IBM Spectrum Archive tape tiers without affecting the IBM Spectrum Scale namespace.

IBM Spectrum Archive EE uses IBM Spectrum Archive LE for the movement of files to and from the physical tape devices and cartridges. IBM Spectrum Archive EE can manage multiple IBM Spectrum Archive LE nodes in parallel, so bandwidth requirements between IBM Spectrum Scale and the tape tier can be satisfied by adding nodes and tape devices as needed.

For in-depth information for IBM Spectrum Archive EE see *IBM Spectrum Archive Enterprise Edition V1.2.5.1 Installation and Configuration Guide*, SG24-8333.

Figure 1-3 shows the IBM Spectrum Archive EE system view with IBM Spectrum Scale providing the global namespace and IBM Spectrum Archive EE installed on two IBM Spectrum Scale nodes. IBM Spectrum Archive EE can be installed on one or more IBM Spectrum Scale nodes. Each IBM Spectrum Archive EE instance has dedicated tape drives that are attached in the same tape library partition. IBM Spectrum Archive EE instances share tape cartridges and LTFS index. The workload is distributed over all IBM Spectrum Archive EE nodes and their attached tape drives.

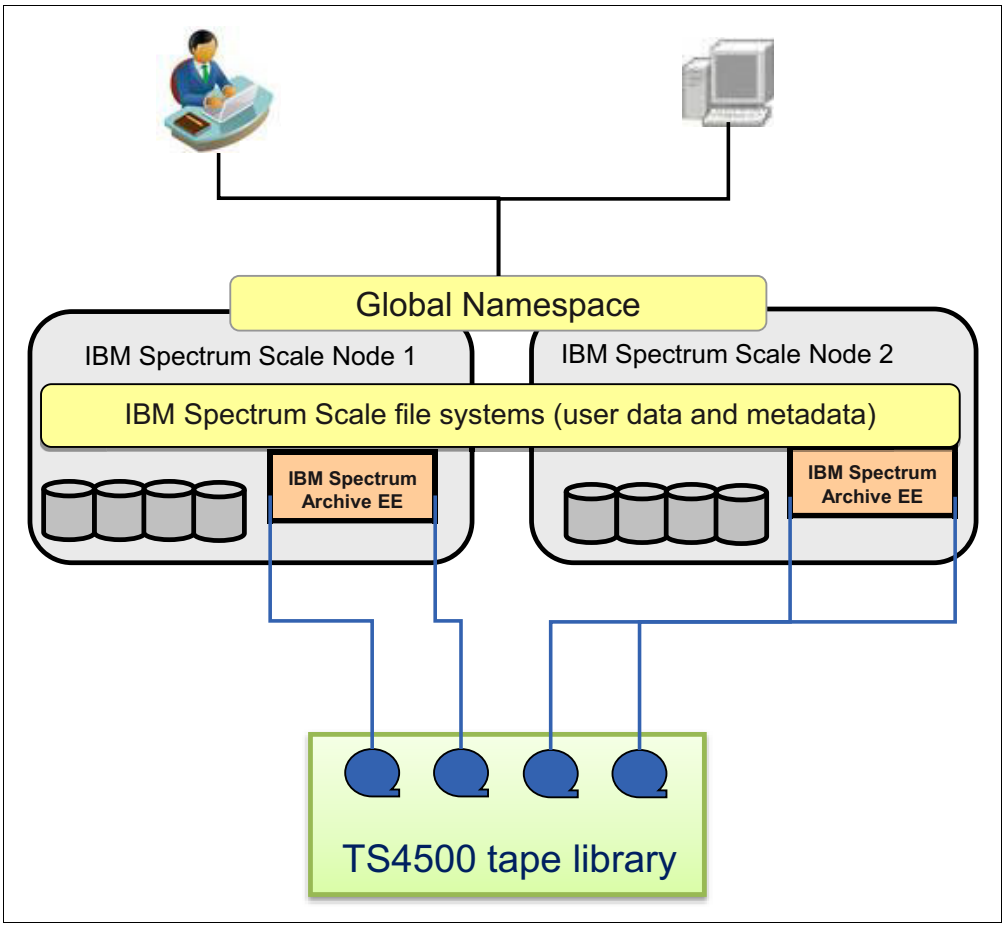

Figure 1-3 IBM Spectrum Archive EE system view

A local or remote IBM Spectrum Archive LE node serves as a migration target for IBM Spectrum Scale, which transparently archives data to tape based on policies set by the user.

IBM Spectrum Archive EE provides the following benefits:

- A low-cost storage tier in an IBM Spectrum Scale environment.
- An active archive or big data repository for long-term storage of data that requires file system access to that content.
- File-based storage in the LTFS tape format that is open, self-describing, portable, and interchangeable across platforms.
- Lowers capital expenditure and operational expenditure costs by using cost-effective and energy-efficient tape media without dependencies on external server hardware or software.
- Provides unlimited capacity scalability for the IBM supported tape libraries and keeping offline tape cartridges on shelves.

- Allows the retention of data on tape media for long-term preservation (10+ years).
- Provides the portability of large amounts of data by bulk transfer of tape cartridges between sites for disaster recovery and the initial synchronization of two IBM Spectrum Scale sites by using open-format, portable, self-describing tapes.
- Provides ease of management for operational and active archive storage.

Figure 1-4 provides a conceptual overview of processes and data flow in IBM Spectrum Archive EE.

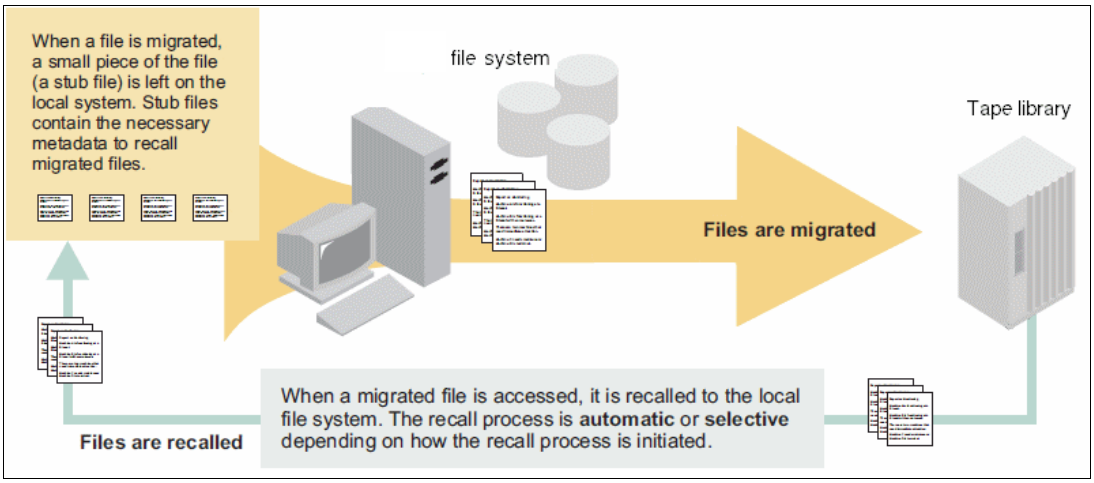

Figure 1-4 IBM Spectrum Archive EE data flow

IBM Spectrum Archive EE can be used for a low-cost storage tier, data migration, and archive needs as described in the following use cases.

Operational storage

The use of an IBM Spectrum Archive tape tier as operational storage is useful when a significant portion of files on an online disk storage system is static, meaning the data does not change. In this case, it is more efficient to move the content to a lower-cost storage tier, for example, to a physical tape cartridge. The files that are migrated to the IBM Spectrum Archive tape tier remain online, meaning they are accessible at any time from IBM Spectrum Scale under the IBM Spectrum Scale namespace.

With IBM Spectrum Archive EE, the user specifies files to be migrated to the IBM Spectrum Archive tape tier by using standard IBM Spectrum Scale scan policies. IBM Spectrum Archive EE then manages the movement of IBM Spectrum Scale file data to IBM Spectrum Archive tape cartridges. It also edits the metadata of the IBM Spectrum Scale files to point to the content on the IBM Spectrum Archive tape tier.

Access to the migrated files through the IBM Spectrum Scale file system remains unchanged with the file data that is provided at the data rate and access times of the underlying tape technology. The IBM Spectrum Scale namespace is unchanged after migration, which makes the placement of files in the IBM Spectrum Archive tape tier not apparent to users and applications.

Active archive

The use of an IBM Spectrum Archive tape tier as an active archive is useful when there is a need for a low-cost, long-term archive for data that is maintained and accessed for reference. IBM Spectrum Archive satisfies the needs of this type of archiving by using open-format, portable, self-describing tapes. In an active archive, the LTFS-file system is the main store for the data, and the IBM Spectrum Scale file system, with its limited disk capacity, is used as a staging area, or cache, in front of IBM Spectrum Archive.

IBM Spectrum Scale policies are used to stage and destage data from the IBM Spectrum Scale disks space to the IBM Spectrum Archive tape cartridges. The tape cartridges from the archive can be exported for vaulting or for moving data to another location. Because the exported data is in the LTFS format, it can be read on any LTFS-compatible system.

1.3 IBM Spectrum Scale

IBM Spectrum Archive EE provides seamless integration of LTFS with IBM Spectrum Scale by providing an IBM Spectrum Archive tape tier under IBM Spectrum Scale. IBM Spectrum Scale policies are used to move files between online disks storage and IBM Spectrum Archive tape tiers without affecting the IBM Spectrum Scale namespace.

IBM Spectrum Scale is a cluster file system solution, which means that it provides concurrent access to one or more file systems from multiple nodes. These nodes can all be SAN-attached, network-attached, or both, which enables high-performance access to this common set of data to support a scale-out solution or provide a high availability platform. The entire file system is striped across all storage devices, typically disk and flash storage subsystems.

You can find the current documentation and publications for IBM Spectrum Scale at the following website:

https://www.ibm.com/support/knowledgecenter/en/STXKQY/ibmspectrumscale_welcome.html

You can find the current documentation and publications for your IBM GPFS™ version at the following website:

https://www.ibm.com/support/knowledgecenter/SSFKCN/gpfs_welcome.html

1.3.1 Overview

IBM Spectrum Scale can help you achieve Information Lifecycle Management (ILM) efficiencies through powerful policy-driven automated tiered storage management. The IBM Spectrum Scale ILM toolkit helps you manage sets of files, pools of storage, and automate the management of file data. By using these tools, IBM Spectrum Scale can automatically determine where to physically store your data regardless of its placement in the logical directory structure. Storage pools, filesets, and user-defined policies can match the cost of your storage resources to the value of your data.

You can use IBM Spectrum Scale policy-based ILM tools to perform the following tasks:

- Create storage pools to provide a way to partition a file system's storage into collections of disks or a redundant array of independent disks (RAID) with similar properties that are managed together as a group.

IBM Spectrum Scale has the following types of storage pools:

- A required system storage pool that you create and manage through IBM Spectrum Scale.
- Optional user storage pools that you create and manage through IBM Spectrum Scale.
- Optional external storage pools that you define with IBM Spectrum Scale policy rules and manage through an external application, such as IBM Spectrum Archive EE.

- Create filesets to provide a way to partition the file system namespace to allow administrative operations at a finer granularity than that of the entire file system.
- Create policy rules that are based on data attributes to determine initial file data placement and manage file data placement throughout the life of the file.

1.3.2 Storage pools

Physically, a *storage pool* is a collection of disks or RAID arrays. You can use storage pools to group multiple storage systems within a file system. By using storage pools, you can create tiers of storage by grouping storage devices based on performance, locality, or reliability characteristics. For example, one pool can be an enterprise class storage system that hosts high-performance FC disks and another pool might consist of numerous disk controllers that host a large set of economical SATA disks.

There are two types of storage pools in an IBM Spectrum Scale environment: Internal storage pools and external storage pools. Internal storage pools are managed within IBM Spectrum Scale. External storage pools are managed by an external application, such as IBM Spectrum Archive EE. For external storage pools, IBM Spectrum Scale provides tools that you can use to define an interface that IBM Spectrum Archive EE uses to access your data.

IBM Spectrum Scale does not manage the data that is placed in external storage pools. Instead, it manages the movement of data to and from external storage pools. You can use storage pools to perform complex operations such as moving, mirroring, or deleting files across multiple storage devices, which provide storage virtualization and a single management context.

Internal IBM Spectrum Scale storage pools are meant for managing online storage resources. External storage pools are intended for use as near-line storage and for archival and backup operations. However, both types of storage pools provide you with a method to partition file system storage for the following considerations:

- Improved price-performance by matching the cost of storage to the value of the data
- Improved performance by:
  - Reducing the contention for premium storage
  - Reducing the impact of slower devices
  - Allowing you to retrieve archived data when needed
- Improved reliability by providing for:
  - Replication based on need
  - Better failure containment
  - Creation of storage pools as needed

1.3.3 Policies and policy rules

IBM Spectrum Scale provides a means to automate the management of files by using policies and rules. If you correctly manage your files, you can use and balance efficiently your premium and less expensive storage resources. IBM Spectrum Scale supports the following policies:

- File placement policies are used to place automatically newly created files in a specific storage pool.
- File management policies are used to manage files during their lifecycle by moving them to another storage pool, moving them to near-line storage, copying them to archival storage, changing their replication status, or deleting them.

A policy is a set of rules that describes the lifecycle of user data that is based on the file's attributes. Each rule defines an operation or definition, such as migrate to a pool and replicate the file. The rules are applied for the following uses:

- Initial file placement
- File management
- Restoring file data

When a file is created or restored, the placement policy determines the location of the file's data and assigns the file to a storage pool. All data that is written to that file is placed in the assigned storage pool. The placement policy that is defining the initial placement of newly created files and the rules for placement of restored data must be installed into IBM Spectrum Scale by running the **mmchpolicy** command. If an IBM Spectrum Scale file system does not have a placement policy that is installed, all the data is stored into the system storage pool. Only one placement policy can be installed at a time.

If you switch from one placement policy to another, or change a placement policy, that action has no effect on existing files. However, newly created files are always placed according to the currently installed placement policy.

The management policy determines file management operations, such as migration and deletion. To migrate or delete data, you must run the **mmapplypolicy** command. You can define the file management rules and install them in the file system together with the placement rules. As an alternative, you can define these rules in a separate file and explicitly provide them to **mmapplypolicy** by using the **-P** option. In either case, policy rules for placement or migration can be intermixed. Over the life of the file, data can be migrated to a different storage pool any number of times, and files can be deleted or restored.

With Version 3.1, IBM Spectrum Scale introduced the policy-based data management that automates the management of storage resources and the data that is stored on those resources. Policy-based data management is based on the storage pool concept. A storage pool is a collection of disks or RAIDs with similar properties that are managed together as a group. The group under which the storage pools are managed together is the file system.

IBM Spectrum Scale provides a single name space across all pools. Files in the same directory can be in different pools. Files are placed in storage pools at creation time by using placement policies. Files can be moved between pools based on migration policies and files can be removed based on specific policies.

For more information about the SQL-like policy rule language, see *IBM Spectrum Scale: Administration Guide*, which is available at this website:

https://www.ibm.com/support/knowledgecenter/STXKQY

IBM Spectrum Scale V3.2 introduced external storage pools. You can set up external storage pools and GPFS policies that allow the GPFS policy manager to coordinate file migrations from a native IBM Spectrum Scale online pool to external pools in IBM Spectrum Archive EE. The GPFS policy manager starts the migration through the HSM client command-line interface embedded in the IBM Spectrum Archive EE solution.

For more information about GPFS policies, see the migration section in the *IBM Spectrum Archive Enterprise Edition: Installation and Configuration Guide*, SG24-8333.

1.3.4 Migration or premigration

The migration or premigration candidate selection is identical to the IBM Spectrum Scale native pool-to-pool migration/premigration rule. The Policy Engine uses the **`ltfsee migrate`** or **`ltfsee premigrate`** command for the migration or premigration of files from a native storage pool to an IBM Spectrum Archive EE tape cartridge pool.

There are two different approaches that can be used to drive an IBM Spectrum Archive EE migration through GPFS policies: manual and automated. These approaches are only different in how the **`mmapplypolicy`** command (which performs the policy scan) is started.

Manual

The manual IBM Spectrum Scale driven migration is performed when the user or a UNIX cron job runs the **`mmapplypolicy`** command with a predefined migration or premigration policy. The rule covers the migration or premigration of files from the system pool to the external IBM Spectrum Scale pool, which means that the data is physically moved to the external tape pool, which must be defined in IBM Spectrum Archive EE.

Automated

The GPFS threshold migration is performed when the user specifies a threshold policy and the GPFS policy daemon is enabled to monitor the storage pools in the file system for that threshold. If a predefined high threshold is reached (which means the filling level of the storage pool reached the predefined high water mark), the monitor daemon automatically starts the **`mmapplypolicy`** command to perform an inode scan.

For more information about migration, see the *IBM Spectrum Archive Enterprise Edition V1.2.5.1 Installation and Configuration Guide*, SG24-8333.

1.3.5 Active File Management

IBM Spectrum Scale Active File Management (AFM) is a scalable, high-performance file-system caching layer that is integrated with the IBM Spectrum Scale cluster file system. AFM is based on a home-cache model. A single home provides the primary file storage that is exported. One or more caches provide a view into the exported home file system without storing the file data locally. Upon file access in the cache, the data is fetched from home and stored in cache.

Another way to get files transferred from home to cache is through prefetching. Prefetching can use the IBM Spectrum Scale policy engine to quickly identify files that match certain criteria.

When files are created or changed in cache, they can be replicated back to home. A file that was replicated back to home can be evicted in cache, whereby the user still sees the file in cache (the file is uncached), but the actual file content is stored in home. Eviction is triggered by the quota that is set on the AFM fileset and can evict files based on size or last recent used criteria.

Cache must be an IBM Spectrum Scale independent fileset. Home can be an IBM Spectrum Scale file system, a Network File System (NFS) export from any other file system, or a file server (except for the disaster-recovery use case). The caching relationship between home and cache can be based on the NFS or native IBM Spectrum Scale protocol. In the latter case, home must be an IBM Spectrum Scale file system in a different IBM Spectrum Scale cluster. The examples in this Redpaper that feature AFM use an NFS protocol at the home cluster.

The AFM relation is typically configured on the cache fileset in one specific mode. The AFM mode determines where files can be processed (created, updated, and deleted) and how files are managed by AFM according to the file state. See Figure 1-5 on page 16 for AFM file states.

Important: IBM Spectrum Archive EE V1.2.3.0 is the first release that supports IBM Spectrum Scale AFM with IBM Spectrum Scale V4.2.2.3. AFM has multiple cache modes that can be created. However, IBM Spectrum Archive EE only supports the independent-writer (IW) cache mode. More cache modes may be supported in the near future.

Independent-writer

AFM's IW cache mode makes home the AFM target for one or more caches. All changes in the caches are replicated to home asynchronously. Changes to the same data will be applied in the home fileset so that the changes are replicated from the caches. There is no cross-cache locking. Potential conflicts must be resolved at the respective cache site

A file in the AFM cache can have different states as shown in Figure 1-5. File states can be different depending on the AFM modes.

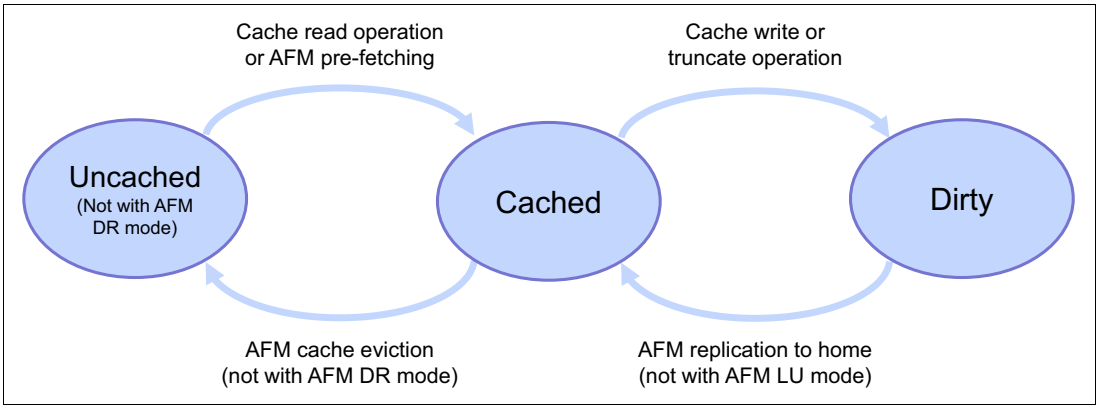

Figure 1-5 AFM file state transitions

Uncached

When an AFM relation is created between cache and home, and files are available in home, these files can be seen in cache without being present. This state means that the file metadata is present in the cache, but the file content is still on home. Such files are in status uncached. In addition, the uncached status is achieved by evicting files from the cache.

Cached

When an uncached file is accessed in cache for a read or write operation, the file is fetched from home. Fetching is the process of copying a file from home to cache. Files fetched from home to cache are in cached state. Another way to fetch files from home to cache is by using the AFM prefetch command (**`mmafmctl prefetch`**). This command can leverage the policy engine to identify files quickly, according to certain criteria.

Dirty

When a cached file in the AFM cache is modified, that file is marked as `dirty`, indicating that it is a candidate for replication back to home. The `dirty` status of the file is reset to cached if the file has been replicated to home. When a file is deleted in cache, this delete operation will also be done on home.

For information about how to configure AFM with IBM Spectrum Archive EE, see the Configuration chapter and Use Case chapter in the *IBM Spectrum Archive Enterprise Edition V1.2.5.1 Installation and Configuration Guide*, SG24-8333.

1.4 OpenStack SwiftHLM

The Swift High Latency Media (SwiftHLM) project seeks to create a high-latency storage back end that makes it easier for users to perform bulk operations of data tiering within a Swift data ring. SwiftHLM enables IBM Spectrum Scale, IBM Spectrum Archive, and IBM Spectrum Protect™ as the key products for this software-defined hybrid storage with object interface to tape technology.

Data is produced at significantly higher rates than a decade ago. The storage and data management solutions of the past can no longer keep up with the data demands of today. The policies and structures that decide and execute how that data is used, discarded, or retained determines how efficiently the data is used. The need for intelligent data management and storage is more critical now than ever before.

Traditional management approaches hide cost-effective, high-latency media (HLM) storage, such as tape or optical disk archive back ends, underneath a traditional file system. The lack of HLM-aware file system interfaces and software makes it difficult for users to understand and control data access on HLM storage. Coupled with data-access latency, this lack of understanding results in slow responses and potential time-outs that affect the user experience.

The Swift HLM project addresses this challenge. Running OpenStack Swift on top of HLM storage allows you to cheaply store and efficiently access large amounts of infrequently used object data. Data that is stored on tape storage can be easily adopted to an Object Storage data interface. SwiftHLM can be added to OpenStack Swift (without modifying Swift) to extend Swift's interface. This ability allows users to explicitly control and query the state (on disk or on HLM) of Swift object data, including efficient pre-fetch of bulk objects from HLM to disk when those objects must be accessed.

This function, previously missing in Swift, provides similar functions as Amazon Glacier does through the Glacier API or the Amazon S3 Lifecycle Management API.

BDT Tape Library Connector (open source) and IBM Spectrum Archive or IBM Spectrum Protect are examples of HLM back ends that provide important and complex functions to manage HLM resources (tape mounts and unmounts to drives, serialization of requests for tape media, and tape drive resources). They can use SwiftHLM functions for a proper integration with Swift.

Although access to data that is stored on HLM can be done transparently without the use of SwiftHLM, this process does not work well in practice for many important use cases and other reasons. SwiftHLM function can be orthogonal and complementary to Swift (ring to ring) tiering (source).

The high-level architecture of the low cost, high-latency media storage solution is shown in Figure 1-6. For more information see *Implementing OpenStack SwiftHLM with IBM Spectrum Archive EE or IBM Spectrum Protect for Space Management*, REDP-5430.

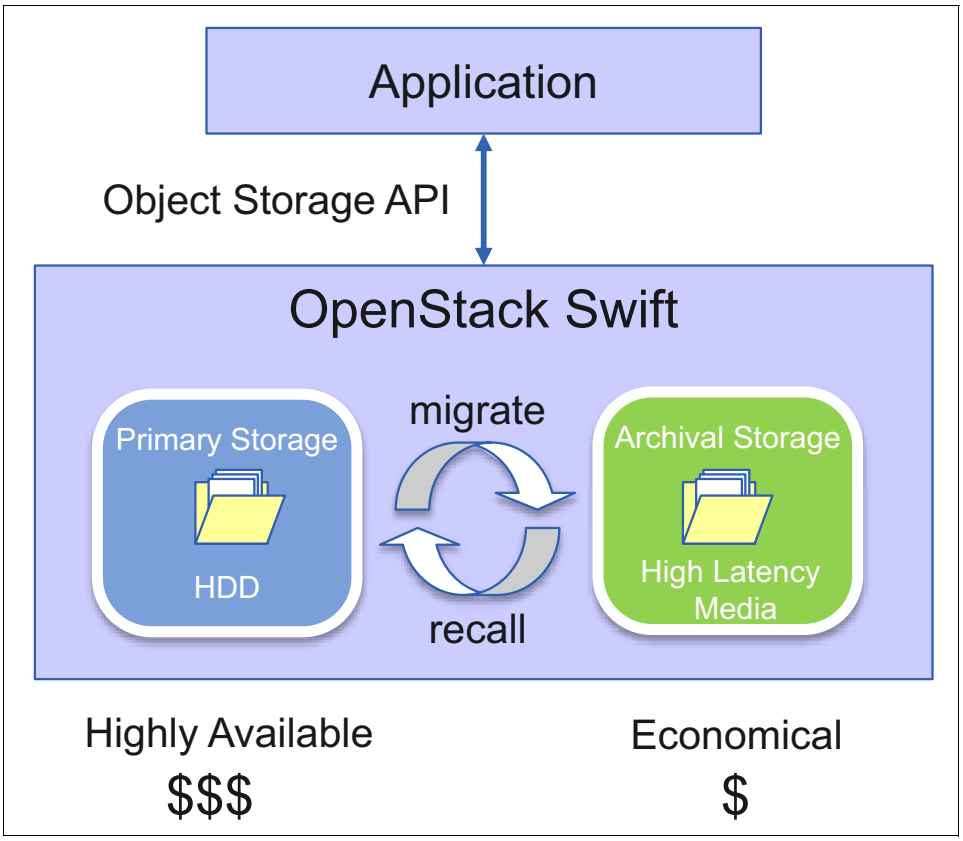

Figure 1-6 High level SwiftHLM architecture

1.5 IBM Spectrum Archive EE Dashboard

IBM Spectrum Archive EE V1.2.4.0 introduces dashboard capabilities allowing customers the ability to visualize their data through a graphical user interface (GUI). By using the Dashboard, you can accomplish these tasks using a web browser rather than logging in to a system and typing commands:

- See if a system is running without error. If there is an error, see what kind of error is detected.
- See basic tape related configurations like how many pools and how much space is available.
- See time-scaled storage consumption for each tape pool.
- See the throughput for each drive for migration and recall.

This monitoring feature consists of multiple components that are installed in the IBM Spectrum Archve EE nodes as well as dedicating an external node for displaying the Dashboard.

The Dashboard consists of the following components:

- Logstash
- Elasticsearch
- Grafana

Logstash is used for data collection, and should be installed on all IBM Spectrum Archive EE nodes. The data collected by Logstash is then sent to Elasticsearch on the external monitoring node where it can query data quickly and send it to the Grafana component for visualization. Figure 1-7 shows the IBM Spectrum Archive EE Dashboard architecture.

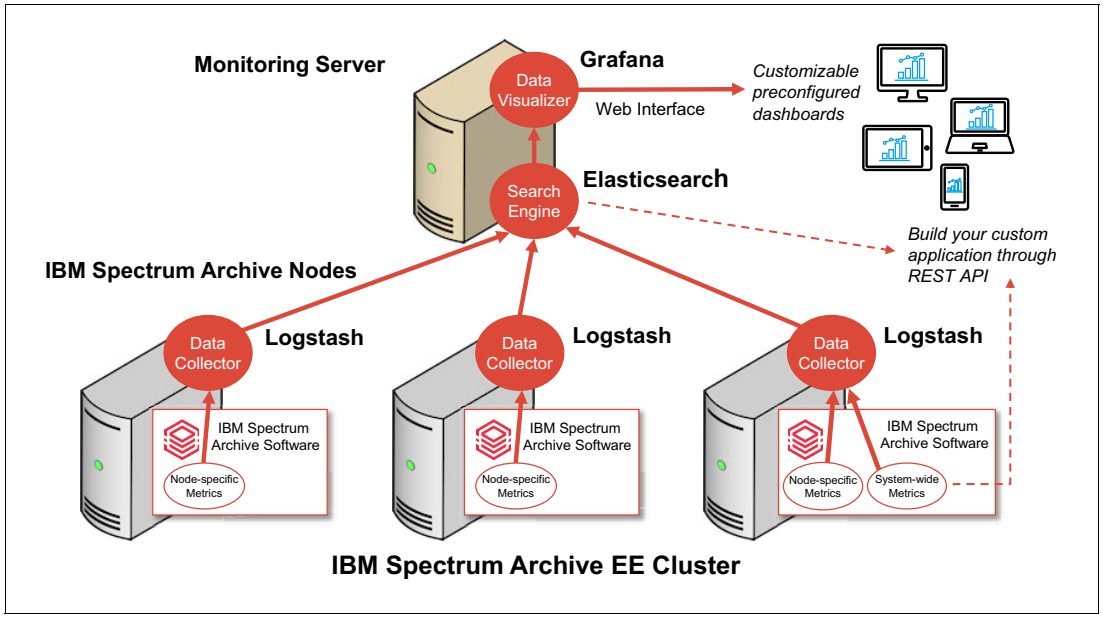

Figure 1-7 IBM Spectrum Archive Dashboard architecture

The Dashboard views are System Health, Storage, Activity, and Config. Figure 1-8 is an example of the IBM Spectrum Archive EE Dashboard Activity view.

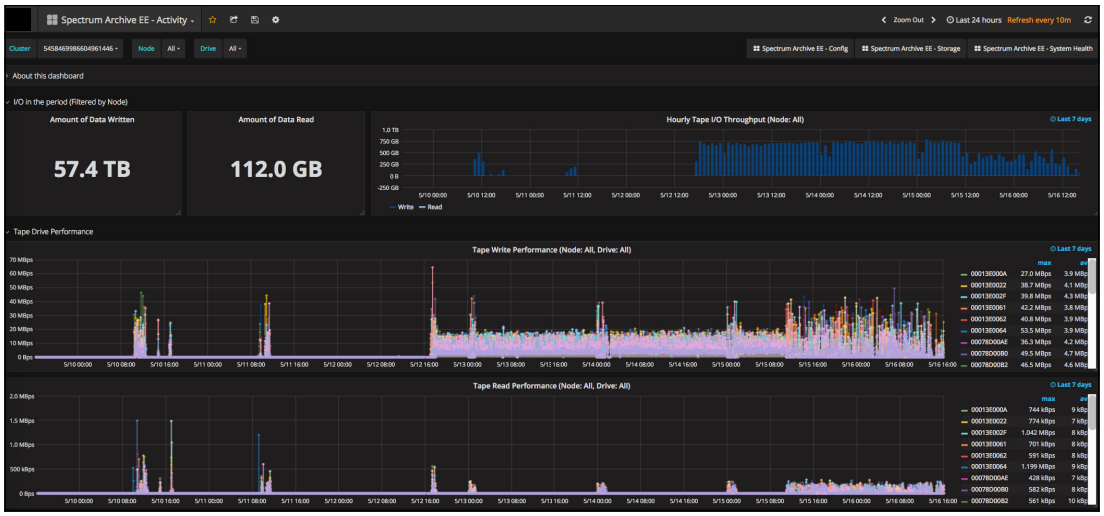

Figure 1-8 IBM Spectrum Archive EE Dashboard activity view

For more information on configuring the Dashboard within your environment, see the *IBM Spectrum Archive Enterprise Edition Dashboard Deployment Guide* at:

https://www.ibm.com/developerworks/community/wikis/form/anonymous/api/wiki/fa32927c-e904-49cc-a4cc-870bcc8e307c/page/89889f48-40ee-41b6-9510-5b6de6fc8409/attachment/779a3b43-cd79-42a7-919a-bf7e2bb03c06/media/SpectrumArchiveDashboard-DeploymentGuide.pdf

1.6 IBM Spectrum Archive EE REST API

The representational state transfer (REST) API for IBM Spectrum Archive Enterprise Edition can be used to access data on the IBM Spectrum Archive Enterprise Edition system. Starting from Version 1.2.4, IBM Spectrum Archive EE provides the configuration information through its REST API. The GET operation will return the array of configured resources as similar as its CLI commands, but in well-defined JSON format. They are equivalent to what "ltfsee info XXX" and "ltfsee XXX show" commands display. With the REST API, you can automate these queries and integrate the information into your applications including the web/cloud.

For installation instructions and usage examples see the *IBM Spectrum Archive Enterprise Edition V1.2.5.1 Installation and Configuration Guide*, SG24-8333.

1.7 Types of archiving

It is important to differentiate between archiving and the HSM process that is used by IBM Spectrum Archive EE. When a file is migrated by IBM Spectrum Archive EE from your local system to tape storage, a placeholder or stub file is created in place of the original file. Stub files contain the necessary information to recall your migrated files and remain on your local file system so that the files appear to be local. This process contrasts with archiving, where you often delete files from your local file system after archiving them.

The following types of archiving are used:

- Archive with no file deletion
- Archive with deletion
- Archive with stub file creation (HSM)
- Compliant archiving

Archiving with no file deletion is the typical process that is used by many backup and archive software products. In the case of IBM Spectrum Protect, an archive creates a copy of one or more files in IBM Spectrum Protect with a set retention period. It is often used to create a point-in-time copy of the state of a server's file system and this copy is kept for an extended period. After the archive finishes, the files are still on the server's file system.

Contrast this with archiving with file deletion where after the archive finishes the files that form part of the archive are deleted from the file system. This is a feature that is offered by the IBM Spectrum Protect archive process. Rather than a point-in-time copy, it can be thought of as a point-in-time move as the files are moved from the servers' file system into IBM Spectrum Protect storage.

If the files are needed, they must be manually retrieved back to the file system. A variation of this is *active archiving*, which is a mechanism for moving data between different tiers of storage depending on its retention requirements. For example, data that is in constant use is kept on high-performance disk drives, and data that is rarely referenced or is required for long-term retention is moved to lower performance disk or tape drives.

IBM Spectrum Archive EE uses the third option, which instead of deleting the archived files, it creates a stub file in its place. If the files are needed, they are automatically retrieved back to the file system by using the information that is stored in the stub file when they are accessed.

The final type of archiving is compliant archiving, which is a legislative requirement of various countries and companies data retention laws, such as Sarbanes-Oxley in the US. These require a business to retain key business information. Failure to comply with these laws can result in fines and sanctions. Essentially, this type of archiving results in data being stored by the backup software without the possibility of it being deleted before a defined period elapses. In certain cases, it can never be deleted.

Important: IBM Spectrum Archive EE is not a compliant archive solution.

2

IBM Spectrum Archive Single Drive Edition

IBM Spectrum Archive Single Drive Edition (SDE) provides direct, intuitive, and graphical access to data stored in IBM tape drives. These drives include LTO Ultrium 8, M8, 7, 6, and 5 tape cartridges, as well as IBM 3592 tape cartridges with IBM TS1155, TS1150, or IBM TS1140 tape drives. IBM Spectrum Archive eliminates the need for additional tape management and software to access data. LTFS is the first file system that works with IBM System Storage tape technology to optimize ease of use and portability for open-systems tape storage.

Note: Throughout this chapter, the terms *supported tape drives* and *supported tape media* are used to represent the following tape drives and tape media. Unless otherwise noted, as of the published date of this book, IBM Spectrum Archive SDE supports IBM LTO Ultrium 8, 7, 6, or 5 tape drives, and IBM TS1155, TS1150, or TS1140 tape drives. The tape media that are supported are LTO Ultrium 8, M8, 7, 6, and 5, and 3592 JC, JB, JD, JK, and JL.

Refer to the IBM Spectrum Archive Single Drive Edition website to check for the latest tape drives and tape media:

https://www.ibm.com/systems/storage/tape/ltfs/specifications.html

IBM Spectrum Archive Single Drive Edition was announced when media partitioning capability became available as part of the LTO-5 tape drive technology. IBM created LTFS as a self-describing tape file system, which means implementing a true file system for tape. IBM Spectrum Archive SDE can write files directly to tape media by using operating system commands and without any additional application. The tape drive appears on the operating system as though it is a USB-attached disk drive. Data can be easily written by dragging and dropping files to or from a tape drive, making it practical and easy to use.

With the recent announcement of IBM Linear Tape-Option Ultrium 8 (LTO-8) specifications, tape storage again provides several advantages to clients over other forms of data storage. For example, tape storage now provides capacity up to 12 TB native capacity per tape cartridge in addition to reliability, portability, cost efficiency, and energy efficiency.

IBM Spectrum Archive SDE is available for Linux, Mac, and Microsoft Windows systems and is available for no extra fee from the IBM Fix Central website:

https://www.ibm.com/support/fixcentral

Refer to the IBM Spectrum Archive Single Drive Edition Knowledge Center for the current supported operating systems and hardware platforms:

https://www.ibm.com/support/knowledgecenter/en/STQNYL

The following topics are included:

- Introduction to IBM Spectrum Archive SDE
- Installation on Linux
- Installation on Mac OS X
- Installation on Windows
- Managing IBM Spectrum Archive SDE
- Troubleshooting
- Command reference
- Tools

2.1 Introduction to IBM Spectrum Archive SDE

LTFS is the first file system starting with LTO generation 5 and IBM TS1140 tape drives to set a new standard for ease of use and portability for open systems tape storage. With IBM Spectrum Archive SDE, accessing data that is stored on an IBM tape cartridge is as easy and intuitive as using a USB flash drive. Tapes are self-describing, and you can quickly recall any file from a tape without having to read the whole tape from beginning to end. Furthermore, any LTFS-capable system can read a tape that is created by any other LTFS-capable system (regardless of the operating system platform). Any LTFS-capable system can identify and retrieve the files that are stored on it. LTFS-capable systems have the following characteristics:

- Files and directories are displayed to you as a directory tree listing.
- More intuitive searches of cartridge and library content are now possible due to the addition of file tagging.
- Files can be moved to and from LTFS tape by using the familiar drag-and-drop metaphor common to many operating systems.
- Many applications that were written to use files on disk can now use files on tape without any modification.
- All standard File Open, Write, Read, Append, Delete, and Close functions are supported.

Archival data storage requirements are growing at over 60% annually. The LTFS format is an ideal option for long-term archiving of large files that need to be easily shared with others. This option is especially important because the LTO tape media that it uses are designed to have a 15-year to 30-year lifespan (depending on the number of read/write passes).

Industries that benefit from this tape file system are the banking, digital media, medical, geophysical, and entertainment industries. Many users in these industries use Linux or Macintosh systems, which are fully compatible with LTFS.

It is important to note that LTO Ultrium cartridges from earlier LTO generations (that is LTO-1 through LTO-4) are not partitionable and therefore cannot be used by LTFS. If LTO Ultrium 4 cartridges are used in an LTO Ultrium 5 drive to write data, the LTO-4 cartridge is treated like an unpartitioned LTO-5 cartridge. Even if an application can deal with partitions, it is not possible to partition the LTO-4 media that is mounted at an LTO Ultrium 5 drive. Similarly, Write Once Read Many (WORM) cartridges of any generation cannot be used by LTFS because they cannot be partitioned.

Although TS1140 tape drives are also supported by IBM Spectrum Archive SDE version 1.3.0 and later, for simplicity, only LTO tape drives are discussed.

Although IBM Spectrum Archive SDE presents the tape cartridge as a disk drive, remember that the underlying hardware is still a tape cartridge and is therefore sequential in nature. Tape does not allow random access. Data is always appended to the tape, and there is no overwriting of files. File deletions do not actually erase the data from tape but simply erase the pointers to the data. Although you can simultaneously copy two (or more) files to an LTFS tape with IBM Spectrum Archive SDE, you get better performance if you copy files sequentially.

To operate the tape file system, the following components are needed:

- Software in the form of an open source IBM Spectrum Archive SDE package
- Hardware, consisting of IBM supported tape drives and supported tape media
- Data structures that are created by IBM Spectrum Archive SDE on tape

Together, these components can handle a file system on LTO media as though it is a disk file system for accessing tape files, including the tape directory tree structures. The metadata of each cartridge, after it is mounted, is cached in server memory. Metadata operations, such as browsing the directory or searching for a file name, therefore do not require any tape movement and are quick.

2.1.1 Downloading IBM Spectrum Archive SDE

IBM Spectrum Archive SDE is distributed similarly to other IBM tape device drivers in that you can download it *at no charge*. For more information and a list of supported operating systems, see the following IBM Tape Storage Systems page:

`http://www.ibm.com/systems/storage/tape/ltfs/index.html`

IBM maintains the latest levels of tape-related IBM System Storage software, the tape device driver, the IBM Spectrum Archive SDE software package, and documentation at the Fix Central download portal:

`http://www.ibm.com/support/fixcentral`

To download the latest version of IBM Spectrum Archive SDE, complete these steps:

1. From the main Fix Central page, select the following options:
   a. For **Product Group**, select **System Storage**.
   b. For **System Storage**, select **Tape systems**.
   c. For **Tape systems**, select **Tape drivers and software**.
   d. For **Tape drivers and software**, select **IBM Spectrum Archive Single Drive Edition (SDE)**.
   e. For **Platform**, to download the latest version of IBM Spectrum Archive SDE, select the correct platform.
   f. Click **Continue**.
2. In the next window, select the IBM Spectrum Archive SDE fix pack to download and click **Continue**. Alternatively, you can select any of the following options:
   – IBM Knowledge Center URL:

     `https://www.ibm.com/support/knowledgecenter/en/STQNYL`
   – LTFS format specifications:

     `http://www.ibm.com/support/docview.wss?rs=577&uid=ssg1S7003166`
   – IBM Spectrum Archive SDE Support Matrix
   – Installation file
   – Readme file
3. On the Download Options page, select the method that you want to use to download the IBM Spectrum Archive SDE and click **Continue**.
4. On the Terms and Conditions page, click **I agree**.
5. On the Download files page, click **Download now**.

2.1.2 Tape format compatibility

The Storage Networking Industry Association[1] (SNIA) defines the LTFS Format Specification as a file system format separate from any implementation on data storage media. Using this format, data is stored in LTFS Volumes. An LTFS Volume holds data files and corresponding metadata to completely describe the directory and file structures stored on the volume.

The LTFS Format has these features:

- An LTFS Volume can be mounted and volume content accessed with full use of the data without the need to access other information sources.
- Data can be passed between sites and applications using only the information written to an LTFS Volume.
- Files can be written to, and read from, an LTFS Volume using standard POSIX file operations.

The LTFS Format is particularly suited to these usages:

- Data export and import.
- Data interchange and exchange.
- Direct file and partial file recall from sequential access media. Archival storage of files using a simplified, self-contained or “self-describing” format on sequential access media.

The LTFS Bulk Transfer standard defines a method by which a set of files, directories, and objects from a source system can be transferred to a destination system. The bulk transfer of large quantities of data is well suited for LTFS due to the economic and environmental characteristics of tape. Building on top of the LTFS format, a standardized method for transferring data is defined that provides many advantages.

The LTFS tape format version is updated from 2.2.0 to 2.4.0. For a PDF of the latest version, see the following LTFS Format Specification website:

https://www.snia.org/tech_activities/standards/curr_standards/ltfs

Formatting media: The **ltfsck** utility checks and recovers media (2.7.3, “Checking or recovering a tape with the ltfsck command” on page 102). The **mkltfs** utility formats media (2.7.2, “Formatting a tape with the mkltfs command” on page 99). The **ltfsck** command in the older LTFS package cannot be used to check and recover a medium that is formatted to version 2. A medium that is formatted to version 2 cannot be converted to a 1.0 version format. By using the **mkltfs** command from a 1.0.x LTFS version, you can reformat the medium to a 1.0 format.

[1] Storage Networking Industry Association (SNIA), https://www.snia.org/tech_activities/standards/curr_standards/ltfs

2.1.3 Recent enhancements

The following enhancements were made to IBM Spectrum Archive SDE version 2.4.0 since version 2.2.2:

- New hardware support
  - IBM LTO8 tape drive support
- LTFS Format Specifications 2.4.0
  - Special character handling

    The following characters are now allowed for file names and extended attribute names: Colon ":", U+0001 through U+001E (TAB, LF, and CR were previously accepted in prior format). Surrogate blocks, BOM, NULL character (U+0000), and characters that cannot be converted to UTF-16, UTF-8 or NFC normalization will continue to be rejected for file names and extended attribute names.

    Special care is required for the colon ":" character on the Windows platform because the colon ":" character is not allowed. Any files created on Linux or Mac OS X that contains a colon will be encoded to allow Windows to display the file name. The colon ":" on Windows will be replaced with the percent encoded string for colon ":" which is %3A. For example, the file `Testfile:1.txt` on Linux will be shown as `Testfile%3A1.txt` on Windows.
  - Permanent write error handling

    To avoid "false positives" scenarios, the error handling for permanent write failures has been improved.
  - Volume advisory locking

    A new virtual extended attribute (VEA) called `ltfs.volumeLockState` has been introduced to change the cartridge's advisory lock status:

    `unlocked (0)`: The volume may be modified.

    `locked (1)`: The volume cannot be modified other than to change the volume advisory lock state.

    `permlocked (2)`: The volume is permanently locked and cannot be modified in any way.
  - Media pool MAM attribute

    Two new virtual extended attributes (VEA) called `ltfs.mediaPool.name` and `ltfs.mediaPool.additionalInfo` have been introduced to write data only to the cartridge's MAM field "MEDIA POOL". The value of the MAM field "MEDIA POOL" is "NAME[INFO]" where NAME is the pool name (specified by `ltfs.mediaPool.name`) and INFO is the supplied additional information about the cartridge (specified by `ltfs.mediaPool.additionalInfo`).

2.2 Installation on Linux

The installation, implementation, and usage of IBM Spectrum Archive SDE are explained. This information is based on the documentation that is published in the IBM Spectrum Archive SDE section of IBM Knowledge Center:

https://www.ibm.com/support/knowledgecenter/STQNYL

2.2.1 Hardware and software requirements

The requirements for IBM Spectrum Archive SDE implementation are listed. At the time of writing this book, IBM Spectrum Archive SDE supports the following Linux operating systems and hardware platforms:

- Supported Linux operating systems (x86_64 and ppcle only):
  - Red Hat Enterprise Linux 7.2 and 7.3
- Supported hardware:
  - Compatible machine
  - x86_64 or Power PC processor
  - 1 GB available RAM for each 1,000,000 files to be stored on a particular tape
  - The IBM Spectrum Archive supported tape drives support Fibre Channel (FC) host bus adapter (HBA)
  - The IBM Spectrum Archive supported LTO tape drives support Serial-attached Small Computer System Interface (SCSI) (SAS) HBA

For more information about connectivity and configurations, see the IBM System Storage Interoperation Center (SSIC) website.

Readme file: The current information for IBM Spectrum Archive SDE supported hardware and software configurations and notices or limitations is in the IBM Spectrum Archive SDE program readme file.

2.2.2 Prerequisites

You need to install certain software *before* you install IBM Spectrum Archive SDE. IBM Spectrum Archive SDE requires the following software. All of these products, other than the tape device driver, are already installed if the latest service packs for your Linux version are installed:

- FUSE
  - fuse
  - fuse-libs
- libxml2
- libuuid
- libicu
- IBM Tape Device Driver for Linux (lin_tape)
- ITDT, although not a prerequisite, is invaluable in configuring IBM Spectrum Archive SDE and troubleshooting tape drive issues and needs to be installed.

To check whether FUSE is installed, run the following command:

```
# lsmod | grep fuse
```

Check its version by using this command:

```
# rpm -qa|grep fuse
```

If any of the modules are not listed, you must load them before you proceed with the IBM Spectrum Archive SDE installation. For more details, see 2.2.4, “Installation procedure” on page 30.

2.2.3 Installing the HBA and HBA device driver

To install the HBA and its device driver for the use of FC tape drives with IBM Spectrum Archive SDE, see the HBA manufacturer documentation. For more information about connectivity, configurations, and supported adapters, see the SSIC website:

http://www.ibm.com/systems/support/storage/config/ssic

2.2.4 Installation procedure

The procedure to install the IBM Spectrum Archive SDE program on a Linux system is explained in this section.

Installing FUSE

Complete the following steps to install the required software on a Linux system:

1. Log on as an administrator.
2. Run the following command to install the FUSE packages.

```
# yum install fuse fuse-libsInstalling the IBM Tape Device Driver
```

Linux: The installation of an IBM Tape Device Driver is required only for Linux.

Before you install the IBM Tape Device Driver for use with IBM Spectrum Archive SDE, complete the following tasks:

1. Connect the tape drive and HBA.
2. Power on the tape drive.
3. Power on the server.
4. Install the tape device driver:
   a. Download the most recent version of the IBM Tape Device Driver from the IBM Fix Central portal (see also “Downloading IBM Spectrum Archive SDE” on page 26):

      http://www.ibm.com/support/fixcentral

   b. Download the *IBM Tape Device Drivers Installation and User’s Guide* from the IBM Support and Download site:

      http://www.ibm.com/support/docview.wss?rs=577&uid=ssg1S7002972

   c. Follow the procedures in the *IBM Tape Device Drivers Installation and User’s Guide* (summarized) to install the IBM Tape Device Driver (Example 2-1).

Example 2-1 Procedure to install the IBM Tape Device Driver

```
# rpmbuild --rebuild lin_tape-1.74.0-1.src.rpm

# rpm -ivh /usr/src/packages/RPMS/x86_64/lin_tape-1.74.0-1.x86_64.rpm
Preparing...                ########################################### [100%]
   1:lin_tape               ########################################### [100%]
Starting lin_tape: FATAL: module
'/lib/modules/3.0.13-0.27-default/kernel/drivers/scsi/lin_tape.ko' is unsupported
```

```
Use --allow-unsupported or set allow_unsupported_modules to 1 in
/etc/modprobe.d/unsupported-modules
lin_tape loaded

# vi /etc/modprobe.d/unsupported-modules

# /etc/init.d/lin_tape restart
Shutting down lin_tape:
Starting lin_tape:

# cat /proc/scsi/IBM*
lin_tape version: 1.74.0
lin_tape major number: 251
lin_tape version: 1.74.0
lin_tape major number: 251
Attached Tape Devices:
Number  model       SN                HBA             SCSI            FO Path
0       ULT3580-HH6 1068000264        MPT SAS Host    0:0:1:0         NA
```

Enabling the system log

Error information for IBM Spectrum Archive SDE operations is displayed on the terminal console. The level of error reporting is based on the log trace level. To set the log trace level, go to the IBM Spectrum Archive SDE section of IBM Knowledge Center **topic** for “setting log trace level”:

https://www.ibm.com/support/knowledgecenter/en/STQNYL_2.4.0/ltfs_managing_troubleshooting_set_log_trace.html

When the IBM Spectrum Archive SDE commands are used, error and trace information is recorded by using the system log mechanism. This mechanism is disabled by default. To enable the LTFS system log and locate more information about LTFS logs, follow these steps:

1. Log on to the operating system as `root`.
2. Edit the system log configuration file on any available editor to enable the system log. Apply the following edits, as shown in Example 2-2.

Example 2-2 System log configuration file

```
Add the following line to /etc/rsyslog.conf
:msg, contains, "LTFS" /var/log/ltfs.log
```

3. Enable the setting by restarting ryslog and issuing the following command:

```
systemctl restart rsyslog
```

4. Open the `/etc/logrotate.d/syslog` file on any available editor. Add or edit the lines shown in Example 2-3.

Example 2-3 Add or edit syslog file

```
/var/log/ltfs.log {
       size 1M
       rotate 4
       missingok
       compress
       sharedscripts
       postrotate
```

```
        /bin/kill -HUP `cat /var/run/syslogd.pid 2> /dev/null` 2> /dev/null ||
true
        /bin/kill -HUP `cat /var/run/rsyslogd.pid 2> /dev/null` 2> /dev/null ||
true
        endscript
              }
```

LTFS records and displays the following types of logs:

Error	A message that indicates an unrecoverable error occurred or an operation unexpectedly failed
Warning	A message that indicates an unexpected condition occurred, but the operation can continue
Information	A message that provides more information about the current operation
Trace	A message that provides information about debugging and troubleshooting

Installing IBM Spectrum Archive SDE

To install the IBM Spectrum Archive SDE program on a Linux system from a binary rpm file, complete the following steps from a Linux command prompt. The same procedure can be used for upgrading existing versions:

1. Log on as `root`.
2. If IBM Spectrum Archive SDE is already installed and mounted, unmount it by entering the following command (assuming `/mnt/ltfs` is the mounted directory):

   ```
   # umount /mnt/ltfs
   ```

3. Run the following command to install a binary rpm file:

   ```
   rpm -ivh ltfs-1.3.0.0-[revision]-[distribution].[arch].rpm
   ```

4. Optionally, run the following command to verify the current version of IBM Spectrum Archive SDE:

   ```
   rpm -qa | grep ltfs
   ```

2.2.5 Uninstallation procedure

Complete the following steps to uninstall IBM Spectrum Archive SDE software on a Linux system.

