

# High-Performance Hybrid Arrays (HPHAs)



## Using the power of SSDs without having to re-write your applications

As application needs continue to grow, computing architectures have evolved along a relatively straightforward path. CPUs get more powerful on a regular basis, networking speeds increase, disk drive capacities continuously double, etc.

But despite all these improvements, applications and their users continue to need more. In many cases the limiting factor is the rate at which I/O operations can be performed.

For example:

- An online transaction processing system is often limited by the rate at which database updates can occur.
- The performance of a search algorithm may depend on how quickly various data structures can be read from disk.
- The number of users that can successfully access a Web site depends on how quickly Web pages can be served.

The traditional approach to this problem has been to use really fast disk drives — for example 15,000 RPM SAS drives — and to “short stroke,” which means that applications use only the outermost tracks on the disks where the performance is best, sacrificing disk capacity for speed.

Because of this, two distinct types of storage solutions have emerged:

- High performance, low capacity solutions built from relatively large numbers of Serial Attached SCSI (SAS) drives
- Lower performance, high capacity solutions built from Serial ATA (SATA) drives

Fortunately, Adaptec’s Unified Serial® Architecture is able to handle both types of solutions, or even mix and match the two within a single controller, so system integrators choose Adaptec technology when building flexible systems to meet these types of disparity requirements.

But every now and then a new technology appears that offers the chance to radically change the way computing systems are put together. Solid State disk drives (SSDs) are one such technology.

Relative to standard magnetic hard disk drives (HDDs) SSDs offer extremely high performance and low latency, consume very little power and require almost no cooling. And the difference is dramatic — certain operations can be performed more than a hundred times faster on an SSD than is possible on a rotating disk.

### What’s the catch?

These advantages do come with a cost. Today’s SSDs are MUCH more expensive than rotating drives, especially when measured using the traditional “cost per GB of capacity” metric. As a result, in most environments it is simply impractical to consider replacing your total storage capacity with SSDs regardless of the potential benefits.

However, a combination of rotating and solid state drives offers an interesting possibility and can be extremely cost efficient, particularly when measured in terms of the “cost per I/O operation,” or the more Green-oriented “power consumption per I/O operation”.

### But how should such a “hybrid” solution be built?

Building a solution which mixes SSD and HDD drives may look easy, and as far as storage management is concerned, it is. But it offers significant challenges to applications since most software was not created to be aware of the possibility of having two types of storage with such different characteristics. In the worst case, your chosen applications may simply have no idea how to partition their data between SSDs and HDDs. In the best, you have to employ “rocket scientists” or “software wizards” to go in and reconfigure or “tune” applications for best performance. And in many cases you have to do this not just once, when you build your systems, but on a continuous basis as your data evolves and ages.

### Adaptec’s High-Performance Hybrid Array (HPHA) Technology

A much better solution would be to offer transparent SSD integration into your storage that provides the same benefit as front-end application tuning. It would deploy SSD technology as a complement to traditional rotating media and create a hybrid form of SSD & HDD storage. This is a reality with Adaptec’s High Performance Hybrid Array technology.

These Hybrid Arrays use SSDs along with SATA or SAS HDDs to combine the best of both types of disk: large, scalable capacities of affordable HDDs combined with the lowest latency, highest IOPS and energy-efficient SSDs to provide the best price-performance solution.

At the heart of these Hybrid Arrays is an SSD-aware storage controller which uses intelligent storage processing to determine how to most efficiently store data between the HDDs and the SSDs without invasive tuning to your applications or operating systems.

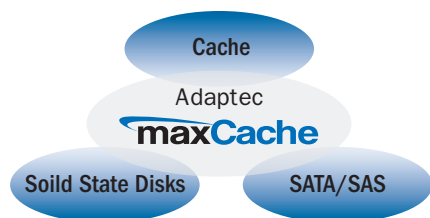
## High-Performance Hybrid Arrays

Using Adaptec maxCache products with SSD Caching, High-performance Hybrid Arrays (HPHAs) provides maximum performance at the lowest capital investment and operating costs. Depending on performance and capacity needs, an HPHA can consist of any combination of high-capacity, low-cost SATA drives or higher-performance SAS drives, plus SSDs, to create a hybrid storage solution that delivers the lowest cost/GB and lowest cost and power consumption per I/O.

### How does an HPHA work?

SSDs have somewhat unusual performance characteristics. A single SSD can, all by itself, satisfy more than 30,000 read operations per second — as much as almost 100 ultra-high performance SAS drives. But write performance, particularly for small random blocks, can be much lower, sometimes even lower than for a rotating hard disks. The performance of an SSD can also vary quite dramatically over time due to fragmentation of its internal flash memory blocks. As a result, figuring out how to tune or reconfigure applications for these “raw” SSDs is a real challenge.

