DØ note 3589
CDF/DOC/COMP_UPG/PUBLIC/4858

Sony AIT-1 Tape Drive Stress Tests

Stephan Lammel and the
Serial Media Working Group

Jan 20$^{\mathrm{th}}$, 1999

This note reports on the stress testing of the Sony AIT-1 tape technology done to evaluate long term reliability questions. The serial media working group has researched the tape market for potential Run II technologies. Several commodity type tape technologies have next generation products that are expected to become available before the start of Run II. For those technologies the current generation products were tested for both functionality and long term reliability. The AIT-1 tape technology of Sony and Seagate is a potential candidate Run II. From our tests we expect a rather low failure rate of the technology.

1 Introduction

The next collider run of the Tevatron, Run II, is scheduled for the year 2000. Both experiments, the Collider Detector at Fermilab (CDF) and the DØ experiment are being upgraded. The experiments plan to record between 500 TByte and 1 PByte of data during the 2 year duration of the run.

In Run I both experiments used Exabyte 8200 and 8500 tape technologies for data storage. Over 50 TByte of data was recorded on 8mm tapes by each of the experiments. Although the experienced failure rate of the technology was significant, both drive and media costs were rather low. A solution based on this technology is considered to require too much operational effort and is not desirable for Run II. The experiments are interested to use a less failure prone, higher performance, and more modern tape technology.

The serial media working group has researched the tape market for tape technologies that are potential candidates for bulk data storage in Fermilab Run II[1]. Sony's advanced intelligent tape, AIT, is such a candidate. The current generation product, AIT-1, is marketed by both Sony and Seagate (Seagate Sidewinder AIT). AIT is a new family of products based on helical scan technology. Although it uses 8mm size tapes it is not read or write compatible with Exabyte's 8mm tape formats. At the end of 1997 the first AIT products became available. The drives read/write tapes of $25 * 10^9$ Bytes capacity at 3 MB/s. Sony counts a GByte as 10^9 Bytes, we use the standard counting of 2^{30} Bytes. This means a AIT-1 tape corresponds to 23.3 GBytes. Sony has started advertisement of a second generation product, AIT-2, with $50 * 10^9$ Bytes capacity and an I/O rate of 6 MB/s.

Fermilab acquired very early two of the first generation AIT drives and some tapes to evaluate and stress test the technology. One of the drives was bought from Sony, the other from Seagate. This was done to find out any differences in the products or enhancements done by either vendor. In March of 1998 Sony provided Fermilab with two additional AIT-1 loaners. In this report we describe the setup and results of the long term reliability tests that were done. The Seagate AIT drive and one of the loaners were given to the High Performance and Parallel Computing Department. The loaner was reported broken with the SCSI interface not working on most compute platforms. Reports of tests on those two units are not part of this note.

2 Test Setup

Tests of the AIT-1 tape technology fall into three classes. The first class of tests involved integration and functionality tests. The first Sony drive was connected to an IBM rs6000/550 running AIX 4.1 via a Rancho converter. The IBM recognized the drive as a tape device and the standard tape device driver worked fine. The Sony drive reported as a "SDX-300C" on a SCSI Inquiry. By default the drive uses data compression, however, this behaviour can be changed with a dip switch on the bottom of the drive. We set the drives to no data compression for our tests. Sony supports two types of AIT-1 tapes, SDX-T3C cassettes with a small, 16 kBit, memory chip and SDX-T3N cassettes without a chip. The chip knows the serial number of the tape, keeps a tape inventory, stores drive and error history, and can contain partitioning information. The load and unload time of the drives depend on the cassette type. We used cassettes with the memory chip and measured load times around 25 sec and unload times of about 30 sec. With 48 kByte blocksize and 512 MBytes filesize we measured write and read speeds of 3.0 MB/s. For 20 MBytes filesize the speed drops to 1.8 MB/s. The Fermilab Tape Tools package, FTT, was then updated with tables for the AIT and entries added to the Operator Communication System package, OCS.

To study long term failure rates under Run II conditions, two drives were setup for non-stop operation. One drive was setup to write/read new tapes with 10 passes per tape. New tapes are potentially more abrasive, thus wearing down the head much more than used tapes. This is particullary true for metal particle tapes. For the AIT, using metal evaporated tapes, this should be less of an issue. While we would have liked to use a new tape for each pass, this would have increased the cost of the stress test significantly. It would have also required operator attendance every two hours. A second drive, one of the loaners, was setup to write/read the same tape over and over. This then provides a reference point for the new tape test and a stress test of the media itself. The AIT-1 tape drives have a cleaning wheel that removes debris from the head as needed. The use of a cleaning tape is required only occasionally. The second test setup then required no operator attendance. In the first test setup the tape had to be changed once a day.

