WHITE PAPER

AIT-5 COMPETITIVE PERFORMANCE AND VALUE

From Small Medium Business to Enterprise Application

Presented By

SONY

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EXECUTIVE SUMMARY

Sony's AIT tape product family has a solid history in meeting a customer's needs and expectations:

- Satisfy Small to Medium-sized Business (SMB), Branch Office, as well as Enterprise data back-up and archiving applications
- Small mechanism and media size
- AIT has been successfully integrated into a wide variety of automation configurations

AIT technology has now been extended to a 5th generation product (AIT-5)

- AIT-5 offers 400GB native / 1.04TB compressed[1] to meet the needs of SMB to Enterprise customers
- Windows® server applications are particularly suited to AIT-5's combination of capacity and performance

Sony has undertaken a series of performance comparison tests to better understand actual, effective I/O transfer rate requirements of the SMB server market[2]

- Under a typical data compression environment (2:1 to 3:1)[3], the AIT-5 drive performs similarly to the much larger and costly LTO-3 Enterprise tape drive
- Effective data throughput of a typical Windows® server application is around 200 GB/hr. This is caused by I/O throughput constraints imposed by the following:
    1. File system overhead
    2. Application overhead
    3. I/O interconnect overhead
- AIT-5 data write performance can range from 175GB/hr to 260GB/hr compressed[1] and provides a good match to the host data rate without degrading its streaming performance
- LTO-3 data write performance is specified to range from 576GB/hr to 864GB/hr compressed[3]. Since this is well beyond the range of ubiquitous SMB server capabilities, the LTO drive will attempt to degrade its performance by more than 60%[3] in order to achieve a reasonable data rate match and avoid excessive re-positioning or "shoe shining".

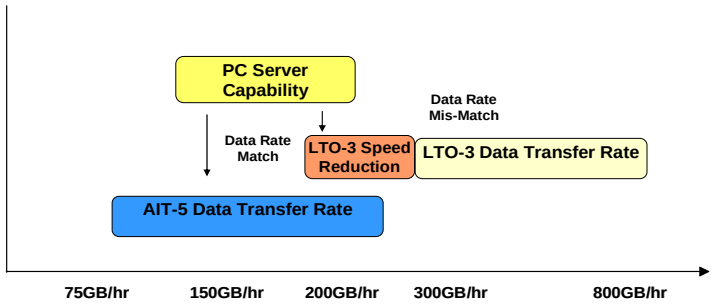

Chart 1. Average Performance[3]

AIT-5, at the same capacity as an LTO-3 drive, provides a much more compact and cost effective solution for SMB and Branch Office applications. Due to the substantial performance reduction required by the LTO-3 drive to function in this environment, the difference in the effective data transfer rate between LTO-3 and AIT-5 is negligible. AIT-5 provides a further customer advantage through its leadership in data density, enabled by a much smaller mechanism and media size.

Looking at real user-observed performance, the AIT-5 technology is an unbeatable value proposition for the SMB market and, through automation extension, to the small Enterprise market as well.

1. GB means one billion bytes. TB means one trillion bytes. Compressed capacity and transfer rate using 2.6:1 ADLC. Actual capacity and transfer rate may vary.
2. Based on Sony's comparison test results as of September 2006
3. Per manufacturer's published specifications as of 9/30/2006

INTRODUCTION – MARKET TRENDS

Today's data-intensive applications, with the need to archive and protect a business' valuable data, are the driving force behind the demand for higher capacity, lower cost, faster and more reliable storage products. Customers want solutions that shorten processing times, run without operator intervention, are easy to use and offer the highest levels of reliability. Based on the trends observable in the marketplace, tape storage is transitioning from its historical role of data protection to more write-once, archival uses. This is true for both Enterprise and "mid-range" SMB and Branch Office applications. According to IDC[4], the revenue from tape shipments in the "mid-range" market segment far exceeded that of the Enterprise segment during the 1st Quarter of calendar 2006. It is this "mid-range" SMB market opportunity for tape that has influenced Sony to prioritize capacity, rather than increased performance, in the development of its next generation of AIT.

