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# High–Performance for Everyday Workloads

## Adaptec Unified Serial™ RAID 3805 vs. 3ware 9690SA-8i, LSI 888ELP

Taking full advantage of the latest high-density servers and workstations without compromising your data or your data protection has become an essential storage challenge for many businesses. The key to achieving optimal performance for your business is to understand how the new RAID controllers designed for the PCI Express (PCIe) environment will work under the demands of your daily workload. This whitepaper will cover how different PCIe RAID controllers perform in real-world workload environments.

### Server and Workstation Characterization

Ensuring your storage subsystem can deliver sufficient performance for your applications can be very complicated. Each server has unique workload characteristics; however there are some basic generalizations we can make about the storage demands typically found in workstations and servers. Although storage system workloads differ quantitatively in terms of the transfer sizes, locality, intensity, and distribution of reads vs. writes, the most common applications can be reduced to six different measurement classifications. By simulating these access patterns, system integrators and administrators can evaluate the performance capabilities for most server and workstation workloads prior to deployment. These measurements, characteristics, and their counterpart applications can be found in the chart below.

### Streaming I/O

Streaming reads and writes are defined as contiguous read or write requests made to the disk(s), and are typically created by media applications such as video or audio. Due to the decreasing cost of Serial ATA (SATA) disks, an increasingly popular streaming application is VTL, or virtual tape libraries. VTL applications use pre-existing backup software to write to disk storage, significantly improving the performance and accessibility of backups, while

decreasing the Recovery Point Objective (RPO) and Recovery Time Objective (RTO). Because VTLs can back up from multiple locations simultaneously, multiple I/O threads are generated throughout the disk, creating a temporally pseudo-random access pattern. Archiving and medical imaging fall into the streaming reads and writes category, and are propelling the need for storage repositories by as much as 50-60% every year.

### Online Transaction Processing

Our digital economy has become more reliant on storage systems for archiving online transactions and vital records – such as database applications including decision support/data warehousing, web-based e-commerce, and business reporting. According to Bellwether IT organizations, transaction processing is increasing by 15-18% per year[1]. Transaction processing requests are generally made against a database such as SAP, Oracle, or SQL and typically consist of a read, modify, write, and verify operation request for a specific record. An active database server may receive thousands of I/O requests per second and end users are generally very sensitive to the time it takes to perform their requested operation. Consequently, maintaining low latency while servicing hundreds or even thousands of users – and ensuring strict in-order processing – is vital for an efficient and reliable transactional disk subsystem.

| Measurement | I/O Characteristics | Typical Applications |
|---|---|---|
| Streaming Reads | 100% Reads; Large contiguous requests; 1-64 concurrent requests. May be threaded. | Media Servers (Video on-demand, etc.). Virtual Tape Libraries (VTL), Application Servers |
| Streaming Writes | 100% Writes; Large contiguous requests; 1-64 concurrent requests. May be threaded. | Media Capture, VTL, Medical Imaging, Archiving, Backup, Video Surveillance, Reference Data |
| OLTP | Typically 2KB – 16KB request sizes; Read modify, write, verify operations resulting in 2 reads for every write; Primarily random accesses. Large number of concurrent requests. | Databases (SAP, Oracle, SQL), Online Transaction Servers |
| File Server | Moderate distribution of request sizes from 4KB to 64KB, however 4KB and 64KB comprise 70% of requests; Primarily random; Generally 4 reads for every write operation. Large number of concurrent requests during peak operational periods. | File and Printer Servers, e-mail (Exchange, Notes), Decision Support Systems |
| Web Server | Wide distribution of request sizes from 512 bytes to 512KB; Primarily random accesses; Large number of concurrent requests during peak operational periods | Web Services, Blogs, RSS Feeds, Shopping Carts, Search Engines, Storage Services |
| Workstations | Primarily small to medium request sizes; 80% sequential and 20% random; Generally 4 reads for every write operation. 1-4 concurrent requests. | Business Productivity, Scientific/Engineering Applications |

**Table 1 – Measurement applicability and related applications and workload characteristics**

1. Joseph C. Pucciarelli, Research Director, IDC, "Building the Pyramids: End-User Trends in Storage Provisioning, Financing & Portfolio Mgmt" presentation

