

SPECTRA® T950 PYTHON® ARCHITECTURE:

TAPE LIBRARY AUTOMATION TAILORED TO FIT THE ENTERPRISE



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Overview

The Economist Joseph Alois Schumpeter (1883-1950) argued that innovation led to “gales of creative destruction” that caused old inventories, ideas, technologies, skills, and equipment to become obsolete. Today these gales mix with the air-conditioning in the modern data center.

Herr Schumpeter was worried about capitalism’s ability to survive, but perhaps a modern IT manager is more imperiled. Trends in processors, storage, networks, and software routinely turn yesterday’s newest technology into today’s refuse.

By examining the changes, however, clear trends emerge: components become faster, smaller, more capacious, and less expensive. These trends apply equally to CPUs, networks and storage. Ultimately, these trends led to the evolution of Spectra Logic’s Python architecture in the Spectra T950 library. The creative engineering of this library buffers—rather than buffets—modern IT managers.

Data Center Evolution

Thirty-five years ago, the mainframe was the center of the data center. It provided centralized processing, centralized storage, and centralized management. The network at that time consisted of a number of unintelligent terminals attached over a slow serial connection. Large external direct-attached solid-state disk (DASD) devices provided disk storage, and tape storage was accomplished on nine-track open-reel tapes.

When tape automation was first introduced, it was in a large StorageTek silo. These innovative systems required a large amount of energy, and a great deal of floor space close to the mainframe. The remainder of space in the data center was used for massive line printers and water cooling equipment for the mainframe. Data was de facto centralized.

As time passed, processor power migrated from the mainframe to mini-computers to networks of workstations using network resources for storage or printing. Network bandwidth started moving toward 100 megabits per second (Mb/sec), and disk drives were storing gigabytes (GB) on small drives. Tape drives were small enough to mount in a workstation’s chassis and could back up the entire system on just a few tapes.

The people managing these networks, however, ceded control. Disk storage was now local and beyond the reach of centralized control. Individual, workgroup, and departmental backups were difficult to manage and enforce. This new distribution had yielded technical advantages on one hand and management difficulties on the other.

With the next storage technology revolution, IT departments reversed the trend of distributed control while retaining the benefits of distributed power. Multiple rack-mount servers, RAID disk storage, and faster networks brought management back to the data center with a new look—rows of rack-mount gear providing file servers, network switching, and storage.

The leap to 1000 Mb Ethernet (Gigabit Ethernet) and Fibre Channel networks has opened new possibilities for enterprise-wide data backup. Networks are now fast enough to permit centralized storage of user data in the data center, where backup schedules are enforced. Both networked attached storage (NAS) and storage area networks (SANs) bloomed, using Fibre Channel and Gigabit Ethernet to share disk and tape storage across the network and over much larger distances than previously possible.

Tape Library Evolution

In less than a decade, automated backup has progressed from a feature unique to large data centers and special applications to a mainstream technology. To complete this maturation process, vendors of software and hardware have improved reliability, simplified use, and lowered costs. Leading vendors are delivering fourth, fifth, and sixth generation products innovated to best meet customer needs.

Surprisingly, many of the trends in processors, networking, and disk storage have not been carried through into automated tape libraries. Tape libraries have improved and adapted at a slower rate and have rarely shown the revolutionary progress seen in other sectors of the storage industry. Instead, libraries apparently relied on advancing tape drive technology, which has followed the trends. Today's data center has moved from using a few physically large and expensive tape drives to now using multiple smaller and less expensive tape drives with greater throughput and capacity. Both the 8mm and half-inch tape cartridge formats have produced several popular drive and media formats. Tape library manufacturers have benefited substantially from these improvements: a new generation tape drive that doubles capacity automatically doubles library capacity with no innovation from the library manufacturer.

Tape library technology is now catching up with technology trends to offer more, and more intelligent, data backup and recovery options. Using libraries that have advanced with technology, many firms have already consolidated disparate backup systems and procedures into one large centralized library. Properly done, this consolidation saves labor, controls costs, and enforces corporate procedures for security, archival storage, and access for all data. Now users now have a raft of new library features, and concerns, that influence any decision in tape library selection.

T950 Python Architecture

Spectra Logic developed the Spectra T950 library with Python architecture specifically to meet the challenges of capacity, physical size, performance, complexity, interoperability, ease of use, and security. The T950 library is named to represent two of its significant features: high density using grouped media, indicated by the T for TeraPack® case; and ready scalability, indicated by 950 for the maximum number of tape slots in the base frame.

The Spectra T950 library modular design supports new technologies in storage and management, and anticipates future needs as enterprises change and grow.

Many years of experience in the storage industry have provided Spectra Logic with an in-depth knowledge of data backup and recovery. Spectra brought this knowledge to a detailed analysis of data storage requirements and trends; the result is the Spectra T950 library.

Architecture Overview

The T950 Python architecture integrates simple, sophisticated and flexible library management with a new way of dealing with space available in a library, grounded in the library's modular architecture.

The library is built on an entire software environment, the BlueScale® environment, that lets you easily manage all aspects of the library. The BlueScale environment supports the graphical, icon-driven user interface, which you can use either through the 10-inch color touch-screen front panel, or through a Web browser from anywhere, optionally secured using SSL.

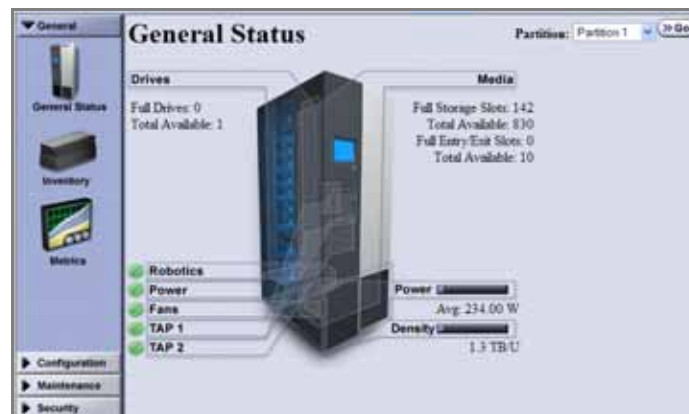


Figure 1. T950 Python BlueScale Interface.

New, powerful features are added regularly to the T950 thanks to the flexible BlueScale interface. The T950 supports encryption through either LTO-4 drives, or through the library; provides media life cycle management; and provides unique power monitoring capabilities.

The T950 Python architecture also supports modularity that simplifies library maintenance—IT staff can replace or add many of the library components in minutes. The architecture also

yields the highest storage density of any competing library through its creative use of interior space within the library.

Typical tape libraries are limited in storage density by the amount of wall space available inside them, as all tapes must be directly accessible and bar-code readable by the robotics.

