Adaptec RAID Series 5 Outperforms the Competition

Adaptec Unified Serial™ RAID 5805 vs. 3ware 9690SA-8i, LSI 8888ELP, ATTO R380, Areca 1680

Your latest digital data and bandwidth-intensive applications demand a new level of performance and make data protection more important and more complicated than ever before. This has become the basic storage challenge for many businesses. The key to making the best storage investment for demanding applications is to understand how the latest high-performance RAID controllers designed for the PCI Express (PCIe) environment will work under the demands of your daily workload. This whitepaper will focus on how different PCIe RAID controllers perform in several of the most common real-world tasks.

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 five 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.

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

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 - 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 - 512KB; Primarily random accesses; Large number of concurrent requests during peak operational periods	Web Services, Blogs, RSS Feeds, Shopping Carts, Search Engines, Storage Services

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

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. Like workstations, file servers are still 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.

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 the latest PCIe RAID controllers from Adaptec, there is no need to compromise either performance or protection for your most demanding applications. Equipped with industry-leading dual-core RAID on Chip (RoC), x8 PCI Express connectivity and 512MB of DDR2 cache, they provide over 250,000 IO per second and 1.2GB/s.

They integrate advanced data protection and provide scalability up to 256 SATA and SAS disk drives using SAS expanders, through flexible offerings that combine internal and external port choices. This product family is designed for OTLP, network attached storage, and other bandwidth-intensive applications.

The latest Adaptec high-performance 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. Redundant path failover minimizes downtime by providing multiple paths to your data.

With a diverse range of Unified Serial controllers available from Adaptec, it is advantageous to have a clear understanding of how they perform in your applications in order to make the best choice for your workstations and servers.

Low Profile Controller	Internal Connectors	Connector Type	External Connectors	Connector Type	Processor	Cache	System Interface
Adaptec RAID 5405	4	SFF8087	0	·	1.2GHz dual-core RAID on Chip	256MB ECC Protected DDR2-533	x8 PCI-E
Adaptec RAID 5445	4	SFF8087	4	SFF8088	1.2GHz dual-core RAID on Chip	512MB ECC Protected DDR2-533	x8 PCI-E
Adaptec RAID 5805	8	SFF8087	0	·	1.2GHz dual-core RAID on Chip	512MB ECC Protected DDR2-533	x8 PCI-E
Adaptec RAID 5085	0	·	8	SFF8088	1.2GHz dual-core RAID on Chip	512MB ECC Protected DDR2-533	x8 PCI-E
Adaptec RAID 51245	12	SFF8087	4	SFF8088	1.2GHz dual-core RAID on Chip	512MB ECC Protected DDR2-533	x8 PCI-E
Adaptec RAID 51645	16	SFF8087	4	SFF8088	1.2GHz dual-core RAID on Chip	512MB ECC Protected DDR2-533	x8 PCI-E
Adaptec RAID 52445	24	SFF8087	4	SFF8088	1.2GHz dual-core RAID on Chip	512MB ECC Protected DDR2-533	x8 PCI-E

Table 2 – Adaptec high-performance Unified Serial solutions maxtrix

Competitive Analysis

Adaptec Unified Serial controllers are designed to deliver performance in a platform that provides the flexibility to connect high-capacity Serial ATA (SATA) drives, high-performance SAS drives, or both in a single environment.

The following charts show a performance comparison between Adaptec Unified Serial controllers and competitors including the LSI 8888ELP, 3ware 9690SA-Si, ATTO R380, Areca 1680, and Promise EX16350 connected to SATA disks and SAS disks.

Figure 1 shows performance in a RAID 5 environment that reflects the demands of OLTP, file, and web servers, using 16 SATA disks. Figure 2 shows performance in the same environment for RAID 6.

Equipped with SATA disks, the Adaptec RAID 5805, with 8 external ports, beats competitors up to 50%. In the SAS comparison, the Adaptec RAID 5805 again outperforms all competitors.