### File Servers

Characterizing file system behavior is difficult due to the wide range of workloads these systems encompass. Shrinking IT budgets and improved network connectivity have led many companies to condense their file servers and as a result, today's file servers typically service more clients than in the past. Network file servers are already challenged with considerable network and file system protocol processing (such as NFS, SMB, or FTP). These servers are ideal candidates for I/O offloading provided by hardware RAID. File server client requests tend to be scattered across the span of the disks, with distinct hot spots. These hot spots, which typically contain file information structures, open-file updates, page-swapping regions, and other frequently-accessed data, benefit from effective temporal caching. File accesses tend to have a bimodal distribution pattern: some files are written repeatedly without being read; other files are almost exclusively read. File servers are characterized by a four-to-one ratio of reads to writes.

### Web Servers

E-business and e-tailing have transformed the international business landscape. The growing dependence of today's commerce on electronically enabled business processes has propelled the growth of web servers. Static and dynamic web page requests are comprised almost exclusively of read requests with generally random I/O distributions. Studies have shown that approximately 84% of web server request sizes fall below 16KB, while the remaining 16% is evenly distributed from 32KB to 1MB (consisting primarily of video, audio, and images). RAID enhances web server performance by distributing the requests across all the participating drives, significantly increasing performance while also improving availability and reliability of the storage server.

### Workstations

The nature of the workstation environment consists primarily of a single user running multiple applications, which operate in such a way as to leverage the operating system virtual memory subsystem (VMS). High-end workstations are classically used for engineering, scientific, graphics design, and office applications, and nowadays even for gaming systems. Workstation workloads are predominantly a mix of random accesses of blocks that match the VMS's page granularity, file allocation table updates, and a sequential component of read and write disk stores once the task is finished, resulting in a four-to-one ratio of reads to writes. Even multi-tasking users must wait for the disk operation to complete before being able to continue; therefore latency is important to maintaining a high level of productivity.

### Measuring Performance

Most vendors consider IOmeter the defacto tool for generating and measuring storage performance. Although its workloads are artificial, IOmeter allows you to simulate application disk requests. In addition, it measures not only the throughput, but provides a wealth of information about the system utilization and latency. The IOmeter workload generator, known as dynamo, has been ported to many operating systems including Windows, Linux, Solaris, NetWare, and MacOS. The GUI itself is only available for Windows on IA32 / IA64 platforms.

### Data Protection

The RAID type used to protect an array of disks is based upon several factors including: capacity, availability, performance, and cost. These factors are based upon current company requirements, however often storage needs change with time. A RAID solution should allow your storage to keep pace with changing business requirements as your needs change. A good solution should also minimize your downtime if an event occurs. Balancing all these factors to create an effective storage subsystem customized to your requirements can be challenging.

To learn more about selecting a RAID level that is right for you, go to: *www.adaptec.com/whichRAID*.

### Putting It All Together

The ideal RAID solution consists of balancing trade-offs between fault tolerance, cost, and performance requirements. For small arrays, redundancy requirements for RAID 5 and 6 may be too high. And, while both a four-drive RAID 6 and a four-drive RAID 10 require forfeiting 50% of your capacity, the RAID 6 can sustain a loss of any two disks, while the RAID 10 can only sustain a loss of one disk from each redundant leg, significantly reducing the Mean Time to Data Loss (MTTDL). If data availability is your primary concern, the lower performance of a RAID 6 may be worth it, especially for applications such as web servers or video-on-demand (VOD) systems where performance is generally indistinguishable.

### The Adaptec Performance and Protection Advantage

With five new low-profile PCIe RAID controllers from Adaptec, there is no need to compromise your data for even your densest servers. With the first–to-market MD2-compliant SATA/SAS hardware RAID controllers, a high-speed 800 MHz Intel® embedded processor, and 256 megabytes of on-board cache, Adaptec offers world-class, high-performing, scalable Unified Serial™ solutions to fit your business needs.

