Sony AIT-5

A report on Sony's fifth generation backup tape format with performance tests and an investigation into backward compatibility with previous AIT generations

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Network storage capacities across SMB and mid-range businesses have grown exponentially over the past couple of years and this is now causing major headaches as administrators struggle to find the right data protection strategy to deal with this data explosion. These problems are further exacerbated by the wide range of choices of backup devices and media that has come on to the market during this period.

Tape has traditionally been one of the top choices for securing critical business data for a number of good reasons and despite the wide choice of formats currently available Sony's AIT (advanced intelligent tape) has always offered one of the best solutions for the SMB and mid-sized company.

It has benefited from one the longest and most stable development programs and since its introduction in 1996 has delivered on the roadmap promises of a new generation every two years. Backward read and write compatibility with two previous generations has always been a key requirement of Sony's roadmap but AIT suffered a major setback in 2005 as these claims had to be withdrawn from the fourth generation AIT-4.

Although the drive worked perfectly with AIT-4 media all compatibility claims had to be withdrawn as AIT-2 and AIT-3 media was found to be damaging the drive's heads such that it was no longer able to reliably use AIT-4 media.

The latest fifth generation AIT-5 aims to set the record straight as Sony claims that it is fully backward read and write compatible with AIT-3 and AIT-4 media.

This requirement is critical to the continued success of this tape format and this report aims to test the new drive in order to ascertain whether the claims have been met. It will run extensive tests on the drive using AIT-3, AIT-4 and, finally, AIT-5 media to determine whether backward compatibility has been successfully implemented.

Further testing will be conducted to determine general performance characteristics and the report will provide a briefing on the current status of competing tape formats and will discuss the pros and cons of the alternatives to tape based backup.

With the release of the AIT-3Ex, Sony has also addressed migration issues for existing users of its lower capacity AIT drives. The AIT-3Ex not only provides backward compatibility with these drives but its media is also compatible with AIT-4 drives running the latest firmware.

Sony wants the AIT-3Ex to be the preferred choice for customers looking to migrate upwards and hence, although it offers a much higher transfer rate of 18MB/sec and capacity of 150GB, AIT-3Ex is available for the same cost as AIT3.

There are a number of driving forces behind the increase in data stored on networks and one of the most influential has been the technological advances in hard disk interfaces. Serial ATA (SATA) has had a huge impact on capacities as this interface combines an unbeatable ratio of capacity, cost and performance and has become the dominant choice not only for entry-level and departmental servers but desktops and workstations as well.

Drive capacities have advanced dramatically as well with 750GB disks being launched at the end of 2006 and the world's first 1TB SATA drive expected to appear in Q2 2007. Serial Attached SCSI (SAS) has also made strong inroads into the SCSI market with the result that the majority of higher performance rack and pedestal servers are now only offered with this interface as the primary choice. Even here, SAS drives have already reached 300GB capacities and the interface technology also allows these to be mixed and matched with SATA drives.

The bottom line is this represents an ever increasing demand on data protection strategies making it imperative to choose the right backup device and media for the job. Tape is still one of the best solutions for securing large amounts of data on a regular basis and for a number of key reasons. True, the initial outlay for the drive itself can be prohibitive for smaller businesses but overall storage costs offered by tape are unbeatable. Furthermore, when it comes to off-site storage, tape is one of the best choices as it is designed to be portable and the robust cartridges have much higher environmental tolerances making them a far safer bet for storing in a remote location.

Hard disk based backup represents a high growth area in the mid-range market and rightly so as it can offer much higher performance than tape. However, many systems are delivered as appliance based solutions which can be prohibitively costly during the initial procurement and installation phases. Furthermore, hard disks are not, nor have they ever been, designed with removability or portability as high priorities.

The physical interfaces on SATA and SAS drives are more robust than IDE and SCSI but regular removal of hard disks may cause wear and tear over a period of time and the drives themselves must be protected from extreme environmental variations when stored off-site.

In general, most hard disk backup appliances are designed to work in tandem with tape where the former provides high speed on-site backup and the latter looks after critical off-site storage.

Another recent development is the virtual tape drive which relies on iSCSI (Internet SCSI) technology to function. The most popular implementation is in appliance based solutions where the system presents both iSCSI disk and tape targets to the network. This allows the product to provide a D2D2T (disk to disk to tape) solution where data can be backed up to fast hard disk based media and the advantage of virtual tape targets is that they appear to the systems running the iSCSI initiator as locally attached tapes drives so will function with all the major backup software products.

