Enterprise Tape: Reliability

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Contents

ABSTRACT

Enterprise tape libraries, like most other storage devices, are regularly tasked with storing and protecting the lifeblood of an organization – data. They also are complex systems with many moving parts and interrelated functions that must work in unison to fulfill their mission.

The architecture and general design of Spectra Enterprise Libraries focus on reliability and data protection through many levels of hardware and software reliability features as well as customer replaceable components and service offerings. These attributes are specifically designed to be integrated and proactive in giving users superior reliability, data availability, and continuous operation of their library.

This white paper discusses many of the individual components, features, and offerings associated with an Enterprise Tape Library system as well as how those items enable great reliability and data availability.

INTRODUCTION

Reliability is not a point in time function, but something that must be maintained over time. Spectra delivers a suite of hardware, software, and service features designed to address user reliability and availability over time.

Spectra Logic™ delivers Enterprise Tape Libraries to the largest and most demanding storage users on the planet, some of which include large national research labs, financial sector firms, and manufacturers. As a vendor to these users, it is incumbent upon Spectra to address their needs in terms of system reliability, ensuring their data is readily available when they need it.

Reliability is not a point in time function, but something that must be maintained over time. Furthermore, it is not a singular characteristic that may be achieved by only one or two features or functions. As a result, Spectra delivers a suite of hardware, software, and service features designed to address user reliability and availability over time.

TAPE DRIVE RELIABILITY – TS1140 TECHNOLOGY TAPE DRIVE

One of the most critical components of an enterprise tape library system is the tape drive. Tape drives are at the core of data availability and integrity and generally perform the bulk of the work that's done by an automated tape system. For users requiring the greatest reliability and data assurance, the TS family (TS1140, TS1150, etc.) of drives delivers a variety of advantages relative to LTO.

The TS1140 technology tape drive includes a number of features that improve drive reliability and data integrity at both the hardware and software levels. From a software perspective, the most notable feature is the use of Error Correct Code (ECC) to reduce Bit Error Rate (BER).

BER indicates the reliability with which a tape drive or other storage device will write data to media without error. For those unfamiliar with the concept of bit error rate (BER), the following definition from Wikipedia may be helpful:

"The **bit error rate** or **bit error ratio** (**BER**) is the number of bit errors divided by the total number of transferred bits during a studied time interval. BER is a unitless performance measure, often expressed as a percentage." [1]

Bit error rates are computed for most storage devices with the BER for TS1140 technology tape drives, also known as Enterprise Drives, being the highest across storage products. Instrumental Technologies regularly provides BER information such as the table below for commonly used storage devices.[2] The column on the right indicates the quantity of data that a device should write with only a single bit error. In this case, the Enterprise tape drive, TS1140 technology in this case, writes far more data without error than any other storage device.

Table 1: Bit error rate for each device

Device	Hard Error Rate in Bits	PB Equivalent
SATA consumer	10E14	0.01
SATA Enterprise	10E15	0.11
Enterprise SAS/FC	10E16	1.11
LTO and some Enterprise SAS SSDs	10E17	11.10
Enterprise TS11xx Tape	10E20	11,102.23

LOAD / UNLOAD CYCLES

In addition to the software feature (ECC/BER) that aids in drive reliability and therefore data availability, the drive's hardware construction also heavily influences the reliability of the enterprise tape system. The load / unload cycle count for the tape drive, also known as the Mean Swaps Between Failure (MSBF), indicates the number of tape drive load and unload cycles a drive is designed to endure before a mechanical failure. In the case of the TS1140 technology tape drive, the Load / Unload cycle time, or MSBF, is rated at 300,000.[3]

To put this reliability number into perspective, assume that the drive undergoes one load or unload cycle every hour on a continuous (24 x 7) basis. It would take just over 34 years for the drive to experience a mechanical failure at this rate. Given that tape drives conduct the bulk of the work within an automated tape system, reliability of this level adds significantly to the overall reliability of the enterprise tape system. As can be seen in Table 2, the TS1140 tape drive delivers superior reliability relative to other tape offerings on the market.