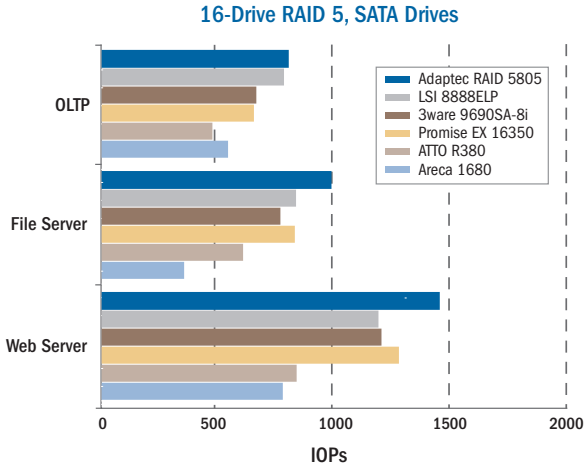

Figure 1. Sixteen-drive competitive workloads performance comparison for Adaptec RAID 5805, 3ware 9690SA-8i, Promise EX 16350, LSI 8888ELP, ATTO R380, and Areca 1680 using sixteen 7200 RPM Seagate SATA II disk drives in a cache enabled RAID 5 array.

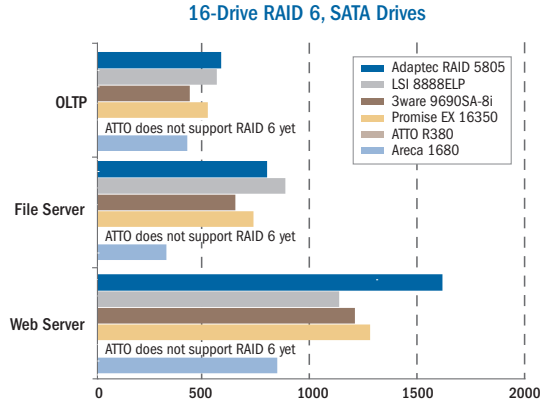

Figure 2. Sixteen-drive competitive workloads performance comparison for Adaptec RAID 5805, 3ware 9690SA-8i, Promise EX 16350, LSI 8888ELP, ATTO R380, and Areca 1680 using sixteen 7200 RPM Seagate SATA II disk drives in a cache enabled RAID 6 array. ATTO does not support RAID 6.

Figure 3 shows performance in a RAID 5 environment that reflects the demands of OLTP, file and web servers, using 16 SAS disk drives. Figure 4 shows performance in the same environment for RAID 5.

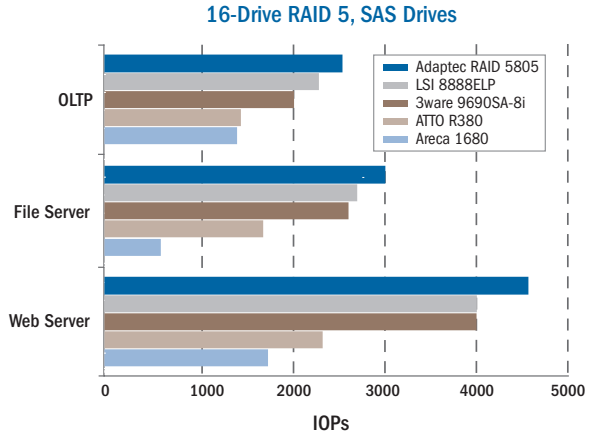

Figure 3. Sixteen-drive competitive workloads performance comparison for Adaptec RAID 5805, 3ware 9690SA-8i, LSI 8888ELP, ATTO R380, and Areca 1680 using sixteen 15K RPM Seagate SAS disk drives in a cache enabled RAID 5 array.

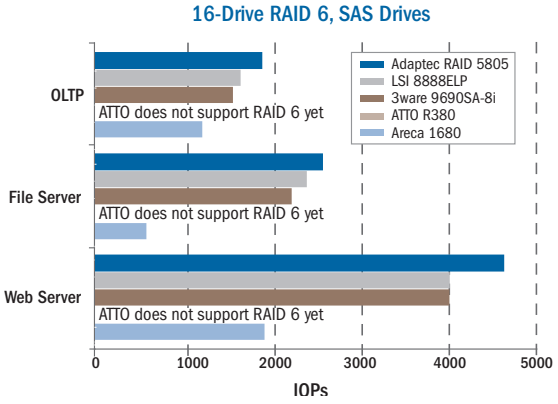

Figure 4. Sixteen-drive competitive workloads performance comparison for Adaptec RAID 5805, 3ware 9690SA-8i, LSI 8888ELP, ATTO R380, and Areca 1680 using sixteen 15K RPM Seagate SAS disk drives in a cache enabled high-availability RAID 6 array. ATTO does not support RAID 6.

The other functional basis for applications is the write operations, used in archiving and backup as well as many of the latest rich-media applications, including media capture, imaging, and video surveillance.

