Spectra Certified Media with CarbideClean

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Abstract

For the last 20 years there have been dire predictions of the death of tape storage. Each new generation of disk has threatened to eliminate the need for tape as a viable storage tier. Yet tape has survived and continues to thrive. This storage medium remains the highest in reliability, lowest in cost, smallest energy use, longest lifespan, and as easy to use as disk by way of LTFS and similar applications that present data on tape in a file-system format.

The reason tape storage continues to maintain a data center presence is because its role has evolved over the years. Up until about 10 years ago tape was primarily used was as a backup platform. Today, tape storage is still being used in backup, disaster recovery and compliance solutions. However, there are two new areas of usage that account for accelerating growth of tape in the data center. One encompasses horizontal applications such as active file archive, low-cost NAS storage, and deep storage archive. Deep storage is extremely low-cost, power efficient and dense storage for data that does not require immediate access. The second main area of growth includes vertical applications such as Web 2.0, cloud services, big data, media and entertainment, oil and gas exploration, life sciences, federal and state government, and social media, among others.

The desire to collect and analyze information for the sake of improving everything from business decisions to overall life experiences has driven data repositories to grow to sizes that were one time inconceivable. Once reserved for the federal government and supercomputing environments, online data repositories of multiple petabytes, and even exabytes, are starting to become common place in the enterprise. These modern use cases are driving new requirements for long term mass storage solutions aimed at increasing efficiency, lowering costs and improving access. Or in other words, these trends are driving the accelerating growth of tape.

For example in 2012 LTO tape capacity shipments posted 13% year-over-year growth with a projected growth of 26% in 2013.[1] The worldwide enterprise tape automation market (defined as libraries with enterprise tape drives) posted nearly a 30% year-over-year revenue growth in 2012.[2]

Things are different

Both, the horizontal tape growth applications and the vertical growth applications use tape differently from the historical backup application usage. This storage model typically writes to new tapes, storing data for constant access as well as long-term preservation. This strategy uses a Write Once Then Store (WOTS) mode of operation.

In support of such highly demanding applications, Spectra Logic has developed a new tool that improves tape drive and tape media reliability: media pre-cleaning using CarbideClean® technology.

[1] Tax, J. Santa Clara Consulting Group historical data
[2] IDC World Branded Tape Analysis 2012

Tape is Incredibly Reliable

Tape is already incredibly reliable. Shelf life for the media is guaranteed for 30 years. Data on tape is protected from many of the integrity issues that can affect disk: disgruntled employees, viruses and malware simply because it is offline.

Tape also has the best Bit Error Rate (BER). BER is the number of bit errors divided by the total number of transferred bits during a studied time interval. Bottom line BER is a measurement of data integrity.

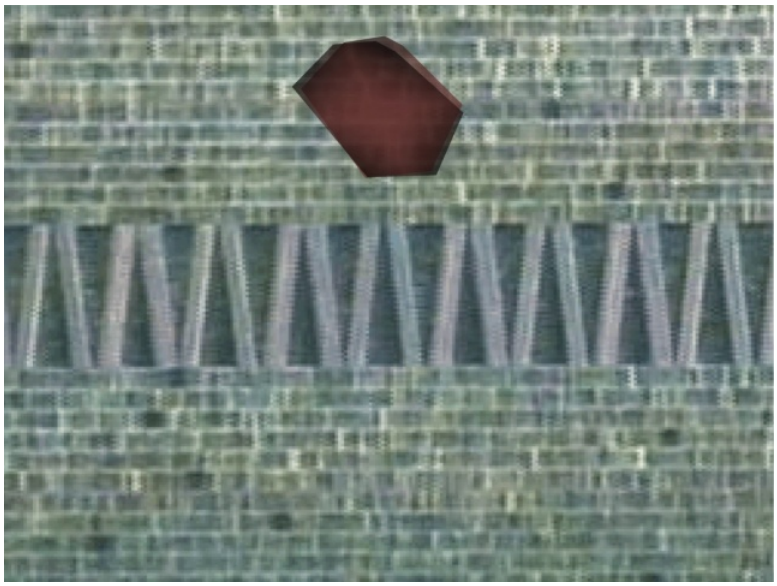
Device	Hard error rate in bits	Equivalent in bytes	PiB equivalent
SATA consumer	10E14	1.25E+13	0.01
SATA Enterprise	10E15	1.25E+14	0.11
Enterprise SAS/FC	10E16	1.25E+15	1.11
LTO and some Enterprise SAS SSDs	10E17	1.25E+16	11.10
Enterprise TS11xx Tape	10E20	1.25E+19	11102.23

Table 1 Disk and Tape Hard Error Rates [3]

Particulates, however pose an increasing risk to all storage technology, including tape, as ever greater amounts of data are stored in a tighter constrained space. With tape technologies, the distance between the tape drive head and the physical tape continues to shrink to support the increasing density of data written to tape. This decreasing tolerance increases the drive's sensitivity to debris that can separate the head from the media enough to interfere with the signal. Small particulates that would have had minimal or no effect on early generations of LTO or TS11x0 Technology can now increase signal noise to unacceptable levels causing decreased throughput, decreased tape capacity and potentially decreasing the integrity of the data. Debris can also damage the drive head decreasing head life to as little as 1400 hours.