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[1] Wikipedia, *Bit Error Rate*. http://en.wikipedia.org/wiki/Bit_error_rate, Web. March 17, 2014.
[2] Instrumental Inc. "Tape: Comparison of Enterprise and LTO". April 19, 2013.
[3] IBM White Paper. "Jaguar 4 Tape Drive 3592 Model E07 / TS1140 Functional Specification – OEM". March 25, 2011.

Table 2: Tape drive comparison*

	TS1140 Technology	Enterprise Drive (T10000 D)	Midrange Drive (LTO-6)
Load / Unload Cycles	300,000	150,000+	100,000

*Sources: IBM, Oracle, and LTO tape drive technical documentation

TAPE MOTION HOURS

Another item affecting overall tape drive reliability is the tape head, which is the business end of a tape drive conducting the data reads and writes. A lot of tape media will stream past the read / write heads of a tape drive during its life, resulting in wear and tear or general degradation of those components. The more often those components wear out and need to be replaced, the greater the likelihood of drive failure.

The TS1140 technology tape drive is built to operate for 75,336 hours of continuous streaming performance in read or write mode. This translates to 8.6 years of non-stop operation.

The TS1140 technology tape drive is built to operate for 75,336 hours of continuous streaming performance in read or write mode. This translates to 8.6 years of non-stop operation.[4] Given the fact that tape drives are generally superseded and replaced with newer models every 3 to 5 years, the heavy duty construction of the tape drive heads is more than sufficient to ensure those critical components are unlikely to fail during the useful life of the drive.

VIRTUAL BACK-HITCH

In the world of tape drives, frequent starting and stopping of the drive results in excess wear and tear on components. In addition, the drive puts the tape media under duress as it gets up to speed, then stops, then re-positions before continuing to reading or writing where it left off prior to the interruption.

The TS1140 technology tape drive uses the built-in virtual back-hitch mode to mitigate the mechanical stop / start motion of the drive which can be affected by data rates and synchronization commands from the host application.

"In this mode, the drive uses an alternate area of tape as a work area to write working copies of datasets to tape during write synchronize operations without back-hitching. Data is accumulated in the data buffer and recursively written to the media on the target wrap when buffer thresholds are met. This technique greatly enhances the effective drive data rate during write synchronize operations, while maintaining full non-volatile integrity of the data."[5]

In short, virtual back-hitch allows the tape to continue writing data, without stopping tape movement, even as it receives commands to synchronize work with the application that would otherwise interrupt drive operation and stop the tape motion.

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[4] IBM White Paper. "Jaguar 4 Tape Drive 3592 Model E07 / TS1140 Functional Specification – OEM". March 25, 2011.
[5] IBM White Paper. "Jaguar 4 Tape Drive 3592 Model E07 / TS1140 Functional Specification – OEM". March 25, 2011.

SPEED MATCHING

The rate at which tape drives move is a direct function of the rate at which host servers and applications push data to the drives. Since the rate at which data is moved to the drives often varies, the fluctuation could cause the drive to stop, then start again as data rates improve. As mentioned previously, excessive start / stop activity has a deleterious effect on the tape drive and media.

To mitigate the effect of variable data rates, the TS1140 technology tape drive has a built in speed matching function to accommodate periods of lower or higher data flow from the host to the drive. Specifically,

"The 3592 E07 (TS1140) drive performs dynamic speed matching in an effort to minimize backhitches when operating from a host that cannot sustain the maximum data rate. The drive will perform dynamic speed matching automatically to adjust the native data rate of the drive as closely as possible to the net host data rate (after data compressibility has been factored out)."[6]

The TS1140 technology tape drive offers 13 speed matching points that are analogous to gears on a bicycle, which allow the drive to automatically increase or reduce tape speed depending on the rate at which it senses data coming from the host. Doing so helps prevent the drive from coming to a complete stop, reducing drive and media wear over time and improving drive reliability.

RECORDING CHANNELS

The read / write heads of a tape drive degrade through normal wear as the number of tape passes across the tape heads increase. Consequently, the TS1140 technology drive architecture has been designed to reduce the number of tape passes the drive heads are subject to. By increasing the number of read / write channels on the head from 16 to 32[7], data is packed more densely on the tape. More densely packed data means fewer passes of the media across the heads are required in order to completely fill a tape, thereby reducing the normal wear on the read / write head and increasing its ability to function reliably.