However, iSCSI performance is entirely dependant on the network infrastructure and the best speeds will only be achieved with an end-to-end link over Gigabit Ethernet. There are also very few solutions on the market that are aimed at the SMB and the choice of virtual tape drives is currently limited to one – an emulated Hewlett Packard LTO-2. Furthermore, the demands for secure off-site backup means that the data on the virtual disk and tape targets must still be migrated to physical tape to allow it to be removed and stored in a remote location.

The past year has also seen the rapid rise in popularity of hosted off-site backup services. These are particularly appealing as they require virtually no investment in backup media and automatically provide a secure off-site storage facility. Backups can be easily automated as required using locally installed client utilities and the data transmitted to a secure remote location.

The biggest drawback to hosted backup is that performance will be determined purely by the size of a business' Internet connection and regular backups of large amounts of data will require substantial investment in a high capacity pipeline. Secondly, data availability and security are now in the hands of a third party and businesses will be totally reliant on the service provider's arrangements for disaster recovery at the backup site.

Tape drive technology and development – particularly in the SMB market - has seen some very significant changes over the past couple of years so it is well worth discussing the current status of the main competing formats and how they have been progressing recently.

DAT

DAT has been the most dramatic as the demise of the incredibly popular DDS-4 format was announced by Sony, HP and Seagate way back in 2001 only for HP to resurrect it in the shape of the DAT72 in 2003.

This successor failed to impress as HP was only able to improve capacity from a native 20GB to 36GB by increasing the media length and making the substrate thinner. Performance has recently been increased marginally to 3.2MB/sec but by today's standards this is pedestrian at best.

More importantly, there has been considerable doubt cast over the next generation DAT160. This was originally supposed to be launched early in 2006 and this was then delayed to Q3 of the same year. This format has seen further delays with the launch now expected in Q2 2007 but it is rumoured that due to the serious limitations imposed by the compact 4mm data cartridges, the drive has moved to 8mm (the same as Sony's AIT) and to maintain backward compatibility with DAT72 will also have a second 4mm head installed as well.

SLR

This linear recording format has been developed solely by Tandberg Data and the company re-vamped its tape drive range during 1999 bringing all the various products under the single SLR (scaleable linear recording) brand name. A key feature of the SLR drives is the claimed reliability as they all use extremely robust 1/4in. data cartridges which employ very few moving parts.

However, development of this format has been slow and is showing signs of reaching its physical limitations. An SLR160 version was expected in 2003 but this didn't materialize and instead Tandberg Data launched the SLR75 and SLR140 the same year. Native performance for both formats is now comparatively poor with the SLR140 only offering speeds of 6MB/sec – barely twice that of the DAT72. Storage capacity is also modest with the SLR75 and SLR140 offering a native 38GB and 70GB respectively.

It's now been three years since these models were launched and there are no indications of when the next generation will be announced.

DLT

The DLT1 format was introduced at the end of 1999 by Benchmark Tape Systems and advertised as combining the capacity of DLT8000 with the performance of DLT7000. The company also claimed it would cost the same as DDS-4 but it failed to deliver on this promise as the DLT1-based drives cost substantially more. Benchmark created this format by licensing Quantum's original DLT technology and modifying it to create a new tape drive. It then re-designed the drive and came up with the ValuSmart Tape 80 in 2001 which reduced drive height allowing it to fit into a 5 ¼" standard expansion bay. This format has proved popular enough that Quantum reacquired the technology but the second generation VS160 only materialised at the beginning of 2003 after a three year wait.

The third generation DLT-V4 drive was launched by Quantum at the beginning of 2006 which doubled native capacity to 160GB but actually uses the same DLT-VS1 cartridges as the VS-160. Unfortunately, performance boosts are in short supply as this format only pushes native transfer rates to 10MB/sec - a modest improvement of 25 per cent over VS-160 which offers a native speed of 8MB/sec. As an SMB backup solution the DLT-V4 is a good choice but its low performance is not ideal for server backup in mid-sized businesses.

VXA

Originally launched in 1999 by Ecrix Corporation, the VXA format has suffered from a number of setbacks and an inordinately long development period that has not adhered to any product roadmap. Acquired by Exabyte early this century, it then took over six years to deliver a mere two new generations and then in 2006 Exabyte put itself up for sale after its CEO resigned. Tandberg Data bought the company outright with plans to merge VXA with its already extensive range of tape drives and formats. The last format to be launched by Exabyte was the VXA-172 which was designed to be firmware upgradeable to VXA-3 but whether there will ever be a VXA-4 remains to be seen.