| Low Profile Controller | Internal Connectors | Connector Type | External Connectors | Connector Type | Processor | Cache | System Interface |
|---|---|---|---|---|---|---|---|
| Adaptec RAID 3405 | 4 | SFF8087 | 0 | · | 500 MHz Intel 80333 | 128MB ECC Protected DDR2-400 | x4 PCIe |
| Adaptec RAID 3805 | 8 | SFF8087 | 0 | · | 500 MHz Intel 80333 | 128MB ECC Protected DDR2-400 | x4 PCIe |
| Adaptec RAID 3085 | 0 | · | 8 | SFF8088 | 800 MHz Intel 80333 | 256MB ECC Protected DDR2-400 | x8 PCIe |
| Adaptec RAID 31205 | 12 | SFF8087 | 0 | · | 800 MHz Intel 80333 | 256MB ECC Protected DDR2-400 | x8 PCIe |
| Adaptec RAID 31605 | 16 | SFF8087 | 0 | · | 800 MHz Intel 80333 | 256MB ECC Protected DDR2-400 | x8 PCIe |

**Table 2 – Adaptec Unifed Serial controller maxtrix.**

Adaptec hardware RAID controllers allow your storage to keep pace with changing business requirements. Online Capacity Expansion (OCE) allows you to dynamically increase the size of your array as your storage and performance requirements grow. Array migration allows you to morph your array from one RAID type to another. Our newest generation of Unified Serial products supports redundant path failover to minimize downtime by providing multiple paths to your data, a feature once only found in costly enterprise-class storage.

Given the diverse options available from Adaptec Unified Serial products, it is advantageous to have a clear understanding of how they perform in the storage workload environment in order to make the best choice for your workstations and servers.

### Drive Choice

One of the most important factors in your system is the choice of high-density Serial ATA (SATA) drives or high-performance Serial Attached SCSI (SAS) drives.

Even if you are seeking a controller to use solely with SATA drives today, controllers which support both drive types, such as Adaptec Unified Serial controllers, help you get the most from your investment.

A Unified Serial controller lets you take advantage of the most scalability with SATA drives. Expand your SATA storage to up to 128 separate disks or storage devices — instead of being limited by the number of ports on the card, and needing to add a controller whenever you run out of ports.

Controllers that support both drive types also provide the flexibility and long-term investment protection to begin integrating SAS drives into the SATA storage environment, without upgrading your controller or replacing equipment you're already using. This flexibility gives you the ability to create the right storage for your business at any given time, using SATA and SAS drives in the same system.

Naturally, pairing SAS drives with a controller that supports SAS, provides the highest performance available today.

In the end, your choice of controller and disks will be the ones that deliver the right combination of performance, protection, and investment flexibility for your business.

### Competitive Analysis

Because 70% of businesses have experienced catastrophic data loss, decreasing the critical backup and restore times helps minimize the monetary and productivity loss to businesses. With downtime costs estimated to be between $900,000 and $2.8 million per hour for many industries, storage performance really matters[2].

The following charts show performance comparison between several hardware RAID controllers for both SATA and SAS drives: LSI 8888ELP, 3ware 9690SA-8i, and the Adaptec RAID 3805.
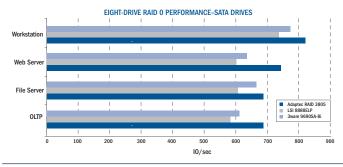


**Figure 1 – Eight-drive competitive workload performance comparison for Adaptec RAID 3805, LSI 8888ELP, and 3ware 9690SA-8i, using eight 7200 RPM Seagate SATA II disk drives in a cache-enabled RAID 0 array.**
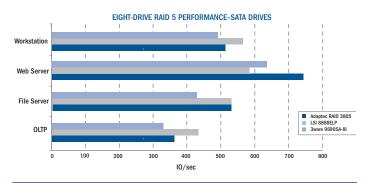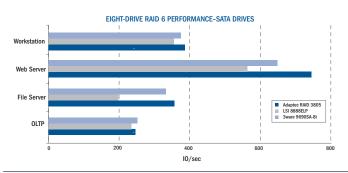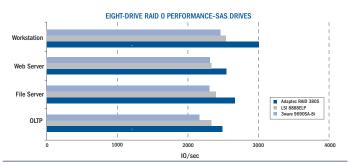


**Figure 2 – Eight-drive competitive workload performance comparison for Adaptec RAID 3805, LSI 8888ELP, and 3ware 9690SA-8i, using eight 7200 RPM Seagate SATA II disk drives in a cache-enabled RAID 5 array.**



**Figure 3 – Eight-drive competitive workload performance comparison for Adaptec RAID 3805, LSI 8888ELP, and 3ware 9690SA-8i using eight 7200 RPM SATA II disk drives in a cache-enabled RAID 6 array.**

RAID controllers should take full advantage of the performance capabilities of the disk drives. This helps reduce hardware costs, and improves overall system performance. For file servers providing workgroup services, a 30% increase in IOP performance means more clients can be serviced, ensuring fairer service times and increased user productivity.