The following shows a small area of a recorded LTO tape. The slanted lines in the center contain servo data that is used by the drive to find the data tracks, which are located on either side of the servo band. The diameter of the particle in this illustration is less than 100 µm (less than the thickness of a sheet of copy paper). Owing to the high density of the recorded data on today's tape media a particle of this size can render hundreds of bits unreadable.

[3] Tape: Comparison of LTO and Enterprise, Instrumental, Inc. http:\\www.instrumental.com April 19, 2013



Tape media with a 100 µm particle

All new media has debris due primarily to the manufacturing process. There are several components of the process that contribute to the debris accumulation.

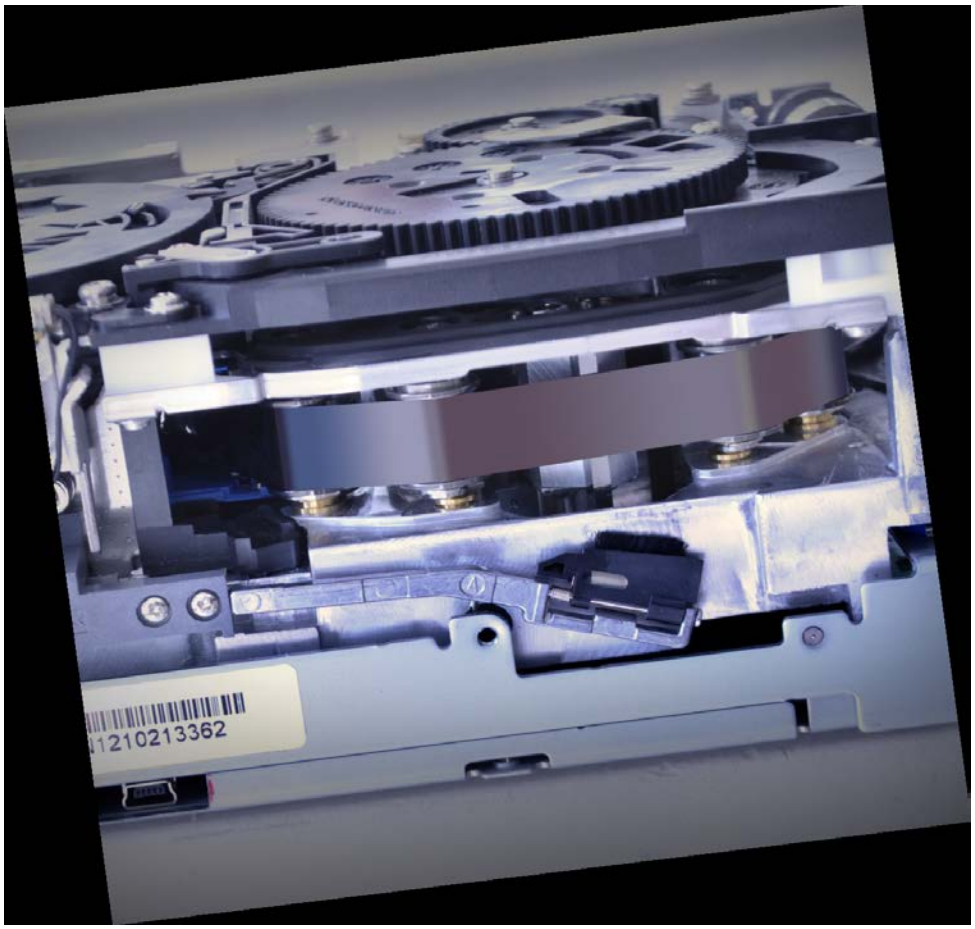
The tape slitting process involves slicing the large roll of coated media into strips about ½ inch wide and thousands of feet long. The slitting operation often leaves debris along the slit edge. Although the process includes removal of the edge debris some remains trapped in the tape potentially impacting drive performance once the tape is used.

The coating process is another source of loose debris. Some of this debris is dislodged only after usage, typically after several passes BOT/EOT and back again.