The T950 implements an innovative TeraPack design, which optimizes storage density—the amount of storage provided per square foot of floor space. By breaking the surface-area boundary, the Spectra T950 library provides much greater capacity than its nearest competitor, and does so with a smaller footprint. In addition to a small footprint and high density, the Spectra T950 library is carefully designed to coexist with other equipment in the data center. Spectra T950 libraries do not require or use racks, but rather align to standard racks. This rack-grid design lets T950 Python libraries reside within any row of rack-mounted gear. The library can be installed on the end of an equipment aisle to facilitate maintenance and provide for the 30-inch width of the chassis, but it is able to function well in any standard rack grid layout.

Ease of Management

Many of the special features of the Spectra T950 library are accessed through the BlueScale interface, including configuration of library partitions, capacity upgrades through CoD, encryption during data backup to tape, and media life-cycle management. Using the BlueScale management environment, it is easy to manage storage:

- ♦ The BlueScale graphical interface, available through the library front panel and through a web browser from anywhere, uses intuitive icons and provides guided configuration.
- ♦ Spectra T950 libraries can be configured to send an SNMP trap in the event of a failure, boundary condition exceeded (temperature or power threshold), or user-intervention needed (blank media or tape mount from vault). An SNMP management application can then queue these requests to a central management console for response.
- ♦ SMTP can likewise be configured to send e-mail notifications in addition to—or instead of—SNMP.

Observatory

The Spectra T950 library provides full-featured access to configuration and operation over the network. A web server on the Library Control Module (LCM) allows remote operation from a Web browser with multi-tiered user security. *Observatory*, shown in Figure 2 on page 8, is

capable of monitoring multiple T-series libraries, with a common architecture, in one central management console.

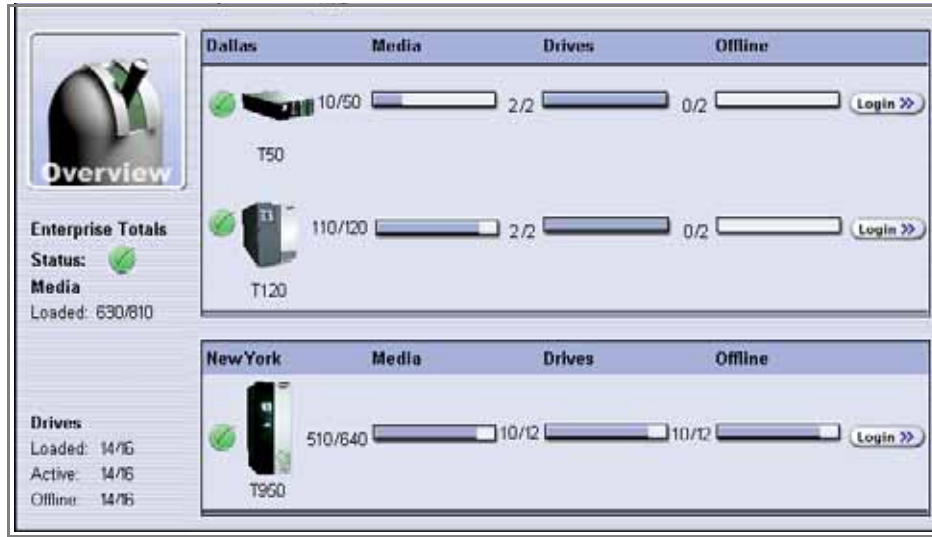


Figure 2. Observatory

Storage Density

Storage density is evaluated in terms of the number of tapes per unit of area—its numerator is capacity. A small footprint is irrelevant if the system cannot provide the required storage or performance. The small-footprint Spectra T950 libraries provide more capacity than most physically larger libraries.

- ◆ Data center space savings: the Spectra T950 library has on average three times the density of comparable libraries.

Library ^a	Footprint in floor tiles - 2'x2	Tapes/foot	Percent Spectra Saves
Spectra T950	2.3 tiles (9.4 sq. ft)	101	
SL8500	3 tiles (12 sq. feet)	25	Spectra T950: 405% more tapes/ft
ADIC i2000	3 tiles (12 sq. feet)	25	Spectra T950: 405% more tapes/ft
IBM TS3500	3 tiles (12 sq. feet)	23	Spectra T950: 439% more tapes/foot
HP ESL712e	2.6 tiles (10.4 sq. feet)	68	Spectra T950: 148% more tapes/foot
STK/SUN L1400M	4 tiles (16 sq. feet)	42	Spectra T950: 240% tapes/foot
Overland NEO 8000	2 tiles (8 sq. feet)	62	Spectra T950: 163% more tapes/foot

a. Based on 12-drive library configurations with 950 tapes

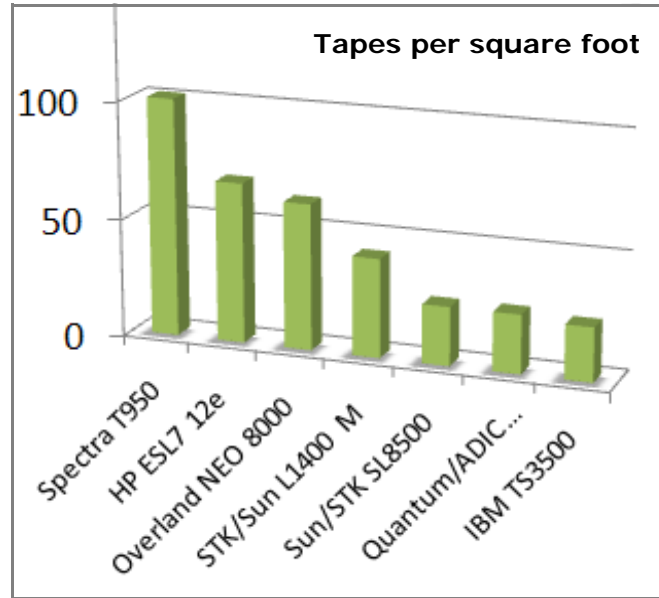


Figure 3. Storage density comparison.

Expanding the T950 Library Capacity and Performance

The Python architecture growth path provides another example of design modularity: the primary frame of the library can have additional frames added on to it, up to a total of eight frames, as shown in Figure 4 on page 10. Each frame contains the combination of drives and media best suited to meet the needs of the user. The frames added to the primary frame can hold a combination of drives and media, or they can hold media only for additional capacity.

The Spectra T950 library offers much greater scalability than competing libraries: the T950 provides an average of five times the capacity—and scalability—of comparable libraries.

Library	Frames	Cartridges	Capacity ^a	Capacity as % of T950	Spectra T950 Scaling Advantage
T950	8	10,050	16 PB		
i2000	8	3,492	5.6 PB	35%	2.8x
L1400M (pass through)	2	1,344	2.1 PB	13%	7.5x
TS3500	16	6,887	11 PB	69%	1.4x
ESL712e (pass through)	5	3,546	5.7 PB	36%	2.8x
NEO 8000	2	1,000	1.6 PB	10%	10x

a. Calculations in this white paper follow the industry default of calculating GB and PB by division of 1,000, rather than 1024.



Figure 4. Single and eight frame T950 configurations.