Important: Eject media from the LTFS drives before you uninstall IBM Spectrum Archive SDE to avoid losing data in the cache.

Use these steps:

1. Log on as `root`.
2. If the IBM Spectrum Archive SDE program is already installed and the tape media is mounted, unmount the tape media by running the following command:

   ```
   # umount /mnt/ltfs
   ```

3. Run the following command to remove the installed package:

   ```
   # rpm -e ltfs-1.3.0.0-[revision]
   ```

4. Remove the mount point:

```
# rmdir /mnt/ltfs
```

2.3 Installation on Mac OS X

This installation, implementation, and usage of IBM Spectrum Archive SDE explanation is based on the documentation that is published at the IBM Spectrum Archive SDE section of IBM Knowledge Center:

https://www.ibm.com/support/knowledgecenter/STQNYL

2.3.1 Hardware and software requirements

The following system hardware and software requirements relate to IBM Spectrum Archive SDE. The current information for IBM Spectrum Archive SDE supported hardware and software configurations and notices or limitations is in the readme file of the software package.

IBM Spectrum Archive SDE supports the following Mac operating systems and hardware platforms:

- Supported Mac operating systems:
  - Mac OS X 10.11 “El Capitan” (64-bit)
  - Mac OS X 10.12 “Sierra” (64-bit)
- Supported hardware:
  - Mac Pro (Intel)
  - x86_64 processor
  - 1 GB available RAM for each 1,000,000 files that are stored on a particular tape
  - The IBM Spectrum Archive supported tape drives support FC HBAs
  - The IBM Spectrum Archive supported LTO tape drives support SAS HBAs

For more information about connectivity and configurations, see the SSIC website:

http://www.ibm.com/systems/support/storage/config/ssic

Readme file: The current information for IBM Spectrum Archive SDE supported hardware and software configurations and notices or limitations is in the IBM Spectrum Archive SDE program readme file.

2.3.2 Prerequisites

You need to install this software *before* you install IBM Spectrum Archive SDE. IBM Spectrum Archive SDE has the following requirements:

- FUSE for OS X (included in the IBM Spectrum Archive SDE package)
- International Components for Unicode (ICU) Framework (included in the IBM Spectrum Archive SDE package)
- Xcode if you need to build an ICU Framework package or IBM Spectrum Archive SDE from its source code

2.3.3 Installing the HBA and HBA device driver

To install the HBA and its device driver to use FC tape drives with IBM Spectrum Archive SDE, see the documents that are provided by the HBA manufacturer. For more information about connectivity, configurations, and supported adapters, see the SSIC website:

http://www.ibm.com/systems/support/storage/config/ssic

2.3.4 Installation procedure

This section describes how to install the required software for IBM Spectrum Archive SDE on a Mac OS X system.

Administrator privileges: IBM Spectrum Archive SDE software and any prerequisites must be installed by an administrator.

Installing OSXFUSE

Tip: To help isolate problems, use the default log viewer of the operating system to sort and filter log entries.

Complete the following steps to install the required software on a Mac OS X system:

1. Log on as an administrator.
2. The OSXFUSE 2.3.9 Apple Disk Image file is included as part of the IBM Spectrum Archive SDE installation package. It can also be downloaded from http://osxfuse.github.com/ if required.
3. Mount the downloaded Apple Disk Image file (for example, OSXFUSE-2.5.2.dmg) by double-clicking the file.
4. Install the OSXFUSE package by double-clicking the `OSXFUSE.pkg` file in the mounted folder.

5. Follow the Installer utility instructions. To proceed with the installation, click **Install OSXFUSE** on the FUSE for OS X window, as shown in Figure 2-1.

Figure 2-1 OSXFUSE installation window

6. The Welcome to the OSXFUSE Installer window opens (Figure 2-2). Click **Continue**.

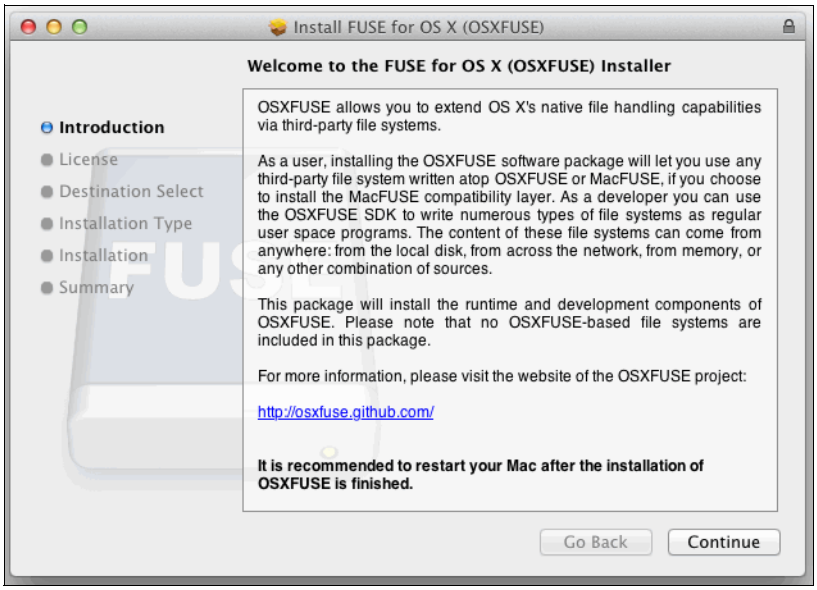

Figure 2-2 OSXFUSE Welcome window

7. The Software License Agreement window opens. Click **Continue**, as shown in Figure 2-3.

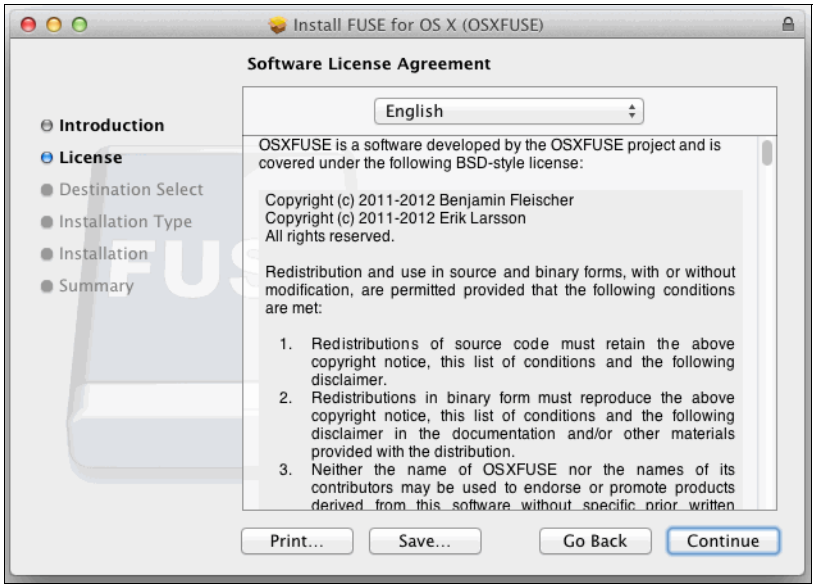

Figure 2-3 OSXFUSE installation software license agreement

8. A pop-up window opens that prompts you to agree to the terms of the Software License Agreement. To continue the OSXFUSE installation process, click **Agree**, as shown in Figure 2-4, and then click **Continue**.

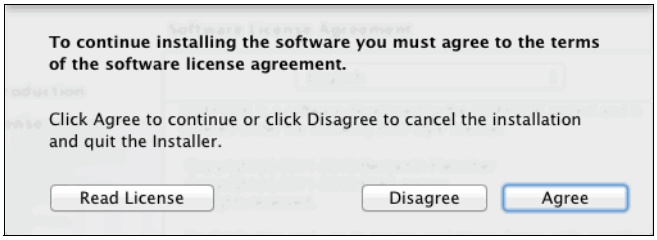

Figure 2-4 OSXFUSE installation software license agreement

9. The next window shows you the components of OSXFUSE 2.3.9 to be installed. Select the defaults and click **Continue** if you want to proceed with the installation. See Figure 2-5.

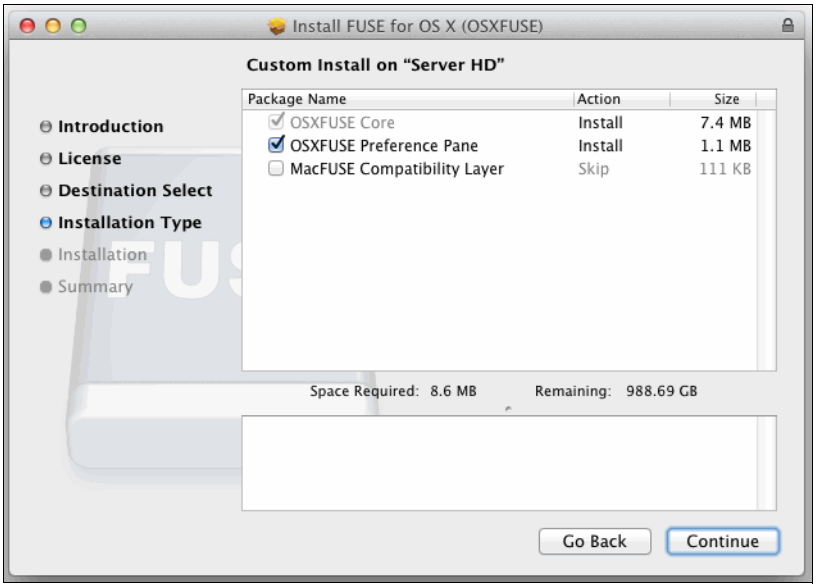

Figure 2-5 OSXFUSE installation package selection

10. The next window shows you the amount of disk space that is needed for the installation of OSXFUSE 2.3.9. Click **Install** if you want to proceed with the installation. See Figure 2-6.

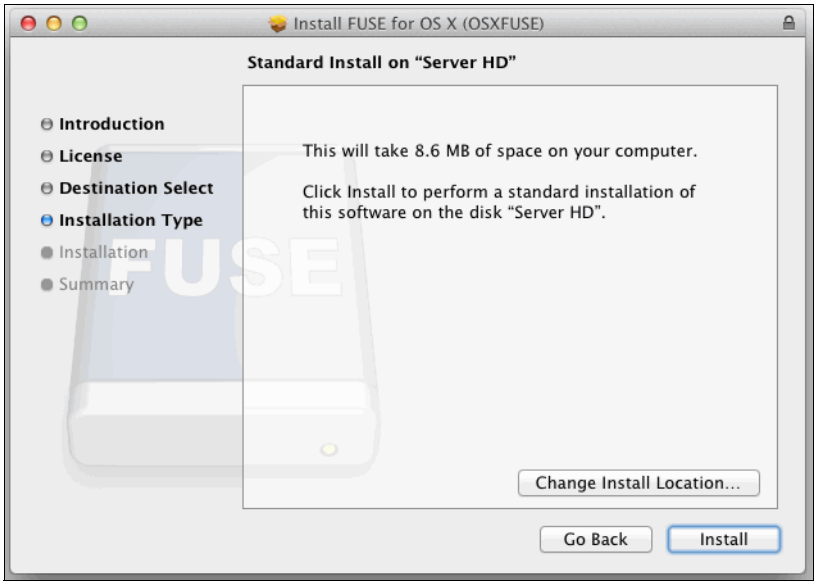

Figure 2-6 OSXFUSE installation disk space requirements

11. Enter the administrator password and click **Install Software**. See Figure 2-7.

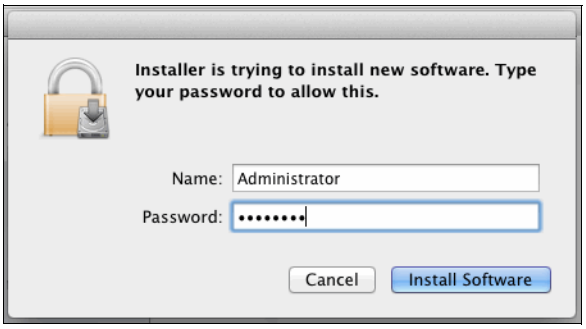

Figure 2-7 OSXFUSE installation password prompt

12. After you click Install, the completion message of the OSXFUSE installation process appears. See Figure 2-8.

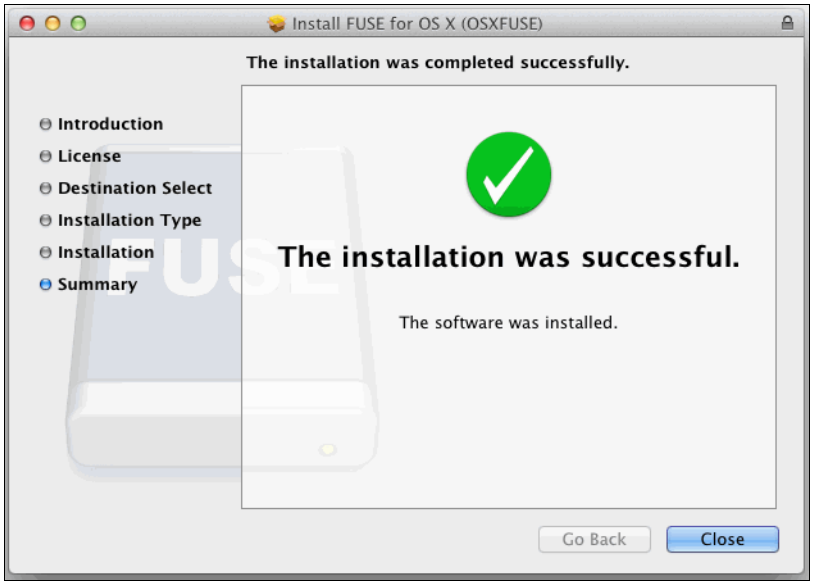

Figure 2-8 OSXFUSE installation completion

Installing the ICU Framework

Complete the following steps to install the required software on a Mac OS X system:

1. Log on as an administrator.
2. Mount the IBM Spectrum Archive SDE binary package Apple Disk Image file or source code by double-clicking it. For more information and procedures, see “Installation on Mac OS X” on page 33.

3. Install the ICU Framework package by double-clicking the **ICU Framework-4.8.1.1.pkg** file in the mounted folder. Figure 2-9 shows the Welcome to the ICU Framework Installer window. Click **Continue** to proceed with the ICU Framework installation steps.

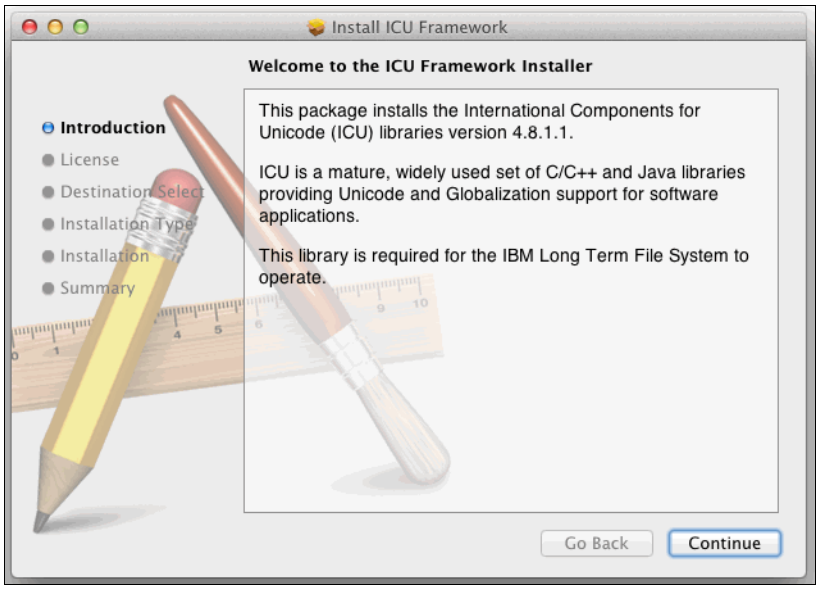

Figure 2-9 ICU Framework installer

4. In the Software License Agreement window, read the software terms and then click **Continue**. See Figure 2-10 for reference.

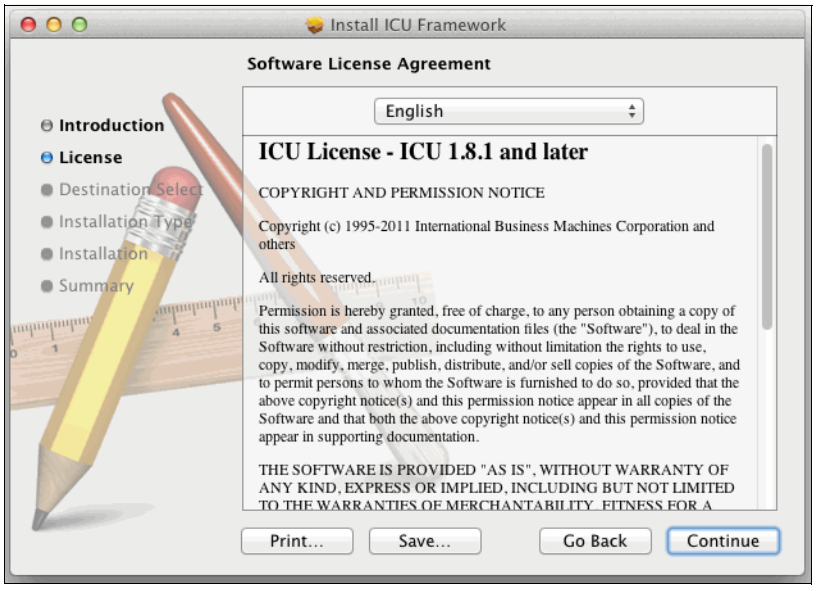

Figure 2-10 ICU Framework software license agreement

5. A pop-up window opens that prompts you to agree to the Software License, as shown in Figure 2-11. If you want to proceed with the ICU Framework installation, click **Agree**.

Figure 2-11 ICU Framework software license agreement pop-up window

6. To continue with the installation procedure, click **Install**, as shown in Figure 2-12.

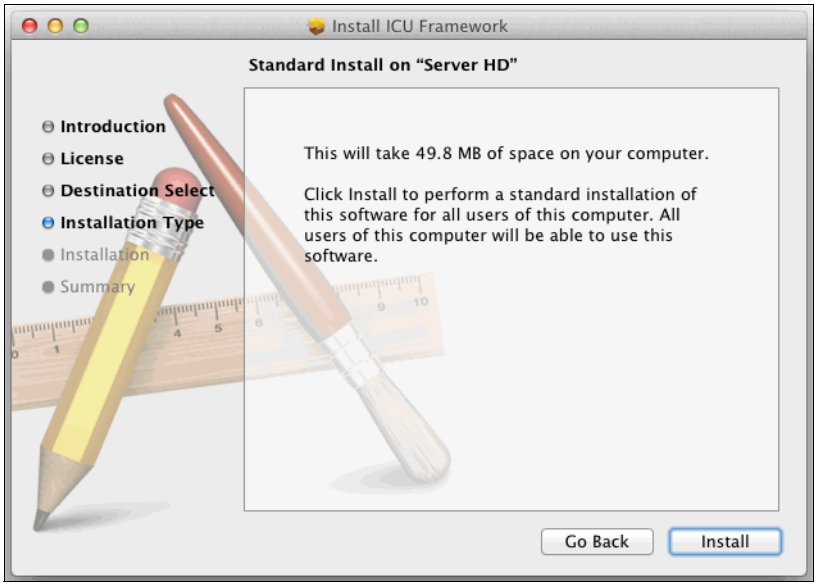

Figure 2-12 ICU Framework destination window

7. Enter the administrator password and click **Install Software**, as shown in Figure 2-13.

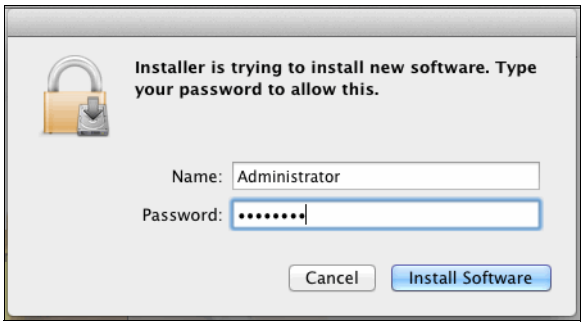

Figure 2-13 ICU Framework administrator password

8. After the installation completes, the installation completed message appears, as shown in Figure 2-14. Click **Close**.

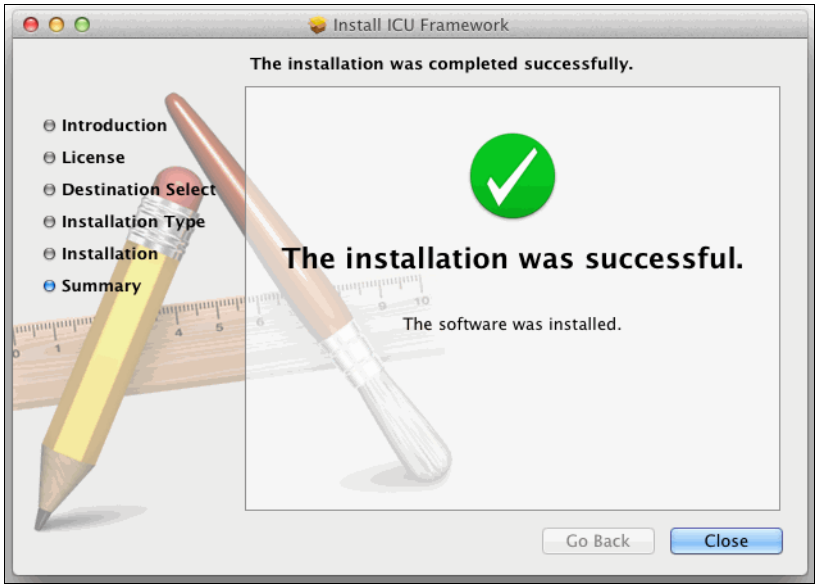

Figure 2-14 ICU Framework installation complete

Enabling the system log

Enable the LTFS system log and locate more information about the LTFS logs on a Mac OS X system.

Error information for LTFS operations is displayed on the terminal console. The level of error reporting is based on the log trace level. To set the log trace level, go to the IBM Spectrum Archive SDE section of IBM Knowledge Center topic for “setting log trace level”:

`https://www.ibm.com/support/knowledgecenter/en/STQNYL_2.4.0/ltfs_managing_troubleshooting_set_log_trace.html`

When the **`ltfs`** command is used, error and trace information is recorded by using the system log mechanism. This mechanism is disabled by default. To enable the system log, complete the following steps:

1. Log on to the operating system as a `root` user.
2. Edit the system log configuration file on any available editor to enable the system log, and add the following line to `/etc/syslog.conf`:

   ```
   user.* /var/log/userlog
   ```

3. Enable the setting by rebooting syslog and issuing the following command:

   ```
   launchctl stop com.apple.syslog
   ```

4. Open the `/etc/newsyslog.conf` file in any available editor, and add or edit the following line:

   ```
   /var/log/userlog 640 5 100 * J
   ```

Installing IBM Spectrum Archive SDE

Install the IBM Spectrum Archive SDE program on a Mac OS X system.

Administrator privileges: IBM Spectrum Archive SDE software and any prerequisites must be installed by an administrator.

Two types of rpm files can be downloaded from the following Fix Central website:

http://www.ibm.com/support/fixcentral/

The following two types of rpm files can be downloaded:

- `ltfs-1.3.0-[revision]-[platform].rpm`
- `ltfs-1.3.0-[revision].src.rpm`

The `ltfs-1.3.0-[revision]-[platform].rpm` download is a binary rpm that is intended for general users who want to use IBM Spectrum Archive SDE on a supported operating system. To learn more about supported operating systems, see 2.3.1, “Hardware and software requirements” on page 33.

The `ltfs-1.3.0-[revision].src.rpm` download is intended for advanced users who want to build the binary rpm. The `src.rpm` file includes the source code files that do not depend on the platform. The binary `rpm` file can be built by following the procedure that is described in the IBM Spectrum Archive Single Drive Edition section of IBM Knowledge Center:

https://www.ibm.com/support/knowledgecenter/en/STQNYL_2.4.0/ltfs_fix_central_upgrade.html

Important: The information that is contained in the readme and install files that are provided with the IBM Spectrum Archive SDE distribution package supersedes the information that is presented here, including the information in the IBM Spectrum Archive section of the IBM Knowledge Center:

https://www.ibm.com/support/knowledgecenter/en/STQNYL_2.4.0/ltfs_sd_ichome.html

Complete the following steps to install IBM Spectrum Archive SDE by using a binary package file:

1. Log on as an administrator.
2. If the IBM Spectrum Archive SDE program is already installed, and the tape medium is mounted, unmount it by issuing the following command:

   ```
   umount /mnt/ltfs
   ```

3. Mount the IBM Spectrum Archive SDE binary package Disk Image file by double-clicking it. Follow the Installer utility instructions.

4. The Welcome page to the IBM Spectrum Archive SDE Installer is shown (Figure 2-15). To proceed with the installation, select **Continue**.

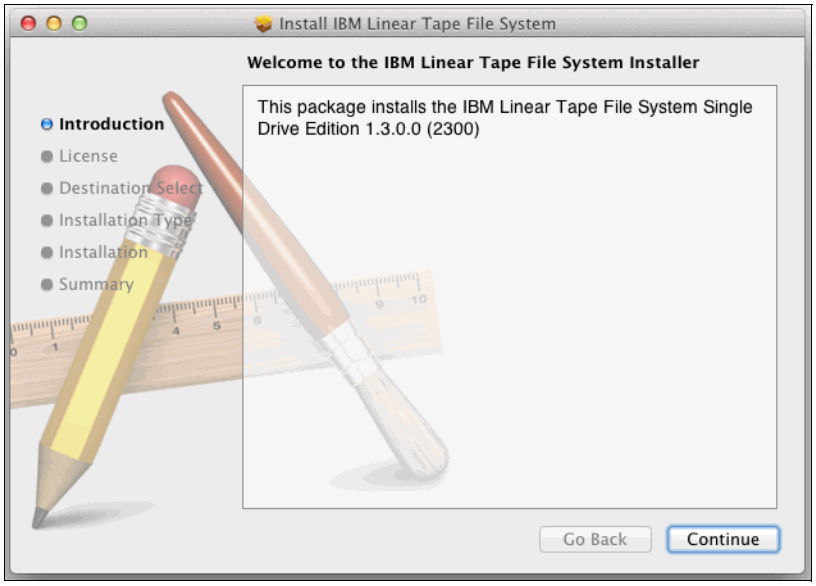

Figure 2-15 Linear Tape File System Single Drive Edition for Mac OSX installer

5. The next window displays the IBM Spectrum Archive SDE Software License Agreement terms (Figure 2-16).

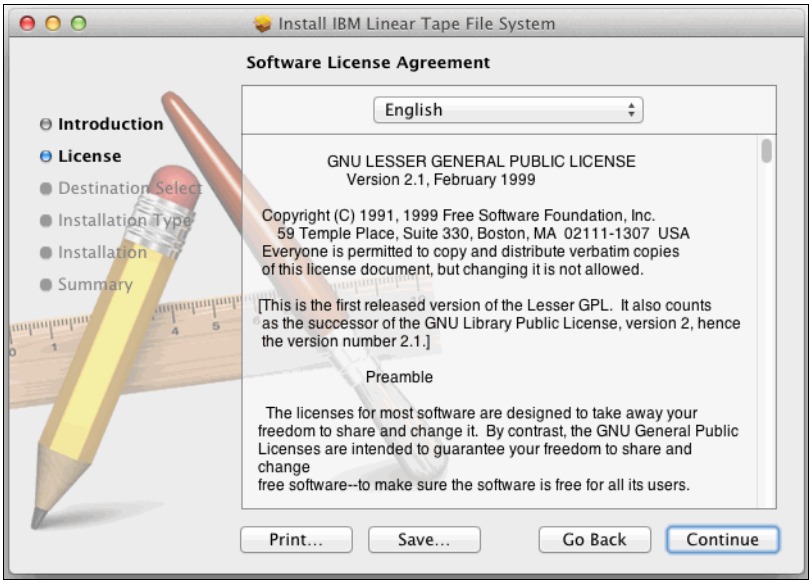

Figure 2-16 IBM Spectrum Archive SDE for Mac OSX installer software license agreement

6. Read the Software License Agreement and select **Continue**. You are asked to select **Disagree** or **Agree** (Figure 2-17).

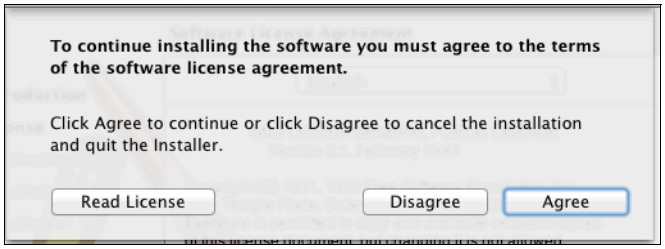

Figure 2-17 IBM Spectrum Archive SDE for Mac OSX license agreement question

7. By selecting **Agree**, you are asked to select a destination.
8. Click **Install** for all users of this computer, then click **Continue** (Figure 2-18).

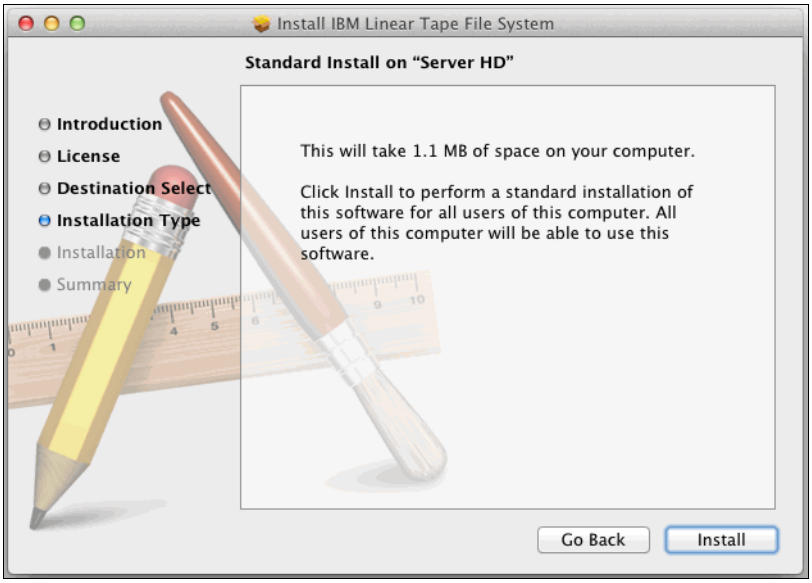

Figure 2-18 IBM Spectrum Archive SDE for Mac OSX installation window

9. In Figure 2-19, you are asked to enter a password. Type the password that is needed to access the server and click **Install Software**.

Figure 2-19 IBM Spectrum Archive SDE for Mac OSX password prompt

10. The next window shows that the installation is successful (Figure 2-20).

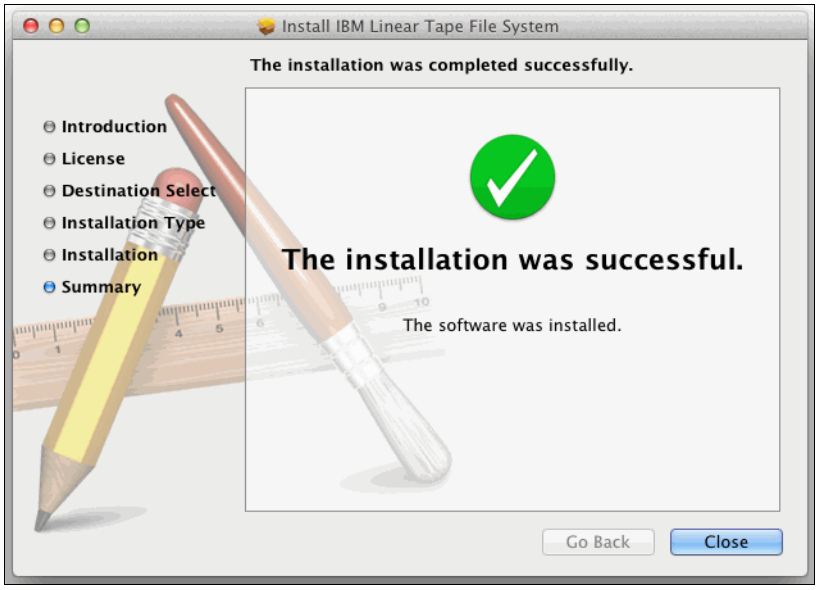

Figure 2-20 IBM Spectrum Archive SDE for Mac OSX installation successful window

11. Click **Close**.
12. As part of the installation process, the following symbolic links to LTFS are created in `/usr/local/bin`:

```
# sudo ln -sf /Library/Frameworks/LTFS.Framework/Versions/Current/usr/bin/ltfs ltfs
# sudo ln -sf /Library/Frameworks/LTFS.Framework/Versions/Current/usr/bin/mkltfs mkltfs
# sudo ln -sf /Library/Frameworks/LTFS.Framework/Versions/Current/usr/bin/ltfsck ltfsck
```

2.3.5 Uninstallation procedure

Important: Eject media from the IBM Spectrum Archive SDE drives before you uninstall IBM Spectrum Archive SDE to avoid losing data in the cache.

Complete the following steps to uninstall the IBM Spectrum Archive SDE software on a Mac OS X system:

1. Log on as an administrator.
2. Open a terminal window. If a tape medium is mounted, unmount it by issuing the following command:

   ```
   # umount /mnt/ltfs
   ```

3. Issue the following command to change the directory to the `/Library/Frameworks` directory:

   ```
   # cd /Library/Frameworks
   ```

4. Issue the following command to remove IBM Spectrum Archive SDE:

   ```
   # sudo rm -rf LTFS.framework
   ```

5. Issue the following command to change the directory to the `/usr/bin` directory:

   ```
   # cd /usr/bin
   ```

6. Issue the following commands in the order that is shown to remove the symbolic links to LTFS:

```
# sudo rm ltfs
# sudo rm mkltfs
# sudo rm ltfsck
```

7. Remove the mount point:

```
# rmdir /mnt/ltfs
```

2.4 Installation on Windows

The installation, implementation, and use of IBM Spectrum Archive SDE here is based on the documentation that is published in the IBM Spectrum Archive SDE section of IBM Knowledge Center:

https://www.ibm.com/support/knowledgecenter/en/STQNYL_2.4.0/ltfs_installing_win.html

2.4.1 Hardware and software requirements

At the time of writing this book, IBM Spectrum Archive SDE supports the following Windows operating system and hardware platforms:

- Supported Windows operating systems (64-bit only):
  - Windows 8.1
  - Windows 10 (Anniversary Update)
  - Windows Server 2012 R2
  - Windows Server 2016
- Supported hardware:
  - x86_64 processor
  - 1 GB available RAM for each 1,000,000 files that are stored on a particular tape
  - The IBM Spectrum Archive supported tape drives support FC HBAs
  - The IBM Spectrum Archive supported LTO tape drives support SAS HBAs

For more information about connectivity and configurations, see the SSIC website:

http://www.ibm.com/systems/support/storage/config/ssic

Readme file: The current information for IBM Spectrum Archive SDE supported hardware and software configurations and notices or limitations is in the IBM Spectrum Archive SDE program readme file.

2.4.2 Prerequisites

The software that you need to install *before* you install IBM Spectrum Archive SDE is listed. IBM Spectrum Archive SDE has the following requirements:

- Microsoft Visual C++ 2010 Redistributable Package (x86 or x64)
- Microsoft .NET Framework 4

Important: The current information for IBM Spectrum Archive SDE supported hardware and software configurations and notices or limitations is in the IBM Spectrum Archive SDE program readme file.

ITDT, although not a prerequisite, is invaluable in configuring IBM Spectrum Archive SDE and troubleshooting tape drive issues and needs to be installed, as well.

Unsupported Windows features

The Windows features, drivers, and commands that are not supported by IBM Spectrum Archive SDE are described:

- New Technology File System (NTFS)

  NTFS features that are not supported by IBM Spectrum Archive SDE:

  - Compression of files within a folder (IBM Spectrum Archive SDE uses the compression of the tape drive).
  - Encrypted files and directories.
  - Quota management.
  - Reparse points.
  - Defragmentation.
  - Change journals to monitor file activity.
  - Scanning of all files or directories that a security identifier owns.
  - Access control lists. The Security tab is not displayed when the user views the file property by right-clicking and then selecting **Properties**.
  - Alternate data streams. The Details tab is not available when the user views the file property by right-clicking and then selecting **Properties**.
  - Shadow copies. The Previous Version tab is not displayed when the user views the file property by right-clicking and then selecting **Properties**.
  - Opportunistic locks.
  - Recycle bins.
  - Short names.
  - Audit and alarm events (as specified in access control lists).
  - Windows sparse files application interfaces.
  - Transactional NTFS (TxF).
  - Guest user accounts.

- Network file and folder sharing

  Support for this feature by IBM Spectrum Archive SDE varies depending on the operating system version.

  IBM Spectrum Archive SDE on Windows 7 does not support network file and folder sharing even though Windows has a mechanism to support this feature. On Windows 7, the Sharing tab is not available when you view the file property by right-clicking and then selecting **Properties**.

Other versions:

- IBM Spectrum Archive SDE 1.3.0 supports network file and folder sharing for Windows Server 2008 R2.
- IBM Spectrum Archive SDE does not support Windows XP. However, users on Windows XP (and other Windows operating systems) can access IBM Spectrum Archive SDE as a client of Windows Server 2008 R2 through network file sharing.

- File system filter drivers

  Although Windows has a mechanism to support file system filter drivers, IBM Spectrum Archive SDE Windows does not support their use. File system filter drivers cannot attach to IBM Spectrum Archive SDE by using the documented mechanisms or application interfaces.

- Native commands for a disk drive

  IBM Spectrum Archive SDE does not support the following commands, which are shown with the associated error messages and the assumption that `Q:` is the IBM Spectrum Archive SDE drive in use:

  - `chkdsk`

    ```
    C:\>chkdsk q:
    Cannot open volume for direct access.
    ```

  - `format`

    ```
    C:\>format q:
    Insert new disk for drive Q:
    and press ENTER when ready...
    Error in IOCTL call.
    ```

  - `defrag`

    ```
    C:\>defrag q:

    Microsoft Disk Defragmenter

    Copyright (c) 2007 Microsoft Corp.

    The request is not supported. (0x80070032)
    ```

  - `recover`

    ```
    C:\>recover q:

    RECOVER on an entire volume is no longer supported.

    To get equivalent functionality use CHKDSK.
    ```

  - `label`

    ```
    C:\>label q:

    Volume in drive Q: is LTFS

    Volume label (11 characters, ENTER for none)? Newname

    Cannot change label on this volume. The request is not supported.
    ```

2.4.3 Installing the HBA and HBA device driver

To install the HBA and its device driver for use by FC tape drives with IBM Spectrum Archive SDE, see the documents that are provided by the HBA manufacturer. For more information about connectivity, configurations, and supported adapters, see the SSIC website:

http://www.ibm.com/systems/support/storage/config/ssic

2.4.4 Installation procedure

The procedure to install the required software for IBM Spectrum Archive SDE on a Windows system is explained in this section.

Administrator privileges: IBM Spectrum Archive SDE software and any prerequisites must be installed by an administrator.

Installing the Microsoft Visual C++ 2010 Redistributable Package

The process to install the Microsoft Visual C++ 2010 Redistributable Package on a Windows system for IBM Spectrum Archive SDE is described in this section. If it is not installed, you are prompted to install it if you attempt the IBM Spectrum Archive SDE installation (Figure 2-21).

Figure 2-21 Visual Studio C++ warning

Complete the following steps to install the required software on a Windows system:

1. Log on as an administrator.
2. Go to the Microsoft Visual C++ 2010 Redistributable Package download site for the corresponding system type (x86 or x64). Download the following package from the Microsoft website:

   http://search.microsoft.com/results.aspx?form=MSHOME&mkt=en-us&setlang=en-us&q=visual+c%2b%2b+redist
3. Double-click the package in Windows Explorer to display the User Account Control window.
4. Click **Yes** when the message "`Do you want to allow the following program to make changes to this computer?`" displays.
5. Follow the installation instructions for the program.

Installing Microsoft .NET Framework 4

Installing Microsoft .NET Framework 4 on a Windows system for IBM Spectrum Archive SDE is described in this section. If it is not installed, you are prompted to install it if you attempt the IBM Spectrum Archive SDE installation (Figure 2-22).

Figure 2-22 Microsoft .NET Framework warning

Complete the following steps to install the required software on a Windows system:

1. Log on as an administrator.
2. Go to the Microsoft .NET Framework 4 (Standalone Installer) download website:

   `http://search.microsoft.com/Results.aspx?q=microsoft+.net+framework+4&mkt=en-US&FORM=QBME1&l=1&refradio=0&qsc0=0`
3. Download the file to your local folder.
4. Double-click the file in Windows Explorer.
5. Click **Yes** when the message "`Do you want to allow the following program to make changes to this computer?`" displays.
6. Follow the installation instructions for the program.

Uninstalling IBM Tape device driver

IBM Spectrum Archive SDE version 1.3.0.2200 and later do not require the installation of the IBM Tape Device Driver. You see the following warning (Figure 2-23) if you attempt the IBM Spectrum Archive SDE installation.

Figure 2-23 IBM Tape Driver warning

Before you uninstall the tape device driver, it is necessary to remove or disable the device within Windows. For more details, see the *IBM Tape Device Drivers Installation and User's Guide*, GC27-2130-13. Run **`uninst.exe`**, which is included in the IBM Tape package, to uninstall it.

Installing IBM Spectrum Archive SDE

The procedure to install or upgrade IBM Spectrum Archive SDE on a Windows system from a `.exe` file is explained in this section. Three types of installers correspond to system types (32-bit and 64-bit operating systems), as explained here.

As an example, a program version is 1.3.0.2200 for a 64-bit operating system, and the installer file name is `IBM_LTFS_SDE_1.3.0.2200_x64.exe`. The installer for a 32-bit operating system can be installed only on a 32-bit operating system. Likewise, the installer for a 64-bit operating system can be installed only on a 64-bit operating system. If you attempt to install IBM Spectrum Archive SDE on the wrong operating system type, the installer displays a warning message and terminates.

Complete the following steps:

1. Log on as an administrator.
2. Open Windows Explorer and double-click the **.exe** file. A dialog box displays with a drop-down menu from which you can select a language for the installation. After you select a language, click **OK** (Figure 2-24).

Figure 2-24 IBM Spectrum Archive SDE for Windows language prompt

3. Click **Next** on the Welcome to the InstallShield Wizard for IBM Spectrum Archive SDE 1.3.0 for Windows window to display the Software License Agreement window (Figure 2-25).

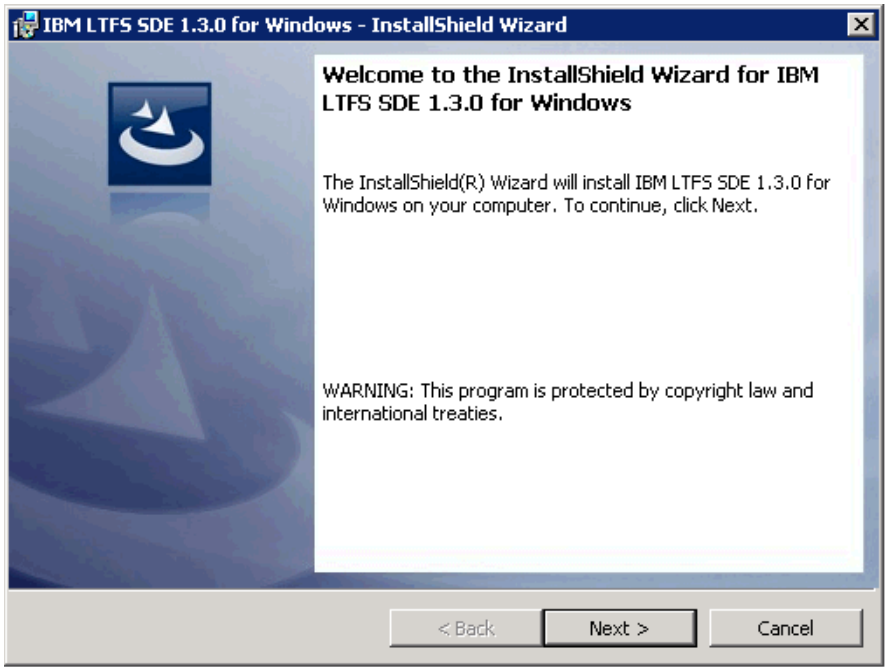

Figure 2-25 IBM Spectrum Archive SDE for Windows Welcome window

4. Select **I accept both the IBM and the non-IBM terms** (Figure 2-26) and click **Next**. Select **Read Non-IBM Terms** (to open a non-IBM license agreement) and click **Close**.

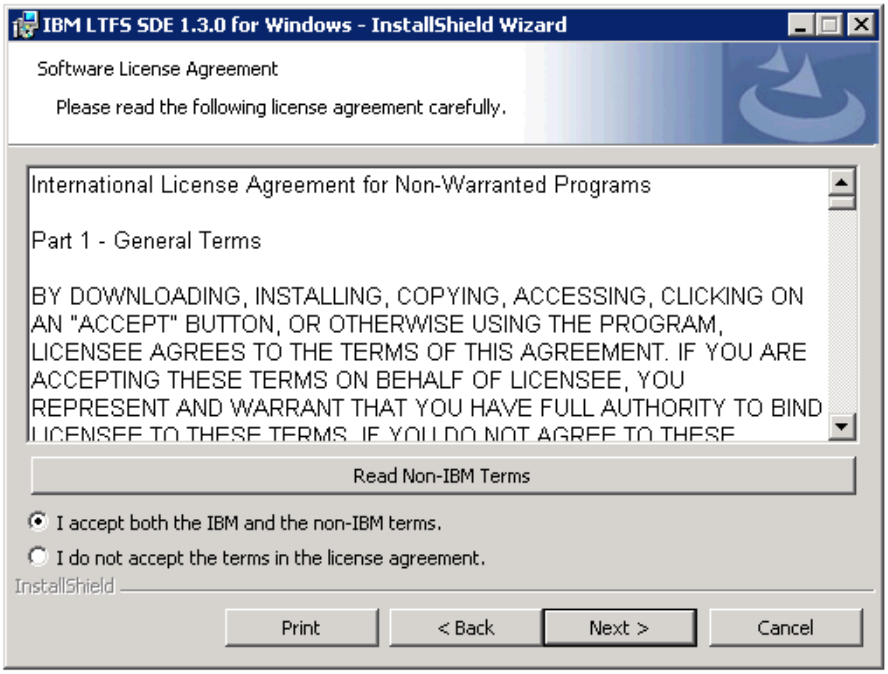

Figure 2-26 IBM Spectrum Archive SDE for Windows Software License Agreement

5. The Destination Folder for the installation of IBM Spectrum Archive SDE is shown (Figure 2-27).

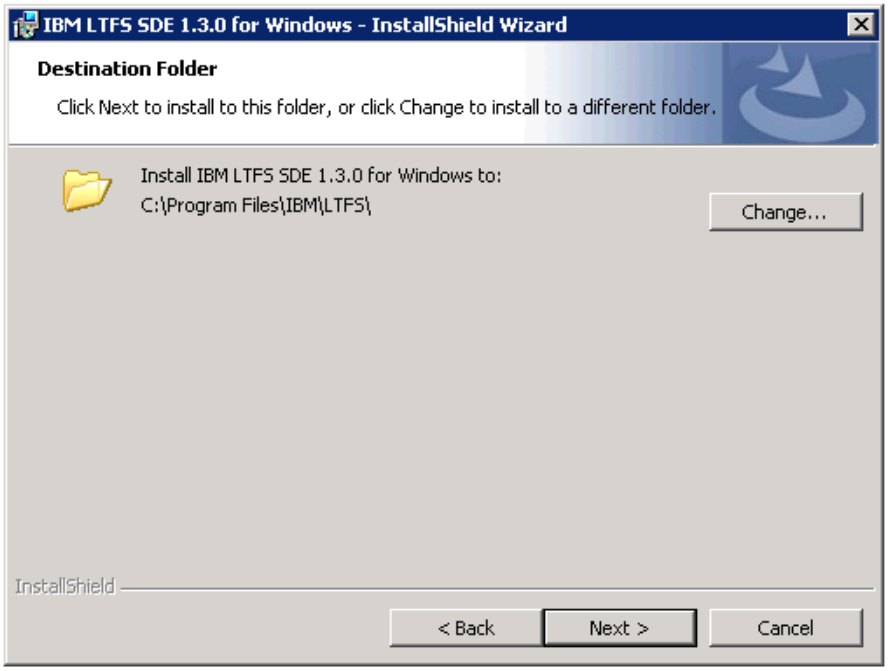

Figure 2-27 IBM Spectrum Archive SDE for Windows installation Destination Folder window

6. The Destination Folder wizard allows you to change the folder to install the program. The default destination folder is set to `C:\Program Files\IBM\LTFS\`. If you want to change the default folder, click **Change** and select a new folder. Otherwise, click **Next**.
7. The Ready to Install the Program window opens (Figure 2-28). Click **Install**.

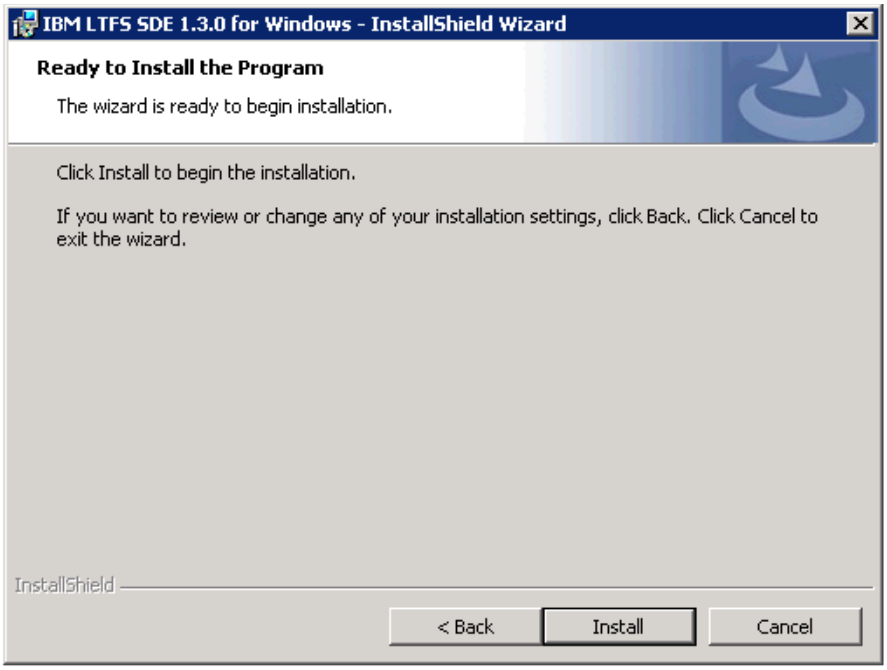

Figure 2-28 IBM Spectrum Archive SDE for Windows Ready to Install procedure

The Installing IBM Spectrum Archive SDE 1.3.0 for Windows window opens (Figure 2-29).

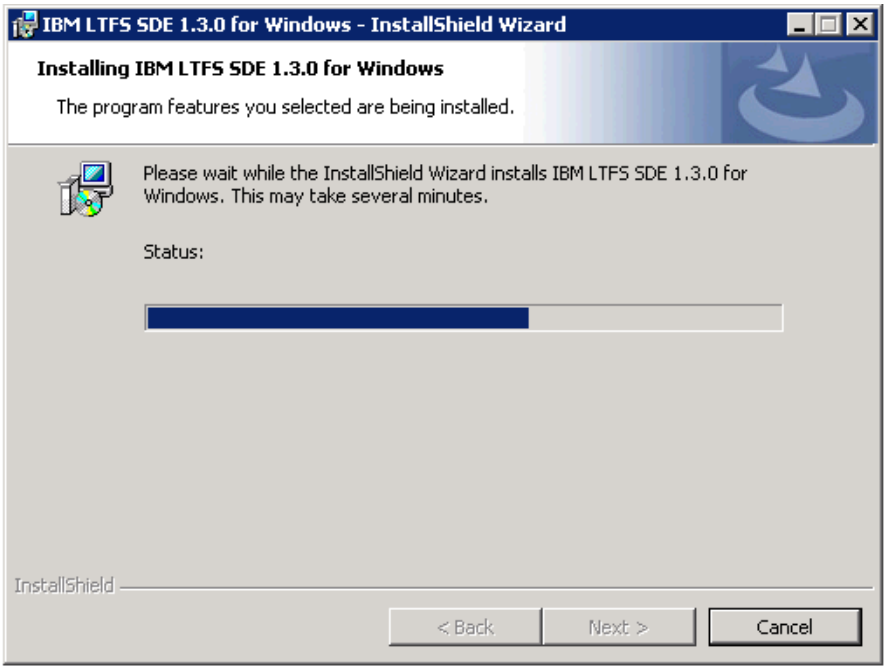

Figure 2-29 IBM Spectrum Archive SDE for Windows installing

8. Click **Finish** in the InstallShield Wizard Completed window (Figure 2-30).

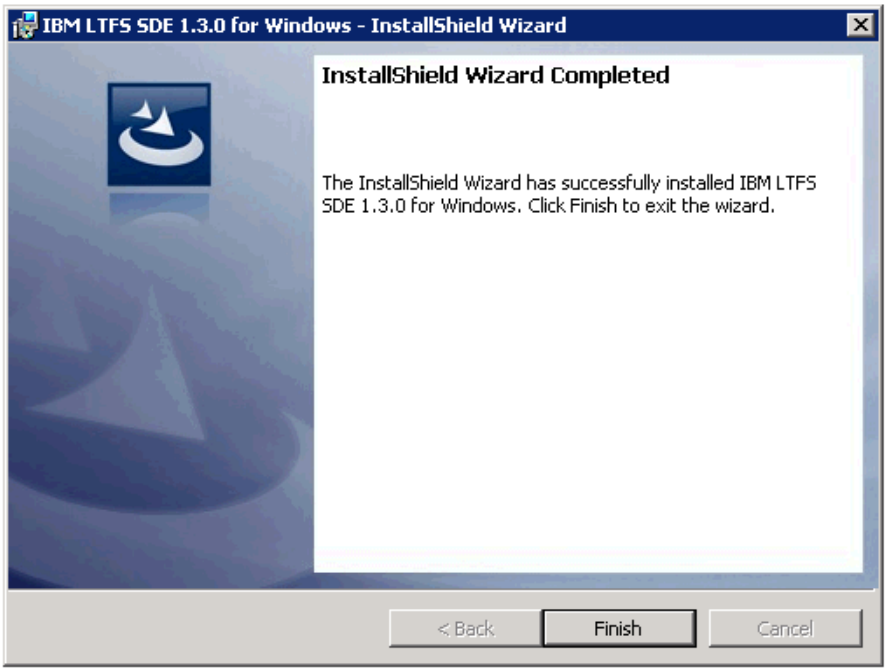

Figure 2-30 IBM Spectrum Archive SDE for Windows installation complete

9. The final window (Figure 2-31) is a reminder to restart your computer before you use IBM Spectrum Archive SDE. Click **Yes**.