REINFORCED TAPE CARTRIDGE

The tape media, in addition to the drive, must be well designed and built in order to deliver a high degree of reliability within the enterprise tape library system. The TS1140 technology drive uses a reinforced tape cartridge specified to withstand a 1 meter drop onto a tile floor while remaining operable with leader pin in place. Furthermore, the cartridge is rated up to 20,000 load / unload cycles.[8] In contrast, the LTO6 technical specifications include no similar durability requirements for LTO media.

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[6] IBM White Paper. "Jaguar 4 Tape Drive 3592 Model E07 / TS1140 Functional Specification – OEM". March 25, 2011.
[7] Karp, Jim. "IBM TS1140 Tape Drive – Technology, Features, and Function", October, 2011.
[8] IBM. "Jaguar 4 Tape Drive 3592 Model E07 / TS1140 Functional Specification – OEM" March 25, 2011.

The added durability of the TS1140 (3592 JC) media cartridge helps ensure system reliability, particularly within systems with high duty cycle requirements for both drives and media.

TS1140 TECHNOLOGY SUMMARY

From the tape drive software to the hardware and mechanical design, to the construction of the tape media, TS1140 technology drives and media comprise the most durable, reliable tape subsystem on the market. As the core components of a highly reliable enterprise tape system, the TS1140 technology drive helps set the foundation of a truly superior system from a reliability standpoint.

TFINITY™ LIBRARY RELIABILITY

Tape drive and media technology improve their reliability, durability, and availability with each succeeding generation of drive. However, without an equally impressive automated library "wrapper", even the most reliable tape drive technology will be only as strong as the weakest link when it comes to total system reliability. With that in mind, Spectra enterprise libraries deliver a wide array of features and functionality at the hardware and software levels, all of which are designed to complement the world's leading tape drive and media technology, delivering superior enterprise tape reliability.

HARDWARE

Users of Enterprise tape libraries generally assume those libraries will last through multiple generations of tape drives. The expected useful life of a tape library is often 10 to 15 years – sometimes more. Due to the length of time a library may be in service, it must be designed to be durable, serviceable, and above all, reliable in performing its required functions, namely housing tape media and drives while serving media to those drives on a regular, continuous basis.

Knowing the expectations of users, Spectra Enterprise tape libraries are designed to meet or exceed user criteria for reliability. While some hardware differences are apparent within the Spectra library line, many are common across the Enterprise portfolio and are treated as such. However, some features, such as dual robots, are unique to only one Spectra library, the TFinity. As a result, the hardware features discussed below will focus on the TFinity library, which represents the superset of Spectra Enterprise tape library reliability features.

DUAL ROBOTS (TFINITY)

Most libraries incorporate a single robotic tape mover within their architecture. Consequently, when that mover stops working it becomes a single point of failure within the library. The end result is that the entire tape automation system ceases to work.

The dual robotic TeraPorters are a standard feature of the library. During normal operation, each TeraPorter operates independently. The library's BlueScale software

manages the TeraPorters to ensure that they perform as efficiently as possible and do not interfere with each other. In the event that one of the TeraPorters experiences a problem, it automatically moves into its service bay and the other TeraPorter takes over all media move operations. In the event that the malfunctioning TeraPorter is unable to move itself into its service bay, the other TeraPorter pushes it into the bay.[9]

Each robot has access to every slot and every tape drive within the library configuration. Consequently, either robot can allow the library to continue functioning, albeit in a degraded performance mode, if one of the robots stops functioning.

The redundant robot configuration available with TFinity ensures that mechanical failures that may occur with critical robot components do not jeopardize the operational availability of the library. This fault tolerant design aids in enterprise tape reliability in a way that most libraries cannot match given their single robot architecture.

REDUNDANT RIM

All Spectra enterprise libraries include a Robotics Interface Module (RIM) which processes robotics move commands from the host application to the robot directing it to retrieve, load, and store tape media within the library. If a RIM fails, an alternate robot export command path is required to ensure the robot continues to receive its move commands in order to maintain functionality.

Fortunately, Spectra enterprise libraries are designed to include a redundant RIM in an active failover configuration. The BlueScale Controller Failover feature uses two RIMs that are configured as a failover pair. One RIM in the pair is the primary controller and the other is the secondary controller. From the host perspective, the primary controller is the only controller present.