Since the T950 Python architecture supports multiple tape technologies, different numbers of frames, and different allocations of space for drives and media, the actual native capacity is a formula rather than a simple value. The table below shows some of the many frame performance and capacity options. As an example, a five-frame library cascade can be configured the following ways, and more:

Example T950 Configurations 5-frames	Drives	Performance LTO-4 native 80 MB.s	Slots	Capacity LTO-4 native .8 TB/tapes
Base frame, 4 media frames	24	9.8 TB/hour	6030	4824 TB
Base frame, drive frame, 3 media frames	48	19.7 TB/hour	5620	4496 TB
Base Frame, 2 drive frames, 2 media frames	72	29.5 TB/hour	4800	3840 TB
Base frame, 4 drive frames	120	49.2 TB/hour	4390	3512 TB

With Spectra Logic's Capacity-On-Demand feature, CoD, users can buy a Spectra T950 library that does not contain the maximum amount of slots, then upgrade capacity later as needed—without making a service call. Then, once the first frame is fully populated, a field upgrade adding another frame extends capacity up to the five-frame maximum. Capacity is added simply by contacting your sales representative or logging onto the Spectra web site. On purchasing the capacity, you are e-mailed an alphanumeric string that you can enter using the graphical BlueScale interface. The slots instantly become available.

Both the capacity and throughput of Spectra T950 libraries are highly configurable. An eight-frame library can be upgraded to hold as many as 120 tape drives. Sites that do not require that level of parallel throughput, however, can instead take advantage of higher capacity, with up to 10,050 slots.

Power Use and Management

Data center power use is another issue that is increasingly important as power costs continue to soar: “the price of oil... has tripled since 2002.”¹ The costs associated with data center power use are eating into IT budgets.

The price of energy varies, depending on geography, but the increase is substantial: across the U.S., energy costs have increased from 20% to more than 40%² in the last year. An article in *InfoWorld* includes a checklist on how to save power, and the top item on the list is: “Invest in power-efficient hardware.”³ According to the following analysis, the Spectra T950 is the most efficient enterprise tape library compared to competing libraries.

Power use savings: the Spectra T950 library provides **50-80%** savings (average 65%)

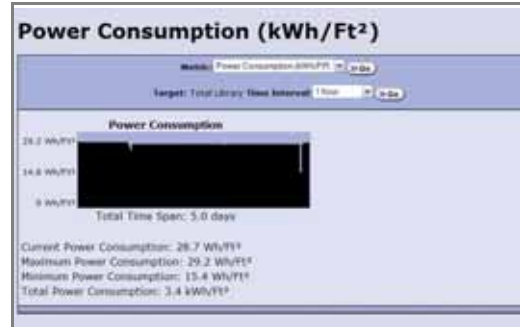
Library ^a	Average Power Use ^b	Heat Dissipation	Percent Spectra Improves over Competition
Spectra T950	785 watts/frame 83.5 watts/foot .8 watts/tape	2,681 BTU/h 285 BTU/hr/ft 2.8 BTU/hr/tape	
SL8500	925 watts/frame 66 watts/foot 2.6 watt/tape	3,159 BTU/h 263 BTU/hr/ft 10.5 BTU/hr/tape	Spectra T950: 70% power savings
ADIC i2000	925 watts/frame 66 watts/foot 2.6 watt/tape	3,159 BTU/h 263 BTU/hr/ft 10.5 BTU/hr/tape	Spectra T950: 70% power savings
IBM TS3500	980 watts/frame 82 watts/foot 3.6 watts/tape	3,347 BTU/h 279 BTU/h/ft 11.75 BTU/h/tape	Spectra T950: 80% power savings
HP ESL712e	1,204 watts/frame 116 watts/foot 1.7 watts/tape	4,112 BTU/h 395 BTU/h/ft 5.8 BTU/h/tape	Spectra T950: 53% power savings
STK/SUN L1400M	1,076 watts/frame 67.2 watts/foot 1.6 watts/tape	3,674 BTU/h 229.6 BTU/h/ft 5.5 BTU/h/tape	Spectra T950: 50% power savings
Overland NEO 8000	1,230 watts 153.7 watts/hr 2.5 watts/tape	4,201 BTU/h 525 BTU/h/foot 8.4 BTU/h/tape	Spectra T950 70% power savings

a. Based on 12-drive library configurations with 950 tapes

b. Power use calculated using storage density values shown on page 8

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1. Goodin, Dan. “IT Confronts the Datacenter Power Crisis,” *InfoWorld*, 10/6/06.
 2. Dunn, Darrel. “Power Surge,” *Information Week*, 2/27/06.
 3. Goodin, Dan. *Ibid.*

Further, the T950 monitors input and output power, drive fans, and voltage supplied to the drives, and tracks and displays total power consumption. Spectra T950 library power supplies can handle a wide variance of input power and current, and cycle while still providing stable power to library components. Python architecture supports power supplies that can continue at full performance in the event that one entire supply stops functioning. The dual AC option lets the system continue if the current on one of the circuits is interrupted.



Power monitoring provides a choice of options—you can look at power consumption now or over hours or days. Use this data to optimize energy use in the context of the entire data center.

Cooling

Proper cooling is vital to tape drives' reliability and media integrity. The Python architecture actively manages system cooling, monitoring temperature both inside and outside the library, and automatically changing the speed or number of fans operating to ensure proper conditions. Powering down unneeded fans saves electricity and saves duty on the fan motors. Fan module failures are also detectable and reportable through remote Web, SNMP and SMTP. The fan module is hot-swappable, preventing interruptions and downtime.

Partitioning

Creating virtual libraries using SLS enables easy storage consolidation and flexibility. A single partitioned T950 replaces multiple small backup systems and libraries, simplifying consolidation. Partitions can also be used to separate discrete data sets. Use SLS to partition the Spectra T950 library into 8 partitions. Each partition is assigned its own drives and media slots, and lets a single physical library use multiple drive technologies, one drive/media type per partition.