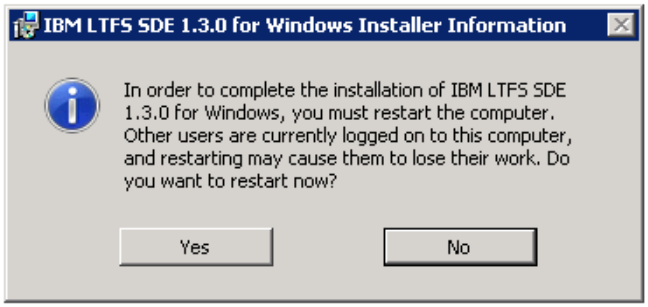

Figure 2-31 IBM Spectrum Archive SDE for Windows restart

2.4.5 Uninstallation procedure

Important: Eject media from the IBM Spectrum Archive SDE drives before you uninstall IBM Spectrum Archive SDE to avoid losing data in the cache.

Complete the following steps to uninstall IBM Spectrum Archive SDE software on a Windows system:

1. Log on as an administrator.
2. If a tape medium is mounted, unmount it by following these steps. Open Windows Explorer, right-click the LTFS drive icon to display a pop-up menu, and then select **Eject**.
3. From the desktop, click **Start** → **All Programs** → **IBM** → **LTFS** → **Uninstall LTFS** to open the Windows Installer program.

4. Click **Yes** when the message "`Are you sure you want to uninstall this product?`" displays.
5. Click **Yes** when the message "`Do you want to allow the following program to make changes to this computer?`" displays.
6. If the message "`All media in the LTFS drives must be ejected before uninstalling LTFS program`" displays, eject all media from all tape drives, and then try again. If this message does not display, proceed to step 7.
7. Click **OK** if either of the following messages displays:
   - "`The following applications should be closed before continuing the uninstall.`"
   - "`The setup was unable to automatically close all required applications.`"
8. Restart the system to completely remove the IBM Spectrum Archive SDE program from your operating system.

2.5 Managing IBM Spectrum Archive SDE

The management of IBM Spectrum Archive SDE on Linux, Mac OS X, and Windows systems is described in this section. Also, hints and tips to use IBM Spectrum Archive SDE are provided.

2.5.1 Managing IBM Spectrum Archive SDE for Linux

The use and management of IBM Spectrum Archive SDE on a Linux system are described.

Initial configuration

A typical initial configuration scenario for most users of IBM Spectrum Archive SDE for Linux is described in this section. Other topics provide information that relates to specific steps in a typical user scenario.

Before you start Linux, power on the tape drive so that the operating system can recognize the tape drive as a SCSI device.

Complete the following steps to configure IBM Spectrum Archive SDE:

1. Open a terminal session and log on as `root`.
2. Insert a tape cartridge into the tape drive.
3. Confirm the tape medium status by running the **`ltfsck`** command. This command checks whether an LTFS file system is on tape. For more detailed information about the **`ltfsck`** command, see 2.7, "Command reference" on page 95 and 2.7.3, "Checking or recovering a tape with the ltfsck command" on page 102.

   Example 2-4 shows an example of the output that is produced by the **`ltfsck`** command that is used on an unformatted volume.

Example 2-4 IBM Spectrum Archive SDE for Linux checking status

```
ltfsck /dev/IBMtape0

LTFS16000I Starting ltfsck, LTFS version 1.3.0.0 (2200), log level 2
LTFS16088I Launched by "ltfsck /dev/IBMtape0"
LTFS16089I This binary is built for Linux (x86_64)
LTFS16090I GCC version is 4.3.4 [gcc-4_3-branch revision 152973]
```

```
LTFS17087I Kernel version: Linux version 3.0.13-0.27-default (geeko@buildhost)
(gcc version 4.3.4 [gcc-4_3-branch revision 152973] (SUSE Linux) ) #1 SMP Wed
Feb 15 13:33:49 UTC 2012 (d73692b) x86_64
LTFS17089I Distribution: SUSE Linux Enterprise Server 11 (x86_64)
LTFS17089I Distribution:
LSB_VERSION="core-2.0-noarch:core-3.2-noarch:core-4.0-noarch:core-2.0-x86_64:co
re-3.2-x86_64:core-4.0-x86_64"
LTFS17085I Plugin: Loading "ibmtape" driver
LTFS12165I lin_tape version is 1.74.0
LTFS12158I Opening a device through ibmtape driver (/dev/IBMtape0)
LTFS12118I Drive identification is 'ULT3580-HH6     '
LTFS12162I Vendor ID is IBM
LTFS12159I Firmware revision is C9C1
LTFS12160I Drive serial is 1068000264
LTFS17160I Maximum device block size is 1048576
LTFS17157I Changing the drive setting to write-anywhere mode
LTFS16014I Checking LTFS file system on '/dev/IBMtape0'
LTFS12207I Logical block protection is disabled
LTFS17168E Cannot read volume: medium is not partitioned
LTFS16080E Cannot check volume (8)
LTFS12207I Logical block protection is disabled
```

4. If the medium is not yet formatted for LTFS, format it by using the **mkltfs** command as described in “Formatting media” on page 81. The LTFS format version is updated from 1.0 to 2.1.1. After a medium is formatted to the later version, it cannot be mounted on an older version of IBM Spectrum Archive SDE or converted to an older format without reformatting. If the media is already formatted for LTFS, skip to step 5.

   This command overwrites the data: By running the **mkltfs** command to format the tape media, you overwrite the existing data on tape.

5. Mount the media by creating a mount point and then by entering the **ltfs** command (Example 2-5).

Example 2-5 IBM Spectrum Archive SDE for Linux starting LTFS

```
# mkdir /mnt/ltfs
# ltfs /ltfs -o devname=/dev/IBMtape0
58e0 LTFS14000I LTFS starting, LTFS version 2.4.0.0 (10015), log level 2
58e0 LTFS14058I LTFS Format Specification version 2.4.0
58e0 LTFS14104I Launched by “ltfs /ltfs -o devname=/dev/IBMtape0”
58e0 LTFS14105I This binary is built for Linux (x86_64)
58e0 LTFS14106I GCC version is 4.8.3 20140911 (Red Hat 4.8.3-9)
58e0 LTFS17087I Kernel version: Linux version 3.10.0-327.el7.x86_64
(mockbuild@x86-034.build.eng.bos.redhat.com) (gcc version 4.8.3 20140911 (Red
Hat 4.8.3-9) (GCC) ) #1 SMP Thu Oct 29 17:29:29 EDT 2015 i386
58e0 LTFS17089I Distribution: NAME=”Red Hat Enterprise Linux Server”
58e0 LTFS17089I Distribution: Red Hat Enterprise Linux Server release 7.2
(Maipo)
58e0 LTFS17089I Distribution: Red Hat Enterprise Linux Server release 7.2
(Maipo)
58e0 LTFS14063I Sync type is “time”, Sync time is 300 sec
58e0 LTFS17085I Plugin: Loading “lin_tape” tape backend
58e0 LTFS17085I Plugin: Loading “unified” iosched backend
```

```
58e0 LTFS14095I Set the tape device write-anywhere mode to avoid cartridge
ejection
58e0 LTFS30416I lin_tape version is 3.0.20
58e0 LTFS30423I Opening a device through ibmtape driver (/dev/IBMtape0)
58e0 LTFS30428I Product ID is 'ULT3580-TD6     '
58e0 LTFS30429I Vendor ID is IBM
58e0 LTFS30432I Firmware revision is H990
58e0 LTFS30433I Drive serial is 1068005796
58e0 LTFS17160I Maximum device block size is 1048576
58e0 LTFS11330I Loading cartridge
58e0 LTFS30472I Logical block protection is disabled
58e0 LTFS11332I Load successful
58e0 LTFS17157I Changing the drive setting to write-anywhere mode
58e0 LTFS11005I Mounting the volume
58e0 LTFS30472I Logical block protection is disabled
58e0 LTFS17227I Tape attribute: Vendor = IBM
58e0 LTFS17227I Tape attribute: Application Name = LTFS
58e0 LTFS17227I Tape attribute: Application Version = 2.4.0.0
58e0 LTFS17227I Tape attribute: Medium Label = 1FD069L6
58e0 LTFS17228I Tape attribute: Text Localization ID = 0x81
58e0 LTFS17227I Tape attribute: Barcode = 1FD069
58e0 LTFS17227I Tape attribute: Application Format Version = 2.4.0
58e0 LTFS17228I Tape attribute: Volume Lock Status = 0x00
58e0 LTFS17227I Tape attribute: Media Pool name =
58e0 LTFS14111I Initial setup completed successfully
58e0 LTFS14112I Invoke 'mount' command to check the result of final setup
58e0 LTFS14113I Specified mount point is listed if succeeded
```

The **ltfs** command advanced help function (**ltfs -a**) lists all the additional command-line options. For more details, see 2.7, “Command reference” on page 95.

Important: Do *not* power off or disconnect the tape drive while the **ltfs** command is mounting a tape media.

6. You can now start writing and reading data to tape. For more hints, see “Further tasks” on page 59 and the IBM Spectrum Archive Single Drive Edition section of IBM Knowledge Center:

   https://www.ibm.com/support/knowledgecenter/en/STQNYL_2.4.0/ltfs_managing.html

Do not use these special characters: To retain compatibility between multiple platforms, do not use the following characters when you create the names of LTFS files, directories, or extended attributes: * ? < > : " | / \

Extended attributes are not always portable between applications and operating systems.

Note: The colon “:” character is an allowed character beginning with IBM Spectrum Archive SDE v2.4.0.

Consider the following four examples of typical user tasks. Example 2-6 shows an example of writing data to the /mnt/ltfs tape directory by using the command-line interface (CLI).

Example 2-6 IBM Spectrum Archive SDE for Linux copying files to tape

```
# mv *.jpg /mnt/ltfs

# ls -las /mnt/ltfs
total 2164
  0 drwxrwxrwx 2 root root      0 Oct  4 09:37 .
  4 drwxr-xr-x 3 root root   4096 Sep 28 16:10 ..
 15 -rwxrwxrwx 1 root root  14344 Sep 24 14:32 file1.txt
715 -rwxrwxrwx 1 root root 731747 Oct  4 09:37 image1.jpg
715 -rwxrwxrwx 1 root root 731747 Oct  4 09:35 image2.jpg
715 -rwxrwxrwx 1 root root 731747 Oct  4 09:35 image3.jpg
```

Example 2-7 shows an example of renaming a file in the /mnt/ltfs tape directory by using the CLI.

Example 2-7 IBM Spectrum Archive SDE for Linux renaming files on tape

```
# mv /mnt/ltfs/image3.jpg /mnt/ltfs/image3.old

# ls -las /mnt/ltfs
total 2164
  0 drwxrwxrwx 2 root root      0 Oct  4 09:48 .
  4 drwxr-xr-x 3 root root   4096 Sep 28 16:10 ..
 15 -rwxrwxrwx 1 root root  14344 Sep 24 14:32 file1.txt
715 -rwxrwxrwx 1 root root 731747 Oct  4 09:37 image1.jpg
715 -rwxrwxrwx 1 root root 731747 Oct  4 09:35 image2.jpg
715 -rwxrwxrwx 1 root root 731747 Oct  4 09:48 image3.old
```

Example 2-8 shows an example of deleting a file from the /mnt/ltfs tape directory by using the CLI.

Example 2-8 IBM Spectrum Archive SDE for Linux deleting a file from tape

```
# rm /mnt/ltfs/image3.jpg

# ls -las /mnt/ltfs
total 1449
  0 drwxrwxrwx 2 root root      0 Oct  4 09:49 .
  4 drwxr-xr-x 3 root root   4096 Sep 28 16:10 ..
 15 -rwxrwxrwx 1 root root  14344 Sep 24 14:32 file1.txt
715 -rwxrwxrwx 1 root root 731747 Oct  4 09:37 image1.jpg
715 -rwxrwxrwx 1 root root 731747 Oct  4 09:35 image2.jpg
```

Example 2-9 shows an example of an application that uses the /mnt/ltfs tape directory.

Example 2-9 IBM Spectrum Archive SDE for Linux creating a tar file on tape

```
# tar -cvf /mnt/ltfs/images.tar /tmp/image4.jpg /tmp/image5.jpg
tmp/image4.jpg
tmp/image5.jpg

# ls -las /mnt/ltfs
total 2889
```

```
   0 drwxrwxrwx 2 root root       0 Oct  4 09:50 .
   4 drwxr-xr-x 3 root root    4096 Sep 28 16:10 ..
  15 -rwxrwxrwx 1 root root   14344 Oct  4 09:47 file1.txt
 715 -rwxrwxrwx 1 root root  731747 Oct  4 09:37 image1.jpg
 715 -rwxrwxrwx 1 root root  731747 Oct  4 09:35 image2.jpg
1440 -rwxrwxrwx 1 root root 1474560 Oct  4 09:50 images.tar
```

7. Unmount the medium by entering the following command:

   ```
   # umount /mnt/ltfs
   ```

   In the Linux environment, the **umount** command requires administrator privileges. Linux users who do not have administrator privileges must use the **fusermount -u** command instead. When the command to unmount is issued, IBM Spectrum Archive SDE attempts to close the mounted medium by performing the following operations:

   – Synchronizing cached data

   – Writing the current index file (first to the data partition and finally to the index partition)

   – Writing the consistency-related data to LTO cartridge memory

   Shutting down the Linux operating system or tape drive without unmounting the medium can cause data loss or a consistency error. If the unmount operation fails, IBM Spectrum Archive SDE sends a fail message to the system log, exits immediately, and releases the device.

8. To eject a tape cartridge from a physical drive, IBM Spectrum Archive SDE first must be unmounted. After the tape medium is unmounted, press the Unload button on the front panel of the drive to eject the tape.

Further tasks

To check for media errors or to roll back, run **ltfsck**. To learn more about using the check and rollback functions, see “Checking and recovering media” on page 88 and “Rolling back media” on page 90.

To view a recent event log of error and warning messages, check the operating system logs. The log includes the level (error or warning), date and time, ID, and description. To learn more about error logs, see “Viewing details” on page 85. If no error or warning message displays for your problem, see the IBM Spectrum Archive Single Drive Edition section of IBM Knowledge Center:

https://www.ibm.com/support/knowledgecenter/en/STQNYL_2.4.0/ltfs_managing_troubleshooting_problem_analysis.html

Formatting media

You must format all media before it is used by IBM Spectrum Archive SDE.

Format version: The LTFS format version is updated from 1.0 to 2.1.1. After a medium is formatted to the later version, it cannot be mounted on an older version of IBM Spectrum Archive SDE or converted to an older format. For more information, see 2.1.2, “Tape format compatibility” on page 27.

You need to complete the steps in Example 2-10 to format a medium for IBM Spectrum Archive SDE.

Example 2-10 IBM Spectrum Archive SDE for Linux formatting a tape

```
mkltfs --device=/dev/IBMtape0 --tape-serial=D00346 --volume-name=D00346L5

LTFS15000I Starting mkltfs, LTFS version 1.3.0.0 (2200), log level 2
LTFS15041I Launched by "mkltfs --device=/dev/IBMtape0 --tape-serial=D00346
--volume-name=D00346L5 --force"
LTFS15042I This binary is built for Linux (x86_64)
LTFS15043I GCC version is 4.3.4 [gcc-4_3-branch revision 152973]
LTFS17087I Kernel version: Linux version 3.0.13-0.27-default (geeko@buildhost)
(gcc version 4.3.4 [gcc-4_3-branch revision 152973] (SUSE Linux) ) #1 SMP Wed Feb
15 13:33:49 UTC 2012 (d73692b) x86_64
LTFS17089I Distribution: SUSE Linux Enterprise Server 11 (x86_64)
LTFS17089I Distribution:
LSB_VERSION="core-2.0-noarch:core-3.2-noarch:core-4.0-noarch:core-2.0-x86_64:core-
3.2-x86_64:core-4.0-x86_64"
LTFS15003I Formatting device '/dev/IBMtape0'
LTFS15004I LTFS volume blocksize: 524288
LTFS15005I Index partition placement policy: None
LTFS17085I Plugin: Loading "ibmtape" driver
LTFS12165I lin_tape version is 1.74.0
LTFS12158I Opening a device through ibmtape driver (/dev/IBMtape0)
LTFS12118I Drive identification is 'ULT3580-HH6     '
LTFS12162I Vendor ID is IBM
LTFS12159I Firmware revision is C9C1
LTFS12160I Drive serial is 1068000264
LTFS17160I Maximum device block size is 1048576
LTFS17157I Changing the drive setting to write-anywhere mode
LTFS15010I Creating data partition b on SCSI partition 1
LTFS15011I Creating index partition a on SCSI partition 0
LTFS12207I Logical block protection is disabled
LTFS17165I Resetting the medium's capacity proportion
LTFS11097I Partitioning the medium
LTFS11100I Writing label to partition b
LTFS11278I Writing index to partition b
LTFS11100I Writing label to partition a
LTFS11278I Writing index to partition a
LTFS15013I Volume UUID is: 73041760-27ba-4e0d-88e6-555c88c20e16

LTFS15019I Volume capacity is 1425 GB
LTFS12207I Logical block protection is disabled
LTFS15024I Medium formatted successfully
```

Simultaneous copy

It is possible to copy multiple files to tape simultaneously, although this method is not advised due to the sequential nature of tape.

Figure 2-32 shows how the extents from each file are interleaved on the tape as it is written to the data partition.

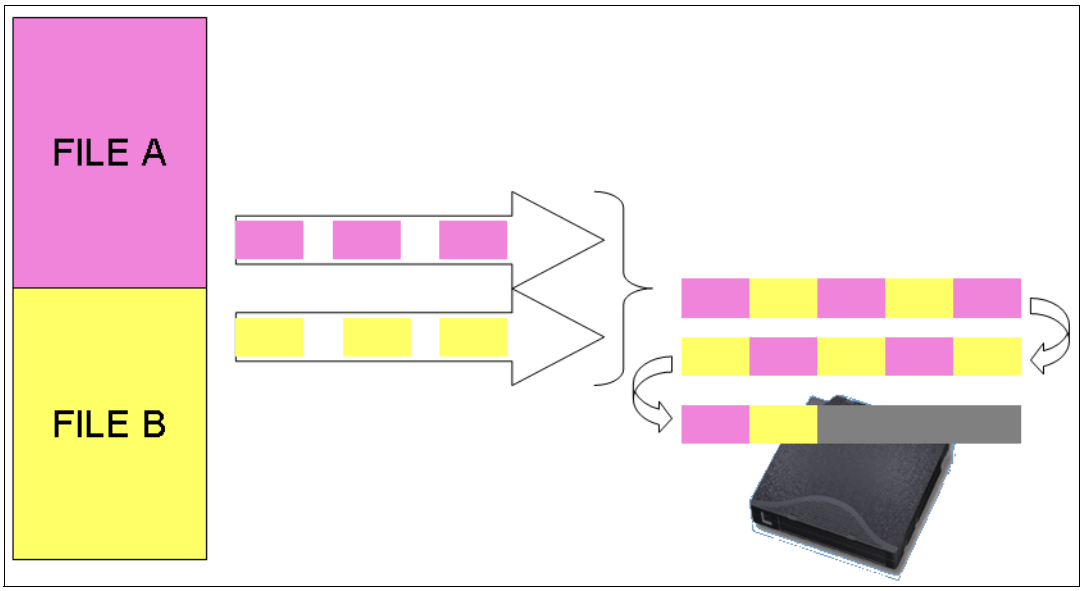

Figure 2-32 IBM Spectrum Archive SDE for Linux simultaneously writing files to tape

Checking and recovering media

The **ltfsck** utility verifies tape media consistency and, if necessary, recovers media from an inconsistent state.

When a tape is mounted, it is checked for consistency. If a consistency problem is found and can be recovered without the loss of data, the recovery is performed automatically. If you cannot perform the recovery without the loss of data, use **ltfsck -f** to locate the latest index and recover the tape from an inconsistent state. After the medium is recovered to a consistent state, **ltfsck -l** can be used to display a list of available rollback points. The **ltfsck** utility then can be used to recover the medium to its last good state. If **ltfsck** detects extra data after the final index in a partition, **ltfsck** deletes it. When the full recover option is specified, **ltfsck** saves the data that would be lost and corrects block information in the `_ltfs_lostandfound` directory.

When the **ltfsck** utility is run, it automatically removes invalid data from the end of the tape and recovers the tape to the last good state. IBM Spectrum Archive SDE appends the most recent changes to the end of the tape without overwriting the existing data. Additional **ltfsck** utility options can be initiated to save the invalid data or to list or recover consistency at a specific rollback point or date. Example 2-11 shows the typical output from the **ltfsck** command.

Example 2-11 IBM Spectrum Archive SDE for Linux checking a tape

```
# ltfsck /dev/IBMtape0

LTFS16000I Starting ltfsck, LTFS version 1.3.0.0 (2200), log level 2
LTFS16088I Launched by "ltfsck /dev/IBMtape0"
LTFS16089I This binary is built for Linux (x86_64)
LTFS16090I GCC version is 4.3.4 [gcc-4_3-branch revision 152973]
LTFS17087I Kernel version: Linux version 3.0.13-0.27-default (geeko@buildhost)
(gcc version 4.3.4 [gcc-4_3-branch revision 152973] (SUSE Linux) ) #1 SMP Wed Feb
15 13:33:49 UTC 2012 (d73692b) x86_64
```

```
LTFS17089I Distribution: SUSE Linux Enterprise Server 11 (x86_64)
LTFS17089I Distribution:
LSB_VERSION="core-2.0-noarch:core-3.2-noarch:core-4.0-noarch:core-2.0-x86_64:core-
3.2-x86_64:core-4.0-x86_64"
LTFS17085I Plugin: Loading "ibmtape" driver
LTFS12165I lin_tape version is 1.74.0
LTFS12158I Opening a device through ibmtape driver (/dev/IBMtape0)
LTFS12118I Drive identification is 'ULT3580-HH6     '
LTFS12162I Vendor ID is IBM
LTFS12159I Firmware revision is C9T5
LTFS12160I Drive serial is 1068000264
LTFS17160I Maximum device block size is 1048576
LTFS17157I Changing the drive setting to write-anywhere mode
LTFS16014I Checking LTFS file system on '/dev/IBMtape0'
LTFS12207I Logical block protection is disabled
LTFS16023I LTFS volume information:
LTFS16024I Volser (bar code) : D00201
LTFS16025I Volume UUID     : da45d932-677c-48ef-8d27-aef1fac2d75e
LTFS16026I Format time     : 2012-10-01 17:09:30.209659101 MST
LTFS16027I Block size      : 524288
LTFS16028I Compression     : Enabled
LTFS16029I Index partition : ID = a, SCSI Partition = 0
LTFS16030I Data partition  : ID = b, SCSI Partition = 1

LTFS11005I Mounting the volume
LTFS12207I Logical block protection is disabled
LTFS11026I Performing a full medium consistency check
LTFS11233I Updating MAM coherency data
LTFS11034I Volume unmounted successfully
LTFS16022I Volume is consistent
LTFS12207I Logical block protection is disabled
```

Rolling back media

You can roll back LTFS media by using the **ltfsck** command. You can list generations for all indexes on the index partition of the medium. When one of the points is specified, the index is rolled back to that point.

To roll back an LTFS medium, follow these steps:

1. List the current generations of the index on the medium by using the **ltfsck** command as shown in Example 2-12.

Example 2-12 IBM Spectrum Archive SDE for Linux listing generations

```
# ltfsck -l /dev/IBMtape0

LTFS16000I Starting ltfsck, LTFS version 1.3.0.0 (2200), log level 2
LTFS16088I Launched by "ltfsck -l /dev/IBMtape0"
LTFS16089I This binary is built for Linux (x86_64)
LTFS16090I GCC version is 4.3.4 [gcc-4_3-branch revision 152973]
LTFS17087I Kernel version: Linux version 3.0.13-0.27-default (geeko@buildhost)
(gcc version 4.3.4 [gcc-4_3-branch revision 152973] (SUSE Linux) ) #1 SMP Wed
Feb 15 13:33:49 UTC 2012 (d73692b) x86_64
LTFS17089I Distribution: SUSE Linux Enterprise Server 11 (x86_64)
```

```
LTFS17089I Distribution:
LSB_VERSION="core-2.0-noarch:core-3.2-noarch:core-4.0-noarch:core-2.0-x86_64:co
re-3.2-x86_64:core-4.0-x86_64"
LTFS16084I List indexes in backward direction strategy
LTFS17085I Plugin: Loading "ibmtape" driver
LTFS12165I lin_tape version is 1.74.0
LTFS12158I Opening a device through ibmtape driver (/dev/IBMtape0)
LTFS12118I Drive identification is 'ULT3580-HH6     '
LTFS12162I Vendor ID is IBM
LTFS12159I Firmware revision is C9T5
LTFS12160I Drive serial is 1068000264
LTFS17160I Maximum device block size is 1048576
LTFS17157I Changing the drive setting to write-anywhere mode
LTFS16018I Listing LTFS file system rollback points on '/dev/IBMtape0'
LTFS12207I Logical block protection is disabled
LTFS16023I LTFS volume information:
LTFS16024I Volser (bar code) : D00201
LTFS16025I Volume UUID     : da45d932-677c-48ef-8d27-aef1fac2d75e
LTFS16026I Format time     : 2012-10-01 17:09:30.209659101 MST
LTFS16027I Block size      : 524288
LTFS16028I Compression     : Enabled
LTFS16029I Index partition : ID = a, SCSI Partition = 0
LTFS16030I Data partition  : ID = b, SCSI Partition = 1

LTFS11005I Mounting the volume
LTFS12207I Logical block protection is disabled
Generation: Date       Time               Zone     SelfPtr->BackPtr (Part, Pos)
           (UTC Date   UTC Time           UTC)
            Commit Message
--------------------------------------------------------------------------------
         6: 2012-10-04 09:51:18.333071738 MST      (0, 5)->(1, 33)
           (2012-10-04 16:51:18.333071738 UTC)
            No commit message
         6: 2012-10-04 09:51:18.333071738 MST      (1, 33)->(1, 27)
           (2012-10-04 16:51:18.333071738 UTC)
            No commit message
         5: 2012-10-04 09:48:37.000085031 MST      (1, 27)->(1, 23)
           (2012-10-04 16:48:37.000085031 UTC)
            No commit message
         4: 2012-10-04 09:43:30.000174779 MST      (1, 23)->(1, 18)
           (2012-10-04 16:43:30.000174779 UTC)
            No commit message
         3: 2012-10-04 09:38:22.000107468 MST      (1, 18)->(1, 9)
           (2012-10-04 16:38:22.000107468 UTC)
            No commit message
         2: 2012-10-03 17:14:24.735644837 MST      (1, 9)->(1, 5)
           (2012-10-04 00:14:24.735644837 UTC)
            No commit message
         1: 2012-10-01 17:11:05.874285414 MST      (1, 5) <<Initial Index>>
           (2012-10-02 00:11:05.874285414 UTC)
            No commit message
LTFS12207I Logical block protection is disabled
```

2. Decide to which date and time you want to roll back. In this example, we chose the generation 1 index.

3. Run the **ltfsck** command to roll back as shown in Example 2-13.

Example 2-13 IBM Spectrum Archive SDE for Linux rolling back index

```
# ltfsck /dev/IBMtape0 -g 1 -r

LTFS16000I Starting ltfsck, LTFS version 1.3.0.0 (2200), log level 2
LTFS16088I Launched by "ltfsck -g 1 -r /dev/IBMtape0"
LTFS16089I This binary is built for Linux (x86_64)
LTFS16090I GCC version is 4.3.4 [gcc-4_3-branch revision 152973]
LTFS17087I Kernel version: Linux version 3.0.13-0.27-default (geeko@buildhost)
(gcc version 4.3.4 [gcc-4_3-branch revision 152973] (SUSE Linux) ) #1 SMP Wed
Feb 15 13:33:49 UTC 2012 (d73692b) x86_64
LTFS17089I Distribution: SUSE Linux Enterprise Server 11 (x86_64)
LTFS17089I Distribution:
LSB_VERSION="core-2.0-noarch:core-3.2-noarch:core-4.0-noarch:core-2.0-x86_64:co
re-3.2-x86_64:core-4.0-x86_64"
LTFS16006I Rolling back to generation 1
LTFS17085I Plugin: Loading "ibmtape" driver
LTFS12165I lin_tape version is 1.74.0
LTFS12158I Opening a device through ibmtape driver (/dev/IBMtape0)
LTFS12118I Drive identification is 'ULT3580-HH6     '
LTFS12162I Vendor ID is IBM
LTFS12159I Firmware revision is C9T5
LTFS12160I Drive serial is 1068000264
LTFS17160I Maximum device block size is 1048576
LTFS17157I Changing the drive setting to write-anywhere mode
LTFS16015I Rolling back LTFS file system on '/dev/IBMtape0'
LTFS12207I Logical block protection is disabled
LTFS16023I LTFS volume information:
LTFS16024I Volser (bar code) : D00201
LTFS16025I Volume UUID     : da45d932-677c-48ef-8d27-aef1fac2d75e
LTFS16026I Format time     : 2012-10-01 17:09:30.209659101 MST
LTFS16027I Block size      : 524288
LTFS16028I Compression     : Enabled
LTFS16029I Index partition : ID = a, SCSI Partition = 0
LTFS16030I Data partition  : ID = b, SCSI Partition = 1

LTFS11005I Mounting the volume
LTFS12207I Logical block protection is disabled
LTFS11034I Volume unmounted successfully
LTFS16082I Saving latest index to data partition to save history
LTFS16067I Rolling back based on the following index chain.
Generation: Date       Time               Zone     SelfPtr->BackPtr (Part, Pos)
           (UTC Date   UTC Time           UTC)
            Commit Message
--------------------------------------------------------------------------------
         1: 2012-10-01 17:11:05.874285414 MST      (1, 5) <<Initial Index>>
           (2012-10-02 00:11:05.874285414 UTC)
            No commit message
LTFS16062I Roll back from the data partition
LTFS11005I Mounting the volume
LTFS12207I Logical block protection is disabled
LTFS11026I Performing a full medium consistency check
```

```
LTFS11233I Updating MAM coherency data
LTFS16086I Volume is rolled back successfully
LTFS12207I Logical block protection is disabled
```

Displaying version information

To display the IBM Spectrum Archive SDE version, run this command:

```
# ltfs -V
LTFS version 1.3.0.0 (2200)
LTFS Format Specification version 2.1.0
```

Changing attributes

In IBM Spectrum Archive SDE, only the write bit can be set or changed. Therefore, the following command makes a file on an LTFS tape read-only:

```
# chmod 555 filename
```

Enabling symbolic links

Beginning with version 1.3.0, IBM Spectrum Archive SDE supports symbolic links. A *symbolic link* (symlink) is used to create a reference to, or an alias for, another file. In addition, IBM Spectrum Archive SDE supports a feature called *live link*. Live link enables IBM Spectrum Archive SDE to follow the mount point and cartridge of the original target. Standard symbolic links are enabled by default but can also be set by using the **-o symlink_type=posix** option with the **ltfs** command. To enable live links, the **-o symlink_type=live** option can be specified.

Enabling logical block protection

Logical block protection (LBP) is a feature that validates data and identifies corrupted data. Beginning with version 1.3.0, it is possible to enable LBP between IBM Spectrum Archive SDE and supported tape drives. When LBP is enabled, all data that is read or written between the tape drives and IBM Spectrum Archive SDE is checked. An error displays if data corruption occurs. To enable LBP, the **-o scsi_lbprotect=on** option is specified with the **ltfs** command. The **-o scsi_lbprotect=off** option is used to disable LBP.

Enabling data-safe mode

Beginning with version 1.3.0, IBM Spectrum Archive SDE supports data-safe mode. *Data-safe mode* is a feature that protects user data by preventing data overwrite situations. When this feature is enabled, the tape drive issues an error after it receives a command to overwrite any data on the currently mounted volume. Data-safe mode is a drive-specific behavior and can be enabled each time that a tape is mounted. It can be disabled only when a tape is not mounted.

To enable or disable data-safe mode, the **scsi_append_only_mode** option is specified with the **ltfs** command. The **scsi_append_only_mode=off** option, which is the default setting, disables the feature. The **scsi_append_only_mode=on** option enables the feature. IBM Spectrum Archive SDE never enables data-safe mode unless the command-line option **-o eject** is specified.

2.5.2 Managing IBM Spectrum Archive SDE for Mac OS X

The use and management of IBM Spectrum Archive SDE on a Mac OS X system are described.

Initial configuration

A typical initial configuration scenario for most users of IBM Spectrum Archive SDE for Mac OS X is described in this section. Other topics that are referenced provide additional information that relates to specific steps in a typical user scenario. Before you start OS X, power on the tape drive so that the operating system can recognize the tape drive as a SCSI device.

Complete the following steps to configure IBM Spectrum Archive SDE:

1. Open a terminal session and log on as an administrator.
2. Insert a tape cartridge into the tape drive.
3. Confirm the tape medium status by running the **ltfsck** command. This command checks whether an LTFS file system is on tape. For more detailed information about the **ltfsck** command, see 2.7, “Command reference” on page 95 and 2.7.3, “Checking or recovering a tape with the ltfsck command” on page 102.

   Example 2-14 shows an example of the output that is produced by the **ltfsck** command when used on an unformatted volume.

Example 2-14 IBM Spectrum Archive SDE for OSX checking status

```
# ltfsck 0
LTFS16000I Starting ltfsck, LTFS version 1.3.0.0 (2300), log level 2
LTFS16088I Launched by "ltfsck 0"
LTFS16089I This binary is built for Mac OS X
LTFS16090I GCC version is 4.2.1 (Apple Inc. build 5666) (dot 3)
LTFS17087I Kernel version: Darwin Kernel Version 11.4.0: Mon Apr  9 19:32:15 PDT 2012; roo
u-1699.26.8~1/RELEASE_X86_64
LTFS17085I Plugin: Loading "iokit" driver
LTFS12158I Opening a device through iokit driver (0)
LTFS12118I Drive identification is 'ULT3580-TD5
LTFS12162I Vendor ID is IBM
LTFS12159I Firmware revision is C7RC
LTFS12160I Drive serial is 1068027083
LTFS17160I Maximum device block size is 1048576
LTFS17157I Changing the drive setting to write-anywhere mode
LTFS16014I Checking LTFS file system on '0'
LTFS12207I Logical block protection is disabled
LTFS16023I LTFS volume information:
LTFS16024I Volser (bar code) :
LTFS16025I Volume UUID     : 96193eeb-c4c9-4563-bc52-a6318c7a32fc
LTFS16026I Format time     : 2012-10-10 14:07:23.945399000 JST
LTFS16027I Block size      : 524288
LTFS16028I Compression     : Enabled
LTFS16029I Index partition : ID = a, SCSI Partition = 0
LTFS16030I Data partition  : ID = b, SCSI Partition = 1

LTFS11005I Mounting the volume
LTFS12207I Logical block protection is disabled
LTFS11026I Performing a full medium consistency check
LTFS11233I Updating MAM coherency data
LTFS11034I Volume unmounted successfully
LTFS16022I Volume is consistent
LTFS12207I Logical block protection is disabled
```

4. If the medium is not yet formatted for LTFS, format it by using the **mkltfs** command as described in “Formatting media” on page 81. The LTFS format version is updated from 1.0 to 2.1.1. After a medium is formatted to the later version, it cannot be mounted on an older version of IBM Spectrum Archive SDE or converted to an older format without reformatting. If the media is already formatted for IBM Spectrum Archive SDE, skip to step 5.

   Overwritten data: Running the **mkltfs** command to format the tape media overwrites the existing data on tape.

5. Mount the media by creating a mount point and then enter the **ltfs** command (Example 2-15).

Example 2-15 IBM Spectrum Archive SDE for OSX starting LTFS

```
# mkdir /mnt/ltfs
# ltfs /mnt/ltfs -o devname=0

LTFS14000I LTFS starting, LTFS version 1.3.0.0 (2300), log level 2
LTFS14058I LTFS Format Specification version 2.1.0
LTFS14104I Launched by "ltfs -o devname=0 /mnt/ltfs"
LTFS14105I This binary is built for Mac OS X
LTFS14106I GCC version is 4.2.1 (Apple Inc. build 5666) (dot 3)
LTFS17087I Kernel version: Darwin Kernel Version 11.4.0: Mon Apr  9 19:32:15 PDT 2012; ro
-1699.26.8~1/RELEASE_X86_64
LTFS14063I Sync type is "time", Sync time is 300 sec
LTFS17085I Plugin: Loading "iokit" driver
LTFS17085I Plugin: Loading "unified" iosched
LTFS14095I Set the tape device write-anywhere mode to avoid cartridge ejection
LTFS12158I Opening a device through iokit driver (0)
LTFS12118I Drive identification is 'ULT3580-TD5     '
LTFS12162I Vendor ID is IBM
LTFS12159I Firmware revision is C7RC
LTFS12160I Drive serial is 1068027083
LTFS17160I Maximum device block size is 1048576
LTFS17157I Changing the drive setting to write-anywhere mode
LTFS11005I Mounting the volume
LTFS12207I Logical block protection is disabled
LTFS14111I Initial setup completed successfully
LTFS14112I Invoke 'mount' command to check the result of final setup
LTFS14113I Specified mount point is listed if succeeded
```

   The **ltfs** command advanced help function (**ltfs -a**) lists all the additional command-line options. For more details, see 2.7, “Command reference” on page 95.

   Important: Do *not* power off or disconnect the tape drive while the **ltfs** command mounts a tape media.

6. You can now start writing and reading data to tape. For additional hints, see “Further tasks” on page 70 and the IBM Spectrum Archive Single Drive Edition section of IBM Knowledge Center:

   https://www.ibm.com/support/knowledgecenter/STQNYL

Do not use these special characters: To retain compatibility between multiple platforms, do not use the following characters when you create the names of LTFS files, directories, or extended attributes: * ? < > : " | / \

Extended attributes are not always portable between applications and operating systems.

Note: The colon ":" character is an allowed character beginning with IBM Spectrum Archive SDE v2.4.0.

To access LTFS tape media, you can use a file manager, such as Finder for Mac OS X, as shown in Figure 2-33 (displaying an icon for the LTFS tape D00999L5). Or, you can use a command-line utility to access the files on a tape medium.

It can take time to browse the directory contents of LTFS by using the Finder. If "View as icon", "View as list", or "View as column" is selected, you can accelerate the Finder by setting the Icon preview to `off`.

Figure 2-33 Mac OSX Finder displaying LTFS tape

Consider the following examples of typical user tasks. Example 2-16 shows an example of writing data to the `/mnt/ltfs` tape directory by using the CLI.

Example 2-16 IBM Spectrum Archive SDE for OSX copying files to tape

```
# mv *.jpg /mnt/ltfs

 ltfs12:/ ltfstest$ ls -las /mnt/ltfs
 total 20480
    0 drwxrwxrwx  2 ltfstest  staff        0 Oct 12 05:01 .
    0 drwxrwxrwx  4 root      wheel      136 Oct 12 04:51 ..
 6144 -rwxrwxrwx  1 ltfstest  staff  3121911 Oct 12 05:01 file1.txt
 1792 -rwxrwxrwx  1 ltfstest  staff   913673 Oct 12 04:59 image1.jpg
 3840 -rwxrwxrwx  1 ltfstest  staff  1951862 Oct 12 04:59 image2.jpg
 8704 -rwxrwxrwx  1 ltfstest  staff  4405310 Oct 12 05:01 image3.jpg
```

Example 2-17 shows an example of renaming a file in the /mnt/ltfs tape directory by using the CLI.

Example 2-17 IBM Spectrum Archive SDE for OSX renaming files on tape

```
# mv /mnt/ltfs/image3.jpg /mnt/ltfs/image3.old

 ltfs12:/ ltfstest$ ls -las /mnt/ltfs
 total 20480
    0 drwxrwxrwx  2 ltfstest  staff        0 Oct 12 05:07 .
    0 drwxrwxrwx  4 root      wheel      136 Oct 12 04:51 ..
 6144 -rwxrwxrwx  1 ltfstest  staff  3121911 Oct 12 05:01 file1.txt
 1792 -rwxrwxrwx  1 ltfstest  staff   913673 Oct 12 04:59 image1.jpg
 3840 -rwxrwxrwx  1 ltfstest  staff  1951862 Oct 12 04:59 image2.jpg
 8704 -rwxrwxrwx  1 ltfstest  staff  4405310 Oct 12 05:01 image3.old
```

Example 2-18 shows an example of deleting a file from the /mnt/ltfs tape directory by using the CLI.

Example 2-18 IBM Spectrum Archive SDE for OSX deleting a file from tape

```
# rm /mnt/ltfs/image3.old
 ltfs12:/ ltfstest$ ls -las /mnt/ltfs
 total 11776
    0 drwxrwxrwx  2 ltfstest  staff        0 Oct 12 05:10 .
    0 drwxrwxrwx  4 root      wheel      136 Oct 12 04:51 ..
 6144 -rwxrwxrwx  1 ltfstest  staff  3121911 Oct 12 05:01 file1.txt
 1792 -rwxrwxrwx  1 ltfstest  staff   913673 Oct 12 04:59 image1.jpg
 3840 -rwxrwxrwx  1 ltfstest  staff  1951862 Oct 12 04:59 image2.jpg
```

Example 2-19 shows an example of an application that uses the /mnt/ltfs tape directory.

Example 2-19 IBM Spectrum Archive SDE for OSX creating a tar file on tape

```
# tar -cvf /mnt/ltfs/images.tar /tmp/image4.jpg /tmp/image5.jpg
tmp/image4.jpg
tmp/image5.jpg

  ltfs12:/ ltfstest$ ls -las /mnt/ltfs
  total 12032
     0 drwxrwxrwx  2 ltfstest  staff        0 Oct 12 05:14 .
     0 drwxrwxrwx  4 root      wheel      136 Oct 12 04:51 ..
  6144 -rwxrwxrwx  1 ltfstest  staff  3121911 Oct 12 05:01 file1.txt
  1792 -rwxrwxrwx  1 ltfstest  staff   913673 Oct 12 04:59 image1.jpg
  3840 -rwxrwxrwx  1 ltfstest  staff  1951862 Oct 12 04:59 image2.jpg
   256 -rwxrwxrwx  1 ltfstest  staff     2048 Oct 12 05:14 images.tar
```

7. Unmount the medium by entering the following command:

   ```
   # umount /mnt/ltfs
   ```

   When the command to unmount is issued, IBM Spectrum Archive SDE attempts to close the mounted medium by performing the following operations:

   – Synchronizing cached data
   – Writing the current index file (first to the data partition and finally to the index partition)
   – Writing the consistency-related data to the LTO cartridge memory

   Shutting down the Mac OS X operating system or tape drive without unmounting the medium can cause data loss or a consistency error. If the unmount operation fails, IBM Spectrum Archive SDE sends a fail message to the system log, exits immediately, and releases the device.

8. To eject a tape cartridge from a physical drive, IBM Spectrum Archive SDE first must be unmounted. After the tape medium is unmounted, press the Unload button on the front panel of the drive to eject the tape.

Further tasks

To check for media errors or to roll back, run the **ltfsck** command. To learn more about using the check and rollback functions, see “Checking and recovering media” on page 72 and “Rolling back media” on page 73.

To view a recent event log of error and warning messages, check the operating system logs. The log includes the level (error or warning), date and time, ID, and description. If no error or warning message displays for your problem, see the IBM Spectrum Archive Single Drive Edition section of IBM Knowledge Center website:

https://www.ibm.com/support/knowledgecenter/STQNYL

Formatting media

You must format all media before use by IBM Spectrum Archive SDE.

Format version: The LTFS format version is updated from 1.0 to 2.1.1. After a medium is formatted to the later version, it cannot be mounted on an older version of IBM Spectrum Archive SDE or converted to an older format. For more information, see 2.1.2, “Tape format compatibility” on page 27.

You need to complete the following steps to format a medium for LTFS as shown in Example 2-20.

Example 2-20 IBM Spectrum Archive SDE for OSX formatting a tape

```
# mkltfs --device=0 --tape-serial=D00999 -volume-name=D00999L5 -f

LTFS15000I Starting mkltfs, LTFS version 1.3.0.0 (2300), log level 2
LTFS15041I Launched by "mkltfs --device=0 --tape-serial=D00999 --volume-name=D00999L5 -f"
LTFS15042I This binary is built for Mac OS X
LTFS15043I GCC version is 4.2.1 (Apple Inc. build 5666) (dot 3)
LTFS17087I Kernel version: Darwin Kernel Version 11.4.0: Mon Apr  9 19:32:15 PDT 2012; ro
u-1699.26.8~1/RELEASE_X86_64
LTFS15003I Formatting device '0'
LTFS15004I LTFS volume blocksize: 524288
LTFS15005I Index partition placement policy: None

LTFS17085I Plugin: Loading "iokit" driver
LTFS12158I Opening a device through iokit driver (0)
LTFS12118I Drive identification is 'ULT3580-TD5     '
LTFS12162I Vendor ID is IBM
LTFS12159I Firmware revision is C7RC
LTFS12160I Drive serial is 1068027083
LTFS17160I Maximum device block size is 1048576
LTFS17157I Changing the drive setting to write-anywhere mode
LTFS15010I Creating data partition b on SCSI partition 1
LTFS15011I Creating index partition a on SCSI partition 0
LTFS12207I Logical block protection is disabled
LTFS17165I Resetting the medium's capacity proportion
LTFS11097I Partitioning the medium
LTFS11100I Writing label to partition b
LTFS11278I Writing index to partition b
LTFS11100I Writing label to partition a
LTFS11278I Writing index to partition a
LTFS15013I Volume UUID is: a79a4f2f-1c89-4146-965e-093307cb075c

LTFS15019I Volume capacity is 1425 GB
LTFS12207I Logical block protection is disabled
LTFS15024I Medium formatted successfully
```

Simultaneous copy

It is possible to copy multiple files to tape simultaneously, although it is not advised due to the sequential nature of tape.

Figure 2-34 shows three separate processes that copy files to tape at the same time.

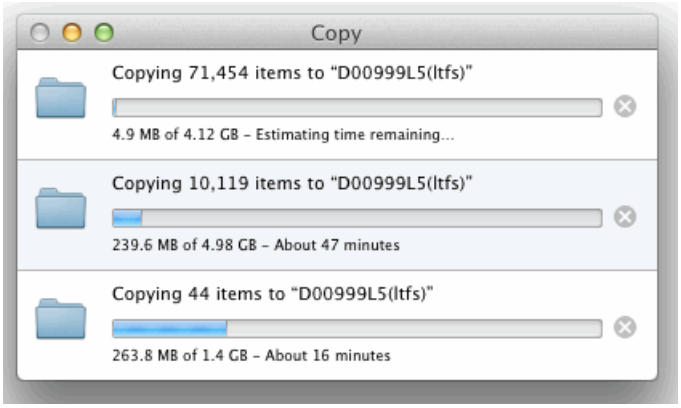

Figure 2-34 IBM Spectrum Archive SDE for OSX simultaneously writing files to tape

Checking and recovering media

The **ltfsck** LTFS utility verifies tape media consistency and, if necessary, recovers media from an inconsistent state.

When a tape is mounted, it is checked for consistency. If a consistency problem is identified and can be recovered without the loss of data, the recovery is performed automatically. If you cannot perform the recovery without the loss of data, use the **ltfsck -f** command to locate the latest index and to recover the tape from an inconsistent state. After the medium is recovered to a consistent state, the **ltfsck -l** command can be used to display a list of available rollback points.

The **ltfsck** utility then can be used to recover the medium to its last good state. If the **ltfsck** utility detects extra data after the final index in a partition, the **ltfsck** utility deletes it. When the full recover option is specified, the **ltfsck** utility saves the data that would be lost and corrects block information in the `_ltfs_lostandfound` directory.

When the **ltfsck** utility is run, it automatically removes invalid data from the end of the tape and recovers the tape to the last good state. IBM Spectrum Archive SDE appends the most recent changes to the end of the tape without overwriting the existing data. Additional **ltfsck** utility options can be initiated to save the invalid data, or to list or recover consistency at a specific rollback point or date. Example 2-21 on page 72 is an example of typical output from the **ltfsck** command.

Example 2-21 IBM Spectrum Archive SDE for OSX checking a tape

```
ltfsck 0

LTFS16000I Starting ltfsck, LTFS version 1.3.0.0 (2300), log level 2
LTFS16088I Launched by "ltfsck 0"
LTFS16089I This binary is built for Mac OS X
LTFS16090I GCC version is 4.2.1 (Apple Inc. build 5666) (dot 3)
LTFS17087I Kernel version: Darwin Kernel Version 11.4.0: Mon Apr  9 19:32:15 PDT 2012; ro
u-1699.26.8~1/RELEASE_X86_64
LTFS17085I Plugin: Loading "iokit" driver
LTFS12158I Opening a device through iokit driver (0)
LTFS12118I Drive identification is 'ULT3580-TD5     '
LTFS12162I Vendor ID is IBM
LTFS12159I Firmware revision is C7RC
LTFS12160I Drive serial is 1068027083
LTFS17160I Maximum device block size is 1048576
LTFS17157I Changing the drive setting to write-anywhere mode
LTFS16014I Checking LTFS file system on '0'
LTFS12207I Logical block protection is disabled
LTFS16023I LTFS volume information:
LTFS16024I Volser (bar code) : D00999
LTFS16025I Volume UUID     : a79a4f2f-1c89-4146-965e-093307cb075c
LTFS16026I Format time     : 2012-10-12 03:22:08.677590000 JST
LTFS16027I Block size      : 524288
LTFS16028I Compression     : Enabled
LTFS16029I Index partition : ID = a, SCSI Partition = 0
LTFS16030I Data partition  : ID = b, SCSI Partition = 1

LTFS11005I Mounting the volume
LTFS12207I Logical block protection is disabled
LTFS11026I Performing a full medium consistency check
LTFS11233I Updating MAM coherency data
LTFS11034I Volume unmounted successfully
LTFS16022I Volume is consistent
```

Rolling back media

You can roll back LTFS media by using the **ltfsck** command. You can list the generations for all indexes on the index partition of the medium. When one of the points is specified, the index is rolled back to that point.

