

# Technology Paper

## 2.5-Inch Enterprise Disc Drives: Key to Cutting Data Center Costs

### Introduction

Cost reduction continues to be a top priority throughout the enterprise, with IT departments under particular pressure to trim expenses wherever possible. Many IT professionals have identified storage consolidation as a core strategy in their battle to cut data center costs and optimize efficiency. Such consolidation can reduce the number of data centers and their floor space requirements, as well as lower both ancillary infrastructure expenditures and storage management costs, all while significantly boosting storage system utilization.

Small form factor (SFF) 2.5-inch enterprise disc drives are spearheading a new class of high-I/O-density storage solutions that facilitate rapid and cost-effective storage consolidation. Remarkably compact and efficient, SFF 2.5-inch drives are key to implementing data centers that provide higher IOPS/U and lower TCO:

- SFF 2.5-inch drives are 70 percent smaller than 3.5-inch drives, enabling them to deliver 130 to 150 percent greater system performance in the same footprint.
- SFF 2.5-inch drives use 40 percent less power and run cooler with reduced airflow requirements, allowing greater storage density and data center space efficiency.

For enterprises seeking to maintain current capacity and I/O performance levels while reducing storage's data center footprint, the cost benefits of 2.5-inch drives are remarkable, with up to **66 percent less rack space** used and **45 percent lower power consumption** (see Figure 1).

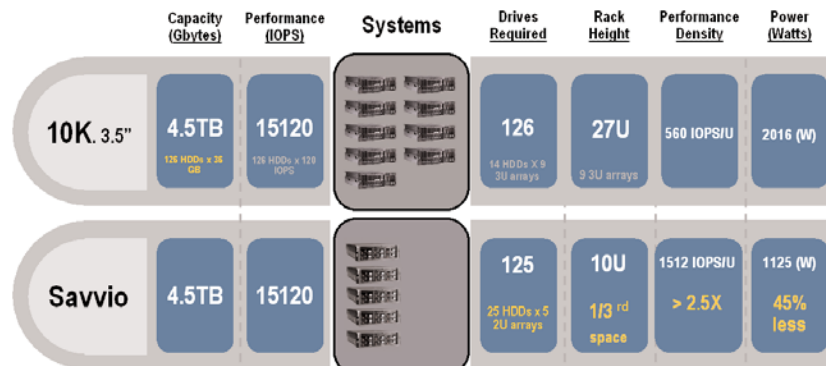


Figure 1

SFF 2.5-inch drives can also significantly expand the role 1U servers and blade servers currently play in the enterprise. 1U servers equipped with six 2.5-inch drives can deliver full RAID 5 functionality, outperforming 2U servers by 150 percent while using half the space. Blade servers are typically equipped with notebook-class disc drives, without the reliability and performance needed for more rigorous enterprise applications. SFF 2.5-inch drives are true enterprise-class devices, their 1.4 million hour MTBF and 10K-RPM disc speed enabling blade servers to cost-effectively address a broader range of enterprise duties.

### **Data Center Sprawl**

Throughout the superheated markets of the late Nineties, economic optimism and Internet euphoria drove data center proliferation at a breakneck pace. Apparently limitless opportunities in e-business and e-commerce brought unprecedented demand for increased server and storage capacity, and the dizzying revenues such opportunities promised seemed to easily justify the enterprise's massive investment in additional data center infrastructure.

Amidst this frenzy of well-funded expansion, there was little time (or fiscal incentive) to efficiently integrate new data centers into existing infrastructures, or even to ensure optimal coordination between the newly deployed data centers themselves. As a result, enterprise data centers evolved into a diffuse hodgepodge of high-priced, spacious facilities that offered impressive throughput and capacity, but low efficiency per square foot and high management costs.

When the economic bubble eventually burst, the enterprise was forced to critically examine every aspect of operations for possible cost-cutting opportunities. These audits promptly revealed a plethora of expensive data centers fraught with storage overcapacity and underutilization. Halting new data center development was an obvious first step, but downsizing and consolidating existing storage systems proved more problematic. With virtually no funding to undertake such consolidation efforts, many enterprises were forced to simply make do until the economy rebounded.