Drive one (S/N 104030) was connected to node b0ib00.fnal.gov, an IBM rs6000/550. The drive has a fast/wide single-ended SCSI interface. It was connected via a Rancho card and the only device on the bus. Although there was significant other activity on the machine this did not limit the test which read and wrote data at full speed. The write/read test consisted of eight write pass in which 44 files of size 512 MBytes were written. This fills 22 GBytes of the 23.3 GBytes tape. The tape is written in ANSI standard with volume label, file headers and trailers. The software uses the old rbio package which does an extra backspace plus tapemark re-write for each file. A next pass wrote 1050 files of size 20 MBytes to the tape with a procedure identical to the previous write passes. While the 512 MBytes files simulate more the number of files per tape in Run II, the 20 MBytes files stress the positioning around tapemarks. A final 10th pass read the 20 MByte files and checked the data of each file. After this the tape was rewound and a double tapemark written to it before it was ejected from the drive. Testing started in January of 1998.

The drive started to loose capacity after about 10 tapes. Write passes took significantly longer. At the 18th tape the capacity had dropped below 21 GBytes. We contacted Sony and learned that the tapes we had were from a bad batch (all tapes have a manuacturing number printed on the front) and are being recalled. We exchanged all tapes via the distributor which took about a month. The stress test resumed in March.

The drive worked flawlessly until the end of June. On the 809th pass the drive failed with an FTT error number 78. After this error the drive refused most SCSI commands. The drive was power cycled without effect. It was cleaned once with a cleaning tape, without effect. We informed Sony about the failure and the drive was send to California for failure analysis. Sony determined that one of the heads of one of the channels was dirty and had an excessive error rate. Sony cleaned the drive a second time with a standard cleaning tape. The drive was then send back to us. The AIT drive has a cleaning LED. The light did not flash on our drive. According to Sony one head of one channel being dirty does not trigger the cleaning LED. The ASC/ASCQ of this condition are not documented either.

In the meantime the machine that was used for the test was retired. The drive was used for integration test on Sun/Solaris and for tape partion work. The stress test on the drive was resumed only very recently, January 1999. So far the drive has completed an additional 100 write/read passes without problem.

The second drive (S/N 270349) was connceted to node whlml.fnal.gov, an IBM rs6000/41w. The drive too has a fast/wide SCSI interface, it shares the bus with four other disks. The machine is kept quite busy with other applications but runs the write/read tests at full speed. The setup was similar to the one above. Eight write passes wrote 44 files of size 512 MBytes in ANSI format. The next pass wrote 1050 files of 20 MBytes size and a 10th pass read the tape and checked the data in each file. The same tape was used over and over. The test started in March of 1998.

The initial loan agreement with Sony was for six month. We returned the drive to Sony middle of January 1999. Up to this time the drive had made 2380 written/read passes without error. It had been cleaned three times with a standard cleaning tape after the drive fell below 22 GBytes capacity. In neither case was the cleaning LED on.

The final class of tests involved load/unload tests. The read/write stress tests put very little load onto the loading mechanism. To stress test this mechanical component two tape drives (S/N 400311 and 400313) were setup in the EMASS library for a load/unload test. During the acceptance test of the EMASS library tapes were cycled through all the drives for two 24 hour periods. We estimate that each of the two AIT drives had about 1,000 tapes loaded and unloaded during this time. In our test eight different tapes were cycled through each drive non-stop. Testing started in middle of November 1998.

The first drive failed with a "media surface error" at the 3778th load/unload. The drive had the tape stuck in the drive and would not release it via a SCSI unload command or push of the eject button. A power cycle cleared up the drive. We verified that the tape was ok and not the cause of the problem. The test was continued and similar failures observed after smaller and smaller number of load/unload cycles. The test was stopped at the 9th load/unload failure when the tape drive was at the (1,000 + 5,860)th load/unload cycle.

The second drive failed with a "media surface error" at the 5160th load/unload. The test was continued and similar failures observed after decreasing numbers of load/unload cycles.

The test was stopped at the 7th load/unload failure when the tape drive was at the (1,000 + 6,018)th load/unload cycle. The observed number of load/unload cycles is much smaller than the specification of 100,000 cycles (for both threading and loading). We are currently working with Sony to understand the problem. The failure seems to be with the tape threading and current information indicates it is limited to a particular batch of tape drives.

3 Conclusions

In our stress tests the AIT-1 tape drives did not perform perfectly but significantly better than previous Exabyte tape technologies. (With Exabyte 8500 technology we have seen drive failures at about 450 full read/write passes for new drives down to about 150 passes for repaired drives.) We observed a cleaning problem after 808 passes on one drive while the second drive in the read/write test run without error for 10 months and 2380 passes. The failure after about 5,000 and 6,000 cycles in the load/unload test is worth noting and for a drive in file pick mode marginally for Run II.

References

[1] J. Bakken *et al.*, Serial Media Working Group First Run II Report, DØ note 3435, CDF-4560 (March 1998).