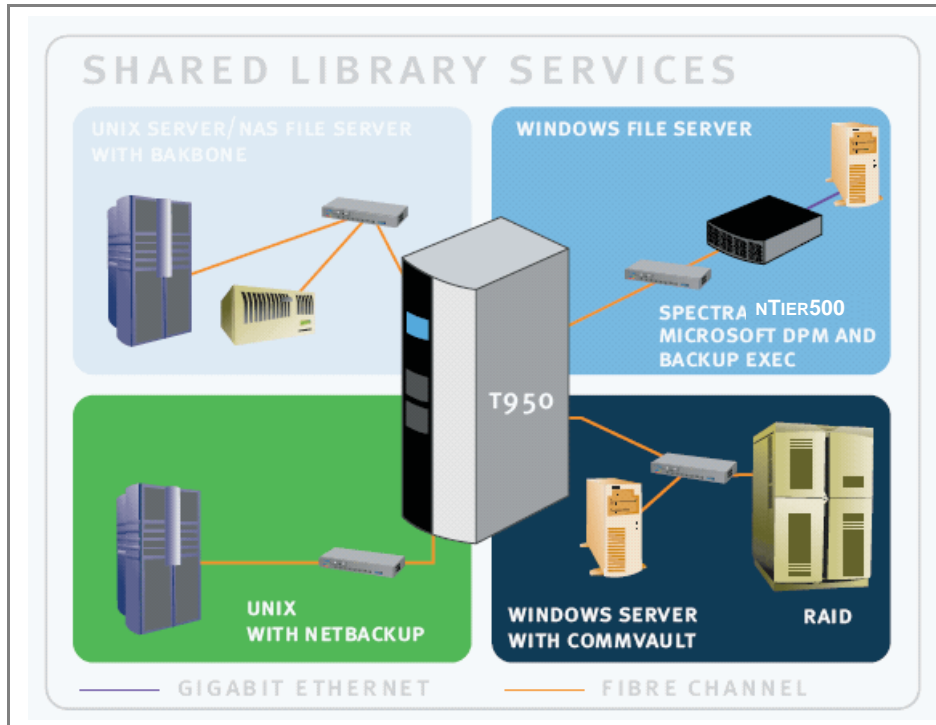


Figure 5. Virtual libraries through SLS

Each host sees a stand-alone tape library with its own slots and drives, as you allocated when you created the partition. The logical library can emulate the control set and reporting characteristics of many popular libraries, so that the library can immediately be managed using all popular backup packages. In storage consolidation, the partition can emulate the exact system it is replacing, transparent to the software. Through partitioning, a single T950 library can be connected to multiple networks, operating systems and backup applications.

SLS is configured and stored directly on the RCM, which communicates the configuration to drives and QIPs. No outside media management software or hardware is required to mix media types.

Integrated Encryption

Costs of losing backup tapes, due to legal and commercial obligations, continues to grow. Assuming a tape contains personal information about 15,000 employees or citizens, the cost to the organization is \$14 million or more, and the additional effect resulting bad publicity will cost the organization.

With BlueScale Encryption, included with the T950, data on any and all tapes can be encrypted while the data is being backed up. Because encrypted data is considered irretrievable, the legal and external costs to the organization losing the tape is zero.

Regardless of whether you encrypt data through the LTO-4 drives, the library QIP hardware, or both, BlueScale Encryption protects data using the strongest available encryption algorithm. In a single step data is both encrypted and backed up. Complete key management is handled through the graphical BlueScale interface.

The process of encryption is straightforward:

- ♦ On setting up encryption, define an encryption password and other encryption security options. To access encryption features, both the superuser password and one or more encryption passwords have to be supplied.
- ♦ Define the data to be encrypted
- ♦ Create an encryption key and assign it to a partition (logical library).
- ♦ Using your backup software, set up backup and recovery tasks so that data to be encrypted or decrypted is sent to the encryption-enabled partition.
- ♦ Make copies of the encryption key (note that these copies are themselves encrypted) for example, to a USB device and store the device with the encrypted key in a secure location, such as a third-party security provider.
- ♦ To restore the data, make sure the key is on the library, importing it if necessary, then simply use the standard backup process to recover the data, which is decrypted, decompressed if necessary, and then restored.
- ♦ To destroy data, simply delete all copies of the encryption key used to encrypt the data.

Encrypted data can be restored using any of these methods:

- ♦ From the original library on which the data was encrypted
- ♦ On any other encryption-enabled Spectra library, regardless of whether it was used to encrypt the data
- ♦ Using a basic Linux server, with one or two tape drives, with the server running the EDU utility, data can be restored without any library, for disaster and doomsday scenarios.

Media

The Spectra T950 library's media handling system, which uses multiple tapes in a TeraPack magazine, lets users group media and move it in packs rather than having to move individual cartridges.

TeraPack magazines securely store and transport media into and outside of the library. The TeraPack media-specific design holds 10 LTO or SAIT tape cartridges, and 9 SDLT tape cartridges. Each data cartridge and each TeraPack case is bar coded to facilitate media management.

The TAP is the physical location where TeraPacks are inserted and removed from the library. Two redundant TAPs are located at the front of each Spectra T950 library. Each TAP enables the user to bulk import and bulk export media with TeraPacks. A single frame Spectra T950 library can hold up to 95 TeraPacks. Within the library, TeraPack magazines reside in physical locations called TeraPack chambers.

The transporter is the robotic mechanism within the library that moves the TeraPack cases to designated locations, inserts individual cartridges into the tape drives, and moves the Tera-Pack magazines to and from the TAP. The robotics that make up the transporter are extremely reliable and designed for accuracy in positioning, as shown in Figure 7 on page 20.

The differentiating features of the Spectra T950 library's comprehensive media management system include:

Less manual intervention. Using Spectra Certified Media, tapes are purchased, loaded, transported, stored, unloaded, and moved off-site in TeraPack magazines. Operators rarely (or never) have to handle individual cartridges. This reduction in human intervention decreases labor and maintenance costs, and errors and/or data loss due to the mishandling of media.

Optimized storage density. Storing media in TeraPacks provides a dramatic increase in storage density due to the innovative horizontal design of the TeraPack. TeraPack cases are stored in a shelf-like fashion inside the library; space is not wasted by having to allow the robotics direct access to each individual tape cartridge.

Two-tiered tracking. Tracking large numbers of cartridges is easy, since bar coded media reside in bar coded TeraPacks. This simplifies logging and reconciling media for accurate tape management.

Reduced robotics load. Grouped media handling reduces wear on the robotics because fewer motions are required during the importing and exporting process. Traditionally, only one cartridge was moved at a time; the transporter makes it possible to move multiple tapes simultaneously.

Time savings. The transporter's ability to move an entire TeraPack case full of tapes lets data center staff import and export media in true bulk fashion. Now, 10 LTO tapes can be moved in the same amount of time that it used to take to move just one tape cartridge.

Spectra Logic performed a test to compare the time to unload 1000 cartridges from the Spectra T950 library and from a competitor's half-inch tape library. Note that, to remove 1000 tapes from the T950, the operator handles only 100 Terapack magazines. The dramatic time savings are shown here:

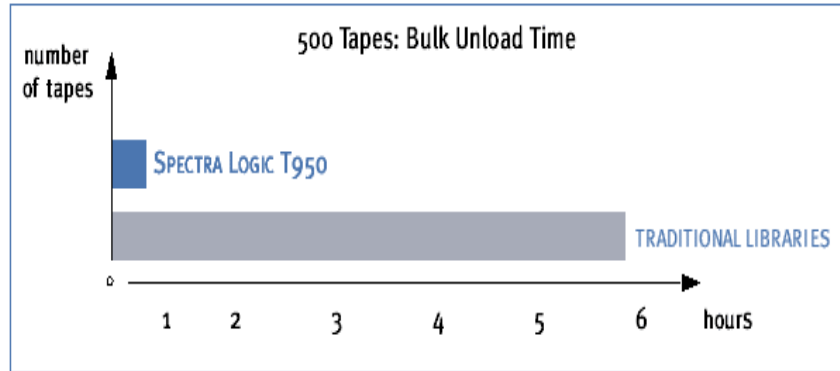


Figure 6. Time savings in loading and unloading tapes.