### **Consolidation Conundrum**

As today's vital economy continues to gain momentum, many enterprises now are focused on implementing their postponed storage consolidation initiatives. A recent Gartner study indicated 94 percent of respondents were either considering or actively undertaking storage consolidation. At its core, storage consolidation seeks to cut costs and improve efficiency by housing a reduced number of storage devices in fewer, smaller and better-integrated data center facilities. Not only will this significantly lower expenditures on the physical structures themselves (IDC estimates that total cost of ownership for data center space can exceed \$1000 per square foot), it will boost storage utilization levels and thus storage system ROI.

But for one critical caveat: storage utilization levels must not become so elevated as to significantly degrade I/O performance. It's axiomatic that when user numbers remain unchanged and disc drive counts drop (via storage consolidation), user-to-drive ratios rise and drive utilization levels climb. In today's growth economy, enterprises can be expected to **substantially increase** user numbers. Fewer, smaller systems must be able to meet the needs of **more** users.

### **Cutting Data Center Costs With 2.5-Inch Enterprise Drives**

To fully realize the benefits of consolidating a data center's storage systems, enterprises must deploy storage devices specifically designed to deliver high performance in space-constrained environments. Small form factor (SFF) 2.5-inch enterprise disc drives are precisely such devices, enabling a new class of **high-I/O-density** storage solutions. Exploiting the SFF 2.5-inch drive's optimal blend of performance, compact size and reliability, these new storage solutions provide both superior IOPS (input output per second) and greater space efficiency than conventional 3.5-inch, 10K-RPM-based systems.

Central to the SFF 2.5-inch drive's value proposition is the concept of **IOPS/U**, or input output per second/unit (of vertical rack space). IOPS/U is a critically important measurement in any storage consolidation strategy because it factors in both a storage device's **performance** and its **space requirements**. SFF 2.5-inch drives are purpose-built to excel in these two key criteria and are ideally complemented by the new Serial Attached SCSI (SAS) interface. SAS combines superior throughput (3.0 Gbits/sec) with compact cabling and connectors that use less enclosure space, thus significantly enhancing airflow/cooling in high-density computing environments.

The economies of data center consolidation are compelling. Computerworld reports that DHL's consolidation efforts are saving the company about \$24 million per year; after consolidating the IT infrastructure of recently acquired Airborne Express, DHL expects annual savings to exceed \$50 million. Cost reductions such as this reflect more than just shrinking floor space needs. Less data center server and storage hardware also requires less ancillary infrastructure, such as routers, switches, cabling, UPS and rack cabinets, directly translating into lower costs as new hardware is deployed. This also enables fewer IT staff to administer and maintain the systems, reducing a major cost factor in data center overhead.

Note that the savings provided by SFF 2.5-inch storage solutions aren't limited to large enterprises that own or lease dedicated data centers; mid-size companies that employ co-location services can also realize significant cost savings. For example, common applications such as data warehousing, e-mail and CRM can easily demand several terabytes or more of storage. Deploying 10 Tbytes of capacity consumes approximately 60U of co-location rack space (utilizing 3.5-inch, 36-Gbyte, 10K-RPM drives). To achieve this same capacity using SFF 2.5-inch, 36-Gbyte drives would require roughly 22U of space. With typical monthly co-location fees running anywhere from \$150/U to \$500/U, the savings from SFF deployment could immediately translate into \$5,700 to \$19,000 per month.

Cost savings are clearly a consolidation priority, but optimal storage consolidation also demands that performance needs be met both today and tomorrow, enabling enterprises to keep pace as markets expand and business opportunities grow. This ability is particularly key as online, transactional storage continues to play an ever-increasing role in the real-time enterprise.