The two controllers use the library's internal communication bus to monitor each other and to maintain a cache of the library's inventory database. A failover event occurs when the secondary controller detects that the primary controller is no longer communicating on the library's internal communication bus. After sending a query to the primary controller to confirm that it is no longer communicating, the secondary controller takes over the exact configuration of the primary controller and begins receiving and processing the media changer commands sent from the host.[10] The resultant failover configuration ensures that the robot command path from the host is constantly available to deliver superior reliability.

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[9] Spectra Logic, "TFinity User Guide", Revision G, December, 2013.
[10] Spectra Logic, "TFinity User Guide", Revision G, December, 2013.

REDUNDANT POWER

As with all things electrical, the power supply system is crucial to continuous, reliable operation. Enterprise libraries from Spectra are designed with a redundant power supply system ensuring uninterrupted power is available to all library subcomponents such as robots, drives, and fans.

Enterprise libraries are designed to support both N+1 and N2 power supply configurations in which a minimum number of power supplies required to support all necessary components are included plus one additional power supply for failover purposes. For instance, if the minimum number of power supplies for a library, based upon the number of tape drives included, is three, then a fourth power supply is configured. In such a case, up to two of the power supplies may fail with the two remaining power supplies providing ample power for all electrical components to continue functioning to ensure uninterrupted operations across all electrical components within the library.

In addition to the redundant power supplies on Spectra Enterprise libraries, TFinity also provides redundant power paths to the robots for added reliability. The robots receive power through a brush and rail system along the bottom of the library. This system consists of two power paths, a primary path and a secondary path. Should the primary path fail to provide electricity to the robots, the secondary path automatically defaults to carry the electrical load that sustains robotics operation.

SOFTWARE (BLUESCALE)

The reliability of an Enterprise Library system can be elevated with the intelligent inclusion of software features that enhance data availability beyond what the hardware alone can provide. In this respect, Spectra Enterprise Libraries integrate a number of advanced software features as part of the BlueScale library operating system that further improves system reliability.
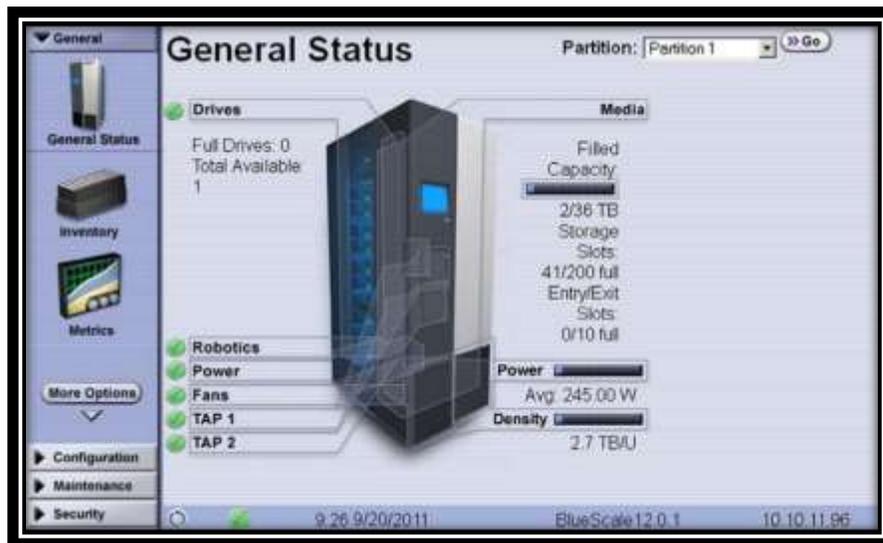

Figure 1: BlueScale Library Interface front panel

MEDIA LIFECYCLE MANAGEMENT (MLM)

The lifeblood of an enterprise is its data. Therefore, it's critical that the medium on which that data is stored is monitored, protected, and replaced before errors may occur that prevent the data from being retrieved reliably when required.

The Media Lifecycle Management (MLM) function within BlueScale enables users to monitor, assess, and address the health of the tape media at their convenience. The MLM function captures over 30 data points with TS1140 technology tape drives, shown in Table 1, for every Spectra certified media cartridge in the system, and records those data points within the library's database, using a red, yellow, green stoplight report that can be downloaded as a CSV file for analysis. In addition, the data points for a specific piece of media are recorded on the memory chip (MAM) on each cartridge ensuring that two synchronous copies of the cartridge's media health are kept and updated regularly. The data on the cartridge memory chip means the tape cartridge is self-describing.