CAPACITY VS. PERFORMANCE

In archival applications, large amounts of data are written once and read infrequently. In this environment, high capacity is a critical tape characteristic, providing both functional and cost benefits. Higher capacity tapes can hold more data, reducing the total number of cartridges required and physical space to house them, and can help to determine whether additional staff or equipment are required in order to meet application requirements.

Although data throughput to tape is secondary to capacity in importance, it is still a factor as higher transfer rates permit more data to be archived in a fixed amount of time which can also affect operating costs and the total cost of ownership. However, the data throughput rate is determined by a number of other factors that not only involve the capabilities of the data storage device itself, but also the data type and data throughput capability of the host system and its I/O interconnect. It is this combination and interaction that will demonstrate the "real" user-observed performance of a tape solution.

THE DIMENSIONS OF DATA TRANSFER PERFORMANCE

The effective data throughput performance, as seen by the user, is a combination of many variables, from the performance capability of the tape sub-system, to the host data type and compressibility, as well as the actual data throughput capability of the host system. Each needs to be examined and understood in order to provide a complete picture and valid competitive comparison.

In many comparisons of competitive tape solutions, the focus generally seems to be on the raw hardware capability of the tape device, without much consideration for the application and data type environment. This can result in a very misleading view of a user's environment. For example, in a typical stand-alone Windows® PC server SMB environment, the real data throughput of the system may only be in the 100GB/hr to 200GB/hr range[3], whereas in a high-performance UNIX® multi-processor Enterprise server environment, the I/O throughput capability could range from 300GB/hr to over 1000GB/hr[3], requiring vastly different tape drive performance capabilities. From a data throughput perspective, a tape drive designed for the SMB market will likely be sub-optimal for the Enterprise market and similarly a tape drive designed for Enterprise-class systems will likely be sub-optimal for the SMB market. In fact, based on competitive performance tests[2], Sony has found that Enterprise-class tape drives, such as the LTO family, tend to perform far below their native throughput rate when not used in an Enterprise system data rate environment.

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4. IDC – July 2006

THE LIMITATION OF DATA TRANSFER PERFORMANCE

Most current tape technologies are "streaming" drives that read and write at a particular given data rate and perform best when the data rate between the drive and the host is reasonably matched. If there is a "mismatched" difference in data rates, such as a host data stream of 100GB/hr to a tape drive designed for an on-tape data rate of 200GB/hr[1], then the tape drive will fill up its buffer and write a burst at 200GB/hr. The drive will stop, back-up, then start up again and write another buffer full of data at 200GB/hr. This back-and-forth repositioning between recording bursts of data will continue until the tape is full or the I/O task is completed. The greater the difference between the host data rate and the drive's on-tape recording rate, the more time will be spent re-positioning tape, as opposed to writing data. These start-stop and re-position cycles will not only dramatically reduce the effective throughput performance of the tape drive but may also affect drive reliability due to the additional wear and stresses placed on the tape drive's motors, media and tape path. Although some drives, such as the LTO family, will attempt to step down their tape speed so as to try and keep up with the incoming data rate[2], there is a limit to how low tape speed can be reduce while still keeping the tape reading and writing data reliably.

Additionally, most current tape drives automatically employ hardware compression techniques on the incoming data and thereby multipy the effective tape drive data rate by the compressibility factor of the incoming data. A compression factor between 2 and 4 is not uncommon in today's applications and most tape drive manufacturers quote an average compression factor of between 2 and 3 in their specifications[3]. This means, for example, that for an incoming data stream at 100GB/hr, the drive designed to record at a native 200GB/hr will now be writing this data in bursts at an effective rate of between 400GB/hr to 600GB/hr, further increasing the time spent re-positioning tape rather than writing data. The compressed data rate gap between the host and the tape drive needs to be critically evaluated when considering the effectiveness of competitive tape solutions, particularly in an SMB environment.