Data safety. Outside the physical library, TeraPack dust covers protect media from contamination, corruption, and exposure. Once the TeraPack magazine has been removed from the library, a clear cover snaps on to the top of the case and protects the cartridges from human mishandling and from potentially damaging environmental conditions.

Easy transport and storage. Stackable TeraPack cases are a convenient size for movement to off-site storage and media rotation.

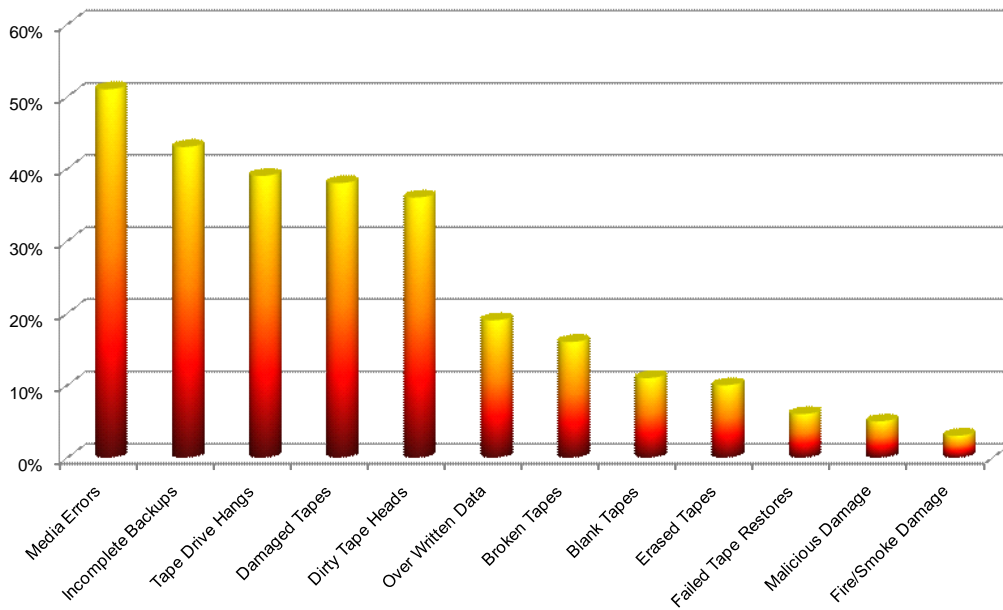
Software management. Use the Rotation Manager feature of the BlueScale graphical interface to track media by TeraPack cases, so a single bar code represents ten bar-coded tapes. You can export the data in a format several backup software applications can import and use to track the location of data after it's exported.

Media Life Cycle Management

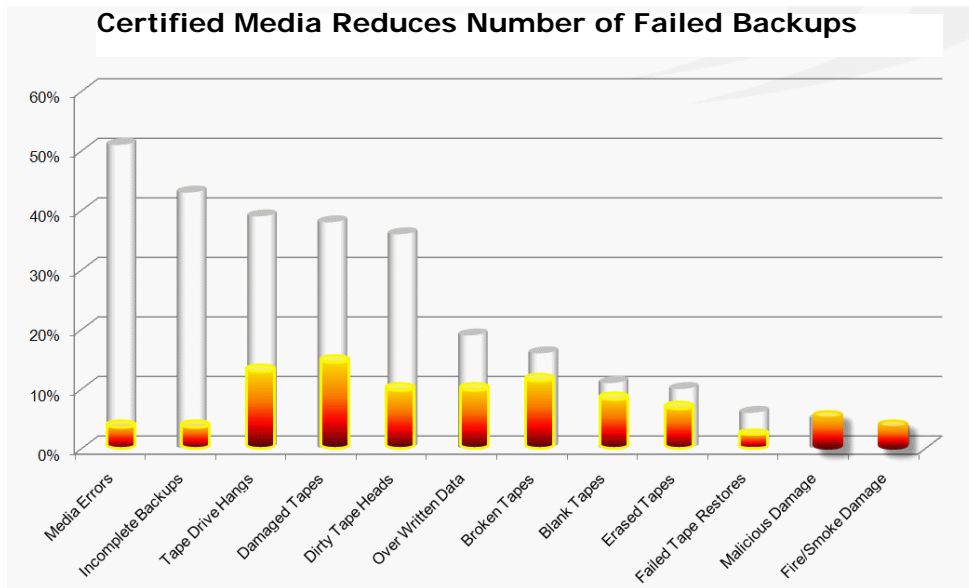
The Spectra T950 library combines its intelligent BlueScale environment with Spectra Certified Media—media with a memory. Spectra Certified Media has a built-in memory capacity, and across its lifetime stores information you can use to reduce backup problems associated with tape.

Smart Certified Media helps you greatly reduce errors associated with tape-related failed backups by making it easy to find drives experiencing a high error rate, identify tapes prone to error, and identify tapes that have been used the specified number of times (for example, tape manufacturers specify the number of loads/unloads and write passes that a tape can handle before end of life).

Data Center Survey: Reasons for Failed Backups



Using Spectra Certified Media with the T950 library significantly reduces the chances of failed backups:



Media Flexibility

The Spectra T950 library provides reliable operation with all of the well-established tape technologies: LTO, SDLT, SAIT, and portable Spectra RXT RAID. Spectra T950 libraries support all of these formats within the same library.

Each TeraPack case contains only one media type. Each library partition supports one type/generation of drives and media. Simply provide multiple partitions to support multiple technologies. The library's transporter securely handles all cartridge types between partitions.

This is an advantage for legacy systems that may use older media types. It also represents a convenient migration path for data centers moving to a single media format, or for applications moving to a new technology or generation. The TeraPack design provides a secure method for mixing media in a single library.

Connectivity

Generally, early tape libraries attached directly onto the SCSI bus of a host machine, requiring the library to be close to the machine that it was backing up. Software packages allowed client backup over the network, but the network was frequently only 10 or 100 Mb/sec, and it was likely carrying other traffic.

The emergence of Fibre Channel, Gigabit Ethernet, and other technologies enabled NAS and SANs. Spectra Logic was a pioneer in this technology and has developed Fibre Channel and Gigabit Ethernet interfaces across all of its current library lines.

Extending this tradition, Python architecture provides the most connectivity options. As well, its modular design supports library flexibility, making it easy to add connectivity options as they enter widespread use.

A Spectra T950 library provides any mix of these protocols:

- ◆ iSCSI
- ◆ Fibre Channel
- ◆ Gigabit Ethernet

Native Fibre Channel drives can be attached directly to the host bus adapter where required, but many additional features are available using QIP connectivity.

Platform Independence

Spectra T950 libraries with QIP connectivity and drive independence support many storage applications, including backup, archival storage, storage management, data acquisition, and near-online storage. It also supports all major backup software packages on all major host platforms, including UNIX, Linux, Microsoft Windows, Novell, Apple Macintosh, and special applications such as those that collect digital video, seismic, medical imaging, and telemetry data.