Media Lifecycle Management (MLM) reporting points for TS11x0:

- Media health
- Write protected
- First write partition
- Maximum capacity
- Drive efficiency
- Media serial number
- Current partition
- Barcode
- Manufacturer
- First write library
- Soft write errors
- Media efficiency
- Compression ration
- Tape generation
- Load count
- Loaded

- Manufacturer data
- Media type
- Last write library
- Remaining MAM capacity
- Last four load device serial numbers
- Export user
- Born on date
- Cleans remaining
- Remaining capacity
- Current drive display
- Last four load device efficiency
- Export time
- Last write partition
- Soft read errors
- Drive status (last four)
- Exported

Providing access to this kind of real time data on tape cartridge health gives users the opportunity to mitigate media related problems that can fail a tape read or write request before they occur, subsequently preventing data service interruption. MLM reports may also be used as cross reference points with the Drive Lifecycle Management reporting feature to identify and isolate drive / media error combinations that would otherwise be difficult to diagnose. In either case, whether using MLM alone or in conjunction with DLM, the system reliability of Enterprise Library increases, delivering greater data availability than is otherwise possible.

Figure 2: Media Lifecycle Management Report

DRIVE LIFECYCLE MANAGEMENT

Tape drives are the work horses of the Enterprise Library system. They endure the most duress by virtue of their duty cycles and as a result are prone to experiencing more frequent issues than other components within the system. This fact alone makes it important to be able to monitor drives on a continuous basis and address any potential drive issues before they develop into actual problems.

The BlueScale library operating system includes the Drive Lifecycle Management (DLM) feature. Each time a cartridge is unloaded from a drive, the library collects the media health data from the drive. This data includes read / write errors, tape alerts, and flags generated during the time the most recent cartridge was loaded in the drive. It also includes the current value for the drive's single character display (SCD) and any errors detected at the time the cartridge is unloaded. All of this data, plus the MLM data for the 50 most recently loaded cartridges, is stored in the DLM database. This data is used to generate an overall drive health status for the library, as well as health reports for each individual drive.[11]

DLM displays health status icons next to each tape drive identifier.

Clicking on the associated buttons deliver specific drive details, allows users to perform a functional test on the drive, and even reset the drive as needed.

The status and health reports for the drives within the library are accessible through the drive status screen on the library's BlueScale interface. The interface provides status icons for quick visual assessment as well as multiple options to collect drive traces, monitor performance, and even perform functional tests on the drives without removing them from the library.[12] This level of functionality can readily help users identify and diagnose drive issues before they become work stopping drive problems. Additionally, DLM reporting can be used as a cross-reference with MLM status on tape media health to help identify and isolate drive / media issues that would otherwise go undetectable while continuing to manifest themselves as failed jobs.

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[11] Spectra Logic, "TFinity User Guide", Revision G, December, 2013.
[12] Spectra Logic, "TFinity User Guide", Revision G, December, 2013.

You can save the MLM report to a USB device as a comma separated value (CSV) file or email it to a pre-configured email recipient and manipulate that file for analytical purposes to help pinpoint issues.

Figure 3: Drive Lifecycle Management Report

DATA INTEGRITY VERIFICATION (DIV)

The data contained within a library on tape media may reside on that media for an indefinite period of time. For instance, tape media life for archive purposes has been estimated by tape manufacturers out to 30 years.[13] Given the potential window of opportunity for data to reside on tape, delivering reliability features that can help ensure data integrity over extended periods improves system reliability not only on a point-in-time basis, but longitudinally over time as well. The Data Integrity Verification feature set within BlueScale provides that kind of functionality.

PreScan

PreScan provides verification of data cartridges by performing a basic functionality test and health check on each imported cartridge. As a part of the PreScan process, any cartridges that are not already in the MLM database are added. During the PreScan process, the library automatically inserts each cartridge into an available TS1140 or later generation drive assigned to the partition. The drive loads the cartridge and checks it to determine whether it has any of the following characteristics:

- MLM-enabled

- Broken or dislodged leader

- Red media health

- Write protected

- Encrypted tape with a moniker not currently stored in the library

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[13] IBM. Tape Media Specifications Web Site, http://www-03.ibm.com/systems/storage/media/3592/specifications.html, accessed March 20, 2014.