Test Platform

The key aim of this report is to test backward compatibility claims for AIT-5 but also to confirm the quoted performance rates for the drive. For testing purposes a high performance Supermicro pedestal server was chosen which was equipped with the following specification:

Chassis: Supermicro SYS-7045B
Motherboard: Supermicro X7DBE+
Processors: 2 x 3GHz Intel Xeon 5160
Memory: 4GB 533MHz FBDIMMs
Storage: Intel 6-port SATA/3Gbps controller,
Disks: 4 x 500GB WD5000YS SATA/3Gbps in RAID-0 stripe
Network: 2 x Intel Gigabit Ethernet .

The system was installed with Windows Server 2003 SP1 and to test backward compatibility Symantec's Backup Exec 10d was selected. This highly popular backup application has one of the best scheduling functions of all allowing extensive testing to be run automatically.
A 7.4GB data collection representative of a typical small business or departmental server was used for all testing and comprised nearly 13,400 files in 1,142 directories which included Word documents, Excel spreadsheets, Access and SQL databases along with PowerPoint presentations plus video clips, audio files, C++ source program files and ZIP archives.

The data types were chosen as they contain a balanced mixture of compressible and non-compressible files. Testing with a number of tape drives has shown that this test data will allow a tape drive to deliver its quoted native speeds. As can be seen in the performance results, the AIT-5 drive easily achieved the quoted native speed of 24MB/sec and the slightly higher speeds are due to the efficient compression algorithms used by the drive.

Photography courtesy of PC Pro

Test Scenario

For backward compatibility tests a schedule was configured within Backup Exec which would automatically erase the inserted media and follow this with a full backup of the test data after which it would run a tape verification. The schedule was allowed to run for a minimum of 250 passes for each task and on completion a full restoration to a new location on the server was then also scheduled to run at least 250 times. The test began with a new AIT-3 tape and after a minimum of 1,000 passes had been completed the media was removed, replaced with an AIT-4 tape and the tests rerun. Finally, the AIT-4 tape was replaced with an AIT-5 tape and the tests all rerun a third time. The end result was a total of at least 3,000 passes equally applied across AIT-3, AIT-4 and then AIT-5 media. During testing the media was not refreshed so each tape had to handle at least 1,000 passes. For general performance testing the server was also loaded with Computer Associates ARCserve r11.5 and EMC Retrospect Server 7.5 and the three backup products were asked to backup, verify and restore the test data. The tests were run three times with AIT-3, AIT-4 and AIT-5 media to determine the backup and restore speeds for each type.

Backward Compatibility Test Results

The backward compatibility tests took approximately three weeks to complete and the AIT-5 drive returned a perfect score with Backup Exec reporting no errors or failures for any media during this period. In fact, due to some test schedules overrunning their allotted period the total number of passes using the AIT-5 drive actually came to over 3,700. Add to this the full performance tests using the three backup software products and the tape drive handled over 3,750 passes and was in use continuously for approximately 500 hours.

Job History – 3740 Items							Filter:	Filter - Successful jobs	
Job Name	Device Na...	Job Type	Job Status	Percent ...	Start Time	End Time	Elapse...	Byte Cou	
Repeat Restore AIT5	SONY 1	Restore	Successful	100%	05/12/2006 08:45	05/12/2006 08:51	0:05:51	7,848,041,1	

Job History – 0 Items							Filter:	Filter - Failed jobs	
Job Name	Device Na...	Job Type	Job Status	Percent ...	Start Time	End Time	Elapse...	Byte Count	
None									