SFF 2.5-inch enterprise disc drives are uniquely suited to meet the dual objectives of performance and space-efficiency. These compact drives are 70 percent smaller than 3.5-inch units, enabling them to deliver **130 to 150 percent greater system performance** in the **same footprint** (IOPS/U) and boost data center ROI. To look at it another way, 2U storage arrays equipped with 2.5-inch enterprise drives provide:

- 70 percent more IOPS (2U box vs. 3U box)
- 33 percent reduction in rack space (2U vs. 3U)
- 155 percent more IOPS (on IOPS/U basis compared to 3U)

Furthermore, 2.5-inch drives use 40 percent less power and thus run cooler and require less airflow; this enables greater storage density and data center space efficiency. Here again SAS proves to be an optimal complement to SFF 2.5-inch disc drives, as the greater drive counts found in high-density storage solutions are easily handled by the exceptional scalability of SAS (128 devices per edge expander and over 16,000 devices in a single SAS domain).

In addition, the 2.5-inch drive's compact chassis delivers benefits that go beyond higher drive counts. It also improves airflow within 1U spaces, allowing servers to use faster processors that consume more power and generate more heat.

Finally, SFF 2.5-inch drives reduce TCO with superior reliability and longer service life; their 1.4 million hour MTBF is approximately 15 percent greater than prior-generation 3.5-inch, 10K-RPM drives.

As the following table illustrates, SFF 2.5-inch enterprise disc drives boost data center performance and efficiency across a broad range of storage applications:

Data Center Economies of SFF 2.5-Inch Enterprise Drives			
Storage Application	SFF 2.5-Inch Solution	Conventional 3.5-Inch Solution	Results
2U Rack-Optimized Storage Array	25 2.5-inch enterprise drives	14 3.5-inch enterprise drives	2.5-inch drives give <b>over 185% greater performance</b> in same footprint
Rack Server	1U—six (6) 2.5-inch enterprise drives	2U—six (6) 3.5-inch enterprise drives	2.5-inch drive enables full <b>RAID 5</b> functionality in <b>1U</b> space, delivering <b>150% greater performance</b> than 3.5-inch/2U server while <b>saving 50%</b> on rack space costs
Blade Server	One 2.5-inch <b>enterprise</b> drive	Two 2.5-inch <b>notebook-class</b> drives (mirrored)	2.5-inch enterprise drive gives blade server <b>enterprise-class reliability, 150% higher IOPS</b> in same footprint

\*Based on \$1000/sq. ft. estimated data center cost (Source: IDC)

Table 1

For most enterprises, greater capacity will always be a goal. This is hardly surprising, given that IDC projects worldwide data growth at approximately 50 percent per year over the next several years. Here again SFF 2.5-inch drives prove their value, for as capacity grows and more data must be accessed, **drive I/O must increase simply to maintain current effective performance** (IOPS/GB). Substituting higher-capacity 3.5-inch drives (in order to keep drive footprint constant) will actually drop IOPS/GB. By contrast, SFF 2.5-inch drives can maintain (or even increase) IOPS/GB at higher capacities because more drives will fit into a given chassis size than 3.5-inch units. More drives per GB = more actuators accessing the same amount of data, yielding higher IOPS/GB.

## Driving the Server Revolution

As detailed in Table 1 (see above), the far-reaching benefits of SFF 2.5-inch disc drives aren't limited to storage arrays. Today's 1U servers and blade servers are driving a new cost-effectiveness paradigm; adding 2.5-inch enterprise drives to these economical servers will significantly boost their ability to meet a broad range of enterprise applications.

Deploying a 1U server with six SFF 2.5-inch drives enables it to achieve full RAID 5 functionality in **half the space** required by a 2U server equipped with six 3.5-inch disc drives, and the 1U server will provide a 150 percent performance improvement. For additional perspective, consider that 1U servers equipped with 2.5-inch drives also deliver:

- 58 percent more IOPS on a IOPS/U basis [six 2.5-inch drives (1U) vs. six 3.5-inch drives (2U)]
- 40 percent lower power consumption [six 2.5-inch drives (1U) vs. six 3.5-inch drives (2U)]
- 220 percent more IOPS at similar power level (two 2.5-inch-equipped 1U servers vs. one 3.5-inch-equipped 2U server)

A blade server with a single 2.5-inch, 10K-RPM enterprise drive will enjoy far greater reliability, while yielding 150 percent more IOPS, than an identical server utilizing a two-notebook-drive mirrored solution. Such notebook drives offer only 5400-RPM or 7200-RPM disc speeds; furthermore, they are designed for lighter, 8/5 duty cycles. Lastly, notebook-class units lack the full-featured enterprise I/O protocol that helps SFF 2.5-inch drives deliver superior performance.