When the PreScan process is complete, the library stores the tape health information for the cartridge in the MLM database. It also writes the MLM data to the cartridge MAM. When the drive ejects the cartridge, the library returns it to its original slot.[14] This process helps ensure that newly imported tapes, whether new media or those imported from another library, are ready and available for use and can be counted upon to perform without failure when called upon.

QuickScan & PostScan (Available with TS11x0 in 1Q15)

QuickScan and PostScan perform a readability verification test to verify data integrity for all of the cartridges in the MLM database. Both will use a TS1140 or later generation Global Spare drive assigned to the partition or a TS1140 or later generation drive within the partition (QuickScan only) to check each TS1140 or later generation cartridge in the partition for media errors that can impact the ability to restore the data.

The scan process is performed by the library independent of the backup software or server normally used to read and write data to the tape. You can choose to perform either scan function automatically or manually. For automatic scans you can set the scanning frequency and select options to determine the type of scan performed.[15]

In the case of QuickScan, the scan process starts from the beginning of tape and moves to the end of data on tape for one full wrap, taking only moments to complete. In contrast, PostScan performs the same readability scan from beginning of tape to the end of data across all wraps of the tape. This process may take a few hours to complete depending on the volume of data written to the tape being scanned.

Global Spare

Global Spare allows users to remotely replace the failed drive with an operable drive already installed in the library

Because tape drives generally operate at a higher duty cycle rate than many other library components, it is reasonable to understand they are also likely to experience a failure more often than other components. When a drive in a library fails in a way that is unrecoverable it needs to be physically replaced. While drive replacement in Spectra Enterprise Libraries is a customer enabled event, Global Spare allows users to remotely replace the failed drive with an operable drive already installed in the library.

In order to mitigate downtime associated with tape drive failure even further, Spectra libraries provide a feature called BlueScale Global Spare. The BlueScale Global Spare feature provides a way to remotely substitute an available tape drive in the library for a failed drive of the same type. The feature lets you configure an installed drive as a designated spare for other drives in the library. This drive can then be substituted for a failed drive in any partition that is configured to use the Global Spare drive.

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[14] Spectra Logic, "TFinity User Guide", Revision G, December, 2013.
[15] Spectra Logic, "TFinity User Guide", Revision G, December, 2013.

When a drive fails, the user simply logs into the BlueScale web interface from any location, selects the Global Spare option for the failed drive, and continues normal operations.[16]
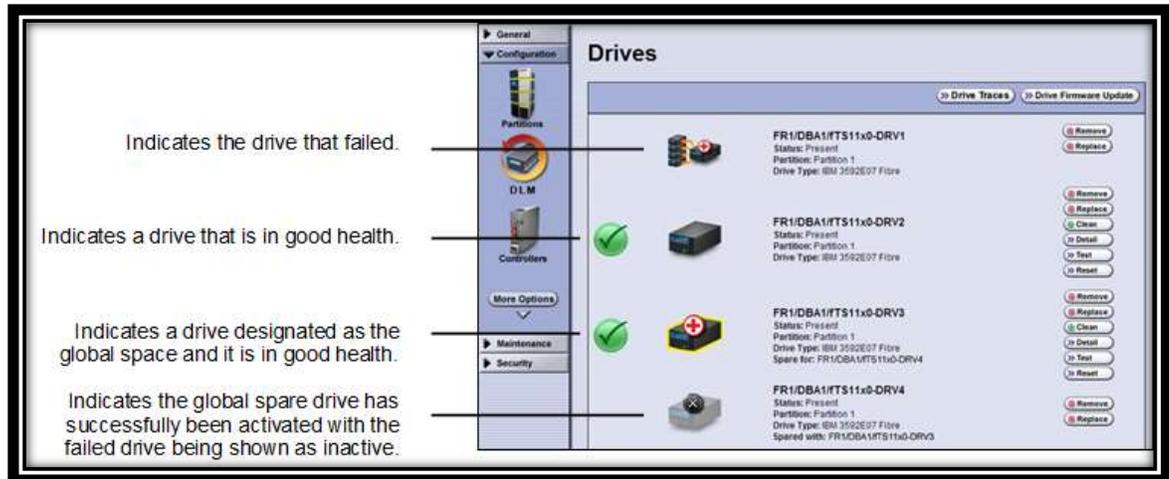