To roll back an LTFS medium, follow these steps:

1. List the current generations of the index on the medium by using the **ltfsck** command (Example 2-22).

Example 2-22 IBM Spectrum Archive SDE for OSX listing index generations

```
ltfsck -l 0
LTFS16000I Starting ltfsck, LTFS version 1.3.0.0 (2300), log level 2
LTFS16088I Launched by "ltfsck -l 0"
LTFS16089I This binary is built for Mac OS X
LTFS16090I GCC version is 4.2.1 (Apple Inc. build 5666) (dot 3)
LTFS17087I Kernel version: Darwin Kernel Version 11.4.0: Mon Apr  9 19:32:15 PDT 2012; ro
-1699.26.8~1/RELEASE_X86_64
LTFS16084I List indexes in backward direction strategy
LTFS17085I Plugin: Loading "iokit" driver
LTFS12158I Opening a device through iokit driver (0)
LTFS12118I Drive identification is 'ULT3580-TD5     '
LTFS12162I Vendor ID is IBM
LTFS12159I Firmware revision is C7RC
LTFS12160I Drive serial is 1068027083
LTFS17160I Maximum device block size is 1048576
LTFS17157I Changing the drive setting to write-anywhere mode
LTFS16018I Listing LTFS file system rollback points on '0'
LTFS12207I Logical block protection is disabled
LTFS16023I LTFS volume information:
LTFS16024I Volser (bar code) : D00999
LTFS16025I Volume UUID     : a79a4f2f-1c89-4146-965e-093307cb075c
LTFS16026I Format time     : 2012-10-12 03:22:08.677590000 JST
LTFS16027I Block size      : 524288
LTFS16028I Compression     : Enabled
LTFS16029I Index partition : ID = a, SCSI Partition = 0
LTFS16030I Data partition  : ID = b, SCSI Partition = 1

LTFS11005I Mounting the volume
LTFS12207I Logical block protection is disabled
Generation: Date       Time               Zone     SelfPtr->BackPtr (Part, Pos)
           (UTC Date   UTC Time           UTC)
            Commit Message
--------------------------------------------------------------------------------
         5: 2012-10-12 05:17:22.816475000 JST      (0, 5)->(1, 39)
           (2012-10-11 20:17:22.816475000 UTC)
            No commit message
         5: 2012-10-12 05:17:22.816475000 JST      (1, 39)->(1, 35)
           (2012-10-11 20:17:22.816475000 UTC)
            No commit message
         4: 2012-10-12 05:10:51.953390000 JST      (1, 35)->(1, 32)
           (2012-10-11 20:10:51.953390000 UTC)
            No commit message
         3: 2012-10-12 05:07:53.001042000 JST      (1, 32)->(1, 29)
           (2012-10-11 20:07:53.001042000 UTC)
            No commit message
         2: 2012-10-12 05:02:47.001043000 JST      (1, 29)->(1, 5)
           (2012-10-11 20:02:47.001043000 UTC)
            No commit message
         1: 2012-10-12 03:22:43.566055000 JST      (1, 5) <<Initial Index>>
           (2012-10-11 18:22:43.566055000 UTC)
            No commit message
LTFS12207I Logical block protection is disabled
```

2. Decide to which date and time you want to roll back. In this example, we chose the generation 3 index.
3. Run the **ltfsck** command to roll back as shown in Example 2-23.

Example 2-23 IBM Spectrum Archive SDE for OSX rolling back

```
# ltfsck -g 3 -r 0

LTFS16000I Starting ltfsck, LTFS version 1.3.0.0 (2300), log level 2
LTFS16088I Launched by "ltfsck -g 3 -r 0"
LTFS16089I This binary is built for Mac OS X
LTFS16090I GCC version is 4.2.1 (Apple Inc. build 5666) (dot 3)
LTFS17087I Kernel version: Darwin Kernel Version 11.4.0: Mon Apr  9 19:32:15 PDT 2012; r
-1699.26.8~1/RELEASE_X86_64
LTFS16006I Rolling back to generation 3
LTFS17085I Plugin: Loading "iokit" driver
LTFS12158I Opening a device through iokit driver (0)
LTFS12118I Drive identification is 'ULT3580-TD5     '
LTFS12162I Vendor ID is IBM
LTFS12159I Firmware revision is C7RC
LTFS12160I Drive serial is 1068027083
LTFS17160I Maximum device block size is 1048576
LTFS17157I Changing the drive setting to write-anywhere mode
LTFS16015I Rolling back LTFS file system on '0'
LTFS12207I Logical block protection is disabled
LTFS16023I LTFS volume information:
LTFS16024I Volser (bar code) : D00999
LTFS16025I Volume UUID     : a79a4f2f-1c89-4146-965e-093307cb075c
LTFS16026I Format time     : 2012-10-12 03:22:08.677590000 JST
LTFS16027I Block size      : 524288
LTFS16028I Compression     : Enabled
LTFS16029I Index partition : ID = a, SCSI Partition = 0
LTFS16030I Data partition  : ID = b, SCSI Partition = 1

LTFS11005I Mounting the volume
LTFS12207I Logical block protection is disabled
LTFS11034I Volume unmounted successfully
LTFS16082I Saving latest index to data partition to save history
LTFS16067I Rolling back based on the following index chain.
Generation: Date       Time               Zone     SelfPtr->BackPtr (Part, Pos)
           (UTC Date   UTC Time           UTC)
            Commit Message
--------------------------------------------------------------------------------
         3: 2012-10-12 05:07:53.001042000 JST      (1, 32)->(1, 29)
           (2012-10-11 20:07:53.001042000 UTC)
            No commit message
LTFS16062I Roll back from the data partition
LTFS11005I Mounting the volume
LTFS12207I Logical block protection is disabled
LTFS11026I Performing a full medium consistency check
LTFS11233I Updating MAM coherency data
LTFS16086I Volume is rolled back successfully
LTFS12207I Logical block protection is disabled
```

The tape now contains the files that were in existence at the time of the generation 3 index. Example 2-24 shows the files before and after rolling back.

Example 2-24 Files on tapes before and after rolling back

Before rollback:

```
ltfs12:/ ltfstest$ ls -las /mnt/ltfs
total 12032
   0 drwxrwxrwx  2 ltfstest  staff        0 Oct 12 05:14 .
   0 drwxrwxrwx  4 root      wheel      136 Oct 12 04:51 ..
6144 -rwxrwxrwx  1 ltfstest  staff  3121911 Oct 12 05:01 file1.txt
1792 -rwxrwxrwx  1 ltfstest  staff   913673 Oct 12 04:59 image1.jpg
3840 -rwxrwxrwx  1 ltfstest  staff  1951862 Oct 12 04:59 image2.jpg
 256 -rwxrwxrwx  1 ltfstest  staff     2048 Oct 12 05:14 images.tar
```

After rollback:

```
ltfs12:/ ltfstest$ ls -las /mnt/ltfs
total 20480
   0 drwxrwxrwx  2 ltfstest  staff        0 Oct 12 05:07 .
   0 drwxrwxrwx  4 root      wheel      136 Oct 12 04:51 ..
6144 -rwxrwxrwx  1 ltfstest  staff  3121911 Oct 12 05:01 file1.txt
1792 -rwxrwxrwx  1 ltfstest  staff   913673 Oct 12 04:59 image1.jpg
3840 -rwxrwxrwx  1 ltfstest  staff  1951862 Oct 12 04:59 image2.jpg
8704 -rwxrwxrwx  1 ltfstest  staff  4405310 Oct 12 05:01 image3.old
```

Displaying version information

To display the IBM Spectrum Archive SDE version, run this command:

```
# ltfs -V
LTFS version 1.3.0.0 (2200)
LTFS Format Specification version 2.1.0
```

Changing attributes

LTFS-formatted tape media have the following limitations:

- Only the write permission of a file or directory can be changed.
- The owner of a file or directory cannot be changed.

The following command makes a file on an LTFS tape read-only:

```
# chmod 555 filename
```

Enabling symbolic links

Beginning with version 1.3.0, IBM Spectrum Archive SDE supports symbolic links. A *symbolic link* (symlink) is used to create a reference to, or an alias for, another file. In addition, IBM Spectrum Archive SDE supports a feature called *live link*. Live link enables IBM Spectrum Archive SDE to follow the mount point and cartridge of the original target. Standard symbolic links are enabled by default but can also be set by using the **-o symlink_type=posix** option with the **ltfs** command. To enable live links, the **-o symlink_type=live** option can be specified.

Enabling logical block protection

Logical block protection (LBP) is a feature that validates data and identifies corrupted data. Beginning with version 1.3.0, it is possible to enable LBP between IBM Spectrum Archive SDE and supported tape drives. When LBP is enabled, all data that is read or written between the tape drives and IBM Spectrum Archive SDE is checked. An error displays if data corruption occurs. To enable LBP, the **-o scsi_lbprotect=on** option must be specified with the **ltfs** command. The **-o scsi_lbprotect=off** option is used to disable LBP.

Enabling data-safe mode

Beginning with version 1.3.0, IBM Spectrum Archive SDE supports data-safe mode. *Data-safe mode* is a feature that protects user data by preventing data overwrite situations. When this feature is enabled, the tape drive issues an error after it receives a command to overwrite any data on the currently mounted volume.

Data-safe mode is a drive-specific behavior and can be enabled each time that a tape is mounted. It can be disabled only when a tape is not mounted. To enable or disable data-safe mode, the **`scsi_append_only_mode`** option must be specified with the **`ltfs`** command. The **`scsi_append_only_mode=off`** option, which is the default, disables the feature. The **`scsi_append_only_mode=on`** option enables the feature. IBM Spectrum Archive SDE never enables data-safe mode unless the command-line option **`-o eject`** is specified.

2.5.3 Managing IBM Spectrum Archive SDE for Windows

This section describes the process to use and manage IBM Spectrum Archive SDE on a Windows system.

Initial configuration

A typical initial configuration scenario for most users of IBM Spectrum Archive SDE for Windows is summarized. Other topics provide additional information that relates to specific steps in a typical user scenario. Before you start Windows, power on the tape drive so that Windows can recognize the tape drive as a SCSI device.

Complete the following steps to configure IBM Spectrum Archive SDE:

1. From the desktop, click **Start** and then right-click **Computer**.
2. Select **System Properties** from the menu and then click **Device Manager**.

   Right-click the root tree (computer name) and select **Scan for hardware changes**. IBM Spectrum Archive SDE now recognizes the tape drive as a new device. You can then use the IBM Spectrum Archive SDE Configuration panel to assign a new drive letter to the drive.

   IBM Spectrum Archive SDE Configuration panel: With IBM Spectrum Archive SDE 1.2.1 and earlier on Windows 7, the IBM Spectrum Archive SDE Configuration panel opens automatically. With IBM Spectrum Archive SDE 1.2.5 and later, open the Configuration panel manually from the All Programs menu.

3. After you install IBM Spectrum Archive SDE for Windows, you need to assign a drive letter to an LTO tape drive to use the program. After a drive letter is assigned, no application other than IBM Spectrum Archive SDE can access the drive letter. You assign a drive letter to an LTFS tape drive by using the Configuration panel. In the Start menu, click **All Programs** → **IBM** → **LTFS** → **Configuration** as shown in Figure 2-35.

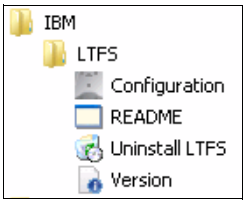

Figure 2-35 IBM Spectrum Archive SDE for Windows Start menu items

4. The Configuration panel in Figure 2-36 displays the following information:
   – Drive Letter: Assigned or unassigned. The Drive Letter pop-up menu has three possible scenarios:
     • Unassigned (blank)
     • Assigned (with SCSI device address)
     • Unchangeable (reserved by the system)
   – Tape Drive: Details of port, bus number, target ID, logical unit number, and drive serial number (a 10-digit value)
   – State: The current state of the LTFS drive

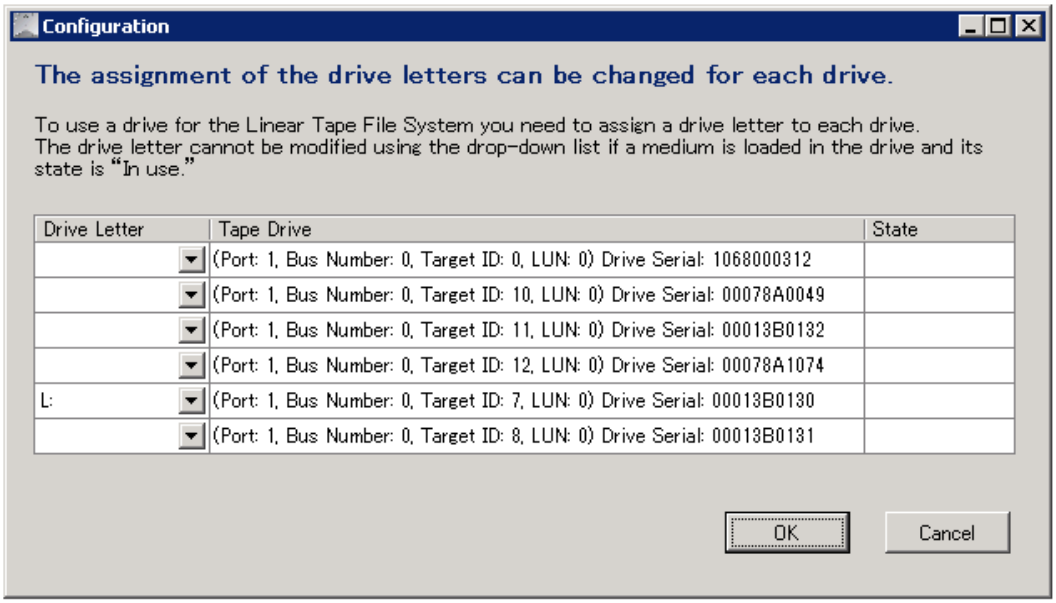

Figure 2-36 IBM Spectrum Archive SDE for Windows configuration panel

Select any unused drive letter in the same row as the tape drive that you want to use and click **OK**. In this example, we assigned drive `L:` to the tape drive 1.0.7.0 (serial number 00013B0130).

The panel that is shown in Figure 2-36 is the same panel for both Windows 7 and Windows Server 2008 R2. You can have multiple sessions with IBM Spectrum Archive SDE on Windows Server 2008 R2. For example, while you open the Configuration panel, another user can open another panel and configure another tape drive.

Important: For dual-path tape drives, be aware that IBM Spectrum Archive SDE does not support data path failover.

In a Windows 7 system, you see the Configuration panel display (Figure 2-36) when any of the following situations occur:

– The system restarts after you install IBM Spectrum Archive SDE.

  After you install IBM Spectrum Archive SDE, restart the system to launch it. During the system startup, IBM Spectrum Archive SDE checks whether one or more LTFS tape drives are connected. The Configuration panel displays when a connection is detected.

– The system detects a new IBM Spectrum Archive SDE-supported device.

  IBM Spectrum Archive SDE periodically checks the SCSI devices that are connected to the system. The Configuration panel displays when one or more IBM Spectrum Archive SDE-supported tape drives are detected.

  If a medium is already mounted in the drive, its state is “In use.” Eject a medium first before you change or remove a drive letter. For more information, see Figure 2-37 on page 79. If a medium is not mounted, select the drive letter that you want to change or remove, then select another drive letter or a blank field and click **OK**.

5. Insert a tape cartridge into the tape drive. After the cartridge is recognized by IBM Spectrum Archive SDE, it is automatically loaded and the drive icon changes to IBM Spectrum Archive SDE. Under normal operating conditions, when a cartridge is loaded, the icon changes to indicate the status of the medium and possible user action. See Table 2-1.

Table 2-1 IBM Spectrum Archive SDE for Windows drive icons

Medium	Icon	Right-click menu options
The medium is not inserted.		**Properties** is available. The **Check** and **Rollback** buttons are unavailable.
The medium is not ready. One of the following operations is running: load, format, check, rollback, or eject.		**Properties** is available. The **Check** and **Rollback** buttons are unavailable.
The medium is inserted, but it is not an LTO supported medium.		**Eject** and **Properties** are available. The **Check** and **Rollback** buttons are unavailable.
The LTFS-formatted medium is mounted.		All options are available.
The write-protected LTFS-formatted medium is mounted.		**Eject** and **Properties** are available. The **Check** and **Rollback** buttons are unavailable.
A write error occurred during the write operation. The LTFS-formatted medium is read-only and must be ejected and reinserted to write data.		**Eject** and **Properties** are available. The **Check** and **Rollback** buttons are unavailable.
The LTO medium is inserted, but not formatted for IBM Spectrum Archive SDE.		**Eject** and **Properties** are available. The **Check** and **Rollback** buttons are unavailable.

Medium	Icon	Right-click menu options
The LTFS-formatted medium is inserted, but the data has inconsistencies. A check and recover operation is required to use the medium.		All options are available.

6. Confirm the tape medium status. If the medium is not yet formatted for LTFS, format it by using the Format menu option as described in “Formatting media” on page 81. The LTFS format version is updated from 1.0 to 2.1.1. After a medium is formatted to the later version, it cannot be mounted on an older version of IBM Spectrum Archive SDE or converted to an older format without reformatting.

7. You can now start writing and reading data to the tape. Optimize the access performance to large files, especially multimedia files, by using the folder refresh option. For additional hints, see “Further tasks” on page 80 and the IBM Spectrum Archive Single Drive Edition section of IBM Knowledge Center website:

   https://www.ibm.com/support/knowledgecenter/STQNYL

   Special characters: To maintain portability between multiple platforms, do not use the following characters when you create the names of the LTFS-formatted files, directories, or extended attributes: * ? < > : " | / \

   Note: The colon “:” character is an allowed character beginning with IBM Spectrum Archive SDE v2.4.0.

8. Eject the medium from the LTFS drive by using the Eject menu option.

   Important: After a drive letter is assigned to a tape drive and an LTFS medium is loaded into the drive, all attempts to eject the medium by using the Eject button on the tape drive fail. The Eject panel is the only way to remove the medium from the drive.

   Follow these steps:

   a. Open Windows Explorer, right-click the LTFS drive icon to display a pop-up menu, and then select **Eject** as shown in Figure 2-37.

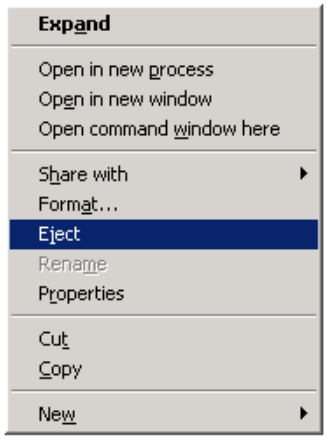

Figure 2-37 Eject menu

b. Click **OK** when the Eject Medium panel displays (Figure 2-38).

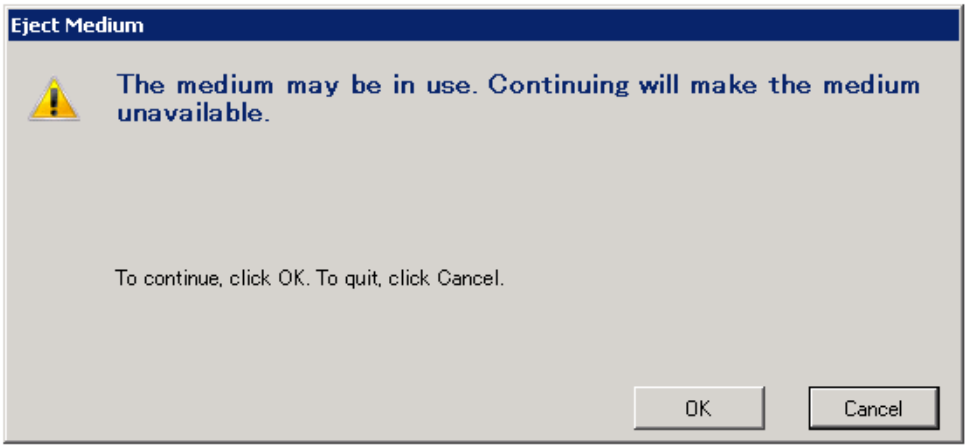

Figure 2-38 IBM Spectrum Archive SDE for Windows Eject Medium panel

c. A pop-up window (Figure 2-39) opens to indicate that ejecting the medium is still in progress. There is no message to indicate that the ejection of the medium is complete. However, the drive icon in Windows Explorer changes to indicate that there is no longer a tape in the drive.

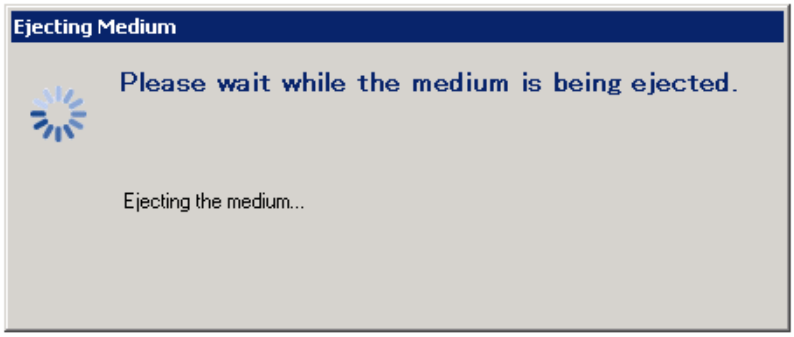

Figure 2-39 IBM Spectrum Archive SDE for Windows Ejecting Medium panel

IBM Spectrum Archive SDE has a cache to store data in the main memory and to write it to the medium in a certain condition. Without flushing data in the cache, data is lost if the system or drive power turns off.

To protect data, it is important to eject the LTFS medium from the drive *before* you shut down the system. If shutdown is initiated while an LTFS medium is still in the drive, a warning message is displayed and you are returned to the Windows desktop.

While you use IBM Spectrum Archive SDE, any of the following actions can result in an unrecoverable state when you attempt to return to IBM Spectrum Archive SDE:

- Hibernation mode
- Forced shutdown
- Windows update

Further tasks

To check for media errors or to roll back, click **Properties**, then click **Check** or **Roll back**. To learn more about using the Check and Rollback panels, see “Checking and recovering media” on page 88 and “Rolling back media” on page 90.

To view a recent event log of error and warning messages, click **Details** on the Properties panel. The log includes the level (error or warning), date and time, ID, and description. The ID links to a message in the IBM Spectrum Archive SDE section of IBM Knowledge Center that provides an explanation and action to help solve the problem. To learn more about using the Properties panel, see “Viewing details” on page 85. If no error or warning message displays for your problem, see the IBM Spectrum Archive Single Drive Edition section of IBM Knowledge Center:

https://www.ibm.com/support/knowledgecenter/STQNYL

Formatting media

You must format all media for LTFS before you use it.

Format version 2.1.1: The LTFS format version is updated from 1.0 to 2.1.1. After a medium is formatted to the later version, it cannot be mounted on an older version of IBM Spectrum Archive SDE or converted to an older format. For more information, see 2.1.2, “Tape format compatibility” on page 27.

You need to complete the following steps to format a medium for LTFS:

1. Open Windows Explorer, right-click the LTFS drive to display a pop-up menu, and then select **Format** as shown in Figure 2-40.

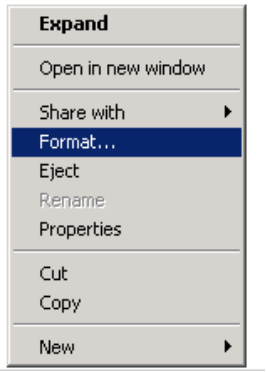

Figure 2-40 Format menu option

2. Click **OK** when the Format Medium panel displays.

3. In the Tape Serial Number and Tape Volume Name fields (Figure 2-41), enter the tape serial number and tape volume name. Typically, the tape volume name matches the physical cartridge label. You also can eject the medium after you format it by selecting **Eject the medium after formatting completes**.

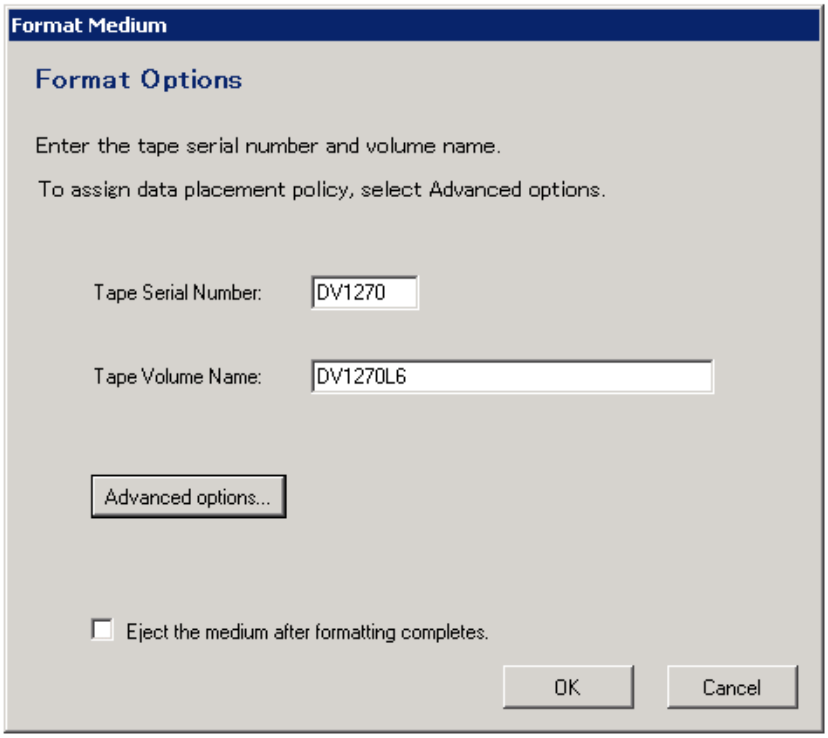

Figure 2-41 IBM Spectrum Archive SDE for Windows Format Medium panel

Important: The tape serial number is required to use six alphanumeric characters. Only uppercase alphabetical characters are acceptable. For example, “ABC123” is acceptable, but “abc123” is not.

To maintain portability between multiple platforms, the following characters cannot be used for volume names in LTFS: * ? < > : “ | / \

4. Click **Advanced options** to display an Advanced Options window (shown in Figure 2-42). You can optionally specify which files can be stored in the index partition.

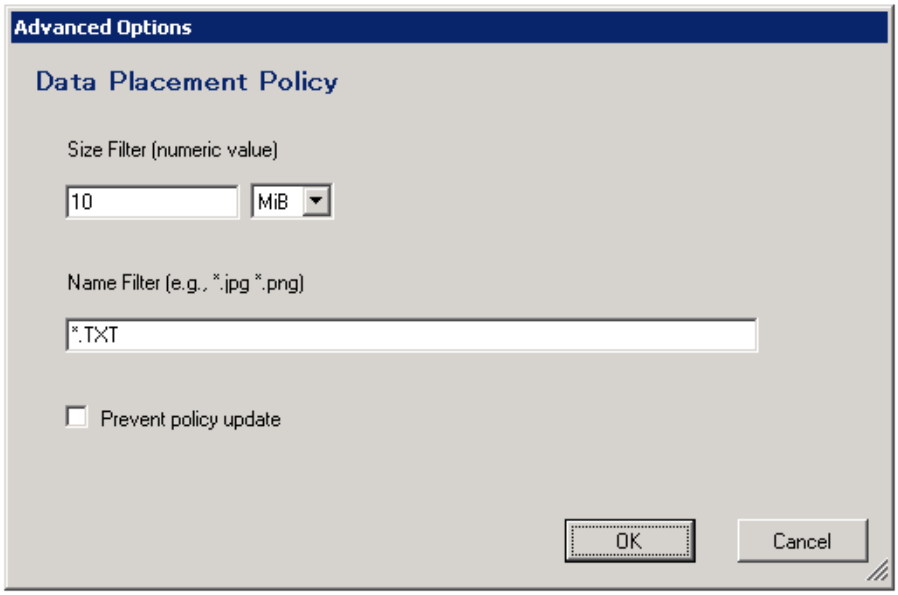

Figure 2-42 IBM Spectrum Archive SDE for Windows Advanced Options panel

The following formatting rules display:

Size Filter (numeric value):

Only files that are smaller than the size that is set in this field are stored in the index partition. Numeric values and byte size units from KiB (kibibyte) to GiB (gibibyte) can be set from the drop-down list. In this example, the size is set to 10 MiB.

Name Filter (for example, *.jpg *.png):

Only files with names that match the names in this field are stored in the index partition. A space needs to be inserted between two or more names. In this example, the file type is set to *.TXT.

Important: The name filter can only be set when the size filter is set. Both values are applied to filtered files.

You have the option of selecting the “Prevent policy update” check box. If this check box is selected, IBM Spectrum Archive SDE does not allow a change in the selected formatting data placement policy when a medium is mounted. The policy also applies when a medium is mounted on Linux and Mac OS X operating systems. To learn more about the **`--no-override`** option, see 2.7.2, “Formatting a tape with the mkltfs command” on page 99. After these fields are complete, click **OK** and the Format Medium panel is displayed again (Figure 2-43).

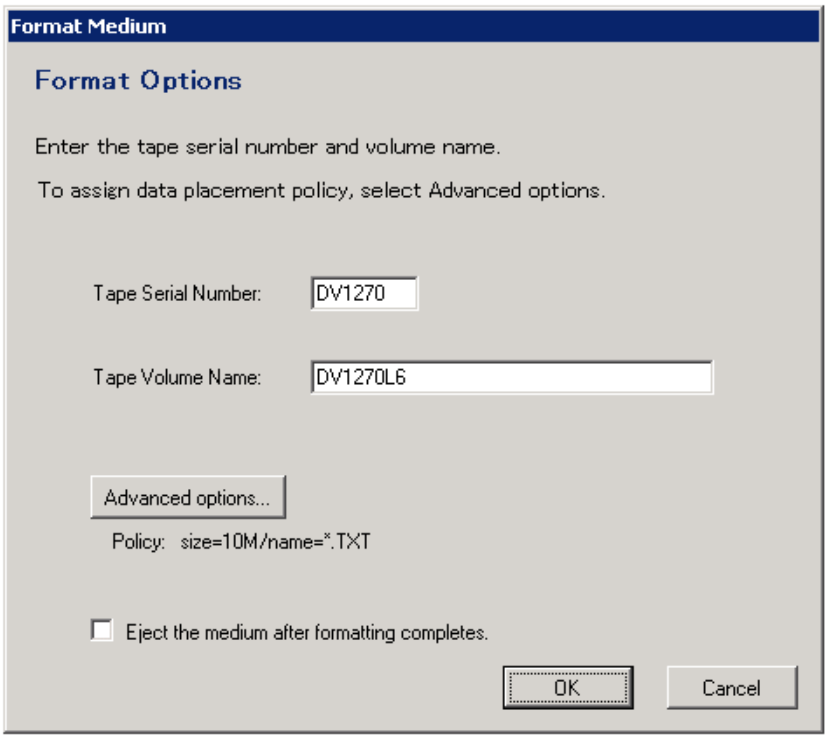

Figure 2-43 IBM Spectrum Archive SDE for Windows Format Medium panel

5. Click **OK** to continue formatting. See the progress indicator (Figure 2-44) to track the operation.

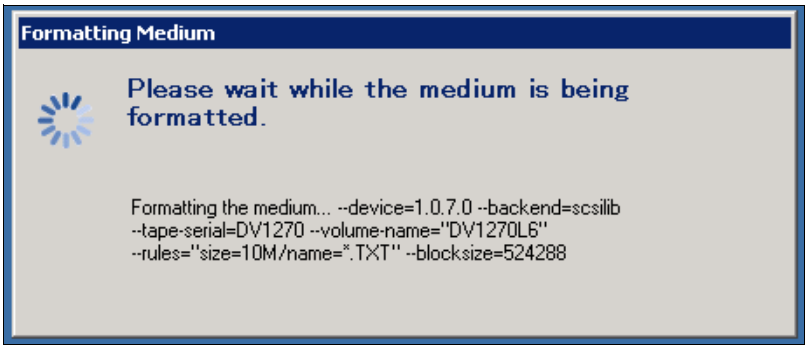

Figure 2-44 IBM Spectrum Archive SDE for Windows Formatting Medium panel

Important: You cannot access the medium while the format process is in progress. If you attempt to access it through file system calls, an error message is returned on the Windows desktop.

6. When formatted, the medium is ready for use by IBM Spectrum Archive SDE (Figure 2-45).

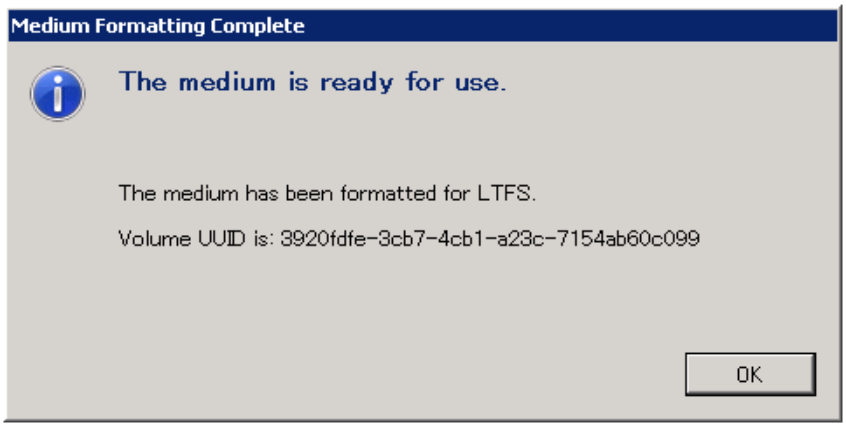

Figure 2-45 IBM Spectrum Archive SDE for Windows Medium Formatting Complete panel

Viewing details

You need to complete the following steps to view the tape details:

1. Open Windows Explorer, right-click the LTFS drive to display a drop-down menu, and then select **Properties** (Figure 2-46).

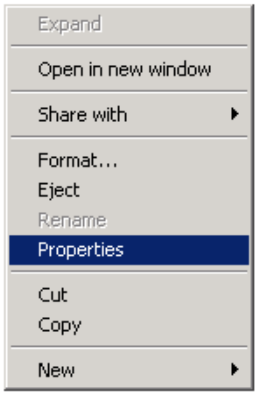

Figure 2-46 Properties menu option

2. A Properties panel displays (Figure 2-47).

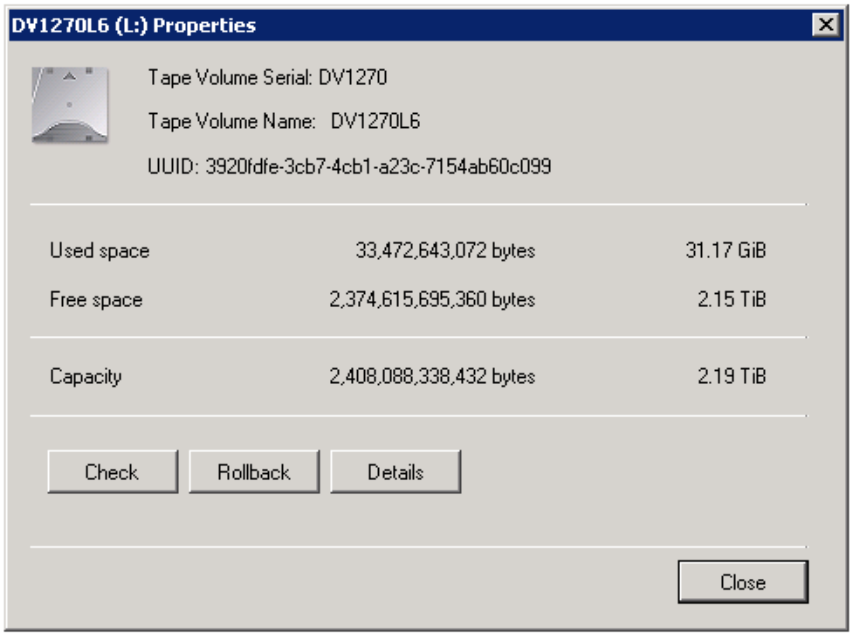

Figure 2-47 IBM Spectrum Archive SDE for Windows media properties panel

The Properties panel displays the following information:

- Tape volume serial number
- Tape volume name
- Universally Unique Identifier (UUID)
- Used and free space (in binary units)
- Capacity (in binary units)

The Properties panel also displays the following options:

- Check
- Rollback
- Details

3. To check for media errors or to roll back, click Check or Rollback. For additional information, see “Checking and recovering media” on page 88.

4. Click **Details** to display the Details window (Figure 2-48).

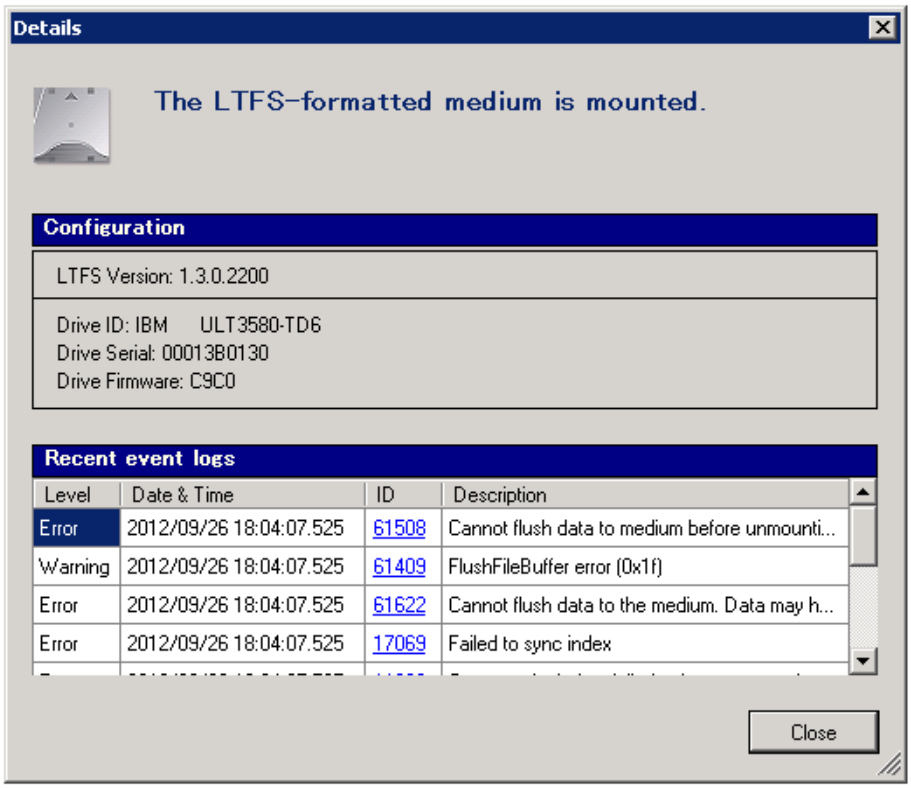

Figure 2-48 IBM Spectrum Archive SDE for Windows media properties details panel

The Details window displays the following information:

– Configuration:
  - IBM Spectrum Archive SDE version
  - Drive ID
  - Drive serial
  - Drive firmware
– Recent event logs:
  - Level (error or warning)
  - Date and Time
  - ID (a number that is assigned to a specific system error or warning message with a hyperlink to the IBM Spectrum Archive SDE section of IBM Knowledge Center)
  - Description

Resource: If no error or warning message displays for your problem, see the IBM Spectrum Archive Single Drive Edition section of IBM Knowledge Center:

https://www.ibm.com/support/knowledgecenter/STQNYL

Simultaneous copy

It is possible to copy multiple files to tape simultaneously, although it is not advised due to the sequential nature of tape. Figure 2-49 shows multiple files that are written to tape at the same time. For an explanation of how the file extents are interleaved on tape, see “Simultaneous copy” on page 60. Figure 2-49 shows files that are being copied simultaneously in two separate sessions.

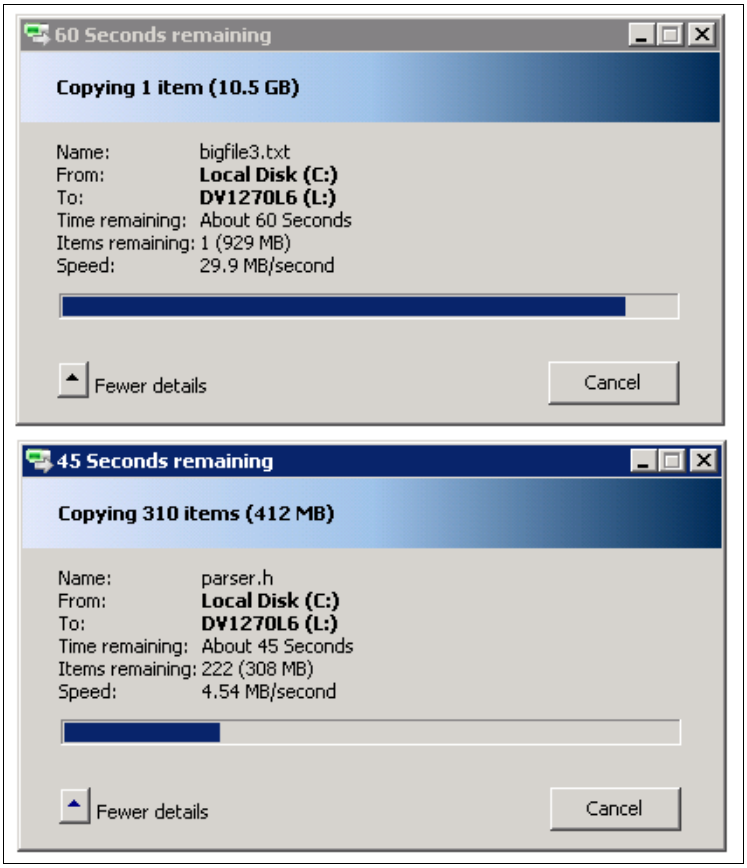

Figure 2-49 IBM Spectrum Archive SDE for Windows simultaneously writing files to tape

Checking and recovering media

You can check and recover LTFS media by using the Check panel.

Important: Directory and file data are stored in index files that specify their exact position and size. If the index file is inconsistent or does not match the data on the medium, IBM Spectrum Archive SDE cannot access it. However, iBM Spectrum Archive SDE can recover extra data blocks from which metadata is excluded from the index file. The recovered data is stored in the `ltfslostandfound` directory in the root directory. When the tape medium is mounted, the directory is viewable at the mount point.

Complete the following steps to check media consistency and to recover a medium:

1. Open Windows Explorer, right-click the LTFS drive to display a drop-down menu, and then select **Properties**. For more information, see “Viewing details” on page 85.
2. Click **Check** to begin the consistency check and recover operation (Figure 2-50).

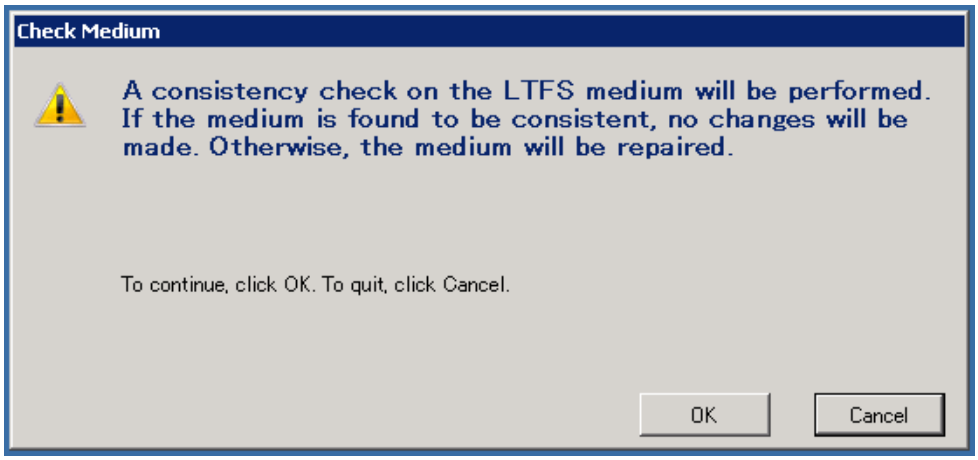

Figure 2-50 IBM Spectrum Archive SDE for Windows LTFS check and rollback panel

3. Click **OK** when the Check Medium panel displays or click **Cancel** to quit the operation. For more information about consistency checking, see “Checking or recovering a tape with the ltfsck command” on page 102. Figure 2-51 displays while the consistency check is run.

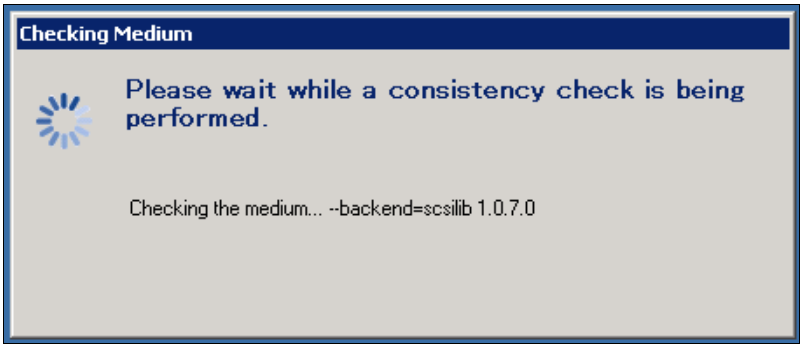

Figure 2-51 IBM Spectrum Archive SDE for Windows LTFS Checking Medium in progress

4. If the medium has inconsistencies, as much data as possible is recovered before the medium is automatically mounted. If an inconsistency in a file cannot be recovered, a message displays that directs you to the Rollback panel. For more information, see “Rolling back media” on page 90 for more information.

5. After you view the results on the Check Medium Complete window (Figure 2-52), click **Close**.

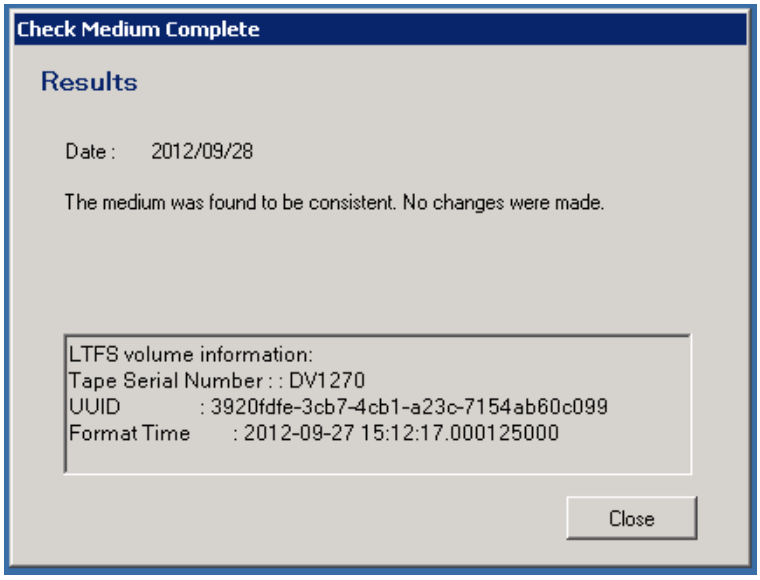

Figure 2-52 IBM Spectrum Archive SDE for Windows Check Medium Complete panel

Rolling back media

You can roll back LTFS media by using the Rollback panel. The Rollback panel lists generations for all indexes on the index partition of the medium. When one of the points is specified, the index is rolled back to that point.

To roll back an LTFS medium, follow these steps:

1. Open Windows Explorer, right-click the LTFS drive icon to display a drop-down menu, and then select **Properties** to display a Properties panel. To learn more about using the Properties panel, see the topic “Viewing details” on page 85.
2. Click **Rollback** (Figure 2-53) to begin the rollback operation.

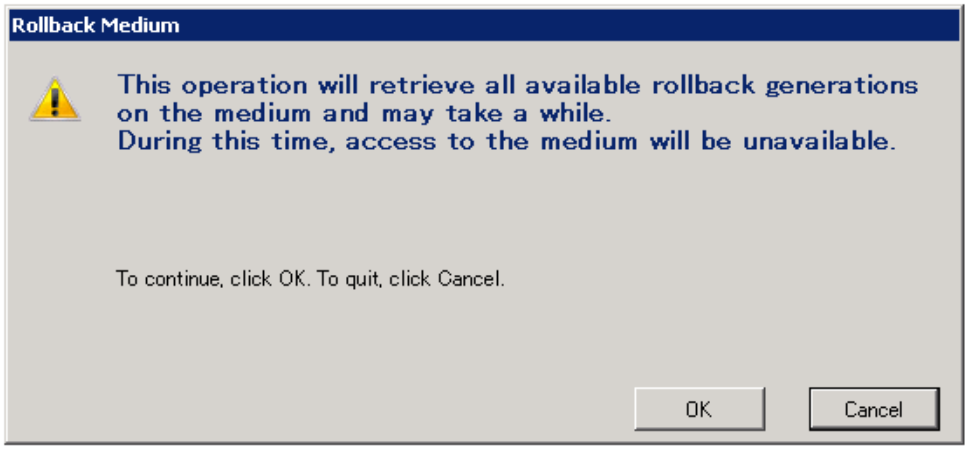

Figure 2-53 IBM Spectrum Archive SDE for Windows Rollback Medium panel

3. Click **OK** when the Rollback Medium dialog box displays to continue the operation or click **Cancel** to quit the operation. Even if you click Cancel, it can take time to mount the medium again. See the Canceling Rollback progress indicator to track the operation. If you continue, see the Retrieving Rollback Generations progress indicator to track the operation. When the operation is complete, the Rollback Cartridge window displays the following information:
   - Generations: A list of all generations that are contained on the medium

     Generation numbers are created incrementally starting at 1. The generation number 1 indicates that the index is created when the medium is formatted. A new index is automatically created whenever data in the main memory cache is flushed to the medium.
   - Date and time: A list of the date and time that an index is created
4. Data for the most recent generation can be removed from the medium by selecting **Erase rollback generations more recent than the selected rollback generation**. By removing this data, you can help optimize storage capacity because the erased area is used again by IBM Spectrum Archive SDE. Data newer than this generation cannot be recovered. When this option is not selected, any existing generation can be recovered even following a rollback operation. This option is equivalent to the **`-j`** or **`--erase-history`** command on Linux and Mac OS X operating systems. To learn more about using this command, see 2.7.3, “Checking or recovering a tape with the ltfsck command” on page 102.
5. Select one generation to which to roll back, then click **OK**. See the Rollback Cartridge progress indicator to track the operation. A Rollback Medium window (Figure 2-54) then displays with the selected generation highlighted.

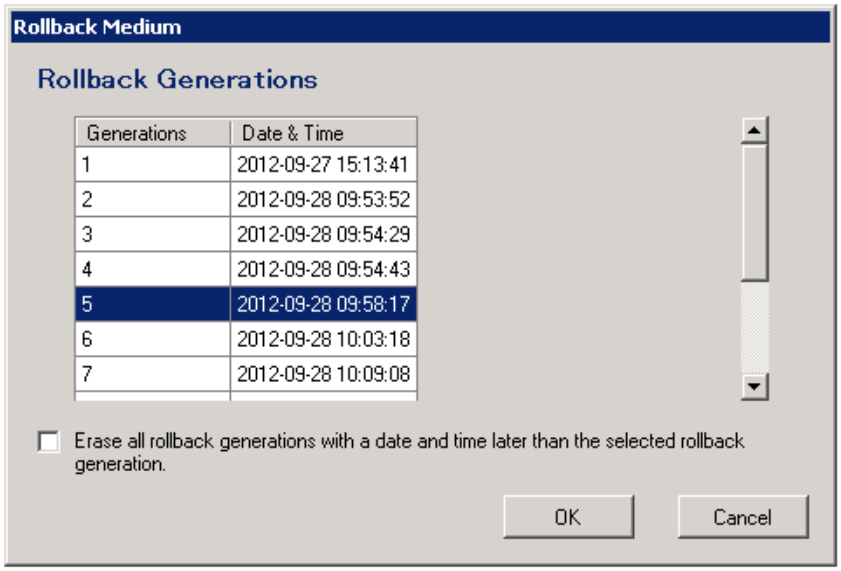

Figure 2-54 IBM Spectrum Archive SDE for Windows Rollback Medium generation panel

6. You have the option of selecting the “Erase all rollback generations with a date and time later than the selected rollback generation” check box. Select the generation (point-in-time) to which you want to roll back and click **OK** to complete the procedure.

The medium is now rolled back to an earlier state. The index list is updated to include the most recent generation. IBM Spectrum Archive SDE currently has no means of searching a rollback generation for a specific file. However, you can view the underlying XML of the index (see 2.8.1, “Using the IBM LTFS Format Verifier” on page 105) and search for particular file names and their date and time stamps.

Displaying version information

You can check the current IBM Spectrum Archive SDE program version by using the Version panel. Complete the following steps:

1. From the desktop, click **Start** → **All programs** → **IBM** → **LTFS** → **Version** (Figure 2-55). Click the Version shortcut to display an “About the IBM Linear Tape File System Single Drive Edition” panel.

Figure 2-55 IBM Spectrum Archive SDE for Windows version information

2. Click **OK** to close the window.

Changing attributes

In IBM Spectrum Archive SDE, only the write bit can be set or changed. So, the following command makes a file on an LTFS tape read-only:

```
>attrib +r filename
```

Other file attributes, such as system, hidden, and archive, cannot be changed.

Extended attributes

A file can have multiple extended attributes. The maximum size of an extended attribute is 4 KB. Within Windows, there is no method of viewing extended attributes directly so a utility must be used to view or set them.

2.6 Troubleshooting

The process to troubleshoot the IBM Spectrum Archive SDE on Linux, Mac OS X, and Windows operating systems is described in this section. When IBM Spectrum Archive SDE detects a problem while it accesses the file system, IBM Spectrum Archive SDE automatically reports an IBM Spectrum Archive SDE-specific error message that leads you to the solution. Furthermore, all operating systems also save error messages in their system logs. To optimize service performance, it is advised that you enable the system log. Detailed steps are provided on the IBM Spectrum Archive SDE section of IBM Knowledge Center.

If a problem occurs with IBM Spectrum Archive SDE, follow these steps:

1. Check to determine whether the tape drive reports an error. If the tape drive has a problem, it reports an error character on a single-character display (SCD). When this error character displays, the IBM Spectrum Archive SDE does not work properly. To solve the problem efficiently, check the SCD first. If it displays any character, see the tape drive maintenance manual to find the solution.
2. Check for the most recent error message and the corresponding ID on the console.
3. Check for the options that are available on the IBM Spectrum Archive SDE section of IBM Knowledge Center to analyze problems.
4. If you cannot find any action to solve the problem, see the IBM Spectrum Archive SDE section of IBM Knowledge Center for additional suggestions about how to troubleshoot the problem.