Figure 5 compares performance in an environment with 100% sequential writes up to 256KB, using 16 SATA disks. Figure 6 shows performance in the same environment using 16 SATA disks.

Using SATA disks, the Adaptec RAID 5805 outperforms competitors by 30 to 160%. Using SAS disks, the Adaptec RAID 5805 achieves even higher performance, more than 30% higher than the nearest competitor.

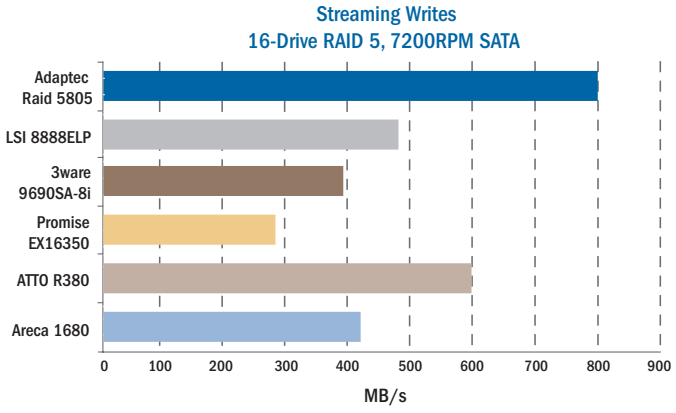

Figure 5. Competitive performance analysis for controllers with SATA disks in file write-heavy environments.

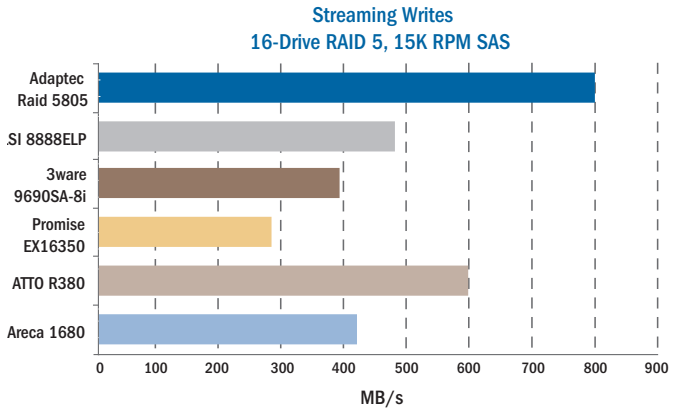

Figure 6. Competitive performance analysis for controllers with SAS disks in file write-heavy environments.

Adaptec Unified SAS Controllers: Performance for Today and Tomorrow

With storage needs increasing 40% each year, it's necessary to invest in a RAID controller that allows your storage to grow with your business. With full support for enclosure management, a flexible mix of internal and external ports, and the ability to attach up to 256 disk drives using SAS expanders, the latest Adaptec Unified Serial controllers are guaranteed to grow with your business.

These controllers increase the performance of the SATA drives you may be using now. However, SAS drives provide better performance and higher reliability than nearline and enterprise SATA disks. Although they are more costly per GB than SATA, they can provide up to 500% more transactions for demanding applications.

The Adaptec Unified Serial platform allows you to seamlessly grow from direct attached SATA drives into a serial-attached environment that integrates SATA drives and SAS drives, and makes reallocating storage or upgrading performance as simple as swapping out disks. This provides performance for your current needs while opening a growth path to the fully SAS infrastructure of the future.

System Test Disclosure

- Adaptec 5805
  - 512MB DDR2-533 cache
  - Array write/read cache enabled
  - Default stripe size used
- Intel S5000XVN, Intel 5160 (Woodcrest), 2GB DDR2-667 FBDIMM
- Microsoft Server 2003 Enterprise Edition 64-bit, SP2 + all updates as of 12/06/2007
- SATA: 7200RPM Seagate ST3250624NS
  - Disk cache enabled
- SAS: 15K RPM Seagate ST336754SS
  - Disk cache enabled

RAID Controller	Drivers	Firmware	Utility
Adaptec RAID 5805	StorPort 10633	10633	Adaptec Storage Manager 15286
LSI 8888ELP	StorPort 2.17.0.64	1.12.120320	MegaRAID Storage Manager v2.30-00
3ware 9690SA-8i	MiniPort v3.00.03.092	v4.04.00.002	3DM 2 v2.07.00.003
ATTO R380	StorPort 1.1.2.0	6.27.07	ATTO Configuration Tool v3.12
Areca 1680	StorPort 6.20.0.14	1.43	Areca HTTP Proxy Server Gui 1.82

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