Specification	AIT-5	LTO[3]
Native Cartridge Capacity (GB)	400	400
Native Transfer Rate (GB/Hr)[1]	86	288
Compressed Capacity (GB, 2:1)	1,000	1,000
Compressed Transfer Rate (GB/Hr, 2:1)	**172***	576
Data Rate Reduction Needed	0%	65%

* AIT-5 performance is closely aligned to the average Windows® PC server performance

Table 1. Comparison of Tape Drive Specifications vs. Typical SMB Windows® Throughput[3]

Sony's AIT-5 drive, for example, has demonstrated a capability to perform well against various levels of data compression and generally "scales" at 100% of its rated performance, up to at least 3:1 compression[2]. This means that for an average data set compressibility of 3:1, AIT-5's throughput capability would be 259GB/hr. Many SMB and Branch Office server I/O throughput capabilities to a tape drive tend to be limited to a range between 150GB/Hr to 200GB/Hr. Although this is well within the capabilities of AIT-5, this effective throughput rate is well below the optimum performance specifications of Enterprise-class tape drives, such as the LTO-3, which have a specification of 864GB/Hr with 3:1 compression[3]. In a lower throughput rate SMB server environment, LTO-3 will attempt to significantly reduce its transfer rate in order to limit

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excessive re-positioning cycles, and will significantly underperform its true capability. This transfer rate reduction was replicated in Sony's Windows® server transfer rate performance testing[5].

WINDOWS® SERVER DATA TRANSFER PERFORMANCE MEASUREMENTS

In order to more fully explore the impact of system harware, software and application overhead for servers used in an SMB and Branch Office back-up and archiving application, Sony developed a Windows® server configuration commonly used in the SMB and Branch Office and tested AIT and LTO tape drive performance in a typical application using compressible data[2]. As anticipated, there were several system I/O bottlenecks which limited the maximum sustainable throughput to the tape drives.

The following describes the test configurations, applications and results. Since AIT-4 has the same confirmed performance specifications as Sony's new AIT-5 drive, AIT-4 was used in Sony's various system performance tests, along with an IBM® LTO-3 tape drive.

TEST SYSTEM CONFIGURATION

A Windows® SMB server configuration, using a typical mass storage sub-system was constructed by Sony for its testing as follows:

Server: HP® ProLiant – ML370 G4 with Dual Intel® Xeon® 3.6GHz (2 way multi-processor)
HDD Interface: Ultra SCSI 320
HDD Storage: 728GB using 4 drives in a RAID-5 configuration
HDD RAID Controller: PCI-X Ultra 320 Array Controller
HBA - for HDD: SMART Array 6402, Ultra SCSI 320
For Tape: Adaptec® 29320, Ultra SCSI 320
Operating System: Windows® Server 2003
Application Software: Symantec™ Backup Exec™ 10d

TEST METHODOLOGY AND OBSERVATIONS

For the test data, a total capacity of 20GB was prepared, consisting of 512KB files with average compression ratios of between 2:1 and 3:1[2]. Backup, Verify and Restore operations were performed three times using each tape drive and an average of the three measurements were used to calculate the overall transfer rate performance, as follows.

The results, particularly for the Backup to tape, show that the AIT and LTO models perform fairly equally (within 8%) in this environment. AIT performance was 208GB/Hr, or 92.5% of its rated throughput of 216 GB/Hr at 2.5:1 compression[1]. The LTO drive, on the other hand, performed at 225 GB/Hr which is about 30% of its rated performance of 720 GB/Hr at 2.5:1 compression.[2] In other words, in order to match the data rate from the SMB server, the LTO-3 needed to downgrade its capability by over 65%. Similar results were observed in the data Restore tests, although the LTO drive slightly outperformed the AIT drive. In this particular test, AIT functioned at 60% of its capability and LTO performed at 22% of its capability.

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3. Per manufacturer's published specifications as of 9/30/2006
5. Verification of AIT-5 System Performance in Actual Usage – Sony Corp., April 2006

Based upon Sony's test results, it appears that the LTO-3 drive falls far short of its performance capabilities while AIT drive better suits the SMB customer environment. Although a performance-downgraded LTO drive does perform at the limits of the server's capability, the cost, size and capacity of the AIT drive make it an ideal companion for SMB back-up and archiving applications. When low-end automation solutions are considered and performance capabilities evaluated, AIT is a clear winner, providing the same capacity as the LTO drive but in a much more space-efficient manner valued by SMB users.