Several typical issues that you might encounter and suggested solutions are listed.

2.6.1 Formatting errors

When you run the **mkltfs** command, the following error can occur:

```
LTFS15047E Medium is already formatted (0)
```

Solution

You need to specify the **-f** or **--force** option to format any tape medium that is already formatted for use by IBM Spectrum Archive SDE.

2.6.2 Errors starting IBM Spectrum Archive SDE

You might see this error:

```
fuse: bad mount point `/mnt/ltfss': No such file or directory
LTFS14094E Cannot get mount point (-1)
```

Solution

You mistyped the mount point for LTFS. If the directory does not exist, LTFS does not start.

2.6.3 IBM Tape Device Driver errors

You might encounter the following IBM Tape Device Driver errors.

mkltfs

When you run the **mkltfs** command, the following errors can occur:

```
LTFS12114E Cannot open device '/dev/IBMtape0' (16)
LTFS12012E Cannot open device: failed backend open call
LTFS15009E Cannot open device '/dev/IBMtape0' (-21711)
```

There are several possible reasons for these errors. Either a tape is in the process of mounting or dismounting. Or, these errors indicate a hardware problem or a problem with the lin_tape device driver in Linux.

Solution

A tape can be in the process of mounting or dismounting. Wait 1 minute and then rerun the **mkltfs** command. If that does not solve the problem, run the command:

```
/etc/init.d/lin_tape restart
```

If that does not fix the problem, a service representative needs to examine the tape drive.

ltfsck

When you run the **ltfsck** command, one of the following errors occurs:

- `LTFS12158I Opening a device through ibmtape driver (/dev/IBMtape0)`
- `LTFS12113E /dev/IBMtape0: medium is already mounted or in use`
- `LTFS12012E Cannot open device: failed backend open call`
- `LTFS16011E Cannot open device '/dev/IBMtape0'`

Solution

You cannot run the **ltfsck** command if a tape is mounted. Unmount the tape (for example, the **umount /mnt/ltfs** command) and try the **ltfsck** command again.

2.6.4 Tape drive errors

IBM Spectrum Archive SDE requires that the tape drive is turned on and physically connected to the computer before IBM Spectrum Archive SDE is started. The current state of the hardware within the operating system can be checked by using the following commands and utilities:

- Linux: The **cat /proc/scsi/sg/device_strs** command
- Mac OS X: Use the System Profiler tool
- Windows: Use the Device Manager tool

If the tape drive is not visible, check the cabling, power, and so on, rectify the issue, and then unmount and restart IBM Spectrum Archive SDE.

2.6.5 Tape volume errors

IBM Spectrum Archive SDE performs a check of the index of an LTFS tape volume each time that the LTFS tape volume is mounted. In the unlikely event that problems are encountered when the index is read, the mount operation fails and you are notified of the fault. The **ltfsck** utility (2.7.3, “Checking or recovering a tape with the ltfsck command” on page 102) is useful to help you solve these types of tape volume errors.

2.6.6 Unmount errors

If a process uses the current directory under the LTFS mount point, the unmount operation fails, and an error message displays that is similar to the following error message:

```
# umount /mnt/ltfs
umount: /mnt/ltfs: device busy
```

For example, if the current directory is changed to the LTFS mount point and the terminal window remains open, the unmount command fails. In this case, close the terminal window or use the **cd** command to change the directory.

If several people use IBM Spectrum Archive SDE, you can determine which user is using the LTFS mount point by using the **fuser** command option:

- Linux

  ```
  # fuser -muv /mnt/ltfs
  ```

- Mac OS X

  ```
  # fuser -cu /mnt/ltfs
  ```

2.7 Command reference

The IBM Spectrum Archive SDE application for Linux, Mac OS X, and Windows is managed by three main LTFS commands: **ltfs, mkltfs**, and **ltfsck**. In Windows, the three LTFS commands are invoked from within the graphical user interface (GUI) rather than directly through the command line.

2.7.1 Mounting a tape with the ltfs command

The **ltfs** command is the IBM Spectrum Archive SDE program, which is the main program of the three IBM Spectrum Archive SDE programs. It mounts tape media to the file system through the FUSE interface. By using this command, users can access tape media through POSIX system calls.

Enter the **ltfs** command from the command line to mount the media for use with IBM Spectrum Archive SDE. Table 2-2 lists the command to enter, depending on your operating system.

Table 2-2 Command-line entries for the ltfs command

Operating system	Command-line entry
Linux	`mkdir /mnt/ltfs` `ltfs -o devname=/dev/IBMtape0 /mnt/ltfs`
Mac OS X	`mkdir /mnt/ltfs` `ltfs /mnt/ltfs -f -o devname=0`
Windows	N/A

The **ltfs** command has the following command-line options:

```
usage: ltfs mountpoint [options]
```

The **ltfs** command has the following command-line general options:

-o opt,[opt...] Mount options

-h --help Print help

-V --version Print version

The **ltfs** command has the following command-line FUSE options:

-d -o debug Enable debug output (implies **-f**)

-f Foreground operation

-s Disable multithreaded operation

-o allow_other Allow access to other users

-o allow_root Allow access to root

-o auto_unmount Auto unmount on process termination

-o nonempty Allow mounts over non-empty file/dir

-o default_permissions Enable permission checking by kernel

-o fsname=NAME Set file system name

-o subtype=NAME Set file system type

-o large_read Issue large read requests (2.4 only)

-o max_read=N Set maximum size of read requests

-o hard_remove Immediate removal (do not hide files)

-o use_ino Let file system set inode numbers

-o readdir_ino Try to fill in d_inoin readdir

-o direct_io Use direct I/O

-o kernel_cache Cache files in kernel

-o [no]auto_cache Enable caching based on modification times (off)

-o umask=M Set file permissions (octal)

-o uid=N Set file owner

-o gid=N Set file group

-o entry_timeout=T Cache timeout for names (1.0 second (1.0s))

-o negative_timeout=T
Cache timeout for deleted names (0.0s)

-o attr_timeout=T Cache timeout for attributes (1.0s)

-o ac_attr_timeout=T
Auto cache timeout for attributes (**attr_timeout**)

-o noforget Never forget cached inodes

-o remember=T Remember cached inodes for T seconds (0s)

-o intr Allow requests to be interrupted

-o intr_signal=NUM Signal to send on interrupt (10)

-o modules=M1[:M2...]
Names of modules to push onto file system stack

-o max_write=N Set maximum size of write requests

-o max_readahead=N Set maximum read ahead

-o max_background=N Set number of maximum background requests

-o congestion_threshold=N
Set the congestion threshold of the kernel

-o async_read Perform reads asynchronously (default)

-o sync_read Perform reads synchronously

-o atomic_o_trunc Enable atomic open+truncate support

-o big_writes Enable larger than 4kB writes

-o no_remote_lock Disable remote file locking

-o no_remote_flock Disable remote file locking (BSD)

-o no_remote_posix_lock
Disable remove file locking (POSIX)

-o [no_]splice_write
Use splice to write to the fuse device

-o [no_]splice_move Move data while splicing to the fuse device

-o [no_]splice_read Use splice to read from the fuse device

The **ltfs** command has the following command-line module options:

- [subdir]:

  -o subdir=DIR Prepend this directory to all paths (mandatory)

  -o [no]rellinks Transform absolute symlinks to relative

- [iconv]:

  -o from_code=CHARSET
  Original encoding of file names (default: UTF-8)

  -o to_code=CHARSET New encoding of the file names (default: UTF-8)

The **ltfs** command has the following command-line LTFS options:

-o config_file=<*file*>
Configuration file (default: /etc/ltfs.conf)

-o work_directory=<*dir*>
LTFS work directory (default: `/tmp/ltfs`)

-o atime Update index if only access times changed

-o noatime Do not update index if only access times changed (default)

-o tape_backend=<*name*>
Tape back end to use (default: `ibmtape`)

-o iosched_backend=<*name*>
I/O scheduler implementation to use (default: `unified`, use "`none`" to disable)

-o KMI_backend=<name>

Key manager interface implementation to use (default: none, use "none" to disable)

-o umask=<*mode*> Override default permission mask (three octal digits, default: `000`)

-o fmask=<*mode*> Override file permission mask (three octal digits, default: `000`)

-o dmask=<*mode*> Override directory permission mask (three octal digits, default: `000`)

-o min_pool_size=<*num*>
Minimum write cache pool size. Cache objects are 1 MB each (default: `25`)

-o max_pool_size=<*num*>
Maximum write cache pool size. Cache objects are 1 MB each (default: `50`)

-o rules=<*rules*> Rules for choosing files to write to the index partition.

The rule argument uses this syntax:

size=1M

size=1M/name=pattern

size=1M/name=pattern1:pattern2:pattern3

A file is written to the index partition if it is no larger than the specified size *and* it matches at least one of the name patterns (if specified). The size argument accepts K, M, and G suffixes. Name patterns might contain the special characters: question mark (?) (match any single character) and asterisk (*) (match zero or more characters).

-o quiet Disable informational messages (same as verbose=1)

-o trace Enable diagnostic output (same as verbose=3)

-o syslogtrace Enable diagnostic output to stderr and syslog (same as verbose=303)

-o fulltrace Enable full call tracing (same as verbose=4)

-o verbose=<*num*> Override output verbosity directly (default: 2)

-o eject Eject the cartridge after unmount

-o noeject Do not eject the cartridge after unmount (default)

-o sync_type=<*type*> Specify sync type (default: time@5)

<*type*> is specified in the following manner:

time@*min*: LTFS attempts to write an index each '*min*' minutes. *min* must be a decimal number 1 - 140239377069472 (default: min=5)

`close`: LTFS attempts to write an index when a file is closed.

`unmount`: LTFS attempts to write an index when the medium is unmounted.

-o force_mount_no_eod

Skip EOD existence check when mounting (read-only mount)

-o device_list Show available tape devices

-o rollback_mount=<gen>

Attempt to mount on previous index generation (read-only mount)

-o release_device Clear device reservation (should be specified with -o devname

-o capture_index Capture latest index to work directory at unmount

-o scsi_append_only_mode=<on|off>

Set the tape device append-only mode (default=on)

-a Advanced help, including standard FUSE options

The **ltfs** command hand the following Key manager interface “flatfile” plug-in options:

-o kmi_dki_for_format=<DKi>

Data key identifier to format a cartridge

-o kmi_dk_list=FILE Data key

The **ltfs** command hand the following Key manager interface simple plug-in options:

-o kmi_dk=<DK> Data key

-o kmi_dki=<DKi> Data key identifier

-o kmi_dk_for_format=<DK>

Data key to format a cartridge

-o kmi_dki_for_format=<DKi>

Data key identifier to format a cartridge

-o kmi_dk_list=<DK>:<DKi>/<DK>:<DKi>/.../<DK>:<DKi>

Data key and data key identifier pairs’ list

To mount LTFS by a normal (nonroot) user, verify the following conditions:

- For Mac OS X: The user is logged on as an administrator.
- The user has write permission for the work directory (default of `/tmp/ltfs`).
- The user has write permission for the mount point.
- For Linux: Verify that the file mode of `/usr/bin/fusermount` is set to `chmod 4755`.
- For Linux: Verify that `user_allow_other` is added to the `/etc/fuse.conf file`.

2.7.2 Formatting a tape with the mkltfs command

The LTFS **mkltfs** utility is used to format tape media for use with IBM Spectrum Archive SDE. When the **mkltfs** utility is run on a scratch medium, it performs the following actions:

- Destroys all data on the media
- Creates two partitions on the media
- Creates a UUID for the media
- Writes empty index data in the LTFS format

Enter the **mkltfs** command on the operating system command line to format the media:

- For Linux, enter this command:

```
mkltfs --device /dev/IBMtape0 --force --tape-serial=DV1270
--volume-name=DV1270L6
```

- For Mac OS X, enter this command:

```
mkltfs --device 0 --force --tape-serial=DV1270 --volume-name=DV1270L6
```

- For Windows, enter this command:

```
mkltfs --device=1.0.7.0 --force --tape-serial=DV1270 --volume-name=DV1270L6
```

Example 2-25 shows the output of the **mkltfs** command when it is run on Windows 2008.

Example 2-25 Example of mkltfs output

```
LTFS9015W Setting the locale to 'en_US.UTF-8'. If this is wrong, please set the
LANG environment variable before starting mkltfs.
LTFS15000I Starting mkltfs, LTFS version 1.3.0.0 (2200), log level 2
LTFS15041I Launched by "mkltfs --device=1.0.7.0 --force --tape-serial=DV1270
--volume-name=DV1270L6"
LTFS15042I This binary is built for Windows
LTFS15043I GCC version is 4.7.0 20111220 (experimental)
LTFS17087I Kernel version: Windows
LTFS15003I Formatting device '1.0.7.0'
LTFS15004I LTFS volume blocksize: 524288
LTFS15005I Index partition placement policy: None
LTFS17085I Plugin: Loading "scsilib" driver
LTFS62158I Opening a device through scsilib driver (33e680h)
LTFS62160I Drive serial is 00013B0130
LTFS17160I Maximum device block size is 1040384
LTFS17157I Changing the drive setting to write-anywhere mode
LTFS15010I Creating data partition b on SCSI partition 1
LTFS15011I Creating index partition a on SCSI partition 0
LTFS62207I Logical block protection is disabled
LTFS17165I Resetting the medium's capacity proportion
LTFS11097I Partitioning the medium
LTFS11100I Writing label to partition b
LTFS11278I Writing index to partition b
LTFS11100I Writing label to partition a
LTFS11278I Writing index to partition a
LTFS15013I Volume UUID is: ae23a7ff-1d27-4112-84d4-9aa8ebaa46db
LTFS15019I Volume capacity is 2408 GB
LTFS62207I Logical block protection is disabled
LTFS15024I Medium formatted successfully
```

The description of the **-d <*name*>** or **--device=<*name*>** option follows:

- For Linux, this name is the tape device name. The default for this field is `/dev/IBMtape0`.
- For Mac OS X, this name is the tape device enumerator. The default for this field is 0. The enumerator is generated sequentially starting with 0 and is automatically assigned to each tape device.

The following options are also available for the **mkltfs** command:

-d, --device=<*name*> Tape device (required)

-f, --force Force to format medium

-s, --tape-serial=<*id*>
Tape serial number (six alphanumeric ASCII characters)

-n, --volume-name=<*name*>
Tape volume name (empty by default)

-r, --rules=<*rules*> Rules for choosing files to write to the index partition

The syntax of the rule argument is:

size=1M

size=1M/name=pattern

size=1M/name=pattern1:pattern2:pattern3

A file is written to the index partition if it is no larger than the specified size *and* matches at least one of the name patterns (if specified). The size argument accepts K, M, and G suffixes. Name patterns might contain the special characters: question mark (?) (match any single character) and asterisk (*) (match zero or more characters).

--no-override Disallow mount-time data placement policy changes

-w, --wipe Restore the LTFS medium to an unpartitioned medium (format to an existing scratch medium)

-q, --quiet Suppress progress information and general messages

-t, --trace Enable function call tracing

--syslogtrace Enable diagnostic output to stderr and syslog

-V, --version Version information

-h, --help Help

-p, --advanced-help Full help, including advanced options

-i, --config=<*file*> Use the specified configuration file (default: `ltfs/ltfs.conf`)

-e, --backend=<*name*>
Use the specified tape device back end (default: `scsilib`)

--kmi-backend=<*name*>
Use the specified key manager interface (kmi) back end (default: none)

-b, --blocksize=<*num*>
Set the LTFS record size (default: `524288`)

-c, --no-compression
Disable compression on the volume

-k, --keep-capacity Keep the tape medium total capacity proportion

-x, --fulltrace Enable full function call tracing (slow)

The following options are the key manager interface simple plug-in options:

-o kmi_dk=<*DK*> Data key

-o kmi_dki=<*DKi*> Data key identifier

-o kmi_dk_for_format=<*DK*>

Data key to format a cartridge

-o kmi_dki_for_format=<*DKi*>

Data key identifier to format a cartridge

-o kmi_dk_list=<*DK*>:<*DKi*>/<*DK*>:<*DKi*>/.../<*DK*>:<*DKi*>

Data key and data key identifier pairs list

Example 2-26 is a usage example.

Example 2-26 Usage

```
mkltfs --device=2.0.0.0 --rules="size=100K"
mkltfs --device=2.0.0.0 --rules="size=1M/name=*.jpg"
mkltfs --device=2.0.0.0 --rules="size=1M/name=*.jpg:*.png"
```

2.7.3 Checking or recovering a tape with the ltfsck command

The **ltfsck** utility is used to verify tape media consistency and, if necessary, recover the media from an inconsistent state. When a tape is mounted, the tape is checked for consistency problems.

If a consistency problem is identified and can be recovered without the loss of data, the recovery is performed automatically. If the recovery cannot be made without the loss of data, an automatic recovery is not performed. In this case, the **ltfsck** command or **ltfsck -f** command locates the latest index and recovers a medium in an inconsistent state. After the medium is recovered to a consistent state, you can use the **ltfsck -l** command to view a list of available rollback points. The **ltfsck** utility can then be initiated to recover the media to its last good state.

If the **ltfsck** utility detects extra data after the final index in a partition, it deletes the extra data automatically. When the full recover option is specified, the **ltfsck** utility saves the data that might be lost and corrects block information in the `_ltfs_lostandfound` directory.

When the **ltfsck** utility is run, it automatically removes invalid data from the end of the tape and recovers the tape to the last good state. You can initiate additional **ltfsck** utility options to save the invalid data or to list or recover consistency at a specific rollback point or date.

Enter the **ltfsck** command from the command line to verify the consistency of the LTFS formatted media. Table 4-6 lists the specific command to enter by operating system.

Table 2-3 Command-line examples for the ltfsck command

Operating system	Command-line entry
Linux	`ltfsck /dev/IBMtape0`
Mac OS X	`ltfsck 0`
Windows	`ltfsck 1.0.7.0`

The **ltfsck** command also has the following options:

Usage: **ltfsck** [options] **filesys**

filesys Device file for the tape drive

The following options are available:

-g, --generation=<*generation*>
Specify the generation to roll back

-r, --rollback Roll back to the point that is specified by **-g**

-n, --no-rollback Do not roll back. Verify the point that is specified by **-g** (default)

-f, --full-recovery Recover extra data blocks into the `_ltfs_lostandfound` directory

-z, --deep-recovery Recover EOD missing cartridge

Some blocks might be erased, but recover to final unmount point with an index version of at least 2.0.0 or earlier.

(Must be used for a cartridge that cannot be recovered by a normal option.)

-l, --list-rollback-points
List rollback points as shown in Example 2-27

Example 2-27 Output of the ltfsck -l command

```
# ltfsck -l /dev/IBMtape0

LTFS16000I ltfsck starting, log level 2
LTFS16018I Listing rollback points of LTFS file system on '/dev/IBMtape0'
LTFS16023I LTFS volume information:
LTFS16024I Volser(Barcode) :
LTFS16025I Volume UUID     : fdaeedda-5344-4155-a03a-9ca82b2f2e15
LTFS16026I Format Time     : 2010-03-31 14:49:07.172792075 JST
LTFS16027I Block Size      : 1048576
LTFS16028I Compression     : Enabled
LTFS16029I Index Partition : ID = a, SCSI Partition = 1
LTFS16030I Data Partition  : ID = b, SCSI Partition = 0

LTFS16077I Valid indexes:
Gen: Date ......... Time ...... Zone .. SelfPtr->BackPtr (Part, Pos)->(Part, Pos)
------------------------------------------------------------------------------
1: 2010-03-31 14:50:08.800718541 JST      (0, 5) <<Initial Index>>
2: 2010-03-31 14:55:53.988915408 JST      (0, 9)->(0, 5)
3: 2010-03-31 14:57:38.755561251 JST      (0, 13)->(0, 9)
4: 2010-03-31 14:59:24.992244674 JST      (1, 5)->(0, 17)
4: 2010-03-31 14:59:24.992244674 JST      (0, 17)->(0, 13)
```

The following options are available for the **ltfsck -l** command:

-m, --full-index-info
Display full index information (Effective only for **-l** option)

-v, --traverse=<*strategy*>
Set traverse mode for listing rollback points. Strategy must be forward or backward (default: `backward`)

-j, --erase-history Erase history at rollback

-k, --keep-history Keep history at rollback (default)

-q, --quiet Suppress informational messages

-t, --trace Enable diagnostic output

--syslogtrace Enable diagnostic output to stderr and syslog

-h, --help Help

-p, --advanced-help Full help, including advanced options

-i, --config=<*file*> Use the specified configuration file (default: `ltfs/ltfs.conf`)

-e, --backend=<*name*>
Override the default tape device back end

--kmi-backend=<*name*>
Override the default key manager interface back end

-x, --fulltrace Enable full-function call tracing (slow)

--capture-index Capture index information to the current directory (**-g** is effective for this option)

The following options are the key manager interface simple plug-in options:

-o kmi_dk=<*DK*> Data key

-o kmi_dki=<*DKi*> Data key identifier

-o kmi_dk_for_format=<*DK*>
Data key to format a cartridge

-o kmi_dki_for_format=<*DKi*>
Data key identifier to format a cartridge

-o kmi_dk_list=<*DK*>:<*DKi*>/<*DK*>:<*DKi*>/.../<*DK*>:<*DKi*>
Data key and data key identifier pairs list

Example 2-28 shows the output of the **ltfsck /dev/IBMtape0** command on LTFS formatted media.

Example 2-28 Output of the ltfsck command

```
# ltfsck /dev/IBMtape0

LTFS16000I Starting ltfsck, LTFS version 2.4.0.0 (10015), log level 2
LTFS16088I Launched by "ltfsck /dev/IBMtape0"
LTFS16089I This binary is built for Linux (x86_64)
LTFS16090I GCC version is 4.8.3 20140911 (Red Hat 4.8.3-9)
LTFS17087I Kernel version: Linux version 3.10.0-327.el7.x86_64
(mockbuild@x86-034.build.eng.bos.redhat.com) (gcc version 4.8.3 20140911 (Red Hat
4.8.3-9) (GCC) ) #1 SMP Thu Oct 29 17:29:29 EDT 2015 i386
LTFS17089I Distribution: NAME="Red Hat Enterprise Linux Server"
LTFS17089I Distribution: Red Hat Enterprise Linux Server release 7.2 (Maipo)
LTFS17089I Distribution: Red Hat Enterprise Linux Server release 7.2 (Maipo)
LTFS17085I Plugin: Loading "lin_tape" tape backend
LTFS30416I lin_tape version is 3.0.20
LTFS30423I Opening a device through ibmtape driver (/dev/IBMtape0)
LTFS30428I Product ID is 'ULT3580-TD6     '
LTFS30429I Vendor ID is IBM
LTFS30432I Firmware revision is H990
LTFS30433I Drive serial is 1068005796
LTFS17160I Maximum device block size is 1048576
```

```
LTFS11330I Loading cartridge
LTFS30472I Logical block protection is disabled
LTFS11332I Load successful
LTFS17157I Changing the drive setting to write-anywhere mode
LTFS16014I Checking LTFS file system on '/dev/IBMtape0'
LTFS30472I Logical block protection is disabled
LTFS16023I LTFS volume information:
LTFS16024I Volser (bar code) : 1FD069
LTFS16025I Volume UUID     : 9c590503-82bf-4e1b-9b66-71c89cc5bcc5
LTFS16026I Format time     : 2017-09-25 16:25:48.141842063 MST
LTFS16027I Block size      : 524288
LTFS16028I Compression     : Enabled
LTFS16029I Index partition : ID = a, SCSI Partition = 0
LTFS16030I Data partition  : ID = b, SCSI Partition = 1

LTFS11005I Mounting the volume
LTFS30472I Logical block protection is disabled
LTFS11026I Performing a full medium consistency check
LTFS11233I Updating MAM coherency data
LTFS17227I Tape attribute: Vendor = IBM
LTFS17227I Tape attribute: Application Name = LTFS
LTFS17227I Tape attribute: Application Version = 2.4.0.0
LTFS17227I Tape attribute: Medium Label = 1FD069L6
LTFS17228I Tape attribute: Text Localization ID = 0x81
LTFS17227I Tape attribute: Barcode = 1FD069
LTFS17227I Tape attribute: Application Format Version = 2.4.0
LTFS17228I Tape attribute: Volume Lock Status = 0x00
LTFS17227I Tape attribute: Media Pool name =
LTFS11034I Volume unmounted successfully
LTFS16022I Volume is consistent
LTFS30472I Logical block protection is disabled
```

2.8 Tools

The following tools might be useful when you manage IBM Spectrum Archive SDE.

2.8.1 Using the IBM LTFS Format Verifier

This section describes how to download, install, and run the IBM Linear Tape File System (LTFS) Format Verifier (LFV) utility command (**`lfv`**) to verify media hardware and data compatibility.

Before you begin

Before installing the LTFS LFV, download the most recent version from the Fix Central website.

To download the most recent version of the LTFS LFV, complete the following steps:

1. Open the following URL in your web browser:

   http://www.ibm.com/support/fixcentral

2. Click **Product Group** → **System Storage**.

3. Click **Product Family** → **Tape systems**.
4. Click **Product Type** → **Tape drivers and software**.
5. Click **Product** → **Linear Tape File System (LTFS) Format Verifier**.
6. Select your operating system from the **Platform** menu.
7. Click **Continue**.
8. Narrow the search of available downloads according to your criteria (this step can be skipped).
9. Click **Continue** to view the list of available downloads.
10. Select the version that you want to download.
11. To download the new version, follow the instructions on the Fix Central download page.

Latest levels: IBM maintains the latest levels of the LTFS LFV and information about using the tool and related documentation on the Fix Central website:

`http://www.ibm.com/support/fixcentral`

About this task

To install the LTFS LFV, complete the following steps:

1. Download `lfvinst_<version>linuxx86_64` from this website:

   `http://www.ibm.com/support/fixcentral`

2. To make `lfvinst_<version><OS><arch>` an executable file, run the following command:

   ```
   chmod 700 lfvinst_<version><OS><arch>
   ```

3. To complete the installation, run the following command:

   ```
   fvinst_<version><OS><arch>
   ```

Verifying media compatibility by using the IBM LTFS Format Verifier

This section describes how to verify media hardware and data compatibility by using the LTFS LFV utility command. This section also describes the options that can be used with this command.

Important: LTFS LFV is not shipped with IBM Spectrum Archive EE, but is available as a separate download.

To verify that media are compatible with LTFS, run **`lfv`** from the command line. Enter one of the following commands:

- For Linux systems where the IBM Tape Device Driver is installed, `<target device>` should be `/dev/IBMtape`*X*, where X is the index of the tape device to use, as shown in the following example:

  ```
  ./lfv -f /dev/IBMtape1
  ```

- For Linux systems where no IBM Tape Device driver is installed, `<target device>` should be `/dev/sg`*X*, where X is the index for the tape device to use, as shown in the following example:

  ```
  ./lfv -f /dev/sg0
  ```

Important: The index for the target tape device in the previous examples is shown as 0. If you are unsure which index value to use, run the **./lfv -s** command to scan for all attached tape devices.

The following **lfv** command options are available:

- **-f <target device>**

  The target tape device on which verification is performed.

- **-h**

  Displays help information.

- **-l**

  Specifies the log file name. The default name is `lfv.log`.

- **-ll [Errors|Warnings|Information|Debug]**

  Specifies the log level and the level of logging created. **Errors** is the default value.

- **-lp**

  Specifies the log output directory. The default directory is `./output`.

- **-s**

  Scans the system for tape devices and prints results to the window. This option provides a list of the available devices and can help you identify which drive to use. This option provides the following information:

  – Sequential number.
  – Driver handle/device file name.
  – Drive product name.
  – Drive firmware revision.
  – Drive serial number (S/N).
  – Host (H), bus (B), Target ID (T), and LUN (L) physical address of the drive.

  For example, information that is provided by this list appears as shown in the following example:

  ```
  #0 /dev/IBMtape0 -[ULT3580-TD4]-[85V1] S/N:1300000388 H2-B0-T0-L0
  #1 /dev/IBMtape1 -[ULT3580-HH5]-[A2SG] S/N:1068000051 H2-B0-T1-L0
  ```

- **-v**

  Enables verbose verification information.

- **-V --version**

  Displays the program version.

- **-x**

  Specifies that the extended verification is performed. The extended verification analyzes the entire tape cartridge and can take up to three hours to complete. Quick verification is the default.

2.8.2 IBM Tape Diagnostic Tool

Although ITDT is normally used for tape library and tape drive diagnostics, it can also be used to read LTFS XML information from the partitions on tape. A complete discussion of all command-line options of ITDT is outside the scope of this Redbooks publication. However, a few examples of how to perform LTFS-related tasks by using ITDT are provided.

IBM maintains the latest levels of tape-related System Storage software, the tape device driver, the IBM Spectrum Archive SDE software package, and documentation on the internet. Use the Fix Central download portal:

`http://www.ibm.com/support/fixcentral`

To download the latest version of ITDT, follow these steps:

1. From the main Fix Central page, select the following options:
   a. For Product Group, select **System Storage**.
   b. For System Storage, select **Tape systems**.
   c. For Tape systems, select **Tape drivers and software**.
   d. For Tape drivers and software, select **IBM Tape Diagnostic Tool (ITDT)**.
   e. For Platform, to download all platforms of ITDT, select **All**.
   f. Click **Continue**.
2. Narrow the search of available downloads according to your criteria.
3. Click **Continue** to view the list of available downloads.
4. Select the version that you want to download.
5. Follow the instructions on the Fix Central download page to download the new version.

Resource: IBM maintains the latest levels of the ITDT and information about using the tool and related documentation on the Fix Central website.

Viewing the tape label

The following **`itdt`** command (Example 2-29) lists the tape label of the currently mounted tape on tape drive 1.0.7.0 in Windows. The output is written to the file `TapeLabel.txt`.

Example 2-29 Viewing the tape label

```
# itdt -f 1 0 7 0 chgpart 0 read -d TapeLabel.txt

Changing to partition 0...
Initializing device...
Reading file from tape...
Opening destination file C:\Downloads\PreReq\ITDT\Windows\TapeLabel.txt...
Setting block size to variable...
Read complete, 1 records 80 total bytes read...
Transferrate   0.00 Mbytes/s...
   Exit with code: 0
```

Viewing the latest generation of index

The following **itdt** command (Example 2-30) lists the XML schema for the last LTFS index of the currently mounted tape on tape drive 1.0.7.0 in Windows. The output is written to the file `LastIndexPartition.xml`.

Example 2-30 Viewing the latest generation of index

```
# itdt -f 1 0 7 0 chgpart 0 seod bsf 2 fsf 1 read -d LastIndexPartition0.xml

Changing to partition 0...
Spacing to end of data...
Backward spacing 2 filemarks...
Forward spacing filemark...
Initializing device...
Reading file from tape...
Opening destination file LastIndexPartition0.xml...
Setting block size to variable...
Read complete, 1 records 2781 total bytes read...
Transferrate   0.19 Mbytes/s...
Exit with code: 0
```

Listing records

The following **itdt** command (Example 2-31) lists the records and file marks in the data partition of the currently mounted tape on tape drive 1.0.7.0 in Windows.

Example 2-31 Listing records

```
# itdt -f 1 0 7 0 chgpart 1 list
Changing to partition 1...
Rewinding tape...
Setting block size to variable...
Scanning tape...
Record 1  Length 80
*** Filemark ***1 ***
Record 1  Length 489
*** Filemark ***2 ***
*** Filemark ***3 ***
Record 1  Length 981
*** Filemark ***4 ***
*** Filemark ***5 ***
Record 1  Length 1483
*** Filemark ***6 ***
Record 1  Length 7
*** Filemark ***7 ***
Record 1  Length 2044
*** Filemark ***8 ***
*** Filemark ***9 ***
Record 1  Length 2427
*** Filemark ***10 ***
Record 1  Length 524288
Record 2  Length 524288
Record 3  Length 350507
Record 4  Length 524288
Record 5  Length 524288
Record 6  Length 524288
```

```
Record 7  Length 524288
Record 8  Length 524288
Record 9  Length 524288
Record 10  Length 524288
Record 11  Length 524288
   [etc]
```

Listing the partitions

The following **itdt** command (Example 2-32) lists the records and file marks in the data partition of the currently mounted tape (LTO-6) on tape drive 1.0.7.0 in Windows.

Example 2-32 Listing partitions

```
#itdt -f 1 0 7 0 qrypar
Querying tape partitioning...
  Active Partition ............ 1
  Max. Additional Partitions... 3
  Additional Partitions defined 1
  Partition 0 Size (Meg) ...... 36700
  Partition 1 Size (Meg) ...... 2426400
Exit with code:
```

Copying an LTFS tape

The following **itdt** command () makes a copy of an LTFS tape from tape drive 1.0.7.0 to tape drive 1.0.8.0 (Example 2-33).

Example 2-33 Copying a tape

```
#itdt ltfsphcp 1.0.7.0 1.0.8.0
```

Command reference

The following command-line options are available:

Interactive mode: **itdt [-force-generic-dd] [-D file] [-C file] [-N config][-LP path] [-L file] [-LL level] [-R path] [-h|--help]**

The following options are available. They are not needed for normal program usage:

-force-generic-dd Use Generic device driver.

-D descriptor_file.blz
Use alternate descriptor file (default: `ubv.blz`).

-C config_file.blz Use alternate config file (default: `metrocfg.blz`).

-N cli_config_name Use alternate CLI configuration (default: `CLI_DEFAULT`).

-LP logpath Use 'logpath' as logging path (default: `output`).

-L logfile Use 'logfile' for log messages (default: `metro.log`).

-LL Errors|Warnings|Information|Debug
Set log level (default: `Error`).

-R resultdir Use 'resultdir' as result file path (default: `output`).

-h|--help Display this help text.

-version Print the version number of ITDT.

Use this scripting mode: **itdt [-f filename [-w mode] Subcommand [Subcommand ...]]**

The options are described:

-f filename Device special file for the drive/changer, for example: `/dev/rmt0` (IBM AIX®), `/dev/rmt/0st` (Sun), `tape0` (Mac), `/dev/rmt/0m` (HP), `/dev/IBMtape0` (Linux), and `\\.\tape0` (Windows)

-w mode Open mode, by default, read/write. The valid modes are `1`=Read/write, `2`=Read only, `3`=Write only, or `4`=Append

These general subcommands are available:

allow Allow medium removal for tape or changer devices

devinfo Get device information

inquiry [Page] Perform an **inquiry** command

logpage Page Retrieve a log sense page

loop [Count] Loop subsequent commands

modepage Page Retrieve a mode sense page

prevent Prevent medium removal for tape or changer devices

print Text Print a text message to the console

qrypath Display device and path information

qryversion Display IBM device driver version

release Release the device

reqsense Request and display sense data

reserve Reserve the device

resetdrive Reset the device

scan [-o Formatstring]
Display the list of connected devices

sleep Seconds Sleep for the specified number of seconds

tur Perform a Test Unit Ready (TUR)

vpd Display the Vital Product Data (VPD)

The following medium changer subcommands are available:

audit [Address [Count]]
Initialize element status (optionally with range)

cartridgelocation [Slot [Count]]
Retrieve element status for cartridges

elementinfo Display element information for each element type

exchange Source Dest1 Dest2
Exchange cartridges between two locations

inventory [-i | -v Volid]
Read element status

move Source Dest Move cartridge

position Dest Position to an element

The following tape drive subcommands are available:

append Open the driver in append mode

bsf [Count] Backward space file marks

bsr [Count] Backward space records

chgpart Number [Blockid]
Change to partition with specified number and block ID

density Report density support

display "Message" Display message on the OSD of the drive

erase Erase tape

fdp Create fixed data partition

fdpl Create fixed data longitudinal partition

fsf [Count] Forward space file marks

fsr [Count] Forward space records

getparms Get drive/medium/driver parameters

idp pSize0 pSize1 [pSize2 pSize3]
Create initiator-defined wrap-wise partition

idpl pSize0 pSize1 [pSize2 pSize3]
Create initiator defined longitudinal partition

list List the contents of a tape

load Load medium into drive

logsense Get all log sense pages

qrypos Query tape position

qrypar Query tape partitioning

qrytemp Query drive temperature

qrytemp Query drive temperature

read -d Destination [-c Count]
Read a file

rewind Rewind the tape

rmp Remove partitioning

rtest [-b Blocksize] [-c Count] [-r Repetition]
Perform a read test

rwtest [-b Blocksize] [-c Count] [-r Repetition]
Perform a Read/Write test

seod Space to end of data

setparm autoload [0|1]|autodump [0|1]|blocksize [0-65535]|buffering[0|1]| capacity [0-100]|compression [0|1]|immediate [0|1]| readpastfilemark [0|1]|recordspacemode [1=SCSI|2=AIX]|sili [0|1]| simmim [0|1]|trace [0|1]|trailer [0|1]|volid [volume id]| volumelogging [0|1]|writeprotect [NONE|ASSO|PERS|WORM]| datasafemode [0|1]| skipsync [0|1]
Set drive/medium/tape parameter

setpos [Blockid] Set tape position

sdp [0|1|2|3] Create select data wrap-wise partition

sdpl [0|1] Create select data longitudinal partition

sync Synchronize/flush tape buffers

unload Unload medium from drive

weof [Count] Write file marks

write [-raw] -s Source

Write a file to tape

wtest [-b Blocksize] [-c Count] [-r Repetition]

Perform a write test

The following service aid subcommands are available:

dump Retrieve dumps, including force dump

ekmtest Test encryption key path/setup

encryption Report drive encryption state

ucode "Filename" Perform a firmware update

qrytcpip Query TCP/IP port parameter

settcpip "address"[/Subnet Mask Length]

Set TCP/IP port parameter

ltfsphcp source destination

Performs a physical copy of an LTFS-formatted cartridge

tapephcp source destination

Performs a physical cartridge copy

2.8.3 IBM LTFS Copy Tool

The IBM LTFS Copy Tool is a utility that can be used to efficiently transfer data to and from LTFS tapes.

The LTFS Copy Tool provides the following benefits:

- Ability to copy tape contents with optimum order
- Improved performance for reclamation and defragmentation of a tape medium
- Improved performance for retrieving files from an LTFS-formatted tape medium (when LTFS is built into the tape archive solution)

The IBM LTFS Copy Tool optimizes the performance of data transfers through multithreaded operations, memory or disk buffering, and multifile reads from tape that are ordered by location on the tape. These features are described in more detail.

Multithreaded operation

The IBM LTFS Copy Tool uses memory or disk buffering to transfer data, which enables the data to be transferred during a multithreaded operation. While the program that is running on a thread reads a file on the tape medium or disk to the memory or disk buffer, the program that is running on another thread writes data from the memory or disk buffer to the medium simultaneously. This mechanism improves the copy performance.

Reordering by location

The files on a tape medium allow sequential access only. If multiple files are copied without reordering, LTFS sequentially seeks files on the medium. For example, if the first file exists next to the second file, LTFS searches for the bottom of the second file and reads it, and then seeks back to the beginning of the first file. This seek operation drastically degrades the multifile copy performance of LTFS. By reordering by location, the LTFS Copy Tool reads the second file, and then reads the first file. This approach eliminates any unnecessary seek operations and improves the overall copy performance.

For more detailed information about this tool, see the IBM Spectrum Archive Single Drive Edition section of IBM Knowledge Center:

https://www.ibm.com/support/knowledgecenter/en/STZMZN/com.ibm.storage.hollywood.doc/ltfs_reference_ltfs_copy.html

3

IBM Spectrum Archive Library Edition

IBM Spectrum Archive Library Edition (LE) extends the file manager capability of the IBM Spectrum Archive Single Drive Edition (SDE).

IBM Spectrum Archive LE manages the automation and provides operating system-level access to the contents of the library. IBM Spectrum Archive LE is based on the LTFS format specification, enabling tape library cartridges to be interchangeable with cartridges that are written with IBM Spectrum Archive SDE. IBM Spectrum Archive LE supports most IBM tape libraries.

IBM Spectrum Archive LE enables the reading, writing, searching, and indexing of user data on tape and access to user metadata. *Metadata* is the descriptive information about user data that is stored on a cartridge. Metadata enables searching and accessing of files through the graphical user interface (GUI) of the operating system.

Did you know? IBM Linear Tape File System (LTFS) won a Pick Hit award at the National Association of Broadcasters (NAB) conference.

This chapter includes the following sections:

- Introduction
- Installation
- Managing IBM Spectrum Archive LE
- Command reference
- Hints and tips

Ordering: Two versions of IBM Spectrum Archive Library Edition are available. One version is purchased software, with a software warranty and support. The other version is available without a fee, and comes without warranty and support.

3.1 Introduction

IBM Spectrum Archive LE is a file system that enables direct access to IBM Linear Tape-Option (LTO) IBM tape drives using LTO Ultrium 8, M8, 7, 6 and 5 tape cartridges, as well as IBM 3592 tape cartridges with IBM TS1155, TS1150, and IBM TS1140 tape drives and tape libraries. IBM Spectrum Archive LE eliminates the need for additional tape management software to access data. IBM Spectrum Archive LE is based on the media partitioning feature that was introduced with the IBM Linear Tape-Option Ultrium 5 (LTO-5) and TS1140 tape drives.

Note: Throughout this chapter, the terms *supported tape libraries*, *supported tape drives,* and *supported tape media* are used to represent the following tape libraries, tape drives, and tape media. Unless otherwise noted, as of the published date of this Redbooks publication IBM Spectrum Archive LE supports (refer to Table 1-1 on page 3):

- IBM TS4500 tape library[a]
- IBM TS4300 tape library
- IBM TS3500 tape library[a]
- IBM TS3310 tape library
- IBM TS3200 tape library express
- IBM TS3100 tape library express
- IBM TS2900 tape autoloader express
- IBM LTO Ultrium 8, 7, 6, or 5 tape drives, and IBM TS1155, TS1150, or TS1140 tape drives.
- LTO Ultrium 8, M8, 7, 6, and 5, and 3592 JC, JB, JD, JK, and JL tape media.

Refer to the following website to check for the latest support specifications:

`https://www.ibm.com/systems/storage/tape/ltfs/specifications.html`

a. IBM TS1155, TS1150, and IBM TS1140 support on IBM TS4500 and IBM TS3500 tape libraries only

LTFS is the first file system that works with LTO generation 5 tape technology to set a new standard for ease of use and portability for open systems tape storage. With LTFS, accessing data that is stored on an IBM tape cartridge becomes easy and intuitive. With IBM Spectrum Archive LE and the operating system's graphical file manager (Figure 3-1), reading data on a tape cartridge is as simple as dragging and dropping. In addition, it provides for caching tape indexes. It also provides for searching, querying, and displaying tape content within an IBM tape library without the requirement to mount tape cartridges.

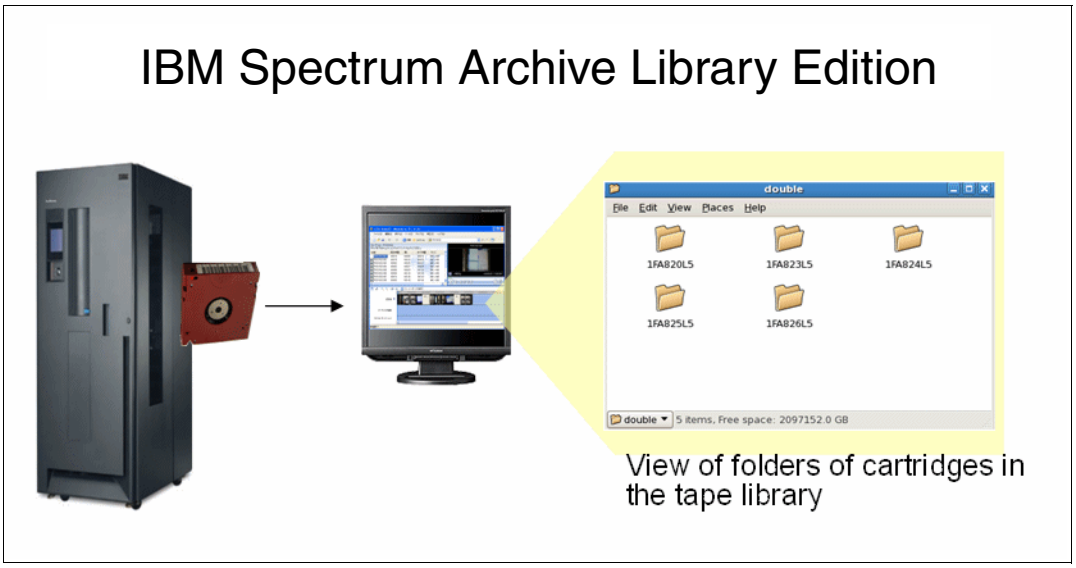

Figure 3-1 IBM Spectrum Archive LE

Under LTFS, tape cartridge usage changes from being application-dependent to application independent. The tape cartridge is now a self-describing, independent storage object similar to a USB drive. Each LTFS cartridge contains the metadata to enable access to the user data on that cartridge. Tape cartridges are portable and robust, and far less prone to damage than a USB hard disk drive. They are also much smaller, lighter, and less expensive. Because nothing is ever overwritten on the tape cartridges, the tapes contain not only the current version of files, but also every previous version of every file that is written to the tape. And the metadata holds all of the necessary information to restore to previous "versions" of the tape.

IBM Spectrum Archive LE provides the following product features:

- Direct access and management of data on IBM supported tape libraries
- Tagging of files with any text, allowing more intuitive searches of cartridge and library content
- Exploitation of the partitioning of the media to support the LTFS format standard
- One-to-one mapping of tape cartridges in tape libraries to file folders
- Capability to create a single file system mount point for a logical library that is managed by a single instance of LTFS and runs on a single computer system
- Capability to cache tape indexes and to search, query, and display tape content within an IBM tape library without having to mount tape cartridges

The following components are needed to operate the tape file system:

- Software in the form of IBM Spectrum Archive LE
- Hardware, consisting of the IBM supported tape libraries, tape drives, and media.

Together, these components can handle a file system on LTO media as though it is a disk file system for accessing tape files, including the tape directory tree structures. After an LTFS tape is mounted and recognized by the IBM Spectrum Archive LE software, its contents can be displayed quickly (that is, at the start of the tape) without a special backup or archive application. Data movement is application independent.

Because each LTFS formatted tape is self-describing, it holds all the needed information to determine the data contents on tape, including the instructions for data arrays, file elements and attributes, and the use of the metadata. An LTFS-formatted tape can be easily transported to other physical locations for reading and writing data.

The LTFS format is an ideal option for storing, on a long-term basis, large files that need to be shared with others, such as for the digital media and entertainment market. Most of these users use Linux or Macintosh systems and can see all the files on tape. With IBM Spectrum Archive LE, users can recall any file from the tape without needing to read the entire tape.

On-tape data structures: These structures are defined by the W3C Extensible Markup Language (XML) 1.0 standard.

3.2 Installation

The system hardware and storage requirements are listed. The required steps to install the IBM Spectrum Archive LE on a Linux system and also on a Windows system are described.

3.2.1 Downloading IBM Spectrum Archive LE

There are two versions of IBM Spectrum Archive Library Edition available. One version is purchased software, with a software warranty and support. The other version is available without a fee, and comes without warranty and support. For more information and a list of supported operating systems, see the following IBM Tape Storage Systems page:

`http://www.ibm.com/systems/storage/tape/ltfs/index.html`

IBM maintains the latest levels of tape-related IBM System Storage software, the tape device driver, the IBM Spectrum Archive LE software package, and documentation on the Internet. Use the Fix Central download portal:

`http://www.ibm.com/support/fixcentral`

To download the latest version of IBM Spectrum Archive LE, complete these steps:

1. From the main Fix Central page, select the following options:
   a. For Product Group, select **System Storage**.
   b. For System Storage, select **Tape systems**.
   c. For Tape systems, select **Tape drivers and software**.
   d. For Tape drivers and software, select **IBM Spectrum Archive Library Edition (LE)**.
   e. For Platform, to download the latest version of IBM Spectrum Archive LE, select the correct platform.
   f. Click **Continue**.

2. In the next window, select the IBM Spectrum Archive LE fix pack to download and click **Continue**. Alternatively, you can select any of the following options:
   - IBM Knowledge Center URL:

     https://www.ibm.com/support/knowledgecenter/en/STZMZN
   - LTFS format specifications:

     http://www.ibm.com/support/docview.wss?rs=577&uid=ssg1S7003166
   - IBM Spectrum Archive LE Support Matrix
   - Installation file
   - Readme file
3. On the Download Options page, select the method that you want to use to download the IBM Spectrum Archive LE and click **Continue**.
4. On the Terms and Conditions page, click **I agree**.
5. On the Download files page, click **Download now**.

3.2.2 Hardware and software requirements

The system hardware and software requirements that relate to IBM Spectrum Archive LE are listed. The current information for IBM Spectrum Archive LE supported hardware and software configurations and notices or limitations is in the readme file of the software package.

Supported tape drives and media

Table 3-1 lists the tape drives and media that are supported by LTFS. The table also gives the native capacity of supported media, and the raw capacity of the LTFS data partition on the media.

Table 3-1 Tape media capacity with IBM Spectrum Archive

Tape drive	Tape media[a]	Native capacity[b, c]	LTFS data partition size[c, d]
IBM TS1155 tape drive[e, f]	Extended type D data (JD)	15 TB (13.64 TiB)	14.562 TB (13.2 TiB)
	Extended type D WORM data (JZ)	15 TB (13.64 TiB)	14.562 TB (13.2 TiB)
	Advanced type C data (JC)	7 TB (6.36 TiB)	6.757 TB (6.14 TiB)
	Advanced type C WORM data (JY)	7 TB (6.36 TiB)	6.757 TB (6.14 TiB)
	Advanced type D economy data (JL)	2 TB (1.81 TiB)	1.937 TB (1.76 TiB)
	Advanced type C economy data (JK)	900 GB (838 GiB)	869 GB (809 GiB)

Tape drive	Tape media[a]	Native capacity[b, c]	LTFS data partition size[c, d]
IBM TS1150 tape drive[g, h]	Extended type D data (JD)	10 TB (9.094 TiB)	9.687 TB (8.81 TiB)
	Extended type D WORM data (JZ)	10 TB (9.094 TiB)	9.687 TB (8.81 TiB)
	Advanced type C data (JC)	7 TB (6.36 TiB)	6.757 TB (6.14 TiB)
	Advanced type C WORM data (JY)	7 TB (6.36 TiB)	6.757 TB (6.14 TiB)
	Advanced type D economy data (JL)	3 TB (2.72 TiB)	2.912 TB (2.64 TiB)
	Advanced type C economy data (JK)	900 GB (838 GiB)	869 GB (809 GiB)
IBM TS1140 tape drive[g, h]	Advanced data type C (JC)	4 TB (3.63 TiB)	3.650 TB (3.31 TiB)
	Advanced data type C WORM (JY)	4 TB (3.63 TiB)	3.650 TB (3.31 TiB)
	Extended data (JB)	1.6 TB (1.45 TiB)	1.457 TB (1.32 TiB)
	Advanced type C economy data (JK)	500 GB (465 GiB)	456 GB (425 GiB)
IBM LTO Ultrium 8 tape drive	LTO 8	12 TB (11.176 TiB)	11.711 TB (10.65 TiB)
	LTO 8 Type M8 cartridge (M8)	9 TB (8.185 TiB)	8.731 TB (7.94 TiB)
IBM LTO Ultrium 7 tape drive	LTO 7	6 TB (5.46 TiB)	5.731 TB (5.21 TiB)
IBM LTO Ultrium 6 tape drive	LTO 6	2.5 TB (2.273 TiB)	2.408 TB (2.19 TiB)
IBM LTO Ultrium 5 tape drive	LTO 5	1.5 TB (1.364 TiB)	1.425 TB (1.29 TiB)

a. WORM media are not supported by IBM Spectrum Archive SDE and IBM Spectrum Archive LE, only with EE.
b. The actual usable capacity is greater when compression is used.
c. See the topic *Data storage values*, found at https://www.ibm.com/support/knowledgecenter/en/STQNYL_2.4.0/ltfs_data_storage_values.html.
d. Values that are given are the default size of the LTFS data partition, unless otherwise indicated.
e. TS1155, TS1150, and TS1140 tape drives support enhanced partitioning for cartridges.
f. Media that are formatted on a 3592 drive must be read on the same generation of drive. For example, a JC cartridge that was formatted by a TS1150 tape drive cannot be read on a TS1140 tape drive.
g. TS1155, TS1150, and TS1140 tape drives support enhanced partitioning for cartridges.
h. Media that are formatted on a 3592 drive must be read on the same generation of drive. For example, a JC cartridge that was formatted by a TS1150 tape drive cannot be read on a TS1140 tape drive.

To learn more about fixes and updates for your system software, hardware, and operating system, see the Fix Central website:

http://www.ibm.com/support/fixcentral

System requirements

The system requirements are described for the IBM Spectrum Archive LE. IBM Spectrum Archive LE supports both Linux and Windows operating systems and hardware platforms. See Table 3-2 for Linux requirements. See Table 3-3 for Windows requirements.

Linux system requirements

Table 3-2 shows the Linux system requirements.