QIP Connectivity

Each QIP provides a drive interface and robotics interface to the host in the desired protocol (Fibre Channel, iSCSI, Gigabit Ethernet). By actively managing this interface, the Spectra T950 library provides many features that are particularly beneficial to the library environment.

Some of these are convenience functions. For example, the QIP can manage a hot-swap of a failing drive by taking the drive offline, cueing the user to replace it, and bringing the new drive up, establishing any previous user settings. By its nature, the QIP provides interface independence; an Ethernet library can be changed to Fibre Channel merely by replacing a QIP.

The QIP also supports emulation of drives and libraries, controlling the inquiry data that a device returns and translating command sequences to their counterparts on a different drive or library. This is a great help for connecting legacy systems and applications which may not recognize or support newer technology devices.

Quad Interface Processor (QIP)

Port Failover The QIP can be configured to reroute data to another port in the event of a Fibre Channel connection failure.

Port Concentration One or two connections to a QIP can drive up to four drives, saving ports and saving the cost of expensive switches.

iSCSI Using Internet SCSI (iSCSI) connectivity, library drives appear as local SCSI drives over an Ethernet network. This supports fast storage networking using widespread IP technology. Note that Spectra Logic has been actively involved in the development of the iSCSI standard and was the first tape library vendor to adopt and integrate iSCSI in tape libraries.

High Reliability

As tape libraries have become mainstream technology, data centers have grown to rely on their availability. Since libraries frequently operate during unattended or minimal staff shifts, reliability is extremely important. Tape libraries are exposed to environmental contamination through tape inserts, yet they must continually operate powerful motors and perform with precision and high reliability over many duty cycles.

New reliability features are included in the Spectra T950 library. Taken in total, the T950 Python architecture works to prevent the most common library failures. From the sheer strength of the Kevlar® belts on the robotics to the intelligence of the controllers, the Spec-

tra T950 library is built so that the library keeps on running, and provides redundancy to continue operation in the case of an unpreventable failure.

Python robotics are optimized for reliability in part through the library's intelligence, that groups tapes queued for eject in a library partition close to the partition's drives. Bulk imports of blank and scratch media in TeraPack magazines also reduce individual moves and save duty. To position TeraPack cases, the T950 robotics perform a two-stage pick of each piece of media. The macro (coarse) movement places the robotics outside of the target TeraPack magazine. The transporter then grabs the TeraPack case and the picker inside performs the micro (fine) movement of picking the individual tape.

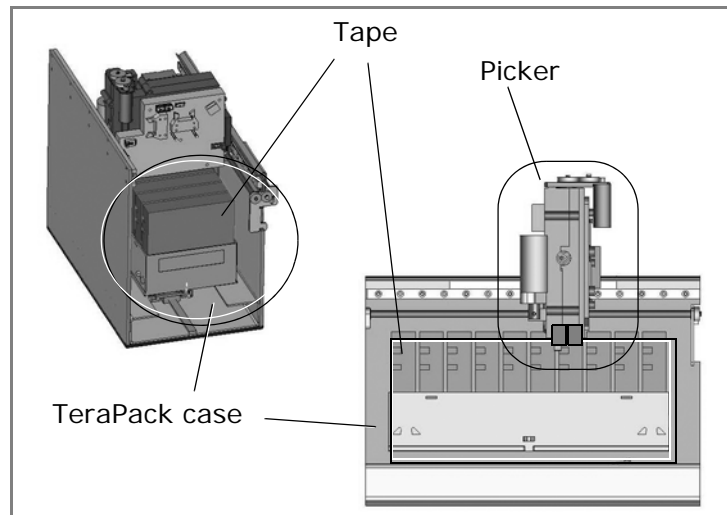


Figure 7. The robotics unit (right) and internal side view of robotics (left).

Library Component Management

While tape drive reliability has improved in recent years, it still remains the most likely target for failure in a library. Mean Time Before Failure (MTBF) statistics for drives show an inherent vulnerability. The Spectra T950 library promotes healthy drives by monitoring environmental conditions and power, and by distribution of duty cycle. The use of Spectra Certified Media, with life-cycle management features, also helps identify drives with a high error-rate, indicating drive problems, so you can address it before the drive fails.

When a drive does fail, the library notifies you through both SNMP, SMTP, and through the library's graphical interface, which you can access through the library's front panel and remotely from anywhere, using a Web browser. You then replace the drive in a swappable sled, in minutes, and continue backups—in most configurations without even disturbing other active processes.

Using Spectra Logic's Python architecture, the library reports back information about the original failed drive, and retains a common drive identifier so drive replacement is automatically accepted without requiring further reboots. Many backup software packages use this drive identifier so that scheduled backups complete. Without this, many servers must be rebooted to recognize different drives on the same port; this is anticipated and prevented when the library uses the same World Wide Name (WWN), serial number, or address for the replacement drive.

Many Spectra T950 library components are hot-swappable. Drives, QIPs, and power supplies can all be replaced without powering down the complete system. Obviously, the backup software and the function of the failing part determine whether a backup needs to be restarted, but, at a minimum, other backups can continue unimpeded. Hot swap replacements require few or no tools and are no more complicated than changing a light bulb.

When the library must be powered down, the unique bar codes on the tape cartridges and TeraPack cases provide an unexpected advantage. The inventory of each TeraPack case is stored in non-volatile random-access memory (NVRAM) when the case is imported, and every case and tape are tracked through every move. This preserves the integrity of the inventory. Power-cycling the library does not require re-inventorying the tapes and TeraPack cases. This saves the time it could take to individually scan hundreds or thousands of tape cartridges on power up.

Other library components have been designed with redundant systems. Additional power supplies and dual AC inputs for AC redundancy support continuing operations in the event of a failure. The Robotic Control Module (RCM) that controls the picker and the Library Control Module (LCM) that runs the touch screen and remote interfaces are the same board technology, each containing the other's microcode to reduce sparing requirements and to provide automatic failover, filling both functions if one module is found to be inactive or incommunicable.

Once a problem is encountered, the library offers SNMP and SMTP notifications; and through the graphical interface and optionally using remote management capabilities, data center staff can troubleshoot, configure, and even perform soft-power cycling on the library without physical access.

Service and Upgrades

SpectraGuard® technical support provides comprehensive on-site maintenance by Spectra Logic's worldwide support team. With years of experience in the industry, the Spectra Logic technical support team has extensive experience in diagnosing and correcting problems with libraries, drives, operating systems, networks, and backup software packages.

Spectra Logic offers a worldwide on-site service and maintenance structure, refined over many years to provide timely, professional service. The Assisted Self Maintenance (ASM) option stores library components on the data center site, that IT staff can rapidly install as

appropriate. Many data centers value this option, as providing maintenance and repair services on their own saves both money and time.