A third source of tape debris comes from the Head Cleaning Agents (HCA) that are added to the coating at time of manufacture. These particles are contained in the magnetic coating layer. Over time, they can become dislodged and subsequently become trapped in the tape pack. HCA's are typically large compared to the required head-media separation distance causing dropouts in data.

Only Spectra has the Solution

Only Spectra had the insight to address the threat posed to tape storage systems by particulates from the perspective of first use media. Spectra Logic collaborated with an independent storage engineering consulting firm to invent a new tape cleaning process aptly named CarbideClean.



Spectra Logic CarbideClean drive

CarbideClean uses a carbide cleaning head to remove particulates prior to a tape's initial use. By first cleaning tapes that will be used in a WOTS fashion, debris is removed without requiring tape reuse. Only Spectra Logic's Certified Media offers multiple integrity and performance advantages—including this pre-cleaning technology.

Validation

To validate the benefits of CarbideClean, Spectra designed and conducted specialized testing. The testing consisted of the following:

- Three LTO-5 drives to write to LTO-5 tapes that had not undergone CarbideCleaning (Control group)
- Three LTO-5 drives to write to LTO-5 tapes that were CarbideCleaned (CC group)
- A total of 6600 tapes were tested (1100 tapes per drive)

The test consists of the following steps:

1. A tape load onto the drive,

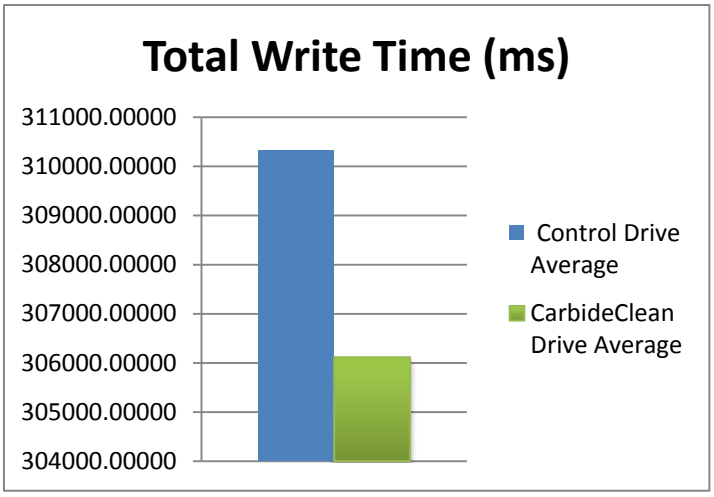
2. Two physical wraps of data written to the tape
3. Gathering of the log parameter data from the drive log pages to quantify performance

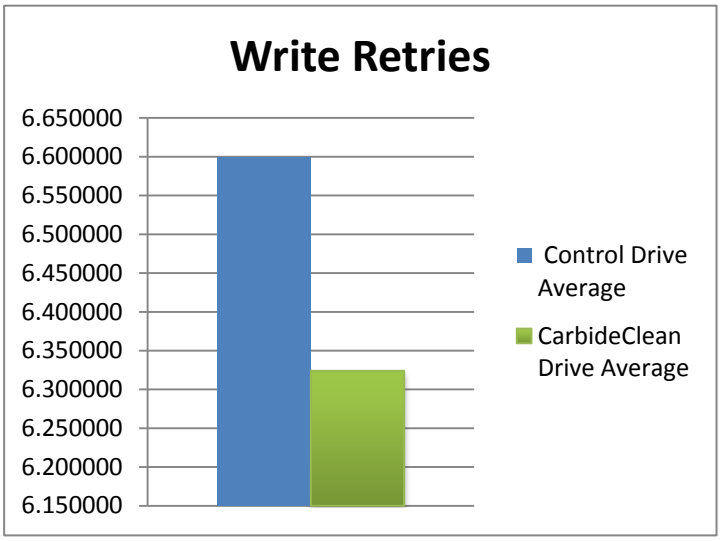
The log parameters measured are as follows:

- Total Write Time - the amount of time that the write to tape took in milliseconds.
- Write Retries - incremented when an error is detected during Read-While-Write verification requiring the drive to rewrite the data set further down the tape.
- Suspended Writes - number of interrupts by a defect or disturbance that results in incorrectly written tracks and the drive has to write the data set further down the tape.
- Media Efficiency - overall measure of the currently mounted media's condition (lower is better)