Table 3-2 Linux system requirements

Linux computers	
Supported operating systems	► Red Hat Enterprise Linux (RHEL) 7. 2 (x86_64) ► Red Hat Enterprise Linux (RHEL) 7.3 (x86_6 4 and ppc64le)
Supported hardware	► x86_64, or ppc64 (IBM POWER8® or later, in Little Endian mode) processor. ► 1 GB of available RAM for each 1 million files that are stored on a tape. ► serial-attached Small Computer System Interface (SAS) or Fibre Channel host bus adapter (HBA) supported by IBM LTO 8, LTO 7, LTO 6, and LTO 5 tape drives. ► Fibre Channel HBA supported by IBM TS1155, TS1150, and TS1140 tape drives. ► USB 3.0 interface that is supported by IBM USB LTO tape drives. ► WORM media is not supported.

Windows systems requirements

Table 3-3 shows the Windows system requirements.

Table 3-3 Windows system requirements

Windows computers	
Supported operating systems	► Windows 8.1 (64 bit) ► Windows 10 (Anniversary update or later) ► Windows Server 2012 R2 (64-bit) ► Windows Server 2016 (64-bit)
Server PC	i386 or x86_64 processor
	1 GB (0.93 GiB) of available RAM for each 1,000,000 files that are stored on a tape
	Serial-attached Small Computer System Interface (SCSI) (SAS) or FC HBA supported by IBM LTO-5 and later generation tape drives
	FC HBA supported by IBM TS1140 tape drives

Important:

- IBM Spectrum Archive LE generates a volume for every cartridge in the library.
- IBM Spectrum Archive LE supports only the *random* mode for TS2900 Tape Autoloader, TS3100 tape library, and TS3200 tape library.
- IBM Spectrum Archive LE supports Control Path Failover (CPF).

Required software

IBM Spectrum Archive LE requires that the following prerequisite packages to be installed:

- Red Hat Enterprise Linux systems:
  - FUSE
    - fuse
    - fuse-libs
  - Java virtual machine (JVM)
  - libxml2
  - libuuid
  - libicu
  - openssl
  - Python 2.7 or later, but earlier than 3.0
  - IBM tape device driver
  - The following software is also required to use the Simple Network Management Protocol (SNMP) to monitor the system:
    - net-snmp
- Windows:
  - Microsoft Visual C++ 2010 Redistributable Package
  - Microsoft.NET Framework 4
  - IBM tape device driver for Windows version 6225 or later
  - Python 2.7.2 or later, but earlier than 3.0

Python: The `leadm` script does not run on Python version 3.0 or later.

To learn more about fixes and updates for your system software, hardware, and operating system, see the Fix Central website:

`http://www.ibm.com/support/fixcentral`

3.2.3 Unsupported Windows features, drivers, and commands

The Windows features, drivers, and commands that are *not* supported by IBM Spectrum Archive LE are listed.

New Technology File System

IBM Spectrum Archive LE does not support the following New Technology File System (NTFS) features:

- Compression of files within a folder (IBM Spectrum Archive LE uses the compression of the tape drive).
- Encrypted files and directories.
- Quota management.
- Reparse points.
- Defragmentation.
- Change journals to monitor file activity.

- Scanning of all files or directories that a security identifier owns (FSCTL_FIND_FILES_BY_SID).
- Access control lists. The Security tab is not displayed when the user views the file property by right-clicking, then selecting Properties.
- Alternate data streams. The Details tab is not available when the user views the file property by right-clicking, then selecting Properties.
- Shadow copies. The Previous Version tab is not displayed when the user views the file property by right-clicking, then selecting Properties.
- Opportunistic locks.
- Recycle bins.
- Short names.
- Audit and alarm events (as specified in access control lists).
- Windows sparse files application interfaces.
- Transactional NTFS (TxF).
- Symbolic and hard links.

Symbolic links: It is possible to access symbolic links that are created in another platform (Linux or OS X); however, it is not possible create a symbolic link with Windows.

File system filter drivers

Although Windows has a mechanism to support file system filter drivers, IBM Spectrum Archive LE Windows does not support their use. File system filter drivers cannot attach to IBM Spectrum Archive LE by using formally documented mechanisms or application interfaces.

Native commands for a disk drive

IBM Spectrum Archive LE does not support the following commands:

- `chkdsk`
- `format`
- `defrag`
- `recover`
- `label`

Symbolic links

The following limitations exist when you use symbolic links on a Windows system:

- The user cannot create a new symbolic link between another file system and IBM Spectrum Archive LE.
- The user cannot create a new symbolic link in IBM Spectrum Archive LE.
- The user cannot delete a symbolic link in IBM Spectrum Archive LE.
- The user cannot rename a symbolic link in IBM Spectrum Archive LE.
- Accessing the symbolic link is always forwarded to the target of the link.
- The target of the link is shown as a file, even if it is a directory.
- The target of the link is not shown.

3.2.4 Installation on Windows

The IBM Spectrum Archive LE program installation on a Windows system is described in this section.

Installing Microsoft Visual C++ 2010 Redistributable package (required software)

Follow this procedure:

1. Go to the Microsoft Visual C++ 2010 Redistributable package download site for the corresponding system type (x86 or x64). There are a couple of Visual C++ packages that are available for download. Be careful to download the correct x64 package. *IBM Spectrum Archive LE supports only x64.*
2. Download the package to your local folder.
3. Double-click the package in Windows Explorer to display the User Account Control window. See Figure 3-2.

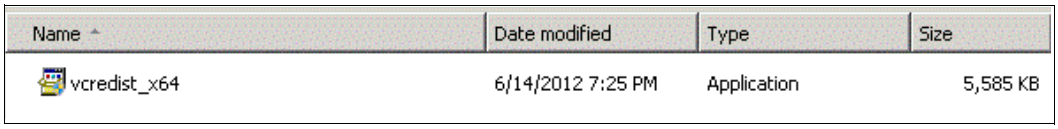

Figure 3-2 Windows Explorer

4. Click **Yes** when the message "`Do you want to allow the following program to make changes to this computer?`" displays.
5. Follow the program instructions until the installation is completed. See Figure 3-3.

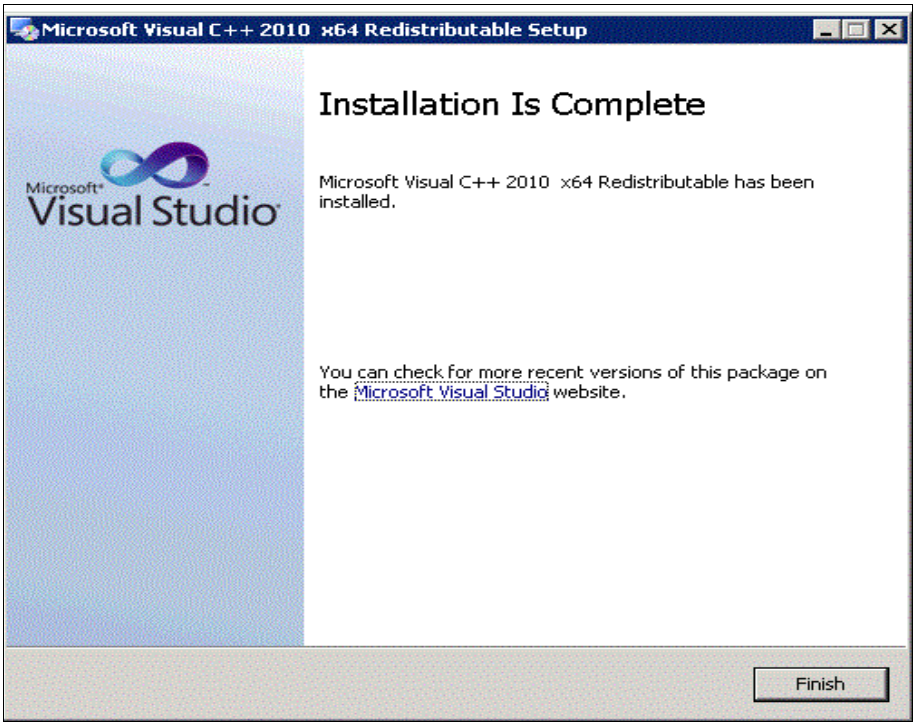

Figure 3-3 Microsoft Visual C++ 2010 Redistributable package

Installing Microsoft .NET Framework 4 (required software)

Follow this procedure:

1. Go to the Microsoft .NET Framework 4 (Stand-alone Installer) download site.
2. Download the file to your local folder.
3. Double-click the file in Windows Explorer. See Figure 3-4.

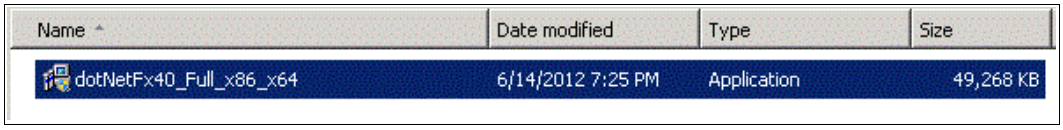

Figure 3-4 Microsoft .NET Framework 4

4. Click **Yes** when the message "`Do you want to allow the following program to make changes to this computer?`" displays.
5. Follow the installer instructions until the installation is completed. See Figure 3-5 and Figure 3-6 on page 126.

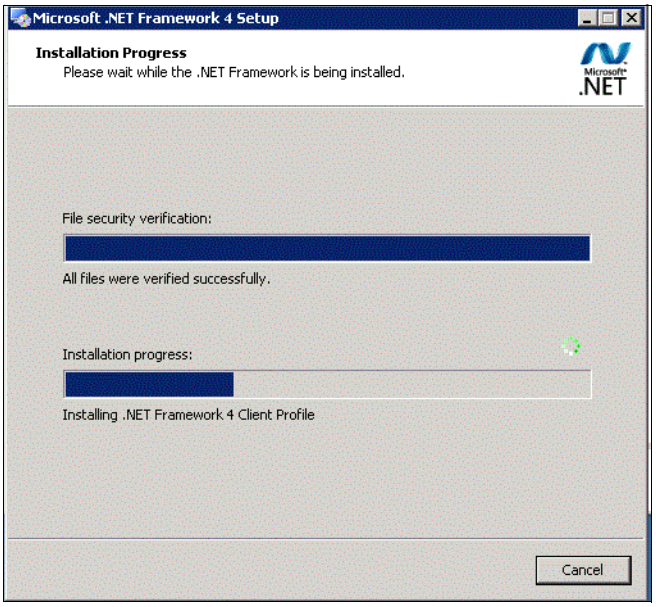

Figure 3-5 Microsoft .NET Framework 4 installer

Figure 3-6 shows a completed installation.

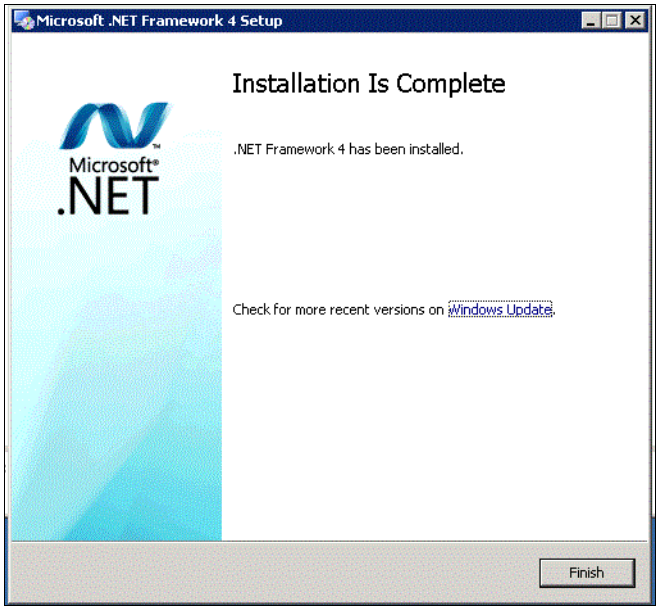

Figure 3-6 Microsoft .NET Framework 4 installation complete

Installing the IBM tape driver for Windows (required software)

Follow these instructions before you begin the installation. Before you install the tape device driver, ensure that the following steps are completed:

1. The HBA and its device driver are installed automatically.

> **Emulex adapter:** If the HBA that is attached to the tape library is an Emulex adapter, set the HBA configuration parameter "`ExtTransferSize`"=2 for Windows 2008 R2 by using the Emulex OneCommand Manager.

2. The tape drive and HBA are connected.
3. The tape drive is powered on.
4. The tape drives in the library are powered on.
5. The server is powered on.

Installation procedure

Complete the following steps to install the tape device driver:

1. Download the current version of the device driver from the IBM Fix Central portal:
   a. Open the following URL in your web browser:

      `http://www.ibm.com/support/fixcentral`

   b. For Product Group, select **System Storage**.
   c. For System Storage, select **Tape systems**.
   d. For Tape systems, select **Tape drivers and software**.
   e. For Tape drivers and software, select **Tape device drivers**.
   f. For Platform, to download the latest version of a tape, select the correct platform.
   g. Click **Continue**.

h. Select the version that you want to download.

> **Installers:** The IBM tape device driver has two installers: exclusive and non-exclusive. Use the exclusive installer with the IBM Spectrum Archive LE.

i. Follow the instructions on the Fix Central download page to download the new version.

2. Download the PDF document, *IBM Tape Device Drivers Installation and User's Guide,* GC27-2130-10, from the IBM Support portal:

   a. Open the following URL in your web browser:

      `http://www.ibm.com/support/us/en/`

   b. Enter the guide name in the **Search support** text box and then click the blue button.

   c. Click **IBM Tape Device Drivers Installation and User's Guide**.

   d. Click **Device_Driver_IUG. PDF** to download the user's guide.

   e. Follow the procedures in the guide to install the tape device driver.

Installing Python for Windows (required software)

Complete the following steps to install Python:

1. Go to the Python Windows download website.
2. Download the file to your local folder.
3. Double-click the file in Windows Explorer. See Figure 3-7.

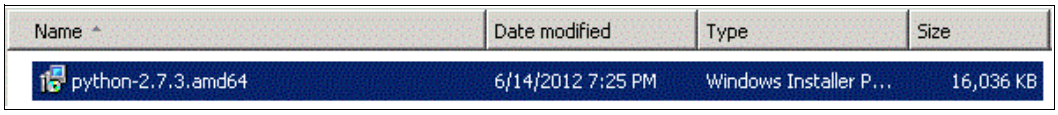

Figure 3-7 Python

4. Follow the installer instructions until the installation is completed. See Figure 3-8 and Figure 3-9 on page 128.

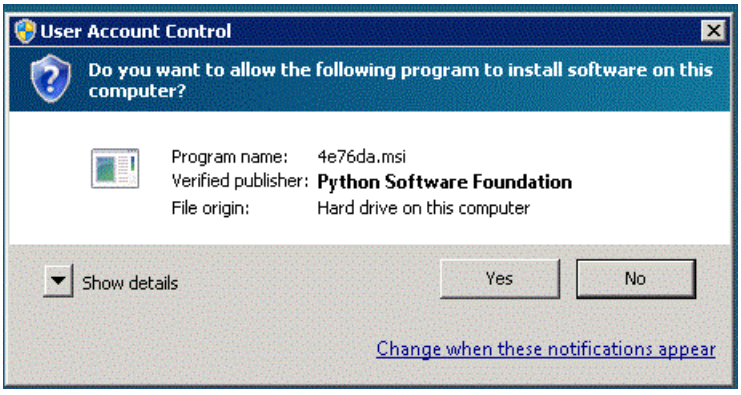

Figure 3-8 Python installer

Figure 3-9 shows a successful installation.

Figure 3-9 Python installation complete

Installing or upgrading IBM Spectrum Archive LE Windows from an .exe file

Follow this procedure:

1. Complete the following steps to install or upgrade IBM Spectrum Archive LE from an `.exe` file:
   a. Open Windows Explorer and double-click the `.exe` file that you downloaded in advance from the IBM website. A dialog box displays with a drop-down menu from which you can select a language for the installation. See Figure 3-10, Figure 3-11, and Figure 3-12 on page 129.

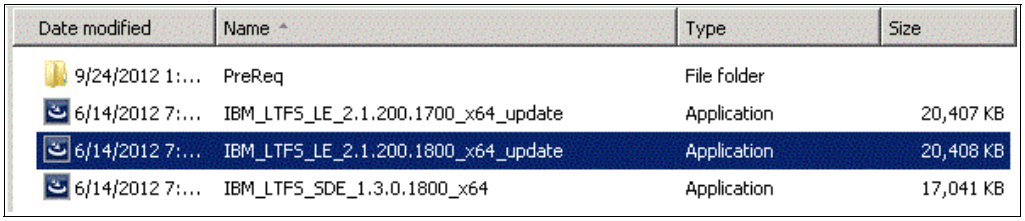

Figure 3-10 Windows Explorer

Figure 3-11 shows selecting the installation language.

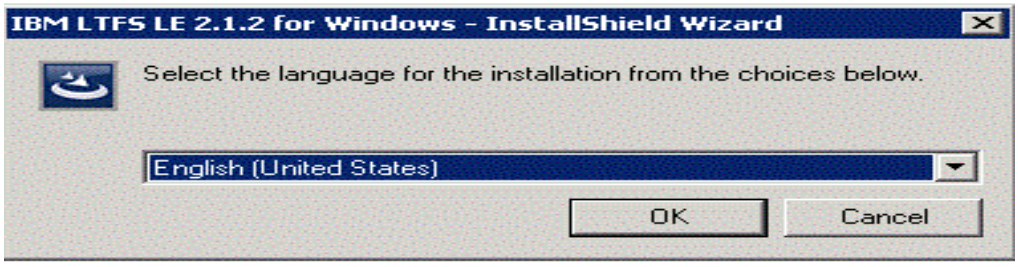

Figure 3-11 IBM Spectrum Archive LE installation wizard

Figure 3-12 shows the welcome window.

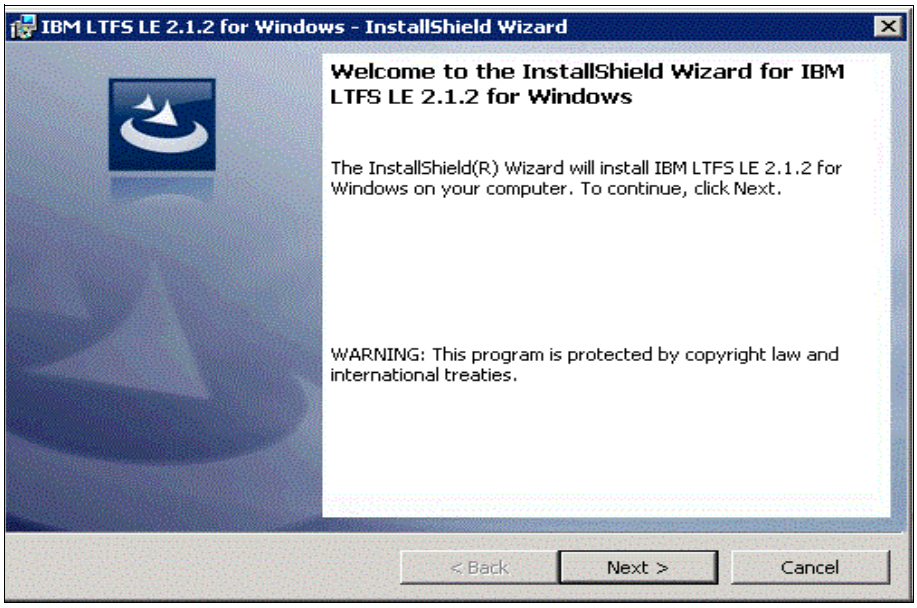

Figure 3-12 IBM Spectrum Archive LE installation wizard

b. Click **OK** to display a Software License Agreement window.

c. Select one of the following options to display the Destination Folder window:

- **I accept the terms in the license agreement** and click **Next** (Figure 3-13).
- **Read Non-IBM Terms** (to open a non-IBM license agreement) and click **Close**.

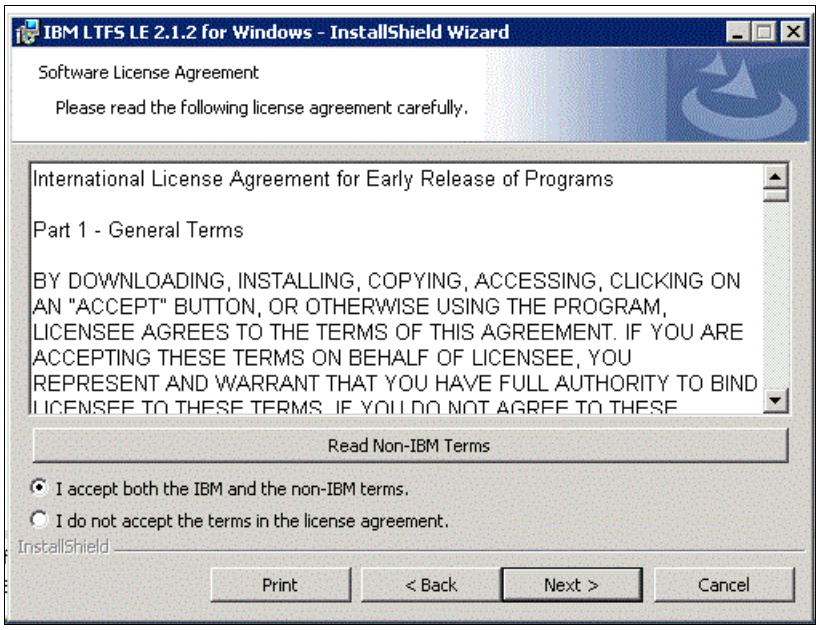

Figure 3-13 IBM Spectrum Archive LE installation wizard

Destination folder: With the Destination Folder wizard, you can change the folder to install the program. The default destination folder is set to `C:\Program Files\IBM\LTFS\`. If you want to change the default folder, click **Change**. Otherwise, click **Next** to skip to step g.

d. If you click **Change**, the Change Current Destination Folder window displays the following options. Either choose a folder from the Look in menu (Figure 3-14) or set the folder name from the Folder name text box.

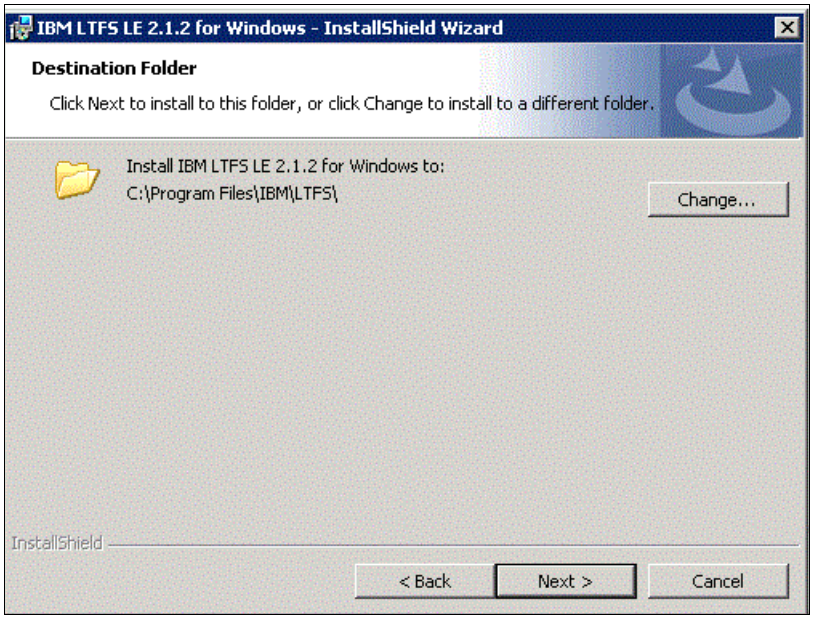

Figure 3-14 IBM Spectrum Archive LE installation wizard

e. After you select an option, click **OK** to proceed to the next step.

f. Click **Next** in the Destination Folder window to display the Ready to Install the Program window (Figure 3-15).

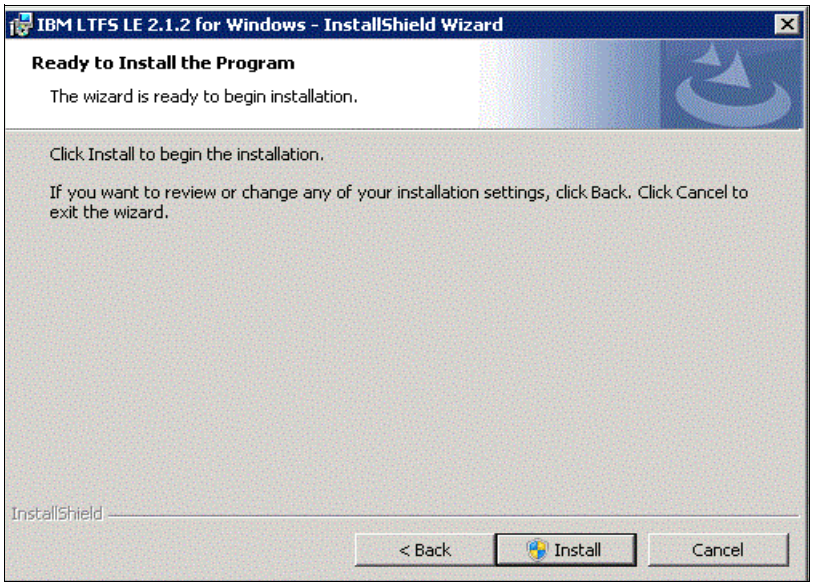

Figure 3-15 IBM Spectrum Archive LE installation wizard

Changes: If you want to change an installation parameter, click **Back**, and then follow the same steps that got you to step g.

g. Click **Install** to display the “Installing IBM Linear Tape File System Library Edition” window.

Progress: You can track the progress of the installation by viewing the status bar.

h. Click **Yes** when the User Account Control window displays the message **“**`Do you want to allow the following program to make changes to this computer?`**”** When the installation completes, the InstallShield Wizard Completed window displays (Figure 3-16).

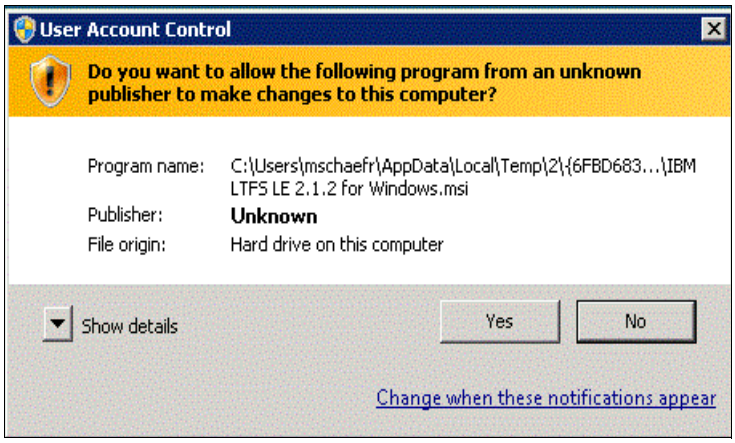

Figure 3-16 User account control window

Administrator password: If you log on to the system as a user account, the User Account Control window displays. To proceed to the next step, type an administrator password and then click **Yes**.

i. Click **Finish** and then **Yes** when the “Installing IBM Linear Tape File System Library Edition Installer Information” window displays to restart the system to launch IBM Spectrum Archive LE. See Figure 3-17 and Figure 3-18.

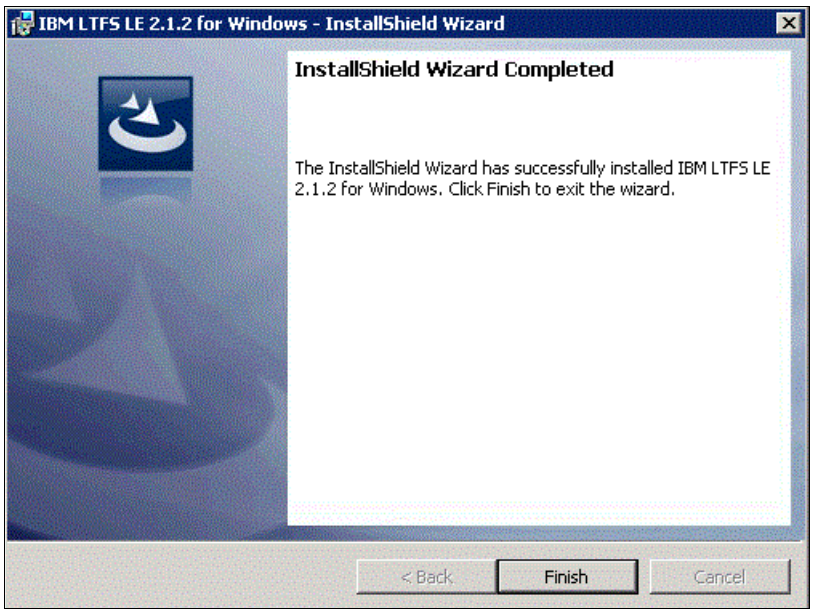

Figure 3-17 IBM Spectrum Archive LE installation wizard

Figure 3-18 shows determining whether to restart immediately.

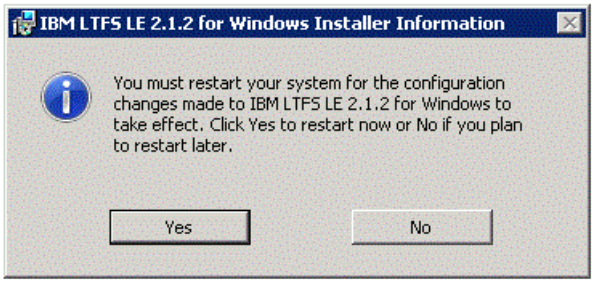

Figure 3-18 IBM Spectrum Archive LE installation wizard

Figure 3-19 shows how the physical tapes are mapped to the Windows file system. Each physical tape cartridge volume serial numbers (VOLSER) is displayed as a directory on Windows Explorer.

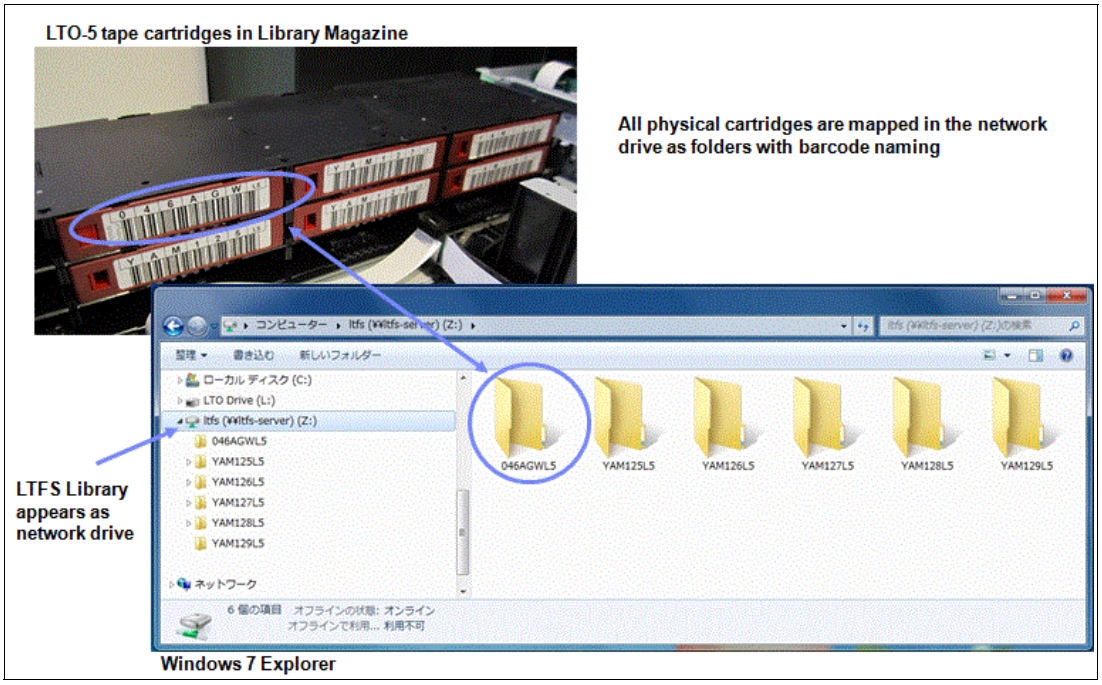

Figure 3-19 Tape library tapes mapped to Windows

Uninstalling IBM Spectrum Archive LE from a Windows system

Complete the following steps to uninstall IBM Spectrum Archive LE:

1. From the desktop, click **Start** → **All Programs** → **IBM** → **LTFS** → **Uninstall LTFS** to open the Windows Installer program.
2. Click **Yes** when the message `Are you sure you want to uninstall this product?` displays.
3. Click **Yes** when the message `Do you want to allow the following program to make changes to this computer?` displays.

> **Administrator**: If you log on to the system as a user account, the User Account Control window displays. You must type an administrator password to proceed to the next step and then click **Yes**.

4. If the message `All LTFS tape libraries must be unmounted before uninstalling LTFS program` displays, unmount all tape libraries from IBM Spectrum Archive LE by using the **`ltfsunmount`** command, and then try again. If this message does not display, proceed to step 5.
5. Click **OK** when either of the following messages displays:
   - `The following applications should be closed before continuing the uninstall.`
   - `The setup was unable to automatically close all required applications.`

> **Progress:** Use the status bar to track the progress of the uninstall.

6. Restart the system to completely remove the IBM Spectrum Archive LE program from your operating system.

Alternative: You also can uninstall the IBM Spectrum Archive LE program from the desktop by clicking **Start** → **Control Panel Uninstall a program under Programs**. Then, restart your operating system.

3.2.5 Installation on Linux

Complete these required steps *before* you install IBM Spectrum Archive LE.

Installing the prerequisite Linux software

IBM Spectrum Archive LE requires the following prerequisite packages to be installed:

- FUSE
  - fuse
  - fuse-libs
- Java virtual machine (JVM)
- libxml2
- libuuid
- libicu
- openssl
- Python 2.7 or later, but earlier than 3.0
- IBM tape device driver
- The following software is also required to use SNMP to monitor the system:
  - net-snmp

Tip: The `leadm` script does not run on Python version 3.0 or later.

Installing the HBA and HBA device driver

To install the HBA and its device driver for use with IBM Spectrum Archive LE, see the documents that are provided by the HBA manufacturer. For a list of supported adapters, go to the following LTO page:

`http://www.ibm.com/systems/storage/tape/lto/`

For information about connectivity and supported configurations, see the IBM System Storage Interoperation Center (SSIC) website:

`http://www.ibm.com/systems/support/storage/config/ssic/`

Installing the IBM tape device driver

Before you install the tape device driver for use with IBM Spectrum Archive LE, complete the following tasks:

1. Install the HBA and its device driver:
   a. Download the current version of the tape device driver from the IBM Fix Central portal:

      http://www.ibm.com/support/fixcentral

   b. Download the *IBM Tape Device Drivers Installation and User's Guide* (a PDF document) from the IBM Support and Download site:

      http://www.ibm.com/support/us/en/

   c. Follow the procedures in the user's guide to install the tape device driver or see 2.2.4, "Installation procedure" on page 30.
2. Connect the tape drive and HBA.
3. Power on the tape drive in the tape library.
4. Power on the server.

Enabling the system log

Error information for IBM Spectrum Archive LE operations is displayed on the terminal console. The level of error reporting is based on the log trace level.

When the IBM Spectrum Archive LE commands are used, error and trace information is recorded by using the system log mechanism. This mechanism is disabled by default. To enable the IBM Spectrum Archive LE system log and locate additional information about IBM Spectrum Archive LE logs, follow these steps:

1. Log on to the operating system as `root`.
2. Edit the system log configuration file on any available editor to enable the system log. Apply one of the following edits, depending on your base system. See Example 3-1.

Example 3-1 System log configuration file

```
Add the following line to /etc/rsyslog.conf
:msg, contains, "LTFS" /var/log/ltfs.log
```

3. Enable the setting by restarting ryslog by issuing the following command:

```
systemctl restart rsyslog
```

4. Open the `/etc/logrotate.d/syslog` file on any available editor (see Example 3-2). Add or edit the following lines.

Example 3-2 Add or edit syslog file

```
/var/log/ltfs.log {
       size 1M
       rotate 4
       missingok
       compress
       sharedscripts
       postrotate
       /bin/kill -HUP `cat /var/run/syslogd.pid 2> /dev/null` 2> /dev/null ||
true
```

```
        /bin/kill -HUP `cat /var/run/rsyslogd.pid 2> /dev/null` 2> /dev/null ||
true
        endscript
              }
```

IBM Spectrum Archive LE records and displays the following types of logs:

Error	A message that indicates an unrecoverable error occurred or an operation unexpectedly failed
Warning	A message that indicates an unexpected condition occurred, but the operation can continue
Information	A message that provides additional information about the current operation
Trace	A message that provides information about debugging and troubleshooting

For more information about how to set the log trace level, see the IBM Spectrum Archive LE Knowledge Center:

https://www.ibm.com/support/knowledgecenter/en/STZMZN/com.ibm.storage.hollywood.doc/ltfs_managing_troubleshooting_set_log_trace._library_edition.html

Latest information: Information in the `readme` and `install` files that are provided with the IBM Spectrum Archive LE distribution package supersedes information that is presented and the information in the information center.

Extracting binary rpm files from an installation package

Extract the binary `rpm` files from an installation package for IBM Spectrum Archive LE on a Linux system.

The IBM Spectrum Archive LE software package, and documentation is available at the IBM Fix Central download portal:

http://www.ibm.com/support/fixcentral

Installation package: The installation package name is `ltfs-2.1.1-[revision].bin`. It includes `rpm` files for the revision and supported platforms and architectures.

Ensure that the following steps are completed before you begin to create a binary `rpm` package:

1. Log on to the operating system as `root`.
2. Confirm the execution permission of `ltfs-2.1.1-[revision].bin` (Example 3-3) by issuing the following command:

   ```
   # ls -l ltfs-2.1.1-[revision].bin
   ```

   Example 3-3 LTFS confirm execution permission

   ```
   [root@double ~]# ls -l ltfs-2.1.1-201109201.i386.bin
   -rwxr-x--- 1 root root 68924904 Sep 29 16:23 ltfs-2.1.1-201109201.i386.bin
   ```

3. Set the execution permission, if it is not already set, by issuing the following command:

   ```
   # chmod +x ltfs-2.1.1-[revision].bin
   ```

Create the rpm packages: If the software shipped as an rpm source file named "src.rpm", issue the following command to create the rpm packages:

```
# rpmbuild --rebuild ltfs-2.1.1-[revision].src.rpm
```

After you verify the execution permission, complete the following steps to extract the binary rpm files:

1. Run the binary file on the system by following the steps that are shown in step 2 of the preceding list. You can launch it on a terminal by issuing the following command in the directory in which the file resides:

   ```
   # ./ltfs-2.1.1-[revision].bin
   ```

   The extracted rpm files are in the directory: /root/LTFSLE/rpm[revision]/[platform]/

2. Select the rpm files that correspond to your platform.

The following files in the rpm folder are extracted:

- ltfs-2.1.1-[revision]-[platform].rpm
- ltfs-license-2.1.0-[revision]-[platform].rpm
- ltfs-library-2.1.1-[revision]-[platform].rpm
- ltfs-admin-utils-2.1.1-[revision].noarch.rpm

The ltfs-admin-utils-2.1.1-[revision].noarch.rpm file is common to all platforms. Both ltfs and ltfs-library rpm file names include platform tags.

For example, if you want to install LTFS rpm files for revision 201109201, by using a Red Hat Linux distribution on a 64-bit architecture, the following files in the rpm folder are required:

- ltfs-2.1.1-201109021-RHEL61.i386.rpm
- ltfs-license-2.1.0-201109021-RHEL61.i386.rpm
- ltfs-library-2.1.1-2011009201-RHEL561.i386.rpm
- ltfs-admin-utils-2.1.1-201109201.noarch.rpm

Installing or upgrading from a binary rpm file

Follow these steps to install or upgrade the IBM Spectrum Archive LE program on a Linux system from a binary rpm file.

Installing the binary rpm files: Install the binary rpm files by following the procedure in "Select the rpm files that correspond to your platform." on page 137.

Complete the following steps from a Linux command prompt:

1. Log on to the operating system as a root user.
2. If IBM Spectrum Archive LE is already installed and you want to upgrade it, unmount the IBM Spectrum Archive LE file system by entering the following command:

   ```
   umount /mnt/ltfs
   ```

   To continue the upgrade, skip to step 5.

3. Run these commands in the following sequence to *install* the rpm packages:

   ```
   # rpm -ihv ./ltfs-license-2.1.0-[platform].[architecture].rpm
   # rpm -ihv ./ltfs-2.1.2-[revision]-[platform].[architecture].rpm
   # rpm -ihv ./ltfs-library-2.1.2-[revision]-[platform].[architecture].rpm
   # rpm -ihv./ltfs-admin-utils-2.1.2-[revision].noarch.rpm
   ```

Required: It is required to install the `ltfs-license rpm` file before you install the other packages. It is required to install the `ltfs rpm` file before you install the ltfs-library file. The commands are the same, whether you install for the first time or upgrade the `rpm` file. For example, if you install the `ltfs-library rpm`, revision 201111110, by using a Red Hat Linux distribution 6.1 on a 64-bit architecture, you issue the following command:

```
# rpm -ihv ./ltfs-library-2.1.2-201111110-RHEL7.x86_64.rpm
```

4. **Optional:** Run the following commands to verify the current version of IBM Spectrum Archive LE:

```
# rpm -q ltfs-license
# rpm -q ltfs
# rpm -q ltfs-library
# rpm -q ltfs-admin-utils
```

5. Run these commands in the following sequence to *upgrade* the binary rpm package:

```
# rpm -Uhv ./ltfs-2.1.2-[revision]-[platform].[architecture].rpm
# rpm -Uhv ./ltfs-library-2.1.2-[revision]-[platform].[architecture].rpm
# rpm -Uhv ./ltfs-admin-utils-2.1.2-[revision].noarch.rpm
```

6. Optional: Run the following commands to verify the current version of IBM Spectrum Archive LE:

```
# rpm -q ltfs-license
# rpm -q ltfs
# rpm -q ltfs-library
# rpm -q ltfs-admin-utils
```

Uninstalling from a Linux system

Follow these steps to uninstall IBM Spectrum Archive LE from a Linux system:

1. Log on to the operating system as a `root` user.
2. If LTFS is mounted, unmount it by entering the following command:

```
# umount /mnt/ltfs
```

3. Run these commands in the following sequence to *remove* the installed packages:

```
# rpm -e ltfs-admin-utils-2.1.2-[revision]
# rpm -e ltfs-library-2.1.2-[revision]
# rpm -e ltfs-2.1.2-[revision]
```

4. Issue the following commands to check that the packages are uninstalled:

```
# rpm -q ltfs
# rpm -q ltfs-library
# rpm -q ltfs-admin-utils
```

If you uninstall to upgrade to a higher version, keep the license module installed. You cannot install an upgrade package without the license module. If you have a license module for a trial version and the license expires, IBM Spectrum Archive LE works in read-only mode. To use all IBM Spectrum Archive LE functions, uninstall the trial license module and install the license module for the product version.

Optional: The extracted `rpm` files for those operating systems other than your system can be deleted. Retain the `rpm` files that belong to IBM Spectrum Archive LE for your operating system in case you need to reinstall.

3.3 Managing IBM Spectrum Archive LE

The following section explains the supported interfaces for use with IBM Spectrum Archive LE for Windows and Linux operating systems. Basic use cases will be covered such as mounting the file system, adding drives, creating directories on tape, and viewing a list of available tapes.

Note: Examples used through this chapter were executed in a Linux environment. Windows command options and output are identical.

3.3.1 IBM Spectrum Archive LE Command Overview

IBM Spectrum Archive LE has two commands that are used, one for mounting to a library and the other for managing the library. To mount the library on a Linux machine, the **`ltfs`** (**`ltfs.exe`** for windows) command is used. Table 3-4 explains how to mount and unmount the IBM Spectrum Archive LE library on the correct operating system. For a detailed list of available options and usage, see “Available command options for the leadm command” on page 166.

Table 3-4 Mounting and unmounting ltfs on linux and windows

Operating System	Command	Purpose
Windows	ltfs.exe	Starts IBM Spectrum Archive LE to mount a tape library. A drive letter must be specified
	ltfsunmount.exe	Unmounts IBM Spectrum Archive LE
Linux	ltfs	Starts IBM Spectrum Archive LE to mount a tape library. A mount point and changer device must be specified.
	umount / fusermount -u	Unmounts IBM Spectrum Archive LE. The IBM Spectrum Archive LE mount point must be supplied

After IBM Spectrum Archive LE is mounted and running, use the IBM Spectrum Archive LE **`leadm`** commands to configure IBM Spectrum Archive LE tape cartridges and perform IBM Spectrum Archive LE administrative tasks. The **`leadm`** command uses the **`leadm <command> <subcommand> [options]`** format.

The following is an overview of the subcommands that are used with the **`leadm`** command:

- **`leadm node show`**

  Use this command to display detailed information about the node. The data is displayed in either JSON or XML format. The default is JSON.

- **`leadm library show`**

  Use this command to display detailed information about the library. The data is displayed in either JSON or XML format. The default is JSON.

- **`leadm drive list`**

  Use this command to list all connected drives. The data is displayed in either LIST, JSON, or XML format. The default is LIST.

- **`leadm drive show`**

  Use this command to display detailed information for a specified drive. The data is displayed in either JSON or XML format. The default is JSON.

- **`leadm drive open`**

  Use this command to open and add drives to the IBM Spectrum Archive LE resource.

- **`leadm drive close`**

  Use this command to close and remove drives from the IBM Spectrum Archive LE resource.

- **`leadm tape list`**

  Use this command to list all available tapes in the library. The data is displayed in either LIST, JSON, or XML format. The default is LIST.

- **`leadm tape show`**

  Use this command to display detailed information for a specified tape cartridge. The data is displayed in either JSON or XML format. The default is JSON.

- **`leadm tape assign`**

  Use this command to add tapes to the IBM Spectrum Archive LE resource.

- **`leadm tape unassign`**

  Use this command to remove tapes from the IBM Spectrum Archive LE resource.

- **`leadm tape move`**

  Use this command to move tapes to specified type of slot. Available slots are ieslot, drive, and homeslot.

- **`leadm tape recover`**

  Use this command to perform checks, full recovery or deep recovery on inconsistent cartridges.

- **`leadm tape rollback`**

  Use this command to perform a rollback on a specified tape to a previous generation.

- **`leadm tape rollbacklist`**

  Use this command to list available rollback generations on specified tapes.

- **`leadm tape unlock`**

  Use this command to unlock tapes from locked drives. This command is used when a tape is in the NEED_UNLOCK state.

- **`leadm tape unmount`**

  Use this command to manually unmount specified tapes from the drive.

- **`leadm tape format`**

  Use this command to format tapes.

- **`leadm tape unformat`**

  Use this command to unformat tapes.

- **`leadm tape sync`**

  Use this command to manually sync tapes.

  For a detailed overview on all the available command options, see 3.4.1, “Available command options for the leadm command” on page 166.

3.3.2 Typical user scenario on a Windows system

For typical user scenarios on a Windows system, see IBM Knowledge Center:

https://www.ibm.com/support/knowledgecenter/STZMZN/com.ibm.storage.hollywood.doc/ltfs_managing_windows_scenario.html

3.3.3 Typical user scenario on a Linux system

This section describes a typical user scenario on a Linux system.

Mounting a library on a Linux system

The **ltfs** command is used to mount a library to the directed mount point. In the following example, the library device name and the mount point are provided as parameters of the **ltfs** command. The library device name is `/dev/IBMchanger0` and the mount point name is `/mnt/ltfs`:

```
$ ltfs -o changer_devname=/dev/IBMchanger0 /mnt/ltfs
```

Important: Before the library is mounted, a mount point, such as `/mnt/ltfs`, must be created. The user must be given write access permission. If you want to mount more than one library device, unique mount points must be created for each device. For example, you can create mount point `/mnt/ltfs0` for library device `/dev/IBMchanger0` and then create mount point `/mnt/ltfs1` for library device `/dev/IBMchanger1`.

If multiple tape libraries are connected to the system, a library device name, such as `/dev/IBMchanger0`, can be changed after you disconnect the cable. To avoid this situation, see the information about persistent naming support in the *IBM Tape Device Driver Installation and User's Guide*, GC27-2130.

To mount a tape library as a normal (nonroot) user, the following steps are required to be performed by a root user:

1. Open a terminal and become a superuser.
2. Create a mount point directory, such as `/mnt/ltfs`, and set the write permission to the directory.

   Important: Unique mount points must be created for each library device.

3. Create a work directory, such as `/tmp/ltfs` (the default work directory) and set the write permission to the directory.
4. Set the write permission to a library device, such as `/dev/IBMchanger0`. This permission is reset to default on boot, so it is necessary to change permission to this device on every boot.

   In Example 3-4, instead of setting permission to the library device on every boot as mentioned in step 4, set the permission to the tape library devices and the tape drives permanently to 666. Add the following lines in the `/etc/udev/rules.d/98-lin_tape.rules` file.

Example 3-4 Persistent set of permission

```
KERNEL=="IBMchanger*", NAME="%k", MODE="0666"
KERNEL=="IBMtape*[!n]", NAME="%k", MODE="0666"
KERNEL=="IBMtape*n", NAME="%k", MODE="0666"
```

5. Add read/execute permission to the `fusermount` (Example 3-5).

Example 3-5 Read/Execute permission

```
su
Password:
mkdir /mnt/ltfs
chmod 666 /mnt/ltfs
mkdir /tmp/ltfs
chmod 666 /tmp/ltfs
chmod 666 /dev/IBMchanger0
chmod 666 /dev/IBMtape0
chmod +rx /bin/fusermount
```

6. Share the tape library. If you want to share the tape library with another user, add the **user_allow_other** option in the `/etc/fuse.conf` file.
7. Mount the tape library (Example 3-6). If you want to mount the tape library as a user other than a superuser and allow another user to access the file system, add the **-o allow_other** option:

   ```
   ltfs /mnt/ltfs -o changer_devname=/dev/IBMchanger0 -o allow_other
   ```

   Otherwise, edit the command line in the following manner:

   ```
   ltfs /mnt/ltfs -o changer_devname=/dev/IBMchanger0
   ```

   Example 3-6 shows an IBM Spectrum Archive LE mount.

Example 3-6 IBM Spectrum Archive LE mount command with -o option to allow another user

```
ltfs -o changer_devname=/dev/IBMchanger0 /mnt/ltfs
LTFS14000I LTFS starting, LTFS version 2.1.2.0 (2200), log level 2
LTFS14058I LTFS Format Specification version 2.1.0
LTFS14104I Launched by "ltfs -o changer_devname=/dev/IBMchanger0 /mnt/ltfs"
LTFS14105I This binary is built for Linux (x86_64)
LTFS14106I GCC version is 4.3.4 [gcc-4_3-branch revision 152973]
LTFS17087I Kernel version: Linux version 3.0.13-0.27-default (geeko@buildhost)
(gcc version 4.3.4 [gcc-4_3-branch revision 152973] (SUSE Linux) ) #1 SMP Wed
Feb 15 13:33:49 UTC 2012 (d73692b) x86_64
LTFS17089I Distribution:
LSB_VERSION="core-2.0-noarch:core-3.2-noarch:core-4.0-noarch:core-2.0-x86_64:co
re-3.2-x86_64:core-4.0-x86_64"
LTFS17089I Distribution: SUSE Linux Enterprise Server 11 (x86_64)
LTFS14063I Sync type is "time", Sync time is 300 sec
LTFS17085I Plugin: Loading "ibmtape" driver
LTFS17085I Plugin: Loading "unified" iosched
LTFS17085I Plugin: Loading "ibmtape" changer
LTFS17085I Plugin: Loading "ondemand" dcache
LTFS11593I LTFS starts with a product license version (2011110430)
LTFS12165I lin_tape version is 1.74.0
LTFS12118I Changer identification is '3573-TL         '
LTFS12162I Vendor ID is IBM
LTFS12159I Firmware revision is Bd50
LTFS12160I Changer serial is 00L4U78C6339_LL1
LTFS12196E IOCTL: INQUIRY PAGE -1056947426 failed -20501 (err 22)
00L4U78C6339_LL1
LTFS12165I lin_tape version is 1.74.0
LTFS12158I Opening a device through ibmtape driver (/dev/IBMtape0)
LTFS12118I Drive identification is 'ULT3580-HH6     '
```

```
LTFS12162I Vendor ID is IBM
LTFS12159I Firmware revision is C9C1
LTFS12160I Drive serial is 1068000264
LTFS17160I Maximum device block size is 1048576
LTFS12165I lin_tape version is 1.74.0
LTFS12158I Opening a device through ibmtape driver (/dev/IBMtape1)
LTFS12118I Drive identification is 'ULT3580-HH6     '
LTFS12162I Vendor ID is IBM
LTFS12159I Firmware revision is C6UN
LTFS12160I Drive serial is 1068000256
LTFS17160I Maximum device block size is 1048576
LTFS13500I On-demand dentry cache is initialized
LTFS11545I Rebuilding the cartridge inventory
LTFS11571I State of tape '001106L3' in slot 0 is changed from 'Not Initialized'
to 'Non-supported'
LTFS11571I State of tape 'DG I69L3' in slot 0 is changed from 'Not Initialized'
to 'Non-supported'
LTFS11571I State of tape '3TX070L3' in slot 0 is changed from 'Not Initialized'
to 'Non-supported'
LTFS11571I State of tape '3DA491L3' in slot 0 is changed from 'Not Initialized'
to 'Non-supported'
LTFS11571I State of tape '3DA493L3' in slot 0 is changed from 'Not Initialized'
to 'Non-supported'
LTFS11571I State of tape '059AHDL4' in slot 0 is changed from 'Not Initialized'
to 'Non-supported'
LTFS11571I State of tape '3SS081L4' in slot 0 is changed from 'Not Initialized'
to 'Non-supported'
LTFS11571I State of tape 'DG I73L3' in slot 0 is changed from 'Not Initialized'
to 'Non-supported'
LTFS11571I State of tape '3TX071L3' in slot 0 is changed from 'Not Initialized'
to 'Non-supported'
LTFS14506I LTFS admin server is listening on port 2112
LTFS14111I Initial setup completed successfully
LTFS14112I Invoke 'mount' command to check the result of final setup
LTFS14113I Specified mount point is listed if succeeded
```

8. When the tape library is mounted, cartridges in the library can be accessed as subdirectories under the mount point `/mnt/ltfs` (Example 3-7).