	AIT-4	LTO-3	Performance Ratio
Backup Transfer Rate **(MB/sec)**	57.7	62.5	1: 1.08
Backup Transfer Rate **(MB/sec)**	38.2	45.9	1: 1.20

Note : Native Transfer Rate Ratio AIT-5 versus LTO3 = 1:3.3[6]

Table 2. Actual Data Throughput Performance Comparison[2]

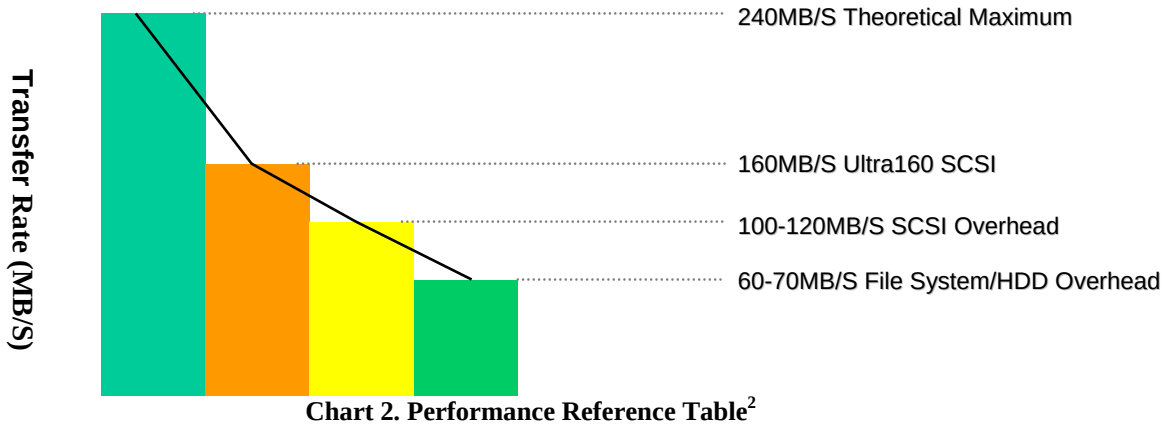

Chart 2. Performance Reference Table[2]

OTHER SOLUTION CONSIDERATIONS

The Helical Scan recording technology of AIT-5 results in an extremely efficient data packing density, low tape tension, low tape speeds and low power consumption, with a rotating drum/head assembly packaged into a compact mechanism which provides single pass recording. The Linear serpentine recording technology of LTO, on the other hand, is characterized by lower data density, very high tape speeds, high power consumption and high transfer rates and a large mechanism.

AIT-5 sets the competitive benchmark for space efficient, high density removable storage from a single drive, 8-cartridge, 1-U auto loader, to larger libraries containing many drives and hundreds of tape cartridges.

2. Based on Sony's test as of September 2006
6. AIT-5 native transfer rate 24 MB/s versus LTO3 native transfer rate 80 MB/s (ratio is 1:3.3), per manufacturer's published specifications as of September 2006

SUMMARY

Inherent performance characteristics ideally position the AIT tape technology family to uniquely support back-up and archiving applications in a SMB Windows® server environment. Enterprise tape solutions, such as LTO-3, offer a more costly, larger form-factor solution that generally cannot perform at rated speeds and are poorly matched to the SMB Windows® server environment and its data throughput capability. With a native capacity of 400GB per cartridge[1], AIT-5 provides the same capacity and equivalent performance in SMB applications,compared to the much larger and more costly LTO-3 enterprise tape technology.

These factors, together with the data storage density of AIT-5, contribute to an ease of use and cost of ownership archiving advantage for AIT that can lower the cost of doing business for SMB and Branch Office enterprise customers.

Sony is committed to maintaining its AIT technology leadership for SMBs with new and enhanced AIT products, such as AIT-5. With the AIT family of compatible tape drives, autoloaders and library systems[7], organizations can grow their tape capabilities, as needed, and know that they have chosen a reliable, easy to use and cost-effective solution.

For more information visit:

www.sony.com/storagebysony

www.sony.com/media

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7. AIT-5 read/writes AIT-4, AIT-3Ex and AIT-3 media. AIT-4 read/writes AIT-3Ex media. AIT-3Ex read/writes to AIT-3Ex, AIT-3 and AIT-2 media. AIT-3Ex reads AIT-2, AIT-1, Ait-1 Turbo and AIT-E Turbo media.