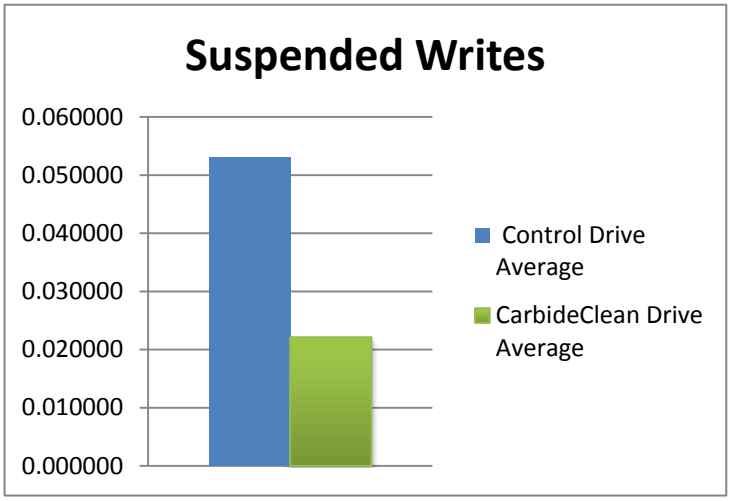
Summary of Results

Total Write Time on average was 4 seconds faster for the CC group than for the Control group. This translates into 160 seconds faster if writing the entire tape. (4 seconds per 2 wraps, 80 wraps on an LTO-5 tape, average 4 seconds * 40 = 160 seconds faster)

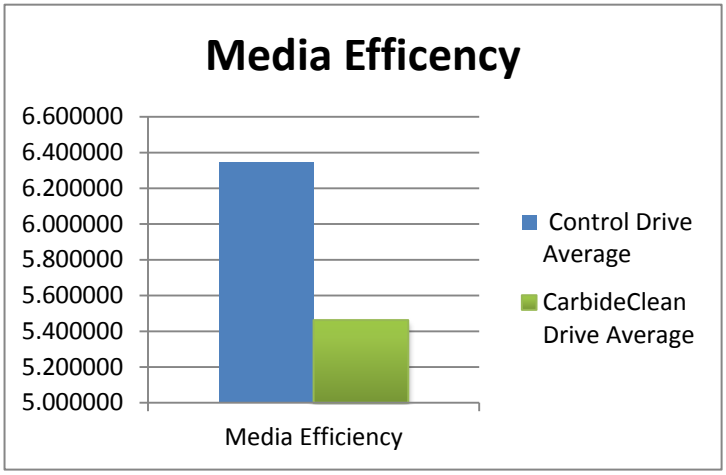




Fewer Write Retries and Suspended Writes translate into better performance and higher capacity

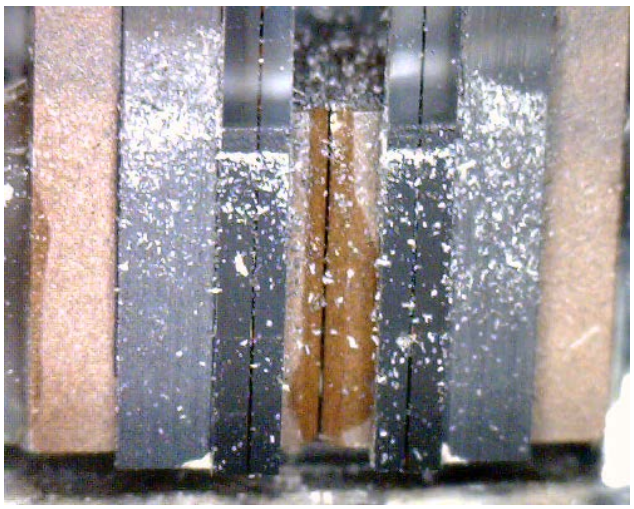


Media Efficiency scores, as rated by the tape drives, were on average lower for the CC group than for the Control group (5.46 vs. 6.34). Approximately, on average 15% better for the CC group than for the Control group.



In addition to the above testing Spectra has found several issues that have contributed to increasing the longevity of the drive tape head.

- Stearic Acid blooming resulting in a fine white powder cleaned from the media by the CarbideClean polisher drive.
- Media that was highly abrasive and would have resulted in excessive wear and tear on the tape head.



Stearic Acid blooming

Conclusion

Archive and deep storage requirements are changing how tape is used. At the same time, these applications demand even more of tape in terms of reliability, data integrity and performance. These demands have amplified the importance of cleaning the manufacturing debris from the media prior to the first use of the tape. Tape drive error rates, re-writes, and reductions in system throughput (transfer rate) are adversely affected by debris[4]

Spectra Logic's Certified Media offers a multitude of features specifically designed to enhance the performance, capacity, data integrity and reliability of tape media. And like CarbideClean they come free with the purchase of Spectra Media.

[4] How Contaminants Affect Tape Data Reliability at High Areal Densities, Applied Engineering Science, Inc., 2011

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