AIT-3
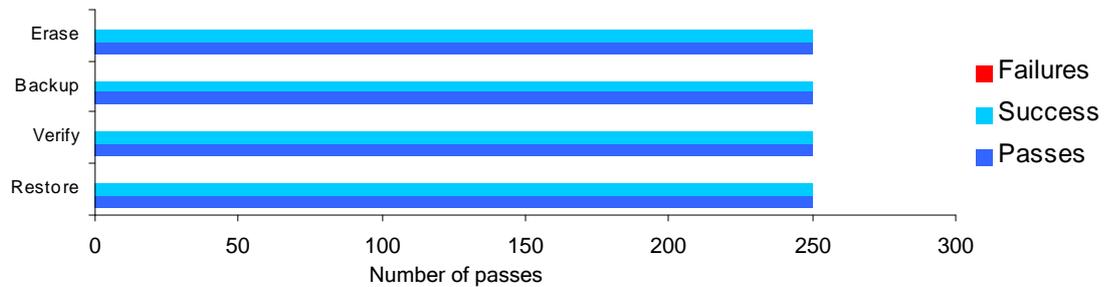
AIT-4
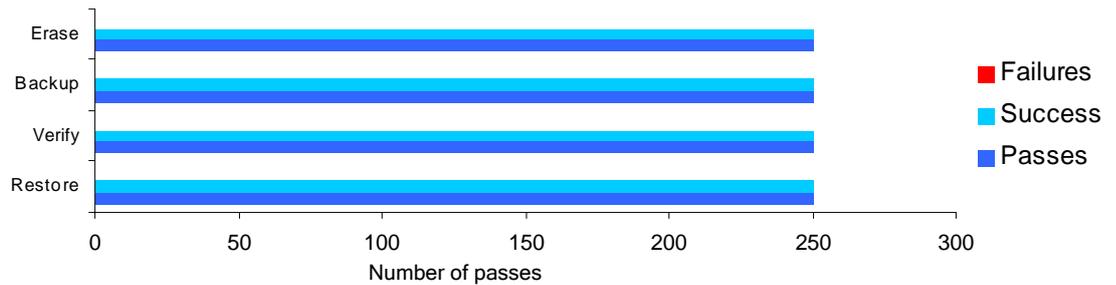
AIT-5
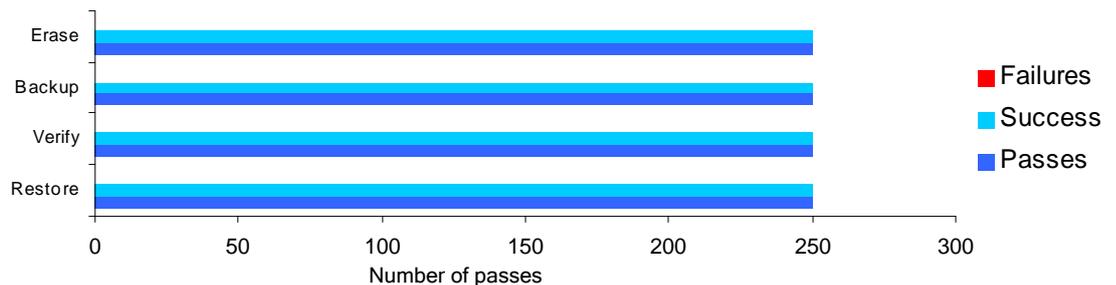
During the performance tests the drive delivered the quoted native speeds for all three backup software products whilst securing the test data to an AIT-5 tape. The best results came from Computer Associates ARCserve r11.5 with it returning an impressive average speed of 29MB/sec. Retrospect reported 26.4MB/sec whilst Backup Exec delivered a marginally lower speed of 23.4MB/sec. Data restoration performance was also very good with ARCserve, once again, reporting the highest speed of 28.4MB/sec.

This level of performance was also maintained when using an AIT-4 tape for backup with all three software products reporting almost identical results to those seen when using AIT-5 media. Although noticeably lower, both AIT-3Ex and AIT-3 media produced impressive results with ARCserve reporting 22.4MB/sec and 21.4MB/sec respectively for the backup tasks. It's worth noting that the latter results represent a near 25 per cent increase in performance over an AIT-3Ex tape drive and almost a doubling in performance over standard AIT-3 tape drives.