   In this example, three tape volumes are under the mount points `D00200L5` and `D00346L5`.

Example 3-7 Cartridges that are loaded in the mount points

```
[root@double ~]# ls -l /mnt/ltfs
drwxrwxrwx 1 root root 0 Dec 31  1969 D00200L5
drwxrwxrwx 2 root root 0 Sep 24 17:44 D00346L5
[root@double ~]#
```

Each subdirectory can be accessed as a file system (Example 3-8):

```
ls -l /mnt/ltfs/D00346L5
```

Example 3-8 Cartridge subdirectory

```
[root@double ~]# ls -l /mnt/ltfs/D00346L5
-rwxrwxrwx 1 root root 20897329 Sep 24 16:48 IBM_LTFS_LE.exe
-rwxrwxrwx 1 root root       40 Sep 25 09:50 test.txt
[root@double ~]#
```

Using the IBM Spectrum Archive LE leadm command-line interface

Using IBM Spectrum Archive LE by using the command-line interface (CLI) commands from a console window is described in this section.

The following examples show the mounted file systems, their contents, and how to use them to move, copy, delete, and touch files by using CLI commands. We defined two mount points for IBM Spectrum Archive LE: `/mnt/double` and `/mnt/lto5`. Mount point `/mnt/double` relates to `/dev/IBMchanger0`. Mount point `/mnt/lto5` relates to `/dev/IBMchanger1`.

We use the following command to mount `/mnt/lto5`:

```
ltfs /mnt/lto5 -o changer_devname=/dev/IBMchanger1
```

Follow these steps:

1. Example 3-9 shows the IBM Spectrum Archive LE mount points before the `/dev/IBMchanger1` library is mounted. The `/mnt/double` and `/mnt/lto5` folders are empty.

   Example 3-9 IBM Spectrum Archive LE mount points before the library is mounted

   ```
   [root@double ~]# ls -l /mnt/double
   total 0
   [root@double ~]# ls -l /mnt/lto5
   total 0
   ```

2. Example 3-10 shows the contents of the IBM Spectrum Archive LE mount points after the `/dev/IBMchanger1` library is mounted. The content of the `/mnt/double` is zero (0). The `/mnt/lto5` mount point contains three cartridges: 1FA554L5, 1FA563L5, and 1FA851L5.

   Example 3-10 IBM Spectrum Archive LE mount points after the library is mounted

   ```
   [root@double ~]# ls -l /mnt/double
   total 0
   [root@double ~]# ls -l /mnt/lto5
   total 3
   drwxrwxrwx 3 root root 0 Sep 28 13:52 1FA554L5
   drwxrwxrwx 2 root root 0 Sep 28 13:52 1FA563L5
   drwxrwxrwx 2 root root 0 Sep  8 09:57 1FA851L5
   ```

3. Use the following command to check and load cartridge 1FA554L5. The cartridge is loaded to any available drive by the library accessor. Example 3-11 shows the cartridge 1FA554L5 is loaded to `/dev/IBMtape2`.

   Example 3-11 Checking and loading cartridges

   ```
   [root@double ~]# leadm tape recover  1FA554L5
   None
   Tape JCC541JC has been successfully recovered.
   ```

4. After the 1FA554L5 cartridge is loaded, you can view the contents of the cartridge in the `/mnt/lto5/1FA554L5` folder by using the following command:

   ```
   ls -l /mnt/lto5/1FA554L5
   ```

   Example 3-12 shows the result.

   Example 3-12 Cartridge contents after loading

   ```
   [root@double ~]# ls -l /mnt/lto5/1FA554L5
   total 0
   [root@double ~]#
   ```

5. Copy the file that you want from a directory to the `/mnt/lto5/1FA554L5` folder by using the following command:

   ```
   cp Mauro_Tests /mnt/lto5/1FA554L5
   ```

   Example 3-13 shows the result.

   Example 3-13 Copying a file to /mnt/lto5/1FA554L5

   ```
   [root@double ~]# cp Mauro_Tests /mnt/lto5/1FA554L5
   [root@double ~]#
   ```

6. After you copy the file from the root directory `Mauro_LTFS_LE_Tests` to the `/mnt/lto5/1FA554L5` folder, you can view its contents by using the following command:

   ```
   ls -l /mnt/lto5/1FA554L5
   ```

   Example 3-14 shows the result.

   Example 3-14 Cartridge contents after the file is copied

   ```
   [root@double Mauro_LTFS_LE_Tests]# ls -l /mnt/lto5/1FA554L5
   total 1
   -rwxrwxrwx 1 root root 74 Oct  7 08:44 Mauro_Tests
   ```

7. You can view the file and see its contents by using the following command:

   ```
   vi Mauro_Tests
   ```

   Example 3-15 shows the result.

   Example 3-15 View cartridge with vi command to view contents

   ```
   [root@double ~]# cd /mnt/lto5/1FA554L5
   [root@double 1FA554L5]# vi Mauro_Tests
   ----- The following is the VI result ----------------------------------------
   This file has been created to perform Spectrum Archive LE tests for Redbooks
   publications purposes.
   ~
   ~
   ~
   ~
   ~
   ~
   ~
   ~
   "Mauro_Tests" 1L, 74C
   ```

8. To touch the cartridge and create more files, use the following command:

   ```
   touch Mauro_Test1 Mauro_Test2 Mauro_Test3
   ```

   Example 3-16 shows the result.

   The touch command: The **touch** command is the easiest way to create new, empty files. You can also use it to change the time stamps (that is, the dates and times of the most recent access and modification) on existing files and directories.

   Example 3-16 Touch 1FA554L5 cartridge to create three new files

```
[root@double 1FA554L5]# touch Mauro_Test1 Mauro_Test2 Mauro_Test3
--------- To see the cartridge contents after touch --------------------------
[root@double 1FA554L5]# ls -l
total 4
-rwxrwxrwx 1 root root  0 Oct  7 09:35 Mauro_Test1
-rwxrwxrwx 1 root root  0 Oct  7 09:35 Mauro_Test2
-rwxrwxrwx 1 root root  0 Oct  7 09:35 Mauro_Test3
-rwxrwxrwx 1 root root 74 Oct  7 09:15 Mauro_Tests
[root@double 1FA554L5]#
```

9. Several **touch** command options are designed to allow users to change the time stamps for files. For example, the **-a** option changes only the access time. The **-m** option changes only the modification time. By using both of these options together, you can change both the access time and the modification time to the current time. Use the following command to change the access and modification time for the `Mauro_Tests` file:

   ```
   touch -am Mauro_Tests
   ```

   Example 3-17 shows the result.

   Example 3-17 Change access and modification times for file Mauro_Tests

```
[root@double 1FA554L5]# touch -am Mauro_Tests
----------- See access and modification time for file Mauro_Tests -------------
[root@double 1FA554L5]# ls -l
total 1
-rwxrwxrwx 1 root root  0 Oct  7 09:53 Mauro_Test1
-rwxrwxrwx 1 root root  0 Oct  7 09:35 Mauro_Test2
-rwxrwxrwx 1 root root 74 Oct  7 09:53 Mauro_Tests
[root@double 1FA554L5]#
```

10. To delete a file from the cartridge, use the following command:

    ```
    rm Mauro_Test3
    ```

    Example 3-18 shows the result.

    Example 3-18 Remove file from the cartridge

```
[root@double 1FA554L5]# rm Mauro_Test3
rm: remove regular empty file `Mauro_Test3'? y
----- To see cartridge content after removing a file --------------------------
[root@double 1FA554L5]# ls -l
total 1
-rwxrwxrwx 1 root root  0 Oct  7 09:35 Mauro_Test1
```

```
-rwxrwxrwx 1 root root  0 Oct  7 09:35 Mauro_Test2
-rwxrwxrwx 1 root root 74 Oct  7 09:15 Mauro_Tests
[root@double 1FA554L5]#
```

Remote access to IBM Spectrum Archive LE

You can share the LTFS file system with other servers on your network. In our case, we successfully tested sharing a file system between Linux and Windows machines by using Samba (http://www.samba.org). The NFS protocol can be used when a file system needs to be shared between UNIX servers.

Configuring NFS and testing remote access to IBM Spectrum Archive LE are explained. Basic knowledge of UNIX is assumed. Additional NFS security measures that are needed to be set up in a production environment are not described. Follow these steps:

1. On the server that runs IBM Spectrum Archive LE, edit the `/etc/exports` file. Add an entry to give everyone read and write access to the LTFS file system (use a random **fsid**). See Example 3-19.

   Example 3-19 Export the LTFS file system

   ```
   [root@double Mauro_LTFS_LE_Tests]# vi /etc/exports
   /mnt/lto5 *(rw,fsid=12345)
   ```

2. Start the NFS daemon:

   ```
   start NFS
   ```

3. From a remote UNIX server, create a local mount point and then connect to the remote (NFS-mounted) LTFS file system and create a file. Remote file creation is shown in Example 3-20.

   Example 3-20 Remote file creation on LTFS

   ```
   [root@vegemite /]# mkdir /remote_LTFS
   [root@vegemite /]# mount double.tucson.ibm.com:/mnt/lto5 /remote_LTFS
   [root@vegemite /]# touch /remote_LTFS/1FA554L5/file_created_via_nfs
   ```

4. On the server that runs IBM Spectrum Archive LE, you can now view the newly created file in the LTFS file system (Example 3-21).

   Example 3-21 Confirmation that the new file exists

   ```
   [root@double 1FA554L5]# ls -l
   total 1
   -rwxrwxrwx 1 root root  0 Oct 17 11:11 file_created_via_nfs
   -rwxrwxrwx 1 root root  0 Oct  7 09:35 Mauro_Test1
   -rwxrwxrwx 1 root root  0 Oct  7 09:35 Mauro_Test2
   -rwxrwxrwx 1 root root 74 Oct  7 09:15 Mauro_Tests
   [root@double 1FA554L5]#
   ```

Similarly, by installing and configuring Samba on the IBM Spectrum Archive LE server, you can enable remote access to the LTFS file system from Windows servers. We tested enabling remote access to the LTFS file system by using Windows 7 Professional, but it also works with Windows 2008. Figure 3-20 shows a view of the IBM Spectrum Archive LE file system running on a Linux Red Hat server using Windows Explorer on Windows 7 Professional.

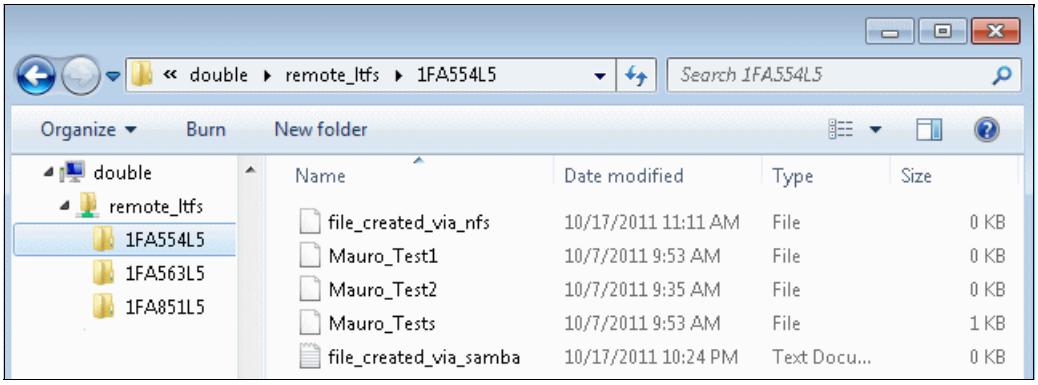

Figure 3-20 Remote access to LTFS file system from Windows 7

Using IBM Spectrum Archive LE with the Linux GUI

You can use the Linux GUI with IBM Spectrum Archive LE. To use the Linux GUI, first mount the library by using the CLI commands from a console window. See “Mounting a library on a Linux system” on page 141. Next, the mounted file systems and their contents are shown. How to use them to move or copy files is shown. In the example, we defined two mount points for IBM Spectrum Archive LE, `/mnt/double` and `/mnt/lto5`. Mount point `/mnt/double` relates to `/dev/IBMchanger0`. Mount point `/mnt/lto5` relates to `/dev/IBMchanger1`.

We use the following command to mount `/mnt/lto5`:

```
ltfs /mnt/lto5 -o changer_devname=/dev/IBMchanger1
```

As shown in Figure 3-21, before `/dev/IBMchanger1`, the mount point `/mnt/lto5` is empty.

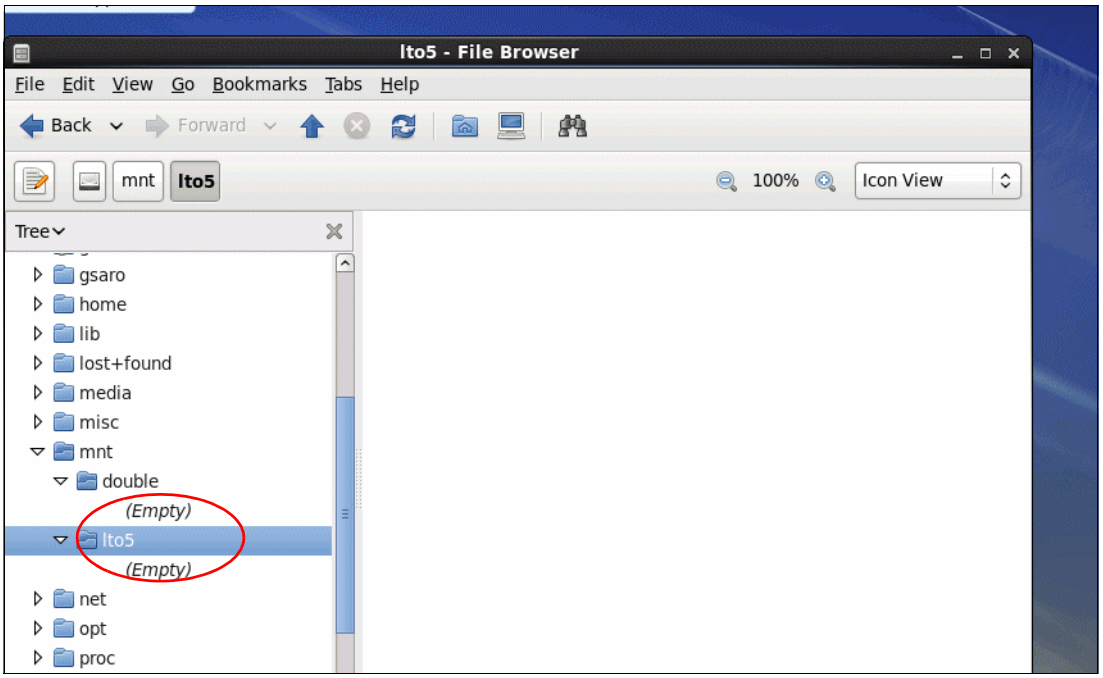

Figure 3-21 The lto5 mount point is empty before mount

After `/dev/IBMchanger1` is mounted, three cartridges are visible in the `/mnt/lto5` mount point: `FA851L5`, `1FA554L5`, and `1FA563L5` (Figure 3-22).

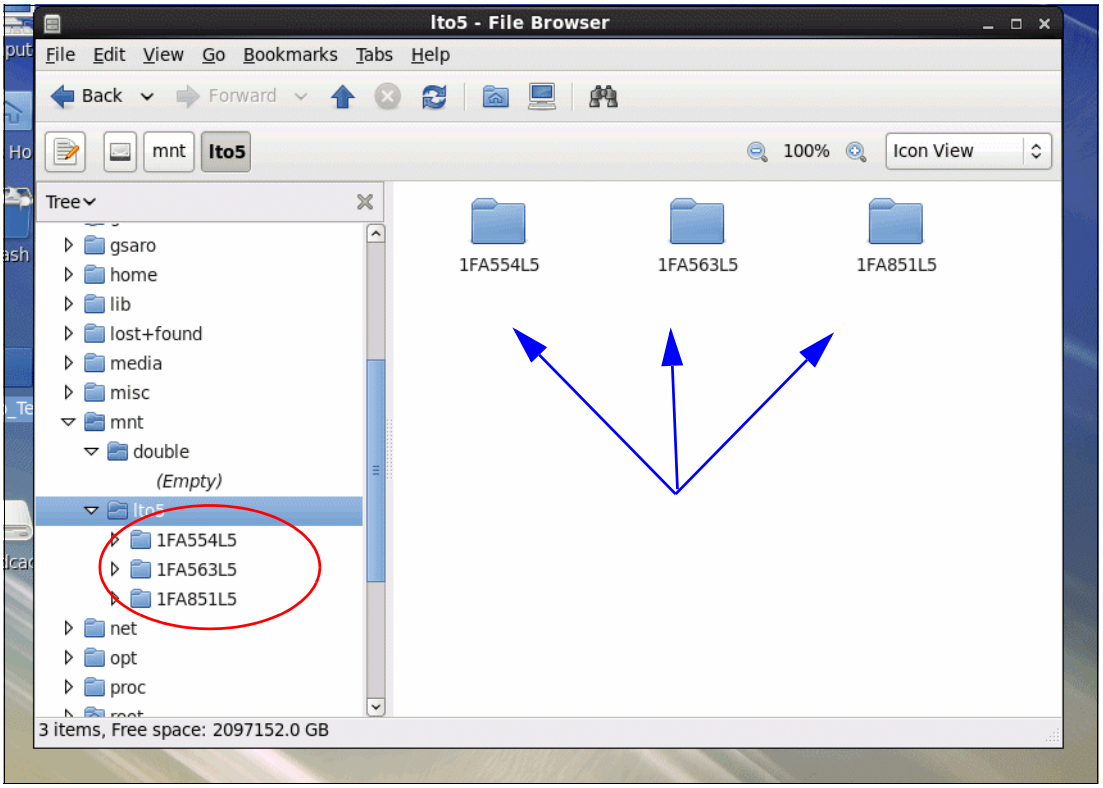

Figure 3-22 The lto5 mount point after mount

If you click one of the three cartridges, you see that the cartridge loads into the drive by the library accessor. As an example, we clicked **1FA554L5** to load the cartridge into the drive (Figure 3-23).

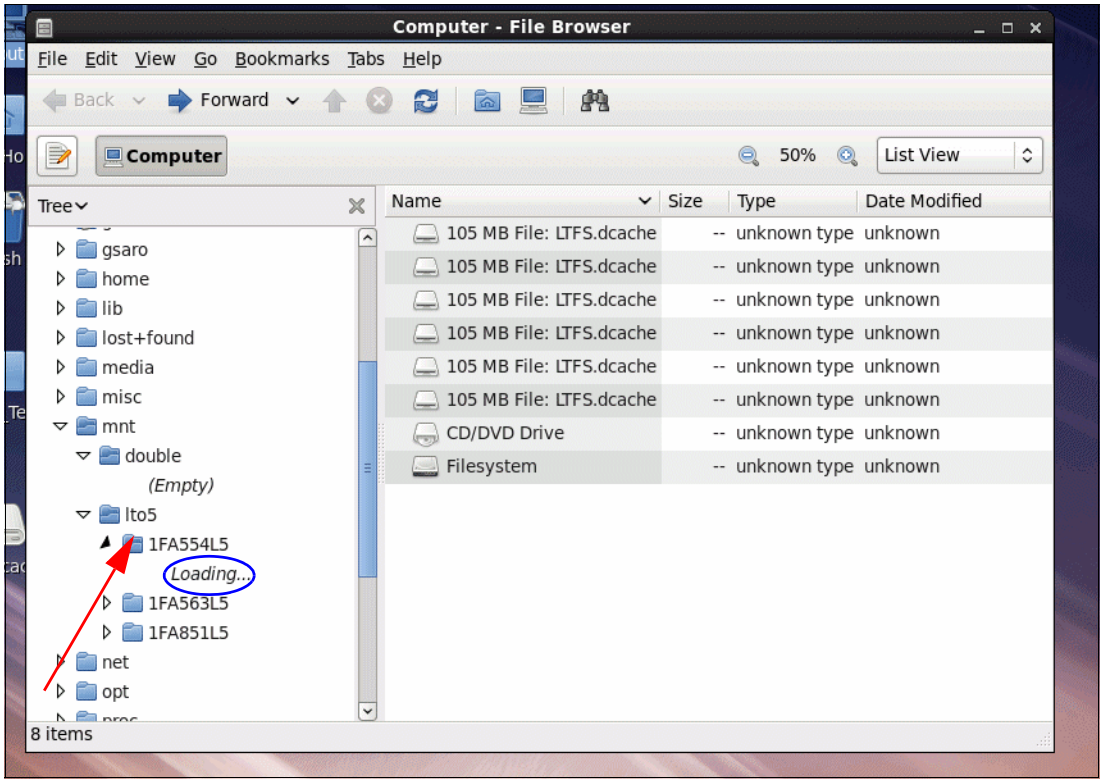

Figure 3-23 The lto5 mount point loading a cartridge

After the cartridge is loaded, you can view its contents. You can drag and drop any type of file (backup files, text files, video files, and audio files) into the tape cartridge.

Figure 3-24 shows our example. In this example, we drag the text file **Mauro_Tests** from the Linux Desktop GUI and drop the file into the cartridge folder. After that, the text file is visible in the cartridge folder `1FA554L5`.

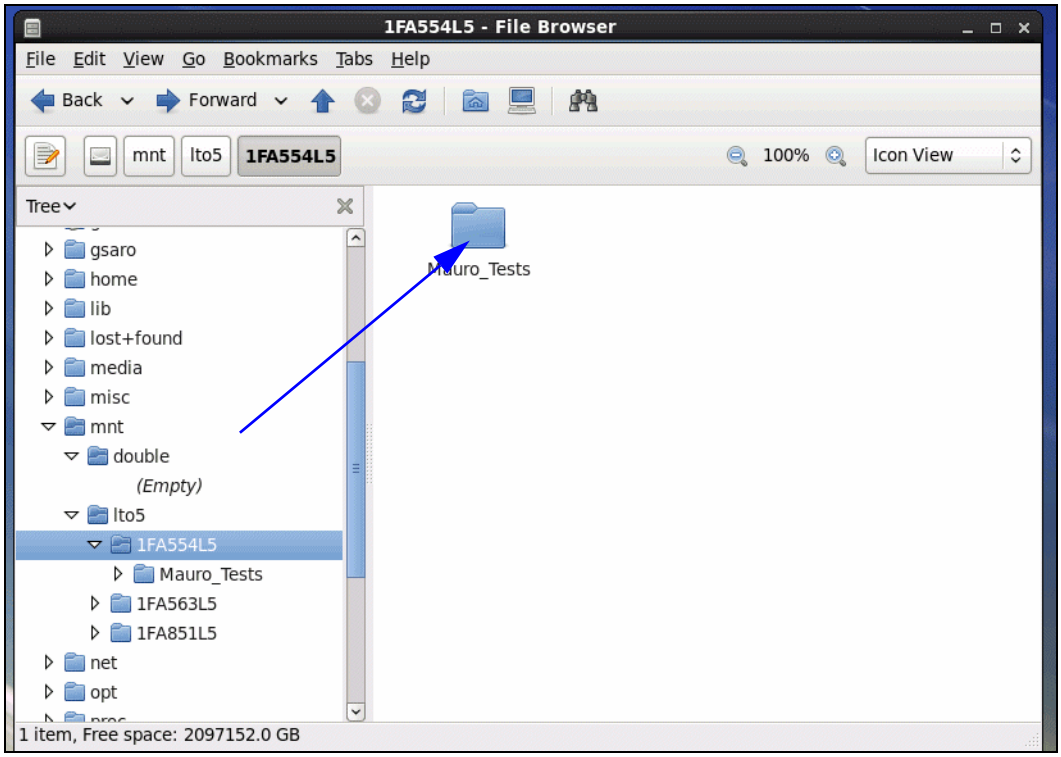

Figure 3-24 The lto5 mount point cartridge mounted folder

Right-click the file to display more options (Figure 3-25).

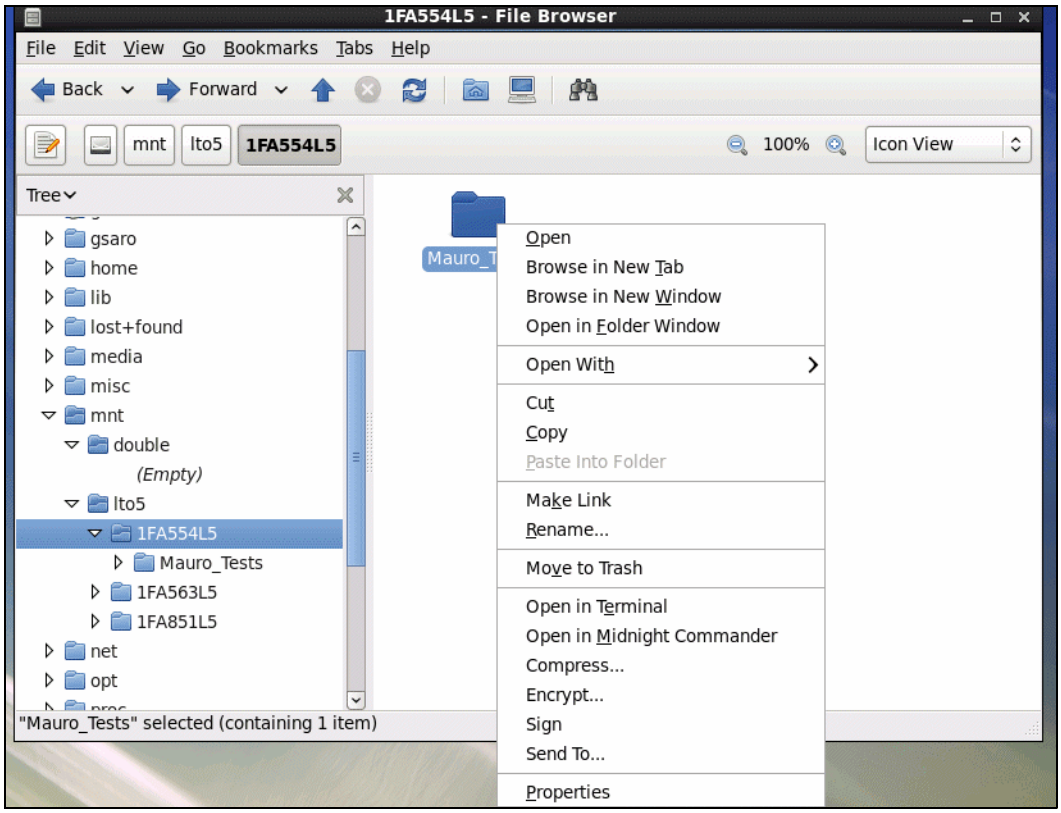

Figure 3-25 The lto5 mount point cartridge mounted options

To unmount the library, use the CLI commands from a terminal window. There is no option that is available from the Linux GUI that permits you to unmount the library.

Unmounting a library

Unmounting a library on IBM Spectrum Archive LE is described in this section.

All files that are in use on cartridges in the tape library must be closed before a library can be unmounted. The library can be forcibly unmounted by using the **force** option (**-f**).

Caution: Using the **force** option (**-f**) can result in data loss.

Use one of the following commands to unmount a library from a mount point:

```
umount /mnt/ltfs
fusermount -u /mnt/ltfs
```

Administrator privileges: The unmount command (**umount**) requires administrator privileges. Users who do not have administrator privileges must issue the **fusermount** command with the **-u** option.

The unmount command (**umount**) flushes all buffered data to the cartridges in the tape library before it unloads the cartridge. After the flushing operation is complete, IBM Spectrum Archive LE updates inventory information and unmounts the library from the mount point.

When the unmounting is completed, the subdirectories under the mount point are removed, along with information in the media library.

You can issue the **ps** command to check whether the process is terminated:

```
ps aux | grep ltfs
```

If a user other than the administrator attempts to access IBM Spectrum Archive LE, the unmount command (**umount**) and the **fusermount -u** command cannot be issued to unmount the tape library from the file system. See Example 3-22.

Example 3-22 Unmount IBM Spectrum Archive LE

```
[root@double ~]# umount /mnt/ltfs
# umount: /mnt/ltfs: device is busy
# umount: /mnt/ltfs: device is busy
[root@double ~]#
```

You can identify the current user of IBM Spectrum Archive LE by issuing the **/sbin/fuser** command. See Example 3-23.

Example 3-23 Identify current user

```
/sbin/fuser -uv /mnt/ltfs
             USER        PID  ACCESS  COMMAND
/mnt/ltfs:            user1     17399   ..c..           (erato)bash
```

To forcibly terminate IBM Spectrum Archive LE, use the shutdown script as shown:

```
/etc/init.d/ltfs stop
```

Important: The (address:port) part of the command points to the library server. If this command is initiated on the library server by using the default setting, localhost:2112 must be specified.

3.3.4 Adding and removing tape drives

This section describes how to add and remove tape drives from the supported libraries using IBM Spectrum Archive LE.

TS2900 Tape Autoloader and TS3100, TS3200, TS3310 tape libraries, and TS4300 tape library

This section describes how to remove and add tape drives for the TS2900 Tape Autoloader and the TS3100, TS3200, TS3310, and TS4300 tape libraries.

When IBM Spectrum Archive LE mounts the library, all tape drives are inventoried. After the library is mounted, the user must issue the **leadm** command. This command allows the user to manage the library and correct a problem if one occurs. For more information, see 3.3.7, “Managing a library by using the leadm command” on page 157.

Complete the following steps to remove a tape drive from the library and to add a tape drive:

1. Unmount the tape library on IBM Spectrum Archive LE. For more information, see “Managing a library by using the leadm command” on page 157.
2. Physically remove the tape drive from the tape library. For information about how to remove the drive, see the *Setup, Operator, and Service Guide* for your tape library at this website:

   `http://www.ibm.com/support/fixcentral`
3. Observe the preferred practices by issuing the following commands to initialize the software stack of the device drivers. IBM Spectrum Archive LE uses `lpfc` as an HBA driver:
   - On Linux systems, issue the following commands to initialize the software stack of the device drivers:

     `lin_taped stop` (Stop the tape device driver daemon)
     `rmmod lin_tape` (Remove the tape device driver)
     `rmmod lpfc` (Remove the HBA driver)
     `modprobe lpfc` (Reload the HBA driver)
     `modprobe lin_tape` (Load the tape device driver)
     `lin_taped start` (Load the tape device driver daemon)
   - On Windows systems, perform the following steps:

     i. Uninstall the Windows device driver.
     ii. Reboot the Windows server.
     iii. Reinstall the Windows device driver.
4. Mount the tape library on IBM Spectrum Archive LE. For more information, see “Mounting a library on a Linux system” on page 141.

TS3500 tape library and TS4500 tape library

This section describes how to remove and add a tape drive for the TS4500 and TS3500 tape libraries.

When IBM Spectrum Archive LE mounts the library, all tape drives are inventoried to it. After the library is mounted, the user must issue the **`leadm`** command. With this command, the user can manage the library and correct a problem if one occurs. For more information, see 3.3.7, “Managing a library by using the leadm command” on page 157.

Complete the following steps to remove a tape drive from the library and to add a tape drive to the library:

1. On Linux systems, remove the tape drive from the IBM Spectrum Archive LE inventory by specifying the **`leadm drive close`** command. A medium in the tape drive is automatically moved to the home slot (if a home slot exists) as shown in the following example:

   ```
   $ leadm drive close  <DRIVE_SERIAL_NUMBER> [DRIVE_SERIAL_NUMBER ...]
   ```
2. Physically remove the tape drive from the tape library. For information about how to remove the drive, see the *Setup, Operator, and Service Guide* for your tape library.

> **Resource:** You can download the Setup and Operator guides from the following website:
>
> `http://www.ibm.com/support/fixcentral`

After you repair a tape drive, or when you replace or install a new tape drive, add the tape drive to the library.

On Linux systems, add the tape drive to the IBM Spectrum Archive LE inventory by specifying the **leadm drive open command** as shown in the following example:

```
$ leadm drive open <DRIVE_SERIAL_NUMBER> [DRIVE_SERIAL_NUMBER ...]
```

On Windows systems, physically add the tape drive to the tape library and then. if the new drive is not automatically recognized, complete the following steps:

1. Uninstall the Windows device driver.
2. Reboot the Windows server.
3. Reinstall the Windows device driver.

3.3.5 Turning on and off a tape drive while mounting IBM Spectrum Archive LE

How to turn on a tape drive and off when you use IBM Spectrum Archive LE is described in this section.

Before you turn on or off tape drive power, you must first prepare the library. Determine which of the following scenarios applies to your environment. Check the interfaces between the server personal computer, tape library, and the target tape drive. Use Table 3-5 to determine which procedure you need to perform:

- Scenario one: The server personal computer connects to the target tape drive, and the target tape drive connects to the tape library. In this case, the target tape drive is used as a control path. No other tape drive is used as a control path. If another control path is established, the control path failover feature is disabled.
- Scenario two: The server personal computer connects to the target tape drive, and the target tape drive connects to the tape library. In addition, the server personal computer connects to another tape drive that also connects to the tape library. The target tape drive and the other tape drive establish multiple control paths and the control path failover feature is enabled.
- Scenario three: The target tape drive connects only to the tape library and does not establish a control path.

HBA: In addition to these interface and control path scenarios, the type of HBA affects how you perform the tape drive power-on or power-off procedure. For details, see Table 3-5.

Table 3-5 Drive firmware upgrade procedure options

	Target tape drive settings		
HBA type	**Scenario1 (CPF disabled)**	**Scenario 2 (CPF enabled)**	**Scenario 3 (no control path)**
SAS	Option A	Option A	Option B
Fibre Channel	Option A	Option B-2	Option B

Procedure

Complete the appropriate steps based on the options that are presented in Table 3-5 on page 155 to successfully remove or restore power from or to a tape drive:

1. For option A, complete the following prerequisite and post-requisite steps:
   a. Before you turn off the tape drive, you must first unmount the tape library from the mount point.
   b. After you turn on the tape drive, you must mount the tape library to the mount point.
2. For option B, complete the following prerequisite and post-requisite steps:
   a. Before you turn off the tape drive, you must remove the target tape drive from the library inventory by issuing the **leadm drive close <DRIVE SERIAL NUMBER> [DRIVE_SERIAL_NUMBER ...]** command.
   b. After you turn on the tape drive, you must add the tape drive to the library inventory by using the **leadm drive open <DRIVE_SERIAL_NUMBER> [DRIVE_SERIAL_NUMBER ...]** command.
3. For option B-2, complete the following prerequisite and post-requisite steps. For this option, the control path automatically switches to another control path when the target drive control path is cut off.
   a. Before you turn off the tape drive, you must remove the target tape drive from the library inventory by issuing the **leadm drive close <DRIVE SERIAL NUMBER> [DRIVE_SERIAL_NUMBER ...]** command.
   b. After you turn on the tape drive, you must add the tape drive to the library inventory by using the **leadm drive open <DRIVE SERIAL NUMBER> [DRIVE_SERIAL_NUMBER ...]** command.

Important: Do not turn off both tape drives that establish the primary and alternate control paths simultaneously or the control path to the tape library is lost.

3.3.6 Adding and removing cartridges

Adding and removing cartridges on the IBM Spectrum Archive LE file system are described.

An unformatted medium cannot be added to the LTFS file system. You need to format the medium before you add it with the **leadm tape format** command. See 3.4.3, “Formatting a medium by using the leadm command” on page 170.

A new cartridge must be added to the LTFS file system to become usable. After it is added, the cartridge volume serial number (VOLSER) is recognized by the operating system as a subdirectory. The **leadm tape assign <TAPE_VOLSER> [TAPE_VOLSER ...]**command adds a medium to the LTFS file system. In the following example, we show you the **leadm** command that is used to add a medium (VOLSER 1FA563L5) to the local library server:

```
leadm tape assign 1FA563L5
```

When a medium is in use, the cartridge cannot be removed from the inventory. The **leadm tape unassign <TAPE VOLSER> [TAPE_VOLSER ...]**command removes a medium from the LTFS file system. The following example shows a command that is used to remove a medium (VOLSER 1FA563L5) from the library mount point `/mnt/ltfs`:

```
leadm tape unassign 1FA563L5
```

Using the I/O station

When a new medium is imported or a used medium is exported, the user moves the medium to or from the I/O station with the **leadm tape move** command with the **-L** option.

To import a new cartridge, the user inserts the cartridge into the I/O station and close it. The cartridge is then moved into the library by specifying the **leadm tape move -L homeslot** command, as shown in the following example:

```
leadm tape move -L homeslot 1FA563L5
```

Then the cartridge is added to the LTFS file system by specifying the **leadmin tape assign** command, as shown in the following example:

```
leadm tape assign 1FA563L5
```

To export a cartridge from the library, the user first move the cartridge from the storage slot to the I/O station. The user then opens the I/O station and removes the cartridge from the station. The cartridge can be removed from the LTFS file system and then exported from the library by specifying the **leadm tape unassign** and **leadm tape move -L ieslot commands**. The following example shows a command to export a cartridge:

```
leadm tape unassign 1FA563L5
leadm tape move -L ieslot 1FA563L5
```

3.3.7 Managing a library by using the leadm command

Managing the tape library and media by using the **leadm** command and the options that can be specified with it is described in this section.

The **leadm** command is used on *Linux* and *Windows* systems to perform the following operations:

- Listing the cartridge location and status
- Listing tape drives and drive status
- Adding a cartridge to the library
- Removing a cartridge from the library
- Formatting a cartridge in the library
- Checking and recovering or rolling back a cartridge in the library

The command can be used with a number of options.

Important: Beginning with version 2.1.1, it is no longer necessary to specify the **-s** option to connect to the local library server. Instead, this option is now set by default and needs to be modified only if there is a need to access a remote library.

IBM Spectrum Archive LE supports access only from localhost by using the **leadm** command. Port 7600 by default, or a port number that is specified by using the **ltfs** command with the **-o admin_port** option, must be blocked by a firewall program. If this port is set as a trusted port by using a firewall program, remove it as a trusted port before you use IBM Spectrum Archive LE. To access the **leadm** command on the server from a remote client personal computer, log on to the server personal computer by using Secure Shell (SSH).

The **leadm** command for Windows users has these characteristics:

- On a Windows system, the **leadm** command *must be preceded by python*, as shown in our examples.
- On a Windows system, you can use PowerShell to run the **leadm** command. When Windows PowerShell is used for the **leadm** command, any option that starts with a dash (-) needs to be in double quotation marks.

Listing the cartridge location and status

The **leadm tape list** command is used to list the cartridge and its status in the IBM Spectrum Archive LE inventory. In the following example, five cartridges are inventoried to the library. The first column shows the bar code label for each cartridge.

Linux

To list the cartridge location and status use this command:

```
$ leadm tape list
```

Example 3-24 shows the output from the **leadm tape list** command.

*Example 3-24 Output from the **leadm tape list***

```
leadm tape list
Barcode  Location      Used     Avail Use% Severity(Status)
JD0331JD     SLOT  13562GiB  13562GiB   0% OK(WRITABLE)
JCA567JC    DRIVE   3399GiB   3111GiB   8% OK(WRITABLE)
JCB020JC     SLOT   6292GiB   6290GiB   0% OK(WRITABLE)
JCB342JC     SLOT         -         -    - OK(NOT_MOUNTED_YET)
JCC537JC     SLOT   6292GiB   6292GiB   0% OK(WRITABLE)
JD0336JD     SLOT         -         -    - INFO(NEED_FORMAT)
JD0332JD     SLOT   9022GiB   9022GiB   0% OK(WRITABLE)
JCB021JC     SLOT         -         -    - OK(WRITABLE)
JCC541JC     SLOT   3399GiB   3399GiB   0% OK(WRITABLE)
```

The supported cartridge locations and medium status are shown in these tables. Table 3-6 lists the supported locations.

Table 3-6 Supported cartridge locations

Location	Description
SLOT	The cartridge is in a storage slot.
IE_SLOT	The cartridge is in an I/O station.
DRIVE	The cartridge is in a tape drive.

Table 3-7 lists the levels of severity.

Table 3-7 Severity definition

Severity	Description
CRITICAL	Spectrum Archive LE is not functioning properly
ERROR	Cartridge is not usable. Next action is required to use it again.
DEGRADED	Cartridge is not healthy. Next action is copy data to another tape and remove this tape. This is strongly recommended.

Severity	Description
WARNING	Cartridge is inaccessible. Next action is to review the tape.
INFO	This is informational only.
OK	Cartridge is healthy.

Table 3-8 lists the supported cartridge status.

Table 3-8 Supported cartridge status

Severity	New Status	Old Status	Description
OK	WRITABLE	Valid LTFS	Good LTFS format state.
OK	WRITE_PROTECTED	Write Protected	Physical write protected or advisory locked from LTFS format.
OK	NOT_MOUNTED_YET	Unknown	Cartridge has not been mounted yet and the contents of the tape is unknown.
INFO	NEED_FORMAT	Unformatted	Cartridge is not currently LTFS formatted.
INFO	NEED_ASSIGN	Unavailable	Cartridge is not considered a resource within Spectrum Archive LE and needs to be assigned.
INFO	FULL	Valid LTFS	Cartridge is full and all updates will be rejected.
INFO	METADATA_WRITABLE	Valid LTFS	Cartridge is almost full and metadata updates are only accepted.
WARNING	NON_SUPPORTED_TAPE	Non-Supported	Cartridge is not supported to be in LTFS formatted tape.
WARNING	INACCESSIBLE	Inaccessible	Cartridge is inaccessible and cannot be included as a resource within IBM Spectrum Archive LE due to library or drive not being a resource within IBM Spectrum Archive LE.
WARNING	DUPLICATED	Duplicated	Two or more cartridges contain the same volser barcode within the library.
WARNING	LABEL_MISMATCH	Unavailable	A mismatch has been detected between the external volser barcode and the VOL1 label on the cartridge when strict label checking is enabled.

Severity	New Status	Old Status	Description
DEGRADED	WRITE_ERROR	Error	Permanent write error occurred on both partitions. Cartridge is in READ-ONLY mode.
DEGRADED	WRITE_FENCED		Permanent write error occurred on a partition. Cartridge is in READ-ONLY mode.
DEGRADED	READ_ERROR	Warning	Permanent read error occurred on cartridge.
ERROR	UNDECRYPTABLE		Cartridge cannot be mounted due to decryption process error.
ERROR	NEED_HBA_CHECK		Cartridge label was read but length of VOL1 label is incorrect.
ERROR	NEED_RECOVERY	Invalid LTFS	Cartridge is in an inconsistent LTFS format state.
ERROR	NEED_UNLOCK	Critical	Cartridge is locked to the drive. Latest unwritten metadata in memory will be erased when the tape is unlocked.

Table 3-9 lists the actions that can be taken based on the type of error.

Table 3-9 Operation actions based on status

Sev (Status)	Write	Read	Mount	Unmount	Assign	Unassign	Move	Format	Unformat	Recovery (Check)	Rollback	List RB Points	Unlock
OK(WRITABLE)	X	X	X	X		X	X	X	X	Check Only	X	X	
OK(WRITE_PROTECTED)		X	X	X		X	X			Check Only		X	
OK(NOT_MOUNTED YET)	X	X	X	X		X	X	X	X	X	X	X	
INFO(NEED_FORMAT)						X	X	X					
INFO(NEED_ASSIGN)					X		X	X	X	X	X	X	
INFO(FULL)		X	X	X		X	X	X	X	Check Only		X	
INFO(METADATA_WRITABLE)	Metadata only	X	X	X		X	X	X	X	Check Only	X	X	
WARNING (NOT_SUPPORTED_TAPE)							X						
INACCESSIBLE													
DUPLICATED													

Sev (Status)	Write	Read	Mount	Unmount	Assign	Unassign	Move	Format	Unformat	Recovery (Check)	Rollback	List RB Points	Unlock
WRITE_ERROR		X	X	X		X	X		X			X	
WRITE_FENCED		X	X	X		X	X		X			X	
READ_ERROR	X	X	X	X		X	X	X	X	Check Only	X	X	
UNDECRYPTABLE							X		X				
NEED_HBA_CHECK							X		X				
LABEL_MISMATCH							X	X	X				
NEED_RECOVERY							X	X	X	X		Forward Only	
NEED_UNLOCK		X				X							X

Listing the tape drives and status in the IBM Spectrum Archive LE inventory

The **leadm drive list** command is used to list the tape drives and their status in the IBM Spectrum Archive LE inventory. The following example shows a valid tape drive `/dev/IBMtape0` that is attached to the tape library `1168001144`.

Use the **leadm** to list the tape drives and status:

```
$ leadm drive list
Serial                Device           Model       Status  Tape
0000013B0142    /dev/IBMtape1        03592E07    Available  -
0000078D9DBA    /dev/IBMtape0        0359255F    Available  -
0000078D82E4    /dev/IBMtape2        03592E08    Available  -
```

Examples: The drive serial numbers in these examples are `0000013B0142`, `0000078D9DBA`, and `0000078D82E4`.

Table 3-10 shows the supported drive status.

Table 3-10 Supported drive status

Drive status	Description	How to recover the tape drive
Available	The drive is available.	No recovery is necessary.
Unavailable	The drive is removed from the library inventory by using the **leadm drive remove** command.	The status changes to `Available` by adding the drive to the library inventory by using the **leadm drive add <drive SN> [drive_sn ...]** command.

Drive status	Description	How to recover the tape drive
Error	The tape drive reports a hardware error.	Check the drive error messages on the library operator panel or tape library Specialist web interface. For instructions about how to use the operator panel or web interface, download the applicable guide. To do so, follow the procedure in Accessing operator guides for tape libraries and drives. Also, for troubleshooting information, see the same guide and the tape drive operator guide.
Locked	The cartridge is in a critical condition. The tape drive for the cartridge is preserved for maintenance.	Back up the data on another medium. Then, remove the cartridge from the library inventory by using the **`leadm tape unlock`** command to change the status to `Available`.
Not installed	If a tape drive is physically removed from the library, the tape drive disappears from the library inventory. But if the library reports an error condition when a drive is removed, the drive status changes to a "`Not installed`" status.	Check the tape library error messages on the library operator panel or tape library Specialist web interface. For instructions about how to use the operator panel or web interface, download the applicable guide. To do so, follow the procedure in the Accessing operator guides for tape libraries and drives. Also, for troubleshooting, see the same guide.

Adding a cartridge to the library

How to add a cartridge to the library by using the IBM Spectrum Archive LE commands is explained in this section. The following command shows a cartridge that is added by using this combination of options:

```
$ leadm tape assign D00661L5
```

After a cartridge is added, the volume serial number (VOLSER) is recognized by the tape library as a subdirectory of the file system.

An unformatted medium: An unformatted medium cannot be added to the library. Format the medium before you add it by specifying the **`leadm tape`** format command.

Removing a cartridge

The following example shows a cartridge that is removed by using this combination of options:

```
$ leadm tape unassign D00661L5
```

If the cartridge is successfully removed, the subdirectory that corresponds to the medium VOLSER disappears.

Formatting a cartridge in the library

The **leadm tape format** command can be specified when one or more cartridges in the IBM Spectrum Archive LE inventory must be formatted. In the following example, the **--rules=size=10M** parameter is added to specify the file placement policy that copies the matching files to the index partition:

```
$ leadm tape format D00661L5 D00662L5 --rules=size=10M
```

When the **leadm tape format** command is issued to format the medium, the medium folder for the cartridge is removed from the LTFS file system. When the format operation is complete, the cartridge is attached to the file system and a subdirectory displays with the VOLSER as the directory name. The name that is read from the bar code that is attached to the back of the tape cartridge is used to set the VOLSER name in the VOL1 label.

Multiple cartridges can be formatted by specifying VOLSERs after the **leadm tape format** command. The following example shows three cartridges that are formatted sequentially or simultaneously:

```
$ leadm tape format AA0031 AA0032 AA0033
```

If a number of drives are available, IBM Spectrum Archive LE randomly uses one of the drives to format a medium. IBM Spectrum Archive LE can use a single drive to sequentially format multiple cartridges or multiple drives to simultaneously format multiple cartridges. IBM Spectrum Archive LE formats only one tape at a time by using one drive at a time per the **leadm** command. However, you can use multiple drives to format multiple cartridges at one time by issuing more than one **leadm** command.

Important: The formatting operation can fail if the medium is already formatted for LTFS. After the formatting is requested, IBM Spectrum Archive LE attempts to mount the target medium to obtain the medium condition. The medium is formatted if the **mount** command finds any of the following conditions:

- The medium is not partitioned for LTFS.
- The medium has an invalid label.
- Labels in both partitions do not have the same value.
- The medium is not formatted for LTFS.

If none of these conditions are found, IBM Spectrum Archive LE assumes that the medium is already formatted so it is not formatted by default. You can specify either the **-f** or **--force** option as an optional **leadm tape format** option. The **-f** or **--force** option commands IBM Spectrum Archive LE to format a medium forcibly regardless of the medium status.

For more information, see 3.4.3, “Formatting a medium by using the leadm command” on page 170.

Logical block protection: To format a cartridge by using logical block protection (LBP), the **-o scsi_lbprotect=on** option must be specified with the leadm command.

Checking and recovering or rolling back a cartridge in the library

The **leadm tape recover** command can be used to check the medium when one or more cartridges in the library are inconsistent and it is necessary to perform a check and recover operation. In this case, the **leadm** command calls the **ltfsck** command. The user also has access to a list of other **ltfsck** options.

In the following example, both **ltfsck** options, **--list-rollback-points** and **--full-index-info**, are added after the **--** tag to get a list of rollback points. The **leadm** then passes those **--list-rollback-points** and **--full-index-info** options to the **ltfsck** command.

```
$ leadm tape rollbacklist D00661L5 D00662L5
```

In the following set of examples, the **--** tag option after the **-c** option initiates setting a parameter for the **ltfsck** command. This option is passed to the **ltfsck** command, for example:

```
$ leadm tape recover AA0031 AA0032 AA0033
```

No option is required to use the **ltfsck** command for normal check and recovery operations. In the second example, the **--** tag that is followed by the **-f** option initiates a full system recovery:

```
$ leadm tape recover AA0031 -f
```

Rollback points can be listed by specifying the **leadm tape rollbacklist** command as shown in Example 3-25.

Example 3-25 Specifying the -l option

```
$ leadm tape rollbacklist AA0031

      Generation:        Date       Time            Zone          SelfPtr->BackPtr
                                                                (Part, Pos)->(Part, Pos)
                1:     2011-03-31  14:50:08.800718541  JST   (0, 5) <<Initial
Index>>
                2:     2011-03-31  14:55:53.988915408  JST   (0, 9)->(0, 5)
                3:     2011-03-31  14:57:38.755561251  JST   (0, 13)->(0, 9)
                4:     2011-03-31  14:59:24.992244674  JST   (1, 5)->(0, 17)
                4:     2011-03-31  14:59:24.992244674  JST   (0, 17)->(0, 13)
```

In Example 3-25, to roll back a medium to generation 3 (time stamp 2011-03-31 14:57:38.755561251), the following command must be issued:

```
$ leadm tape rollback AA0031  -g 3
```

Multiple cartridges can be checked or recovered by specifying VOLSERs that follow the leadm **tape recover** command. The following example shows three cartridges that are checked or recovered sequentially or simultaneously:

```
$ leadm tape recover AA0031 AA0032 AA0033
```

LBP: To check a cartridge by using LBP, the **-o scsi_lbprotect=on** option must be specified with the **leadm** command.

If a number of drives are available, IBM Spectrum Archive LE randomly uses one drive to check or recover a medium. IBM Spectrum Archive LE can use a single drive to sequentially check or recover multiple cartridges, or multiple drives to simultaneously check or recover multiple cartridges.

Enabling logical block protection

This section covers how to enable the LBP for use with IBM Spectrum Archive LE. LBP is a feature that validates data and identifies corrupted data. Beginning with version 2.1.2, you can enable LBP between IBM Spectrum Archive LE and the supported tape drives. When LBP is enabled (at the library level), all data that is read or written between all the tape drives and IBM Spectrum Archive LE is checked. An error displays if data corruption occurs.

To enable LBP, the **-o scsi_lbprotect=on** option must be specified with the **ltfs** or **ltfs.exe** command. The **-o scsi_lbprotect=off** option is used to disable LBP. Optional **mkltfs** parameters and optional **ltfsck** parameters can be specified.

You can also enable LBP when you format a medium and when you check operations with the **leadm** command.

LBP: If IBM Spectrum Archive LE started with LBP enabled by using the **-o scsi_lbprotect=on** option with the **ltfs** or **ltfs.exe** command, you must add the **-o scsi_lbprotect=on** option to format or check a medium. Unless the **-o scsi_lbprotect=on** option is specified for format or check operations, the operations are performed with LBP disabled.