The time savings gained through the ASM program are significant. Typically, even with rapid service, once a problem has been diagnosed, the service engineers have a four-hour window to reach the site, and may take up to four additional hours retrieving and installing parts from a regional parts depot. This contrasts vividly with the rapidity with which sites with ASM return to normal operation. Five components for the T950 take between 2 and 5 minutes to install, and the robotics component requires only 15 minutes.

Because the components are already on-site, this cuts downtime by a minimum of four to eight hours. Instead of waiting an average of eight hours, the T950 can be repaired in 20 minutes or less. This means that T950 users are up and running in a fraction of the time required to adequately service competing libraries. The savings: 80% over all competing libraries.

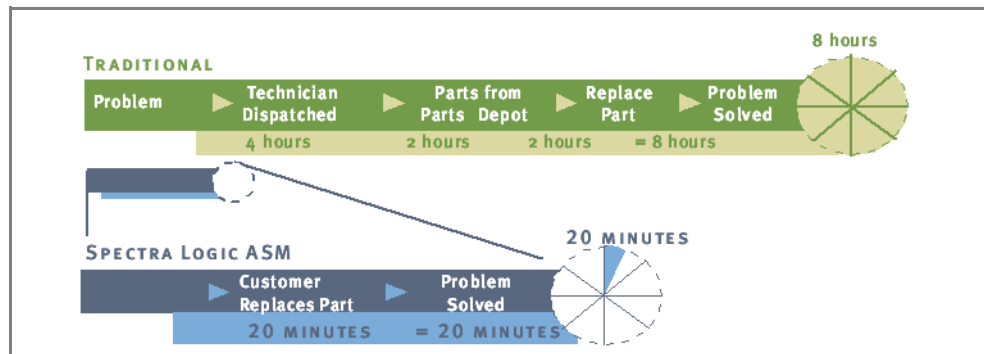


Figure 8. ASM time savings.

The on-site components may include these (depending on the kind of ASM the site uses):

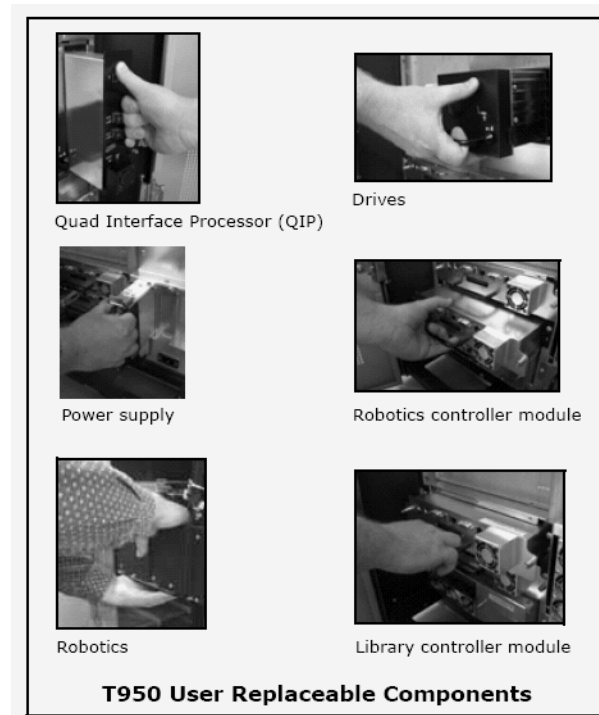


Figure 9. ASM components stored on-site.

AutoSupport

The AutoSupport feature e-mails status and diagnostic information directly to SpectraGuard support staff for continual monitoring, suggestions for preventive maintenance, and enhanced response in the event of failure. AutoSupport can be configured to send regular health updates to SpectraGuard—updates that contain such information as firmware revisions, error correction code (ECC) rates, and any abnormal occurrences. If an issue needs immediate attention, AutoSupport can send an e-mail or pager alert to multiple recipients, such as data center staff, as well as generate a trouble ticket for SpectraGuard Technical Support. This provides SpectraGuard support staff with complete and



detailed information about any problems, as well as access to history and configuration data on file. AutoSupport proactively ensures maximum uptime for the library.

Figure 10. AutoSupport data sent to SpectraGuard technical support.

Total Cost of Ownership

Ultimately, a tape library architecture must not only fit the data center's needs, but also fit the management needs for return on investment (ROI) and operating budget. The Spectra T950 library performs in both departments.

Purchase Price

Competition for technology dollars is always intense, but IT budgets have been squeezed to their limits in recent years. Spectra Logic libraries have always provided good value, and Spectra T950 libraries were developed to allow for very competitive pricing.

Data Center Space

Libraries in the enterprise class are frequently large systems designed to accommodate the robotics' needs and require access from many locations; the data center had to accommodate the library's requirements. Conversely, Spectra T950 libraries were designed to accommodate data centers' needs, with a smaller footprint, fewer access requirements, and a rack-grid design that coexists easily with rack-mounted gear in a typical data center or co-location site.

Over the many years' life of a tape library, the real estate occupied by a large footprint is more costly than the initial investment. The Spectra T950 library's small footprint and high storage density provides both immediate and long-term savings.

Longevity and Scalability

The most expensive thing that can be done to a library is to replace it. The Spectra T950 library was designed to grow with a data center's needs, as capacity and drives—even whole frames—can be added without replacing the library. The system will also accept newer technology drives as they are released. Even power and cooling are rated above present needs to accept drives that, in the future, may require more power or additional cooling.

Maintenance and Uptime

Over the life of the product, maintenance sometimes exceeds the purchase price of the library. The Spectra T950 library provides reliability and long life, and allows data center staff to perform many upgrades, parts replacements, and maintenance functions. This allows Spectra Logic and its reseller partners to offer a variety of SpectraGuard service plans at affordable rates. The ASM programs prevent expensive downtime, since small problems can be fixed quickly with spare parts on-site or staged nearby, and completed with little or no field engineer contact.

Power Requirements

Python architecture's active power management saves money over the life of the product by efficiently using power. Spectra T950 libraries can shut down or slow down fans when conditions allow. Powering down unneeded equipment also reduces cooling expenses in the data center. Providing sufficient power and cooling saves money by increasing tape drive life; reducing power and cooling when it's unneeded saves on utility costs.

Intervention and Labor

Automation was developed to save time and labor. Many sites have learned, however, that automation brings with it additional requirements to configure and manage complex software, to maintain hardware, and to manage media vaulting, retention, and life cycle.

The TeraPack design leverages the effort of data center staff. Tapes can be securely and easily moved to and from vaults and off-site storage, tracked and managed in bar coded segments, and loaded and ejected from the library in bulk; diagonally, new media can be purchased already bar coded in TeraPacks for easy loading and introduction.

The BlueScale user interface provides simplified configuration of even the most advanced features, either from the color touch screen or the remote Web interface. The Spectra T950 library self-discovers components. Adding a new tape drive or QIP causes the system to recognize the new component and prompt the user for configuration information. If the item is a replacement, it can be automatically reconfigured to match the component it replaces.