AIT-5

AIT-4

AIT-3Ex

AIT-3
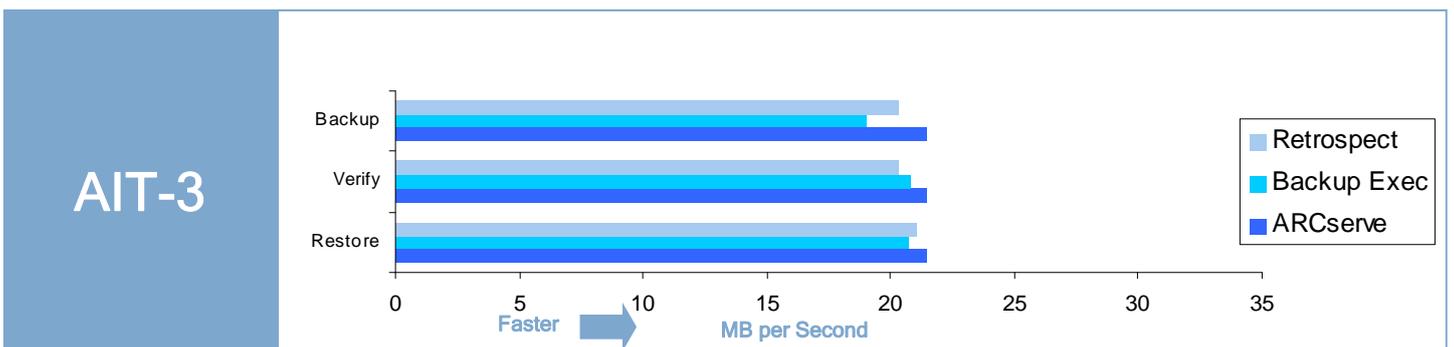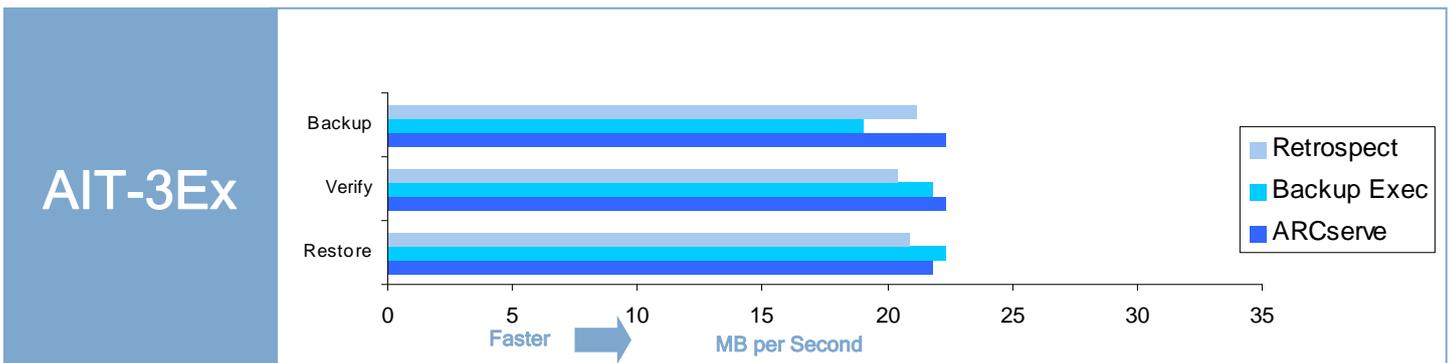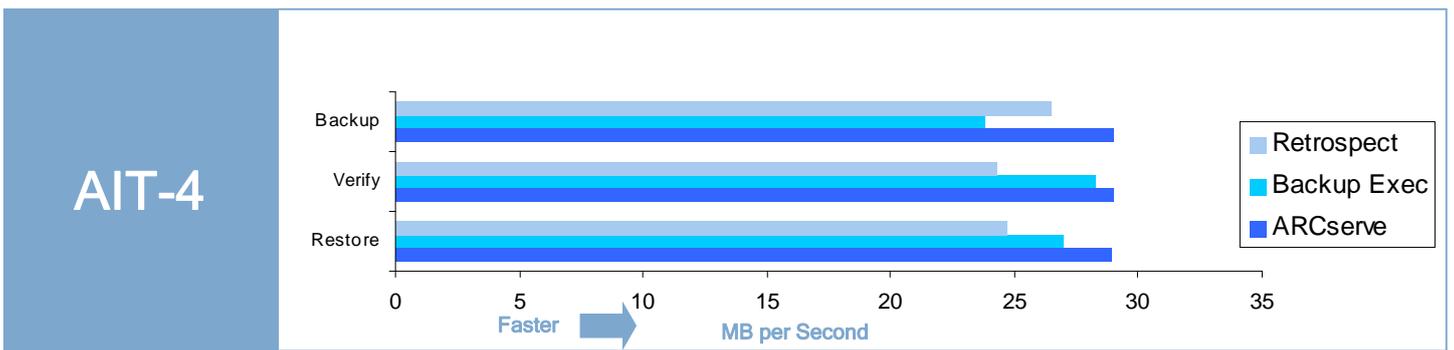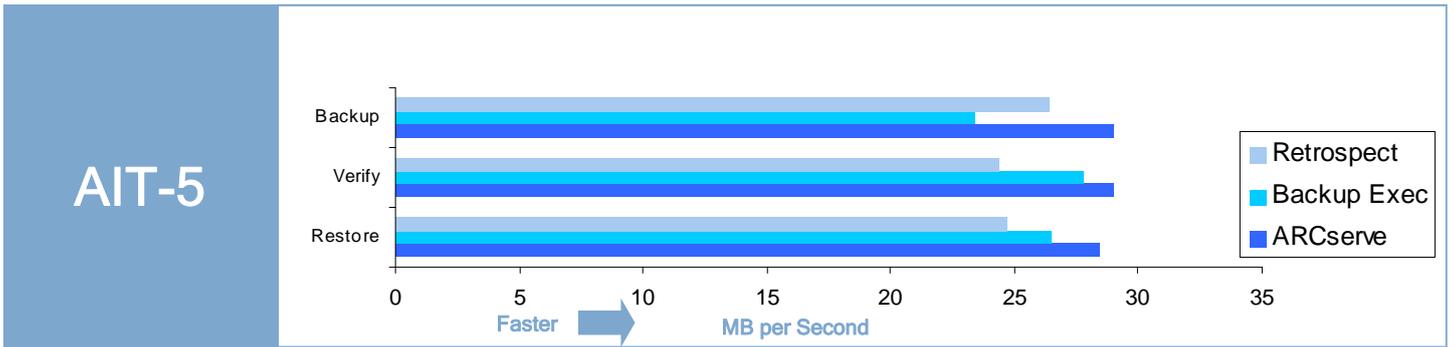
The launch of the AIT-5 tape drives confirms Sony's commitment to its product roadmap but, more importantly, dispels any doubts about its abilities to deliver the required backward compatibility with previous generations. The failure of AIT-4 to deliver in this critical area has caused serious doubts in the industry about the reliability of this format but extensive independent testing has shown that AIT-5 has put it right back on track.