The default setting for LBP is disabled. Because LBP can affect read and write performance, use the default setting. When LBP is needed, enable the feature for each specific action, such as to start IBM Spectrum Archive LE, check a medium, or format a medium. Then, disable the feature again.

Enabling symbolic links

Symbolic links and how to enable the feature for use with IBM Spectrum Archive LE are explained. Beginning with version 2.1.2, IBM Spectrum Archive LE supports symbolic links. A *symbolic link* (symlink) is used to create a reference to, or an alias for, another file. In addition, IBM Spectrum Archive LE supports a feature called *live link*. Live link enables IBM Spectrum Archive LE to follow the mount point and cartridge of the original target.

By default, standard symbolic links are enabled when IBM Spectrum Archive LE starts. The command-line option is the **-o symlink_type=posix** option and is specified with the **ltfs** or **ltfs.exe** command. To enable live links, the **-o symlink_type=live** option is specified.

Certain limitations exist when you use symbolic links on a Windows system. IBM Spectrum Archive LE fails to mount if it detects both **<symlink>** and **<extents>** elements in the **<file>** element as `inconsistent medium`. IBM Spectrum Archive LE also fails to mount if a cartridge with symbolic link information is written on an older IBM Spectrum Archive LE version that does not support symbolic links. If this situation occurs, it is necessary to recover the cartridge with the **ltfsck** command.

Enabling data-safe mode

Data-safe mode and how to enable the feature for use with IBM Spectrum Archive LE are described.

Beginning with version 2.1.2, IBM Spectrum Archive LE supports data-safe mode. *Data-safe mode* is a feature that protects user data by preventing data overwrite situations. When this feature is enabled, the tape drive issues an error after it receives a command to overwrite any data on the currently mounted volume. Data-safe mode is a drive-specific behavior and can be enabled each time that a tape is mounted. It can be disabled only when a tape is not mounted.

To enable or disable data-safe mode, the **scsi_append_only_mode** option must be specified with the **ltfs** or **ltfs.exe** command. The **scsi_append_only_mode=on** option enables the feature. The **scsi_append_only_mode=on** option is the default setting. The **scsi_append_only_mode=off** option disables the feature.

3.4 Command reference

The IBM Spectrum Archive LE program is operated by LTFS commands. Detailed information about the **ltfs** and **leadm** commands is provided.

Important: For IBM Spectrum Archive LE, the **mkltfs** and **ltfsck** functions are provided by the **leadm** utility. The **ltfsck** utility in IBM Spectrum Archive SDE checks and recovers media. The **mkltfs** utility in IBM Spectrum Archive SDE formats media. The **ltfsck** parameters are passed to the **leadm tape recover** command. The **mkltfs** parameters are passed to the **-f** option of the **leadm tape format** command.

3.4.1 Available command options for the leadm command

The following are **leadm** global options that can be used with any **leadm** command:

- **-s host[:port], --server=host[:port]**: Server and port to connect [default: localhost:7600]
- **-r, --refresh:** Refresh inventory before execution [default: False]
- **-t THREADS, --threads=THREADS**: Number of threads [default: 1]

The following option can be used with these **leadm** commands, **node show, library show, drive list, drive show, tape list,** and **tape show**:

- **-o OUTPUT_TYPE, --output=OUTPUT_TYPE**: Output type of result. Valid choices are json or xml [default: json]

The following commands, subcommands, and options are available for the **leadm** command:

- **node show**: Show node information.
- **library show**: Show library information.
- **drive list**: List connected drives.
- **drive show <drive_serial>**: Show drive information.
- **drive open <drive_serial> [drive_serial ...]**: Open and add specified drive to IBM Spectrum Archive LE resource.
- **drive close <drive_serial> [drive_serial ...]**: Close and remove specified drive from IBM Spectrum Archive LE resource.
- **tape list**: List tapes:
  - **-a, --active-only**: List only the tapes that are assigned [default: False].
- **tape show <tape_id>**: show tape information.
- **tape assign <tape_id> [tape_id ...]**: Assign (add) tapes into IBM Spectrum Archive LE resource.

- **tape unassign <tape_id> [tape_id ...]**: Unassign (remove) tapes into IBM Spectrum Archive LE resource:
  - **-f, --force** Force remove [default: False].
  - **-k KEEP STRATEGY, --keep-cache=KEEP STRATEGY**: Cache keep strategy. Valid choices are 'NONE', 'VALID' or 'ALL' [default: NONE].
  - **--keep-on-drive**: Do not move to homeslot after removal [default: False].
- **tape move <tape_id> [tape_id ...]**: Move tapes to specified type of slot:
  - **-L DESTINATION, --destination=DESTINATION**: Destination slot type, Valid choices are 'homeslot', 'drive', 'ieslot'[default: homeslot].
  - **-d DRIVE_SERIAL, --drive-serial=DRIVE_SERIAL**: Destination drive serial.
- **tape recover <tape_id> [tape_id ...]**: Recover inconsistent LTFS tapes:
  - **-f, --full-recovery**: Recover extra data blocks into directory _ltfs_lostandfound [default: False].
  - **-z, --deep-recovery**: Recover EOD missing cartridge [default: False].
  - **-d DRIVE_SERIAL, --drive-serial=DRIVE_SERIAL**: Target drive serial.
- **tape rollback <tape_id>**: Roll back an LTFS tape:
  - **-g NUMBER, --generation=NUMBER**: Specify the generation to roll back.
  - **-v TRAVERSE, --traverse=TRAVERSE**: Set traverse mode for listing roll back points. Strategy should be forward or backward. [default: backward].
  - **-j, --erase-history**: Erase history at rollback [default: False].
  - **-k, --keep-history**: Keep history at rollback [default: True].
  - **-d DRIVE_SERIAL, --drive-serial=DRIVE_SERIAL**: Target drive serial.
- **tape rollbacklist <tape_id> [tape_id ...]**: List rollback points on LTFS tape:
  - **-v TRAVERSE, --traverse=TRAVERSE**: Set traverse mode for listing roll back points. Strategy should be forward or backward. [default: backward].
  - **-m, --full-index-info**: Display full index information [default: False].
  - **--salvage-rollback-points**: List the rollback points of the cartridge that has no EOD [default: False].
  - **--capture-index**: Capture index found under temporary directory [default: False].
  - **-d DRIVE_SERIAL, --drive-serial=DRIVE_SERIAL**: Target drive serial.
- **tape unlock <tape_id> [tape_id ...]**: Unlock tapes from NEED_UNLOCK state.
- **tape unmount <tape_id> [tape_id ...]**: Unmount tapes from the drive.
- **tape format <tape_id> [tape_id ...]**: Format tapes:
  - **-f, --force:** Force format [default: False].
  - **-n VOLUME_NAME, --volume-name=VOLUME_NAME**: Tape volume name.
  - **--rules=RULES**: Rules for choosing files to write to the index partition.
  - **-b NUMBER, --blocksize=NUMBER**: Set the LTFS record size [default: 524288].
  - **-c, --no-compression**: Disable compression on the volume [default: False].
  - **--no-override**: Disallow mount-time data placement policy changes [default: False].
  - **-k, --keep-capacity**: Keep the tape medium's total capacity proportion.

- **--density=DENSITY**: Set density code. Valid only for TS11x0 drives. Valid choices are ‘J4’, ‘J5’ or ‘J5A’ [default: none].
- **-d DRIVE_SERIAL, --drive-serial=DRIVE_SERIAL**: Target drive serial.

- **tape unformat <tape_id> [tape_id ...]**: Unformats tapes:
  - **--long-wipe**: Unformat the medium and erase any data on the tape by overwriting the special data pattern. This operation takes over 3 hours. After you start, you cannot interrupt it.
  - **-d DRIVE_SERIAL, --drive-serial=DRIVE_SERIAL**: Target drive serial.
  - **tape sync <tape_id> [tape_id ...]**: Sync tapes.

Warning: The **leadm** command might not work properly while the tape library or tape drive firmware is updating.

3.4.2 Mounting a medium by using the ltfs command

How to mount tape media by using the **ltfs** command is explained in this section. Enter the **ltfs** command from the command line to mount the library for use with IBM Spectrum Archive LE.

Unique mount points: Unique mount points must be created for each library device. For more information, see “Mounting a library on a Linux system” on page 141.

The following example shows a command-line entry for **ltfs**:

`ltfs /mnt/ltfs -o changer_devname=/dev/IBMchanger`*x*, where *x* is the changer identifier (for example, `changer0` or `changer1`)

The **ltfs** command includes the following options:

- **-o changer_devname=<*dev*>**: Changer device (For example, 1.2.3.4).
- **-o work_directory=<*dir*>**: LTFS work directory.
- **-o trace**: Enable diagnostic output (same as verbose=3)**-o sync_type=<*type*>**Specify sync type (default: time@5). <*type*> must be specified with one of the following values:
  - `- time@min`: IBM Spectrum Archive LE attempts to write an index each '*min*' minutes. *min* must be a decimal number 1 - 35791394. It is equivalent to "**-o sync_type=unmount**" when 0 is specified (default: `min=5`).
  - `- close`: IBM Spectrum Archive LE attempts to write an index when a file is closed.
  - `- unmount`: IBM Spectrum Archive LE attempts to write an index when the medium is unmounted.
- **-o device_list**: Show available tape devices.
- **-o symlink_type=<*type*>**: Specify symbolic link type (default: `posix`). <*type*> must be specified with one of the following values:
  - `- posix`: IBM Spectrum Archive LE behavior is the same as standard symbolic link.
  - `- live`: IBM Spectrum Archive LE replaces mount point path by current mount point.
- **-a**: Advanced help, including standard FUSE options.
- **-V, --version**: Output version information and exit.
- **-h, --help**: Display this help and exit.

The following IBM Spectrum Archive LE FUSE options are available:

- **-o umask=M**: Set file permissions (octal)
- **-o uid=N**: Set file owner
- **-o gid=N**: Set file group
- **-o release_device**: Clear device reservation (should be specified with -o devname or -o changer_devname)

The following IBM Spectrum Archive LE library options are available:

- **-o library_cache**: Set to use and create caches from the MAM, index, and labels (default)
- **-o nolibrary_cache**: Set to disable the use and creation of MAM, index, and labels caches
- **-o volser_only_folder**: Set to exclude volume name from the top-level folder name
- **-o novoluser_only_folder**: Set to include volume name in the top-level folder name (default)
- **-o six_char_folder**: Display first six characters of directory name
- **-o strict_drive**: Mount only corresponding generation of medium with the tape drive, such as an LTO6 drive mounts LTO6 medium only
- **-o nostrict_drive**: Mount any supported generation of medium for the drive (default), such as an LTO6 drive mounts any LTO5 and LTO6 medium

FUSE options

You can use the following FUSE options:

-o gid=N	Set file group
-o release_device	Clear device reservation (specify with **-o devname** or **-o changer_devname**)
-o uid=N	Set file owner
--o umask=M	Set file permissions (octal)

IBM Spectrum Archive LE library options

You can use the following IBM Spectrum Archive LE library options:

-o library_cache	Set to use and create caches from the MAM, index, and labels (default).
-o volser_only_folder	Set to exclude volume name from the top-level folder name.
-o novolser_only_folder	Set to include volume name in the top-level folder name (default).
-o nolibrary_cache	Set to disable the use and creation of the MAM, index, and labels' caches.
-o six_char_folder	Display the first six characters of the directory name.
-o strict_drive	Mount only the corresponding generation of medium with the tape drive. For example, an LTO-6 drive mounts an LTO-6 medium only.
-o nostrict_drive	Mount any supported generation of medium for the drive (default). For example, an LTO-6 drive mounts either an LTO-5 or LTO-6 medium.

IBM Spectrum Archive LE administration interface option

You can use the following IBM Spectrum Archive LE administration interface option:

-o admin_port=<*num*> TCP/IP port in which to listen for connections (default: 2112)

Mounting IBM Spectrum Archive LE by a user other than root

To mount IBM Spectrum Archive LE by a normal user, check for the following requirements:

- The user has write permission for the work directory (default: /tmp/ltfs).
- The user has write permission for the mount point.
- The file mode /usr/bin/fusermount is set to chmod 4755.

Mounting IBM Spectrum Archive LE to have another user access the file system

Use the **ltfs** command to mount the tape library to the file system to allow a user other than the normal user access to it. For more information, see “Mounting a library on a Linux system” on page 141.

3.4.3 Formatting a medium by using the leadm command

How to format a medium in the IBM Spectrum Archive LE library is described in this section.

Important: For IBM Spectrum Archive LE, the **mkltfs** and **ltfsck** functions are provided by the leadm utility. The **ltfsck** utility in IBM Spectrum Archive SDE checks and recovers media. The **mkltfs** utility in IBM Spectrum Archive SDE formats media. The **ltfsck** parameters are passed to the **leadm tape recover** command. The **mkltfs** parameters are passed to the **-f** option of the **leadm tape format** command.

Specifying the **-f** option with the **leadm tape format** command formats an already formatted cartridge for your use. One or more tape volume serial numbers (VOLSERs) are passed to the **leadm tape format** command, as shown in the following set of examples. The **leadm tape format** command can take additional optional options such as **-n** to give the tape a volume name.

```
leadm tape format 1FA563L5 -f
```

The **-n ABC** parameter can be passed to the **leadm tape format** command:

```
leadm tape format 1FA563L5 -f -n ABC
```

When the **leadm** command is issued to format the medium, the medium folder for the cartridge is removed from the IBM Spectrum Archive LE. When the format operation is complete, the cartridge is attached to the file system and a subdirectory displays with the VOLSER as the directory name. The name that is read from the bar code that is attached to the back of the tape cartridge is used to set the VOLSER name in the VOL1 label.

Multiple cartridges can be formatted by specifying VOLSERs after the **leadm tape format** command. The following example shows three cartridges that are formatted sequentially or simultaneously:

```
leadm tape format-t 1FA554L5,1FA563L5,1FA851L5 -f
```

Multiple cartridges: If a number of drives are available, IBM Spectrum Archive LE randomly uses one drive to format a medium. IBM Spectrum Archive LE can use a single drive to sequentially format multiple cartridges or multiple drives to simultaneously format multiple cartridges.

Optional mkltfs parameters

Optional **leadm tape format** parameters can be passed to the drive in the library. The optional parameters can be specified in the following manner:

```
leadm tape format (VOLSER ...) -f [optional format parameters]
```

The LTFS **leadm** command formats tape media for use with IBM Spectrum Archive LE. When the **leadm** command with the **-f** option is run on a scratch medium, it performs the following actions:

- Destroys all data on the media
- Creates two partitions on the media
- Creates a UUID for the media
- Writes empty index data in the LTFS format

3.4.4 Checking or recovering a medium by using the leadm command

You can check and recover or roll back a medium in the IBM Spectrum Archive LE library. Specifying the **leadm tape recover** command checks a volume and recovers it from an inconsistent state. Additional **leadm tape recover** parameters can be passed in to perform full or deep recovery. The following set of examples shows checks and full recovery.

This example shows the **leadm tape recover** command without any optional parameters, which performs a tape check:

```
leadm tape recover 1FA554L5 1FA563L5 1FA851L5
```

In the following example, the **-f** option initiates a full system recovery:

```
leadm tape recovery 1FA563L5 -f
```

Rollback points can be listed by specifying the **leadm tape rollbacklist** command (Example 3-26).

Example 3-26 List of rollback points

```
[root@double ~]# leadm tape rollbacklist 1FA563L5
Generation: Date       Time               Zone     SelfPtr->BackPtr (Part, Pos)
           (UTC Date   UTC Time           UTC)
            Commit Message
--------------------------------------------------------------------------------
         9: 2011-09-28 15:22:06.000096946 MST      (0, 5)->(1, 43)
           (2011-09-28 22:22:06.000096946 UTC)
            No commit message
         9: 2011-09-28 15:22:06.000096946 MST      (1, 43)->(1, 39)
           (2011-09-28 22:22:06.000096946 UTC)
            No commit message
         8: 2011-09-28 13:53:45.232972947 MST      (1, 39)->(1, 36)
           (2011-09-28 20:53:45.232972947 UTC)
            No commit message
         7: 2011-09-06 13:29:05.000140454 MST      (1, 36)->(1, 32)
```

```
            (2011-09-06 20:29:05.000140454 UTC)
             No commit message
          6: 2011-09-06 13:23:57.000132221 MST      (1, 32)->(1, 25)
            (2011-09-06 20:23:57.000132221 UTC)
             No commit message
          5: 2011-09-06 13:18:51.000133129 MST      (1, 25)->(1, 18)
            (2011-09-06 20:18:51.000133129 UTC)
             No commit message
          4: 2011-09-06 13:13:39.000158577 MST      (1, 18)->(1, 15)
            (2011-09-06 20:13:39.000158577 UTC)
             No commit message
          3: 2011-08-30 19:30:00.000138128 MST      (1, 15)->(1, 8)
            (2011-08-31 02:30:00.000138128 UTC)
             No commit message
          2: 2011-08-29 10:01:13.534597445 MST      (1, 8)->(1, 5)
            (2011-08-29 17:01:13.534597445 UTC)
             No commit message
          1: 2011-04-05 11:15:43.409951727 MST      (1, 5) <<Initial Index>>
            (2011-04-05 18:15:43.409951727 UTC)
             No commit message
[root@double ~]#
```

To roll back a medium to generation 3 (time stamp `2011-08-30 19:30:00.000138128`) in Example 3-26, you must issue the following command:

```
leadm tape rollback 1FA563L5 -g 3
```

Multiple cartridges can be checked or recovered by specifying VOLSERs after the **`leadm tape recover`** command. The following example shows three cartridges that are checked or recovered sequentially or simultaneously:

```
leadm tape recover 1FA554L5 1FA563L5 1FA851L5
```

Multiple cartridges: If a number of drives are available, IBM Spectrum Archive LE randomly uses one drive to check or recover a medium. IBM Spectrum Archive LE can use a single drive to sequentially check or recover multiple cartridges, or multiple drives to simultaneously check or recover multiple cartridges.

Optional ltfsck parameters

The IBM Spectrum Archive LE **`leadm tape recover`** command verifies tape media consistency and, if necessary, recovers the media from an inconsistent state. When a tape is mounted, the tape is checked for consistency problems.

IBM Spectrum Archive LE: For IBM Spectrum Archive LE, the **`mkltfs`** and **`ltfsck`** functions are provided by the **`leadm`** utility. The **`ltfsck`** utility in IBM Spectrum Archive SDE checks and recovers media. The **`mkltfs`** utility in IBM Spectrum Archive SDE formats media. The **`ltfsck`** parameters are passed to the **`-c`** option of the **`leadm`** command. The **`mkltfs`** parameters are passed to the **`-f`** option of the **`leadm`** command.

If a consistency problem is discovered and can be recovered without the loss of data, the recovery is performed automatically. If the recovery cannot be made without the loss of data, an automatic recovery is not performed. In these cases, the **`leadm tape recover`** command with the **`-f`** option locates the latest index and recovers a medium in an inconsistent state.

After the medium is recovered to a consistent state, you can use the **leadm tape rollbacklist** command to view a list of available rollback points. The **leadm tape rollback** command can then be initiated to recover the media to its last valid state. If the **leadm tape recover** command detects extra data after the final index in a partition, it deletes the data automatically. When the full recover option is specified, the **leadm tape recover** command saves the data that might be lost and corrects block information in the _LTFS _lostandfound directory.

Optional **leadm tape recover** parameters can be specified in the following manner:

```
leadm tape recover (VOLSER ...) [optional parameters]
```

The leadm command: The **(address:port)** part of the command points to the library server. If this command is initiated on the library server with the default setting, **localhost:2112** must be specified. The **(VOLSER)** part of the command specifies the medium to format.

Example 3-27 shows the output of the command.

Example 3-27 Output of the -l or --list-rollback-points

```
[root@double ~]# leadm tape rollbacklist 1FA563L5
Generation: Date       Time               Zone     SelfPtr->BackPtr (Part, Pos)
           (UTC Date   UTC Time           UTC)
            Commit Message
--------------------------------------------------------------------------------
        26: 2017-10-06 15:37:27.333443253 MST      (0, 5)->(1, 590650)
           (2017-10-06 22:37:27.333443253 UTC)
            No commit message
         1: 2017-09-06 16:22:30.576910025 MST      (1, 5) <<Initial Index>>
           (2017-09-06 23:22:30.576910025 UTC)
            No commit message
         2: 2017-09-06 16:33:40.000226908 MST      (1, 9)->(1, 5)
           (2017-09-06 23:33:40.000226908 UTC)
            No commit message
         3: 2017-09-11 12:02:50.016392669 MST      (1, 13)->(1, 9)
           (2017-09-11 19:02:50.016392669 UTC)
            No commit message
         4: 2017-09-11 12:37:50.000229162 MST      (1, 17)->(1, 13)
           (2017-09-11 19:37:50.000229162 UTC)
            No commit message
         5: 2017-09-11 14:49:27.000219036 MST      (1, 21)->(1, 17)
           (2017-09-11 21:49:27.000219036 UTC)
            No commit message
         6: 2017-09-11 16:34:01.157721185 MST      (1, 25)->(1, 21)
           (2017-09-11 23:34:01.157721185 UTC)
            No commit message
         7: 2017-09-11 16:41:19.592140824 MST      (1, 29)->(1, 25)
           (2017-09-11 23:41:19.592140824 UTC)
            No commit message
         8: 2017-09-11 16:52:23.000215909 MST      (1, 33)->(1, 29)
           (2017-09-11 23:52:23.000215909 UTC)
            No commit message
         9: 2017-09-11 17:07:42.000232741 MST      (1, 37)->(1, 33)
           (2017-09-12 00:07:42.000232741 UTC)
            No commit message
```

```
10: 2017-09-12 08:57:47.000196206 MST      (1, 13306)->(1, 37)
   (2017-09-12 15:57:47.000196206 UTC)
    No commit message
11: 2017-09-12 11:38:26.064877257 MST      (1, 13309)->(1, 13306)
   (2017-09-12 18:38:26.064877257 UTC)
    No commit message
12: 2017-09-12 16:41:14.000245422 MST      (1, 64848)->(1, 13309)
   (2017-09-12 23:41:14.000245422 UTC)
    No commit message
13: 2017-09-12 16:46:33.226064300 MST      (1, 133235)->(1, 64848)
   (2017-09-12 23:46:33.226064300 UTC)
    No commit message
14: 2017-09-12 16:51:56.241383160 MST      (1, 192329)->(1, 133235)
   (2017-09-12 23:51:56.241383160 UTC)
    No commit message
15: 2017-09-12 16:57:05.545618527 MST      (1, 241122)->(1, 192329)
   (2017-09-12 23:57:05.545618527 UTC)
    No commit message
16: 2017-09-12 17:02:27.000192615 MST      (1, 306129)->(1, 241122)
   (2017-09-13 00:02:27.000192615 UTC)
    No commit message
17: 2017-09-12 17:07:34.225706907 MST      (1, 380923)->(1, 306129)
   (2017-09-13 00:07:34.225706907 UTC)
    No commit message
18: 2017-09-12 17:24:55.043923344 MST      (1, 395671)->(1, 380923)
   (2017-09-13 00:24:55.043923344 UTC)
    No commit message
19: 2017-09-12 17:30:02.397542655 MST      (1, 459718)->(1, 395671)
   (2017-09-13 00:30:02.397542655 UTC)
    No commit message
20: 2017-09-12 17:35:09.007784782 MST      (1, 530572)->(1, 459718)
   (2017-09-13 00:35:09.007784782 UTC)
    No commit message
21: 2017-09-12 17:40:32.232709385 MST      (1, 588596)->(1, 530572)
   (2017-09-13 00:40:32.232709385 UTC)
    No commit message
22: 2017-09-12 17:45:39.000209660 MST      (1, 590638)->(1, 588596)
   (2017-09-13 00:45:39.000209660 UTC)
    No commit message
23: 2017-09-13 15:29:19.398032856 MST      (1, 590642)->(1, 590638)
   (2017-09-13 22:29:19.398032856 UTC)
    No commit message
24: 2017-09-14 14:35:57.000243576 MST      (1, 590646)->(1, 590642)
   (2017-09-14 21:35:57.000243576 UTC)
    No commit message
25: 2017-09-22 11:56:11.000192960 MST      (1, 590650)->(1, 590646)
   (2017-09-22 18:56:11.000192960 UTC)
    No commit message

Tape 1FA563L5 has been successfully listed rollback points.

[root@double ~]#
```

To roll back generation 3 (time stamp 2011-08-30 19:30:00.000138128) in Example 3-27 on page 173, issue the following command:

```
leadm tape rollback 1FA563L5 -g 3
```

Time to roll back option: The **-t** option, which specifies the time to roll back, is supported only for the IBM Spectrum Archive SDE.

3.5 Hints and tips

Follow these useful hints and tips.

3.5.1 Sharing a mounted tape library among multiple users

The requirements are described for sharing a mounted tape library among multiple users of IBM Spectrum Archive LE on a Linux system.

Linux only: This information does not apply to Windows users.

For a Linux user other than the user who mounted the tape library to access the mounted file system, add the following line to the /etc/fuse.conf file before you issue the **ltfs** command:

```
user_allow_other
```

To mount the library as a user other than a superuser, in addition to the previous setting, add the **-o allow_other** option to the **ltfs** command as shown:

```
$ ltfs -o changer_devname=/dev/IBMchanger0 -o allow_other /mnt/ltfs
```

To mount the library as a superuser, the **-o allow_other** option is not required, as shown in the following example:

```
# ltfs /mnt/ltfs -o changer_devname=/dev/IBMchanger0
```

On-disk metadata storage feature: The on-disk metadata storage feature is disabled by default. When this feature is enabled, the ability to mount tape libraries is restricted to the root user. To understand the on-disk metadata storage mechanism and to learn how to share a library that is mounted by the root user among multiple users, see Metadata storage at this website:

http://pic.dhe.ibm.com/infocenter/ltfsle/cust/topic/com.ibm.storage.hollywood.doc/ltfs_disk_cache.html

3.5.2 Performance considerations

Performance considerations when you use the IBM Spectrum Archive LE are described. The tape drive is a sequential access device, and not a random access device. The tape drive can take some time to physically locate the position of data on a tape. Optimal performance is achieved after IBM Spectrum Archive LE locates the position of the data to read or write.

Also, because the tape drive is a sequential access device, when a file on the medium is modified, the modified blocks of a file are appended to the bottom of the tape. To read the modified file, IBM Spectrum Archive LE must read from different parts of the tape, which can slow down the access to the data.

To optimize performance, the following practices are suggested when you use IBM Spectrum Archive LE:

- Certain application programs, such as editors, repeatedly overwrite a file. This process divides a file into a number of small blocks. When a file on the medium is opened by using an application program that modifies a file, copy the file to the hard disk. Modify the file on the hard disk before you copy it back to the LTFS volume.
- Set a data placement policy when you use files with a specific suffix.
- It can take some time to copy files to a different folder on the same medium because IBM Spectrum Archive LE locates the source file and destination position for every block. To improve performance, copy the file to the hard disk and then back to the medium.
- If a file under the mount point subdirectory is moved to another subdirectory of the mount point, IBM Spectrum Archive LE is using two tape drives. Until the move operation is complete, both drives are locked, and IBM Spectrum Archive LE cannot perform another operation. This locked state causes library performance to drop. If the tape library has only two drives, IBM Spectrum Archive LE does not work until the operation is completed. To avoid this situation, move the file to the hard disk, and then to the destination directory on another volume. If a tape library has only one drive, IBM Spectrum Archive LE rejects the request to move the file to another subdirectory. Although a copy operation is still possible in this scenario, it is slow.
- If two files are simultaneously written to the mount point subdirectory, a block of each file is sequentially written to the medium. For example, if file A and file B are written, block 1 of file A (A1) is written, block 1 of file B (B1) is written, then A2, B2, A3, B3, and so on are written. When file A is read, IBM Spectrum Archive LE goes to the A1 position and reads a block, then to the A2 position and reads a block, and so on. This sequential reading protocol can take some time to complete. Read performance can be improved by writing data separately. If, for example, higher performance is required for the read operation, (if possible) write file A first, then file B.
- If you attempt to simultaneously write or read data to or from more cartridges (or subdirectories under the root mount point) than the number of tape drives currently in the library, performance drops. This situation might occur, for example, if a user with two drives attempts to write a file on another subdirectory that is not on these two media to a third drive. IBM Spectrum Archive LE uses a sequential protocol to write a block on a medium, then to unload the medium, to load another medium, then to copy a block to that medium, and so on. To improve performance in this example, the user must initiate the write operation after the copy operation is completed.
- If some components of the file system monitoring tool program are enabled, the program might periodically issue commands. This condition creates a short pause during the performance of the operation. To avoid this interruption, the user can disable these types of programs.
- The index cache mechanism can be disabled to ensure the index validity by specifying an option for modifying outside the file system. However, to optimize performance, enable the index cache.

3.5.3 Accessing volumes from Windows by using CIFS

You can change the session timeout value to access volumes from Windows when you use the common Internet file system (CIFS).

A session timeout can occur when an LTFS volume is accessed from a client though network sharing. If this session timeout occurs, users might see a network error. If this kind of network error occurs frequently, change the session timeout value. The default timeout value is 45 seconds.

Attention: These instructions relate to editing the registry. If you make any error while you edit the registry, you can potentially cause Windows to fail or be unable to boot. Then, you are required to reinstall Windows. Edit the registry at your own risk. Always back up the registry according to the Microsoft website instructions before you change anything.

Procedure

Follow this procedure:

1. From the Start menu, select **Run**.
2. Type `regedit` in the Open field and click **OK**.
3. Expand and locate the registry subtree:

```
HKEY_LOCAL_MACHINE \ SYSTEM \ CurrentControlSet \ Services \
    LanmanWorkstation \ Parameters
```

4. Add a REG_DWORD key with the name of `SessTimeout`.
5. Set the timeout value. Initially set the timeout value at `600` and then change the value according to the situation of your machine.
6. Reboot the client.

3.5.4 Data placement policy

How the IBM Spectrum Archive LE uses the data placement policy is described in this section. IBM Spectrum Archive LE uses two partitions on the medium: The index partition and data partition. While the medium is unmounting, an index file is written to both partitions. The index file on the index partition is overwritten by the new index file. The index file on the data partition, however, is appended to the end of the data. Files on the index partition, including the index file, are readable the next time that the medium is mounted. If the file size and name match the data placement policy that is specified by the rules option for formatting the medium, some data files also can be written on the index partition for faster access.

The rules option for the formatting operation sets the following policies:

- File size: smaller than *xxx* bytes
- File name: `*.jpg`, `*.txt`, and so on

Sequence of data placement policy

The data placement policy writes in the following sequence:

1. When a file to write matches the rules as shown in the following example:

   If the policy is set to a file size less than or equal to 1 MB and a file name of `*.txt` and `*.jpg`, the following files match the rules:

   – File `abc.txt` with size 512 kB

   – File `xyz.jpg` with size 1 MB

   These files do *not* match the rules:

   – File `abc.csv` with size 512 kB

   – File `xyz.jpg` with size 1.2 MB

   – File `stu.png` with size 2 MB

2. IBM Spectrum Archive LE writes the file to the data partition and stores it in the memory buffer.
3. When the memory buffer is full or the medium is requested to unmount, IBM Spectrum Archive LE performs the following actions:

   a. Writes an index file at the end of the data partition

   b. Writes the files in the memory buffer to the index partition

   c. Builds an index file and writes it at the end of the index partition

At the next mount, the position of the tape head is near the files in the index partition so that they are quickly readable if those files are accessed immediately. After the files in the data partition are accessed, the access performance is equal to the performance of the other files in the data partition. If specific file suffixes are frequently accessed after the cartridge is mounted, set the data placement policy to include them to improve file access performance.

Index partition size: The size of index partition is much smaller than the data partition. If a large file size is specified for the data placement policy, the index partition might overflow.

3.5.5 Extended attributes

How the IBM Spectrum Archive LE uses extended attributes is described in this section.

IBM Spectrum Archive LE supports valid characters in W3C Extensible Markup Language (XML) 1.0 standard, except for the / (slash), for file and directory names. IBM Spectrum Archive LE version 2.4.0 and subsequent releases support more special characters in file names and in extended attributes than in previous versions by using the percent encoding method. The additional special characters are now supported by percent encoding:

- U+0001 to U+001F (excluding U+0009 (TAB), U+000A (LF), and U+000D (CR), which were supported in previous releases, and continue to be supported without percent encoding)
- The colon (:)

The percent encoding method is also used when there are special characters along with multi-byte characters in the name. The percent encoded logic is applied to the entire string of special and multi-byte characters.

Note: On a Windows system, the colon character appears as `%3A` in the index with percent encoding. The colon appears as an "_" (underscore) in the file name on Windows Explorer, or in the command prompt.

The following characters are not supported for file or directory names on either the Linux or Windows systems:

- Surrogate blocks
- BOM
- NULL character (U+0000)
- Characters that cannot be converted to UTF-16, UTF-8 or NFC normalization

A file can have multiple extended attributes. The maximum size of an extended attribute is 4 KB. When the value of an extended attribute includes binary data, IBM Spectrum Archive encodes the data in base64.

On Linux and Windows, all extended attribute names that start with the prefix `ltfs`, with any capitalization, are reserved for virtual extended attributes. For more information, see "Virtual extended attributes" on page 180.

Linux

Linux supports restrictive naming for extended attributes. Each extended attribute begins with one of the following names and ends with a period (.):

- system.
- security.
- trusted.
- user.

User.* extended attributes: For security purposes, only user.* extended attributes can be modified.

Windows

Windows supports restrictive naming for extended attributes. Windows allows only 8-bit ASCII characters that do not contain any of the following characters:

- ASCII values 0x0000 – 0x001F
- \ / : * ? " < > | , + = [ ] ;

Special characters: Except for the colon, if any of these characters are used on a Linux system, and the medium is moved from that system to Windows, the attributes do not display. If a medium is created on a Linux system that contains a colon, and it is moved to a Windows system, percent encoding is used to include the colon in the file name in the index. The following example shows how the name `Testfile:1.txt` is stored in an index with percent encoding:

```
<name percentencoded="true">Testfile%3A1.txt</name>
```

Virtual extended attributes

IBM Spectrum Archive LE defines a number of extended attributes that provide functionality other than a file system application programming interface (API). *Virtual extended attributes* provide more information about the internal operating status, file system, and directory of a tape medium. An application or operating system also can use the enhanced functionality by writing virtual extended attributes.

IBM Spectrum Archive LE does not include virtual extended attributes in the list of responses for listxattr system calls. Therefore, virtual extended attributes are hidden from a query request. A user must first specify an attribute name to be able to access it. Some standard commands do not work for virtual extended attributes. On Linux, for example, the **getfattr** command works only for extended attributes. The following example shows how a user can access virtual extended attributes:

```
# attr -g ltfs.indexCreator /mnt/ltfsmz4/248AABL5-MOVIES_LTFS
Attribute "ltfs.indexCreator" had a 54 byte value for
/mnt/ltfsmz4/248AABL5-MOVIES_LTFS:
IBM LTFS 2.1.0 (201105090) - Linux - ltfs.tape.library
```

Virtual extended attributes can be divided into four metadata categories. For details, see Appendix A, “Reserved extended attribute definitions” on page 183.

3.5.6 Samba Network File Sharing

Follow the procedure to add a user to a Samba server:

1. Add the Linux/UNIX user by using the **useradd** or **adduser** command:

   Use one of these examples:

   ```
   # useradd <username>
   # passwd <username>
   ```

   or

   ```
   # adduser <username>
   ```

   The adduser command: The **adduser** command adds a user to the system according to the command-line options and the configuration information in the `/etc/adduser.conf` file. They are friendlier front ends to the low-level tools, such as **useradd**.

2. Add a user to Samba.

   User ***<username>*** has an account on the Linux/UNIX system now. Use the **smbpasswd** command to specify that the *username* that follows the command needs to be added to the local `smbpasswd` file:

   ```
   # smbpasswd -a <username>
   ```

3. Add a user to a Samba share.

   By default, a user gets access to `/home/<username>` from the Windows system. To grant access for the user <*username*> to the `/mnt/ltfs` (ensure that the directory `/mnt/ltfs` exists) directory, open the `/etc/samba/smb.conf` file and add/modify the share that is called `[accounts]` (or add any other user-defined share):

   ```
   [accounts]
   comment = Accounts data directory
   path = /mnt/ltfs
   ```

```
valid users = <username>
public = no
writable = yes
```

Or, add a user-defined share (username=`mschaefr` and directory to share `/mnt/ltfs/redbooks`)

```
[LTFS]
comment = Public Stuff
path = /mnt/ltfs/redbooks
public = yes
writable = yes
printable = no
write list = +staff
valid users = mschaefr
```

Save the file.

4. Restart Samba.

```
# service smb restart
```

or

```
# /etc/init.d/smb reload
```

Follow these steps to connect to the Samba share through Windows:

1. Open your Windows Explorer and map the network drive (Figure 3-26).

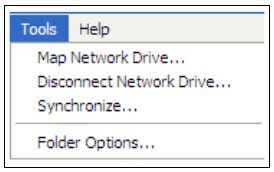

Figure 3-26 Map network drive

2. Enter the destination folder `\\9.11.215.39\LTFS` (Figure 3-27).

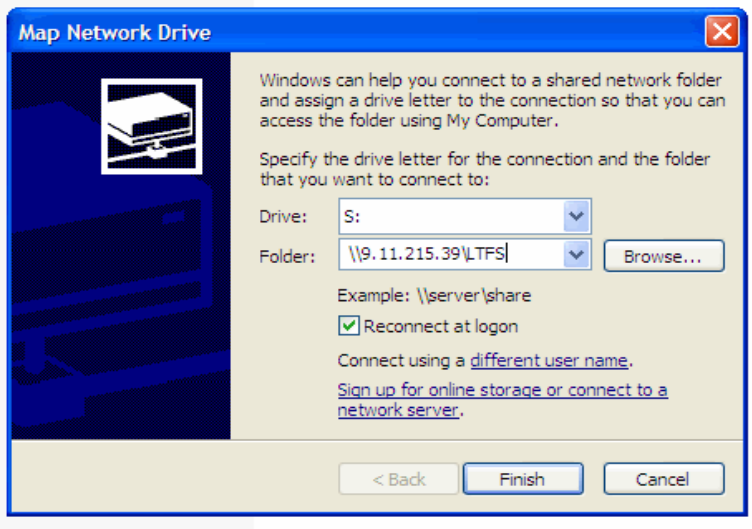

Figure 3-27 Map network drive

3. Log on with the specified user name and password (Figure 3-28).

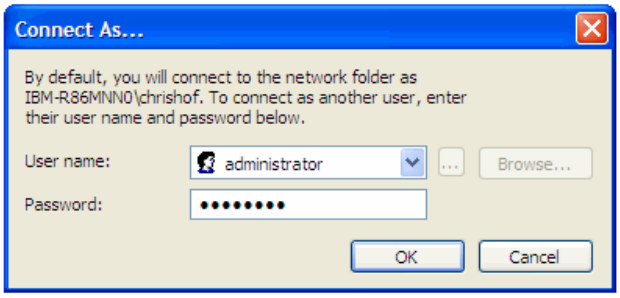

Figure 3-28 Login window

Figure 3-29 shows the IBM Spectrum Archive LE tapes as folders.

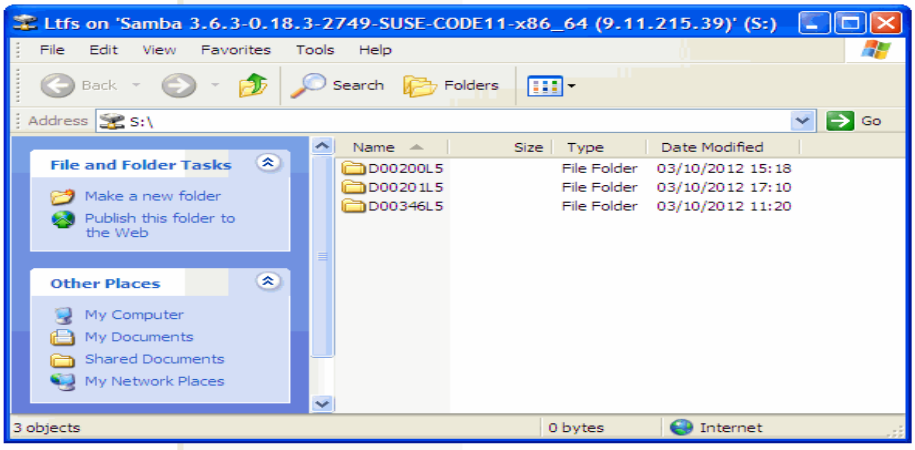

Figure 3-29 Samba Windows Explorer

A

Reserved extended attribute definitions

In an LTFS index, all extended attribute names that start with the prefix `ltfs` with any capitalization are reserved for use by the LTFS format. That is, any names that start with a not case-sensitive match for the letters `ltfs` are reserved. Any writer of an LTFS volume can use reserved extended attribute names to store extended attribute values only in conformance with the following tables.

In this appendix the defined, reserved extended attributes are described in Table A-1, Table A-2 on page 184, Table A-3 on page 185, and Table A-4 on page 187. Support for each of these defined, reserved extended attributes is optional for implementations that are in compliance with the LTFS format specification.

Software metadata

Table A-1 lists the names of the defined, reserved extended attributes for the software metadata.

Table A-1 Software metadata

Name	Accessibility	Availability	Description
ltfs.softwareVendor	Read only	Files and directories	This name is the software vendor name of this LTFS program. The LTFS program returns IBM.
ltfs.softwareProduct	Read only	Files and directories	This name is the product name of the LTFS program. The LTFS program returns LTFS SDE.
ltfs.softwareVersion	Read only	Files and directories	This name is the version number of this LTFS program.

Name	Accessibility	Availability	Description
ltfs.softwareFormatSpec	Read only	Files and directories	This name is the format specification version that is supported by this LTFS program.

Object metadata

Table A-2 lists the names for the defined, reserved extended attributes of the object metadata.

Table A-2 Object metadata

Name	Accessibility	Availability	Description	LTFS format version 1.0
ltfs.accessTime	read/write	Files and directories	This value is the date and time of the last access to the object.	N/A
ltfs.backupTime	read/write	Files and directories	This value is the date and time of the last archive or backup of the object.	N/A
ltfs.changeTime	read/write	Files and directories	This value is the date and time of the last status change to the object.	N/A
ltfs.createTime	read/write	Files and directories	This value is the date and time that the object was created.	ltfs.creationtime
ltfs.fileUID[a]	Read-only	Files and directories	This value is the integer identifier for objects in the file system. This value is guaranteed to be unique within the LTFS volume.	N/A
ltfs.modifyTime	read/write	Files and directories	This value is the date and time of the last object modification.	N/A
ltfs.partition	Read-only	Non-empty file objects only	This value is the partition on which the first extent of the file is stored.	ltfs.partition
ltfs.startblock	Read-only	Non-empty file objects only	This value is the block address where the first extent of the file is stored.	ltfs.startblock

a. Unique identifiers (UIDs) for each file/directory are permanently stored on a version 2.0.0 formatted medium. When a version 1.0 formatted medium is mounted, this attribute returns UIDs for each file/directory, but the values are not permanently stored. The UIDs are stored only while the medium is mounted. When the medium is remounted, different UIDs can be assigned.

Volume metadata

Table A-3 lists the defined, reserved extended attributes for the volume metadata.

Table A-3 Volume metadata

Name	Accessibility	Availability	Description	LTFS format version 1.0
ltfs.commitMessage	read/write	Root directory only	This message is meant to be saved in the tape index on the subsequent synchronization of LTFS to the medium. If the commit message is not changed afterward, all indexes that are written to the medium have that same message in the XML <*comment*> field.	ltfs.commit_message
ltfs.indexCreator	Read only	Root directory only	This string is the creator string for the index. This string provides a human-readable identifier for the product that generated the index.	N/A
ltfs.indexGeneration	Read only	Root directory only	This number is the last index generation number that is written to the tape.	ltfs.index_generation
ltfs.indexLocation	Read only	Root directory only	This value is the location of the last index on the medium in the form p:1, where p is an alphabetic character value that indicates the internal LTFS partition identifier, and 1 is the logical block number within the partition. For example, the value a:1000 indicates that the last index starts on partition “a” at logical block 1000.	N/A
ltfs.indexPrevious	Read only	Root directory only	Location of the previous index on the medium in the form p:1, where p is an alphabetic character value that indicates the internal LTFS partition identifier, and 1 is the logical block number within the partition. For example, the value b:55 indicates that the previous index starts on partition “b” at logical block 55.	N/A
ltfs.indexTime	Read only	Root directory only	This value is the date and time when the last LTFS index is written to the medium.	ltfs.index_time

Name	Accessibility	Availability	Description	LTFS format version 1.0
ltfs.labelCreator	Read only	Root directory only	This value is the creator string for the LTFS label. This string provides a human-readable identifier for the product that generated the LTFS label.	N/A
ltfs.partitionMap	Read only	Root directory only	This value is the only medium partition layout for the LTFS volume. The form of the value is *W:x,Y:z* where *W* and *Y* have the value I, indicating an index partition, or D, indicating a data partition. The alphabetic character values *x* and *y* indicate the internal LTFS partition identifier. For example, the value I:a,D:b indicates that LTFS partition “a” is used as the index partition, and LTFS partition “b” is used as the data partition.	N/A
ltfs.policyAllowUpdate	Read only	Root directory only	This value indicates whether the data placement policy for the volume can be updated.	ltfs.policy_allowupdate
ltfs.policyExists	Read only	Root directory only	This value indicates whether the policy that allows certain files to be written to the index partition is enabled. The policy is set at the time of formatting.	ltfs.policy_is_set
ltfs.policyMaxFileSize	Read only	Root directory only	This value is the maximum file size for files that match the data placement policy for the volume.	ltfs.policy_maxfilesize
ltfs.sync	Write only	Root directory only	Writing any value to this extended attribute initiates a file system sync on any implementation that supports this extended attribute.	N/A
ltfs.volumeBlocksize	Read only	Root directory only	This block size is used on read/write operations as specified at the time of formatting.	ltfs.volume_blocksize
ltfs.volumeCompression	Read only	Root directory only	This value is the compression setting for the volume.	N/A

Name	Accessibility	Availability	Description	LTFS format version 1.0
ltfs.volumeFormatTime	Read only	Root directory only	This value is the date and time when the volume was formatted.	ltfs.volume_format_time
ltfs.volumeName	Read	Files and directories	This name is the tape volume name as set at the time of formatting.	ltfs.volume_name
	Write	Root directory only		
ltfs.volumeSerial	Read only	Root directory only	This value is the tape serial number as specified at the time of formatting.	ltfs.tape_serial
ltfs.volumeUUID	Read only	Files and directories	This value is the Universally Unique Identifier that is assigned to the tape medium.	ltfs.volume_uuid

Media metadata

Table A-4 lists the defined, reserved extended attributes for the media metadata.

Table A-4 Media metadata

Name	Accessibility	Availability	Description
ltfs.mediaBeginningMediumPasses	Read only	Root directory only	This value is the total number of times the beginning of a medium position is passed. If the storage hardware cannot report this data, the value is -1.
ltfs.mediaDatasetsRead	Read only	Root directory only	This value is the total number of data sets read from the medium over its lifetime. If the storage hardware cannot report this data, the value is -1.
ltfs.mediaDataPartitionAvailableSpace	Read only	Root directory only	This value is the total available space in the data partition on the medium. The value is an integer count that is measured in units of 1048576 bytes.
ltfs.mediaDataPartitionTotalCapacity	Read only	Root directory only	This value is the total capacity of the data partition on the medium. The value is an integer count that is measured in units of 1048576 bytes.
ltfs.mediaDatasetsWritten	Read only	Root directory only	This value is the total number of data sets written to the medium over its lifetime. If the storage hardware cannot report this data, the value is -1.

Name	Accessibility	Availability	Description
ltfs.mediaEfficiency	Read only	Root directory only	This value is the overall measure of the condition of the loaded medium. The value 0x00 indicates that the condition is unknown. The range of known values is from 0x01 (best condition) to 0xFF (worst condition). If the storage hardware cannot report this data, the value is -1.
ltfs.mediaIndexPartitionAvailableSpace	Read only	Root directory only	This value is the total available space in the index partition on the medium. The value is an integer count that is measured in units of 1048576 bytes.
ltfs.mediaIndexPartitionTotalCapacity	Read only	Root directory only	This value is the total capacity of the index partition on the medium. The value is an integer count that is measured in units of 1048576 bytes.
ltfs.mediaLoads	Read only	Root directory only	This value is the number of times that the medium is loaded in a drive. For example, with tape media, this value is the tread count. If the storage hardware cannot report this data, the value is -1.
ltfs.mediaMBRead	Read only	Root directory only	This value is the total number of megabytes of logical object data that is read from the medium after compression over its lifetime. The value is rounded up to the next whole megabyte. The value that is reported includes bytes read as part of reading file marks from the medium. If the storage hardware cannot report this data, the value is -1.
ltfs.mediaMBWritten	Read only	Root directory only	This value is the total number of megabytes of logical object data that is written to the medium after compression over its lifetime. The value is rounded up to the next whole megabyte. The value that is reported includes bytes written as part of writing file marks to the medium. If the storage hardware cannot report this data, the value is -1.
ltfs.mediaMiddleMediumPasses	Read only	Root directory only	This value is the total number of times that the physical middle position of the user data region of a medium is passed. If the storage hardware cannot report this data, the value is -1.

Name	Accessibility	Availability	Description
ltfs.mediaPermanentReadErrors	Read only	Root directory only	This value is the total number of unrecovered data read errors over the lifetime of the medium. This value is the total number of times that a read-type command terminated with a sense key of MEDIUM ERROR, HARDWARE ERROR, or equivalent over its lifetime. If the storage hardware cannot report this data, the value is -1.
ltfs.mediaPermanentWriteErrors	Read only	Root directory only	This value is the total number of unrecovered data write errors over the lifetime of the medium. This value is the total number of times that a write-type command terminated with a sense key of MEDIUM ERROR, HARDWARE ERROR, or equivalent over the lifetime of the medium. If the storage hardware cannot report this data, the value is -1.
ltfs.mediaPreviousPermanentReadErrors	Read only	Root directory only	This value is the total number of unrecovered read errors that occurred during the previous load of the medium. This value is the total number of times that a read-type command terminated with a sense key of MEDIUM ERROR, HARDWARE ERROR, or equivalent during the previous load session. If the storage hardware cannot report this data, the value is -1.
ltfs.mediaPreviousPermanentWriteErrors	Read only	Root directory only	This value is the total number of unrecovered write errors that occurred during the previous load of the medium. This value is the total number of times that a write-type command terminated with a sense key of MEDIUM ERROR, HARDWARE ERROR, or equivalent during the previous load session. If the storage hardware cannot report this data, the value is -1.
ltfs.mediaRecoveredReadErrors	Read only	Root directory only	This value is the total number of recovered read errors over the lifetime of the medium. If the storage hardware cannot report this data, the value is -1.

Name	Accessibility	Availability	Description
ltfs.mediaRecoveredWriteErrors	Read only	Root directory only	This value is the total number of recovered data write correction errors over the lifetime of the medium. If the storage hardware cannot report this data, the value is -1.
ltfs.mediaStorageAlert	read/write	Root directory only	This value is a 64-bit value that contains alert flags for the storage system. For data tape media, this value is equal to the standard tape alert flags. If the storage hardware cannot report this data, the value is the string “UNKNOWN.” By writing a value of 1, the corresponding bit is cleared. By writing a value of 0, the current value is retained.

Related publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this book.

IBM Redbooks

The following IBM Redbooks publications provide additional information about the topic in this document. Note that some publications referenced in this list might be available in softcopy only.

- *IBM Spectrum Archive Enterprise Edition V1.2.5.1 Installation and Configuration Guide, SG24-8333*
- *IBM Tape Library Guide for Open Systems*, SG24-5946
- *IBM TS4500 R4 Tape Library Guide*, SG24-8235

You can search for, view, download or order these documents and other Redbooks, Redpapers, Web Docs, draft and additional materials, at the following website:

ibm.com/redbooks

Other publications

These publications are also relevant as further information sources:

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

Online resources

These websites are also relevant as further information sources:

- Awards:

  http://www.emmys.com/news/news/2011-engineering-award-recipients
- IBM Product Support: TS3310:

  http://www.ibm.com/support/docview.wss?uid=ssg1S7005240
- IBM Knowledge Center: TS4300:

  https://www.ibm.com/support/knowledgecenter/en/STAKKZ/3U_kchome.html
- IBM Knowledge Center: TS4500:

  https://www.ibm.com/support/knowledgecenter/STQRQ9
- IBM Spectrum Archive Enterprise Edition section of IBM Knowledge Center:

  http://www.ibm.com/support/knowledgecenter/ST9MBR
- IBM Spectrum Archive Library Edition section of IBM Knowledge Center:

  http://www.ibm.com/support/knowledgecenter/STZMZN

- IBM Spectrum Archive Single Drive Edition of IBM Knowledge Center:
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- IBM System Storage interactive product guide:
  https://www.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=TSO00364USEN
- Linear Tape-Open Program:
  http://www.lto.org/technology
- SNIA Linear Tape File System Format Specification:
  http://snia.org/sites/default/files/LTFS_Format_2.2.0_Technical_Position.pdf

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