The remote library interface includes HTTP Web access, SNMP and SMTP monitoring, status, and diagnostics. This saves labor by providing easy access anywhere in the enterprise; it can even be administered from a technician's home with a VPN connection. The SNMP and SMTP interfaces will alert staff quickly when intervention is required. SpectraGuard AutoSupport uses SMTP to mail performance data, configurations, diagnostics, and failure data directly to Spectra Logic technical support staff.

Specifications

1-Frame T950: Chassis Layout and Physical Size

The following table reflects the capacity and performance options available in the two configurations of the primary frame of the Spectra T950 library.

Primary Frame ^a									
Drives	TeraPack Cases	LTO / SAIT- Native TB					SDLT - Native TB		
		Slots	LTO-4	LTO-3	LTO-2	SAIT	Slots	SDLT 600	SDLT 320
2 - 12	95	950	760	380	190	475	855	257	137
13 - 24	83	830	666	333	166	415	747	224	120

a. Specifications are subject to change at any time without notice.

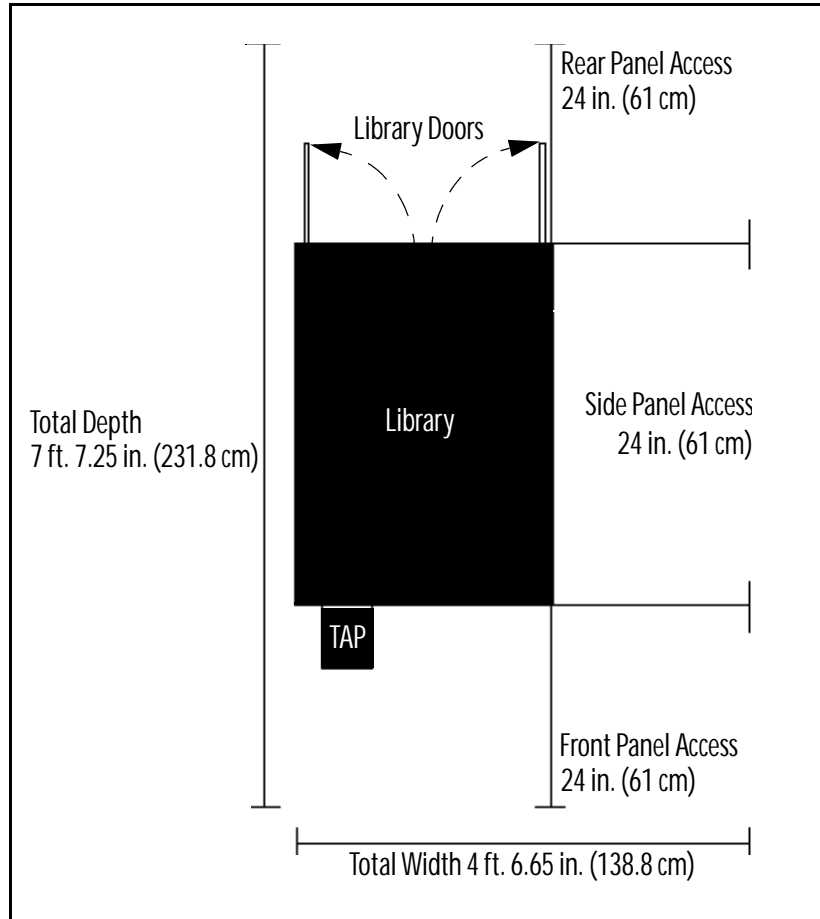


Figure 11. A top view of Spectra T950 library service access dimensions.

Multi-Frame T950: Chassis Layout and Physical Size

The capacity of a library configuration depends on the type(s) of frame(s) in its configuration: media expansion frames and drive expansion frames. Add the following capacities to that of the primary frame to calculate the capacity of the multi-frame configuration:

Drive Expansion Frame ^a									
Drives	TeraPack Cases	LTO / SAIT - Native TB					SDLT - Native TB		
		Slots	LTO-4	LTO-3	LTO-2	SAIT	Slots	SDLT 600	SDLT 320
1 - 12	101	1010	808	404	202	505	909	303	145
13 - 24	89	890	712	356	178	445	801	240	128

a. Specifications are subject to change at any time without notice.

Media Options

Spectra T950 libraries support the following tape drives.

- ◆ LTO
- ◆ SAIT
- ◆ SDLT
- ◆ Spectra RXT RAID

The LTO roadmap published currently shows six generations of LTO drives. Historically, drive performance and capacity has doubled with every generation. The LTO consortium (Hewlett-Packard, IBM, and Quantum) is considering whether to expand the LTO roadmap further, to generations 7 and 8. For more information about LTO technology, visit www.lto.org.

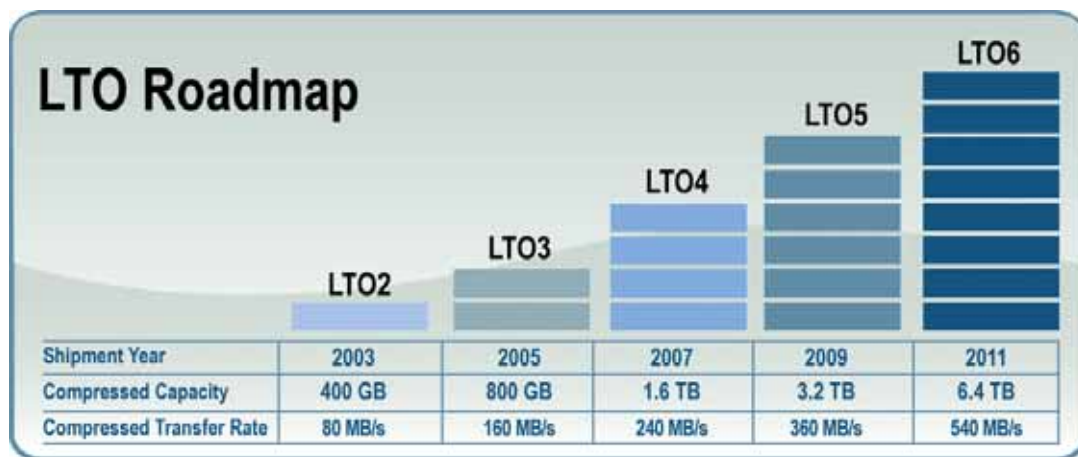


Figure 12. LTO roadmap.

Conclusion

Spectra Logic researched end users' greatest frustrations, in part by tracing the evolution of technology, reflecting Schumpeter's evolutionary business model. Python architecture evolved to alleviate those frustrations.

- ◆ Its simple, comprehensive management interface simplifies day-to-day library management.
- ◆ Its grouped media management offers never-before-seen savings in the time and resources of data center staff.
- ◆ Its modular design offers maximum storage density, expansive data growth, and user-maintainable libraries through ASM.

- ◆ Its connectivity capabilities make this library perfect for current DAS, SAN, and NAS environments, and make it accessible to future technologies.
- ◆ Its reliability and flexible technical support options offer peace of mind.

From the ground up, the Spectra T950 library was created with the end user in mind. It is now easier than ever to back up data.



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