To maintain its 100 per cent record with its product roadmap Sony opted to concentrate on improving capacity as opposed to performance so native speeds for the AIT-5 drive are the same as for its predecessor. However, we don't see this as a major issue as a native transfer rate of 24MB/sec is more than enough to handle the demands of the average SMB and mid-range server. Furthermore, as tape drive performance increases the server itself becomes a bottleneck. Testing in this lab has shown that the enterprise level LTO-3 tape drive, for example, requires storage to be placed on a 2Gbps fibre channel SAN to allow it to reach its native quoted speeds.

The majority of competing tape drive vendors have also placed a higher priority on storage capacity. Quantum's DLT-V4 only offers a modest 25 per cent speed improvement over VS-160 but it pushed native capacity from 80GB to 160GB. Even with its enterprise level DLT-S4 tape drive, Quantum decided to prioritise storage with this tape drive delivering an 800GB capacity and a 67 per cent performance increase.

With the exponential increase in locally held storage on SMB and mid-range servers it becomes imperative that tape drives keep in step and the native 400GB of the AIT-5 tape cartridges is the highest in the industry for this form factor. Although unlikely to be achieved in the real world, Sony's compression ratio of 2.6:1 also allows the cartridges to hold a theoretical maximum of over 1TB of data. By comparison, the native capacities of VXA-320 and DLT-V4 both offer only 160GB capacities - less than half the AIT-5. It's also worth noting that in terms of capacity and performance the AIT-5 is on par with the mid-range Ultrium LTO-2 format which delivers the same speeds but only half the capacity.

It's clear that a number of tape formats in the SMB and mid-range markets are going through a sea-change as manufacturers struggle to deliver a solution that can cope with the ever growing demands of business data protection strategies. Although not as costly as some D2D backup appliances, tape still represents a significant investment and the fact that many formats such as DAT and VXA are not delivering the next generations on schedule is a worry for administrators that need to know their investment is protected.

So far, AIT holds the record of being the only tape format to deliver five generations on schedule and is now the most established on the market. Furthermore, Sony still has a sixth generation on the roadmap which by its current performance will be launched in 2008/9 so providing a future upgrade path for existing users. With the release of the AIT-3Ex, Sony has also delivered a continuous migration path for users of its lower capacity AIT tape drives. This will soon replace the AIT-3 model and its full backward compatibility combined with the fact that the AIT-3Ex media can be used in AIT-4 drives provides a solid upgrade path for users wishing to grow beyond 150GB tape capacities.

Earlier backward compatibility issues look to have been remedied with the drive supplied for testing working perfectly in the test lab for approximately 500 hours and using a mixture of AIT-3, AIT-3Ex, AIT-4 and AIT-5 tapes for a range of tasks. Combining these capabilities with its high native speeds and unbeatable storage capacity makes AIT a top choice for server backup in the SMB and mid-range environments.