**EIGHT-DRIVE RAID 0 PERFORMANCE–SAS DRIVES**

**Figure 4 – Eight-drive competitive workload performance comparison for Adaptec RAID 3805, LSI 8888ELP, and 3ware 9690SA-8i using eight 15K RPM Seagate SAS disk drives in a cache-enabled RAID 0 array.**
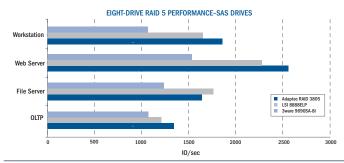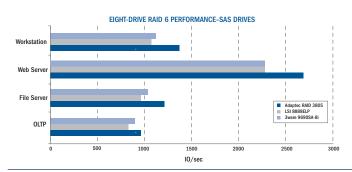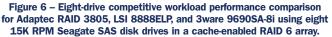
**EIGHT-DRIVE RAID 5 PERFORMANCE–SAS DRIVES**

**Figure 5 – Eight-drive competitive workload performance comparison for Adaptec RAID 3805, LSI 8888ELP, and 3ware 9690SA-8i using eight 15K RPM Seagate SAS disk drives in a cache-enabled RAID 5 array.**

**EIGHT-DRIVE RAID 6 PERFORMANCE–SAS DRIVES**

**Figure 6 – Eight-drive competitive workload performance comparison for Adaptec RAID 3805, LSI 8888ELP, and 3ware 9690SA-8i using eight 15K RPM Seagate SAS disk drives in a cache-enabled RAID 6 array.**

## Caching Features

Adaptec RAID controllers offer up to 256 megabytes of on-board cache to accelerate your application performance. To help optimize the cache effectiveness and robustness, Adaptec RAID code features dynamic caching, allowing caching only when it's beneficial to your current storage usage (for instance, during periods of write activity). Our read-ahead can also provide a significant improvement in streaming read requests, by pre-fetching data from the disks in anticipation of an application request.

## Adaptec Unified Serial Controllers: Your Best Choice for Performance and Protection for Today and Tomorrow

With storage needs increasing an average of 40% per year, it is necessary to invest in a RAID controller that allows your storage to grow with your business.  With full support for enclosure management and the ability to attach up to 128 disk drives, Adaptec Unified Serial controllers are guaranteed to grow with your business.

Serial Attached SCSI (SAS) disk drives provide better performance and higher reliability than nearline and enterprise SATA disks.  Although they are more costly per gigabyte than SATA, they can provide up to 500% more transactions and can supply a much needed performance increase for transactional servers especially in a space-constrained chassis.

Adaptec Unified Serial technology gives you the flexibility to attach SATA or SAS drives or both in a single storage system.  It also allows you to seamlessly grow from direct attached SATA drives into a serial-attached SATA and SAS ecosystem, meeting your current SATA needs while opening a growth path to the SAS infrastructure of the future.

## System Test Disclosure:

- Operating System: Windows 2003 Enterprise Edition, 64-bit, SP2 + all patches as of 10/15/2007
- Motherboard: Intel S5000XVN
- Processor: Intel 5160
- Memory:  2GB DDR2-667 ECC FBDIMM
- System Interconnect: x8 PCIe
- SATA Disks:  Seagate 7200RPM ST3250624NS (write/read cache enabled)
- SAS Disks:  Seagate 15K RPM ST336754SS (write/read cache enabled)
- All disk configurations are direct attached.

| RAID Controller | Drivers | Firmware | Utility |
|---|---|---|---|
| Adaptec RAID 3805 | StorPort 15317 | 15323 | Adaptec Storage Manager 17414 |
| LSI 8888ELP | StorPort 2.13.0.64 | 6.01-0065 | MegaRAID Storage Manager v2.19-00 |
| 3ware 9690SA-8i | v9.4.1.3 | v3.08.02.007 | 3DM 2 v2.06.00.007 |

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