## Profile: 2.5-Inch Enterprise Disc Drives

SFF 2.5-inch, 10K-RPM enterprise disc drives employ a complementary suite of technical advances optimized for high-density enterprise storage environments:

### 2.5-INCH DIAMETER DISCS

Offering the same capacities as typical 3.5-inch enterprise discs, 2.5-inch diameter discs enable improved seek times (15 percent faster) by packing the same amount of data in a smaller area, thus decreasing the distance the actuator must move to locate a given piece of data.

### SHORTER, STIFFER ACTUATOR

Because it traverses the smaller radius of a 2.5-inch disc, the drive's actuator arm can be shorter, stiffer and lighter. Additional stiffness ensures higher strength and greater immunity to vibration, while a lighter arm requires less power to move it, cutting the drive's net power requirements.

### COMPACT DRIVE MOTOR

Spinning fewer (two-disc maximum) smaller-diameter, lighter 2.5-inch discs, the drive's motor can be more compact and less powerful. This yields lower power consumption and heat generation; cooler-running drives can thus be more tightly packed for high-I/O-density applications.

### COST-EFFECTIVE DRIVE PROFILE

The combination of features described above enables SFF 2.5-inch drives to be remarkably efficient, 70 percent smaller than conventional 3.5-inch drives while consuming 40 percent less power. This reduces a 2.5-inch-based system's cost in terms of both rack space and data center footprint.

### ENTERPRISE-CLASS RELIABILITY

To withstand the rigors of online, transactional storage applications, the SFF 2.5-inch disc drive features true enterprise-class reliability, measured under full-duty-cycle conditions. Its 1.4 million hour MTBF is approximately 15 percent higher than prior-generation 3.5-inch, 10K-RPM drives.

### COMPREHENSIVE RANGE OF INTERFACES

SFF 2.5-inch drives are now available in both 2 Gbits/sec Fibre Channel and Ultra320 SCSI interfaces, with Serial Attached SCSI (SAS) released in early 2005. With this full range of enterprise-class interfaces, 2.5-inch drives will easily integrate into existing storage infrastructures.

Specifications: SFF 2.5-Inch Enterprise Disc Drive*	
Form Factor	2.5 inch, 15 mm
Capacity (Gbytes)	36.7, 73.4
Interfaces	Ultra320 SCSI, Serial Attached SCSI (SAS), Fibre Channel
Spindle Speed (RPM)	10,000
Avg. Seek (R, msec)	4.1
Track-to-Track (R/W, msec)	.4/.7
Transfer Rate (Mbytes/sec)	62 to 94; 41 to 63 sustained
Cache Buffer (Mbytes)	8
Full-Duty MTBF (hours)	1,400,000
Disc/Head (#)	1/2 (36.7 Gbytes), 2/4 (73.4 Gbytes)
Idle Power (watts)	<5.1, Read <8.0

\* Seagate Savvio (ST936701LC, ST973401LC) specifications, July 2004

Table 2

## Conclusion

Many of today's enterprises are committed to a challenging fiscal policy: Accelerate growth while simultaneously implementing significant cost reductions. Data center consolidation holds great promise for such cost cutting, but it demands storage solutions that deliver enhanced performance while freeing up expensive data center floor space. The new small form factor 2.5-inch enterprise disc drives are just such a solution, offering superior I/O performance when compared to conventional 3.5-inch disc drives, yet requiring far less data center space and consuming significantly less power. Simply put, this innovative class of speedy, efficient drives heralds a new era of high-density enterprise storage.