Figure 4: Global Spare Drive

With the BlueScale Global Spare feature, the failed drive may be logically replaced immediately and without needing to reconfigure the library, network connectivity, or host application settings to eliminate downtime when a drive fails. This capability is possible because BlueScale virtualizes drive WWN and location so that a physical drive can be abstracted from the logical configuration for replacement without reconfiguring the environment. Once the Global Spare failover has been enabled, the failed drive may be physically replaced at the user's convenience without interrupting library operations.

AUTODRIVE CLEAN

Tapes drives experience a great deal of tape media to drive head interaction over time and will require periodic cleaning to ensure reliable, consistent performance. Spectra Enterprise Libraries provide a drive cleaning function, AutoDrive Clean that happens automatically and results in fewer drive failures. When a drive is unloaded in response to a host request and the data cartridge is moved to its storage location, the library queries the drive to determine if it needs cleaning. If cleaning is required, the library delays notifying the host that the SCSI move command for the unloaded data cartridge is complete while it performs an automatic drive cleaning. During the delay, the library retrieves a cleaning cartridge from the cleaning partition and inserts it into the drive. When the cleaning is complete, the library returns the cleaning cartridge to the cleaning partition and notifies the host that the SCSI move command for the unloaded data cartridge is complete. The library posts a system message that the cleaning was successful.[17]

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[16] Spectra Logic, "TFinity User Guide", Revision G, December, 2013.
[17] Spectra Logic, "TFinity User Guide", Revision G, December, 2013.

HARDWARE HEALTH MONITORING (HHM)

BlueScale Hardware Health Monitoring (HHM) tracks maintenance thresholds for key library components. When the library or one of its components reaches its maintenance threshold the HHM icon appears in the status bar.

Figure 5: Hardware Health Monitoring icon

As with other system message icons, the color of the icon indicates the urgency of the notification. When the HHM icon appears in the status bar, you can click the icon to view information about the notification and send a Hardware Health Monitor ticket to a contact person within your organization or to Spectra Logic Technical Support so they can review the logs and determine if any maintenance tasks are needed.[18] HHM provides proactive notification that critical components are approaching their indicated useful life and may need to be serviced or replaced before they become job disrupting problems.

ASSISTED SELF MAINTENANCE (ASM)

Beyond the built in hardware and software reliability features that are standard with Spectra Enterprise Libraries, users can also deploy an Assisted Self Maintenance (ASM) kit. This service offering from Spectra allows library owners to hold depot stock of customer replaceable components on site. Rather than waiting through a 2 to 4 hour service window for a technician to arrive, diagnose, repair or replace components before resuming operations, customers can replace components within minutes to maintain library operations.

CONCLUSION

Enterprise tape libraries, like most other storage devices, are regularly tasked with storing and protecting the lifeblood of an organization – data. They also are complex systems with a number of potential failure points which can interrupt operations or result in data degradation or loss.

Spectra Enterprise Libraries deliver reliability and data protection in depth through many levels of hardware and software features as well as customer replaceable components and service offerings. The features which are unique to Spectra such as Certified Media with Carbide Clean, MLM, DLM, PreScan, PostScan, QuickScan, Global Spare, AutoDrive Clean, HHM, and ASM are specifically designed to be integrated with standard library and tape drive features to allows users to proactively administer their Spectra library producing superior reliability, data availability, and continuous operation.

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[18] Spectra Logic, "TFinity User Guide", Revision G, December, 2013.

Deep Storage Experts

Spectra Logic develops deep storage solutions that solve the problem of long term storage for business and technology professionals dealing with exponential data growth.

Dedicated solely to storage innovation for more than 35 years, Spectra Logic's uncompromising product and customer focus is proven by the largest information users in multiple vertical markets globally.

Spectra enables affordable, multi-decade data storage and access by creating new methods of managing information in all forms of deep storage—including archive, backup, cold storage, cloud, and private cloud.

For more information, please visit http://www.spectralogic.com.