HPHAs using maxCache SSD Caching combine one or more SSDs with any number of SATA or SAS disk drives to provide consistent, reliable high performance without any need for application tuning or redevelopment. Adaptec’s maxCache SSD Caching uses SSDs as an I/O cache pool – “hot” data that is being accessed often is copied to an SSD cache pool where the benefit of ultra-fast read operations can be advantageous. “Cold” data which is being accessed infrequently, or which is being written continuously, resides on rotating disks. Such a hybrid array can consistently and reliably provide close to 20,000 read operations per second without degrading write I/O performance.

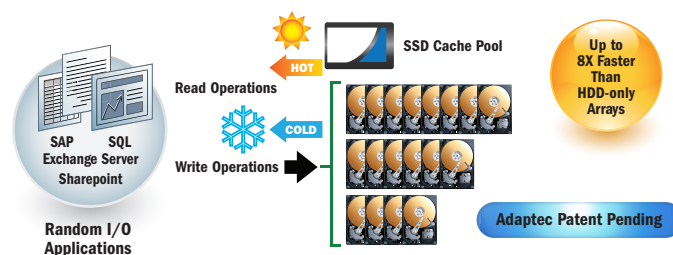


Adaptec leverages its unique presence in the data path to learn the application’s I/O pattern. It then uses its unique ability to interface with the on board DRAM cache, the flash SSD devices, and the rotating media to determine where to place data for the best and most reliable performance.

Initially data is written to, and read from, the rotating disk drives in the system just as it would be normally. But as it “learns the application,” the Adaptec SSD Caching Software progressively copies frequently-read (“hot”) data blocks to the SSD cache pool for faster retrieval during future requests. As they are copied to the SSD cache pool these “hot” blocks automatically displace older “colder” data blocks, naturally adapting to the time-dependencies in your data.

Once copied to the SSD cache pool, updates can happen on both the SSD and the rotating disk drives to keep the data in the SSD cache pool current. Or, if the software detects access patterns to blocks for which the characteristics of the SSD are not well-suited, it simply deletes those blocks from the SSD cache pool and lets the sophisticated algorithms for rotating disk management take over to optimize their storage on the regular disks.

All of this activity is completely transparent to the operating system and all running applications.



**maxCache reads hot data from the SSD cache and routes cold data to the HDDs for maximum performance.**

### HPHA Benefits

HPHAs with Adaptec’s maxCache SSD Caching technology provides the following benefits:

#### Reduced Capital Expenditures

HPHAs create the possibility of storage architectures which can massively upgrade application performance and latency characteristics without the need to replace all of your storage with SSDs. It provides the optimal “cost per IO”.

Using SSD cache pools as part of HPHAs eliminates the need to handle data protection on the SSDs by themselves – you don’t need to double the number of SSDs in your architecture to mirror them for redundancy.

#### Reduced Operating Expenses

HPHAs eliminate the need for doing application-specific tuning or software rewrites, and also make it possible to do the same, or more, with fewer more power-efficient disk drives, reducing power and cooling costs.

#### Uncompromised Data Protection

All data written to an HPHA is stored on the rotating media using the data protection algorithms that have been proven and hardened over many years. Data stored in the SSD cache pool is a copy of the data on the rotating drives. If the SSD should eventually wear out, it can simply be replaced without compromising data integrity in any way.

# High-Performance Hybrid Arrays

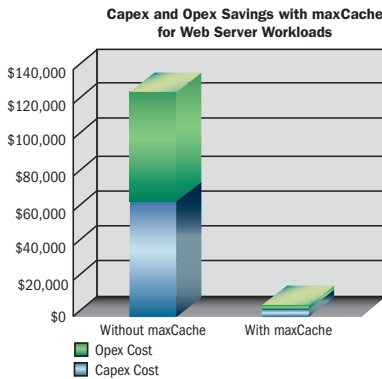
## Improved SSD Consistency and Reliability

Data is written directly to the HDD and copied to the SSDs ONLY when the Adaptec software can see potential benefit to the application. This reduces the number of write operations to the SSD, and also the fragmentation of the data on the SSD, prolonging its life and reducing performance inconsistencies.

## Application Optimization

HPHAs optimize all applications without requiring user intervention or IT application tuning. They work with applications that have no built-in capability to support data partitioning or tuning and also adapt automatically to varying workloads or time dependencies or “aging” behavior in your data.

## Sample Total Cost of Ownership Scenarios



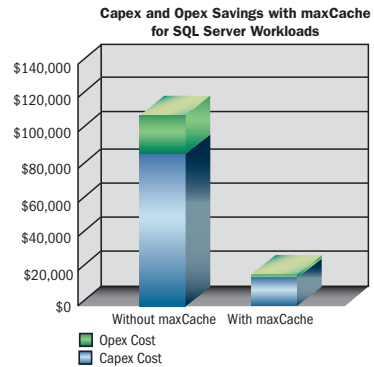
### Web Processing: Assumes incremental need to handle 15,000 IOPS for additional web sites and web hits

	Without maxCache	With maxCache
<b>Servers required</b>	50	2
<b>Rack space required</b>	50u	2u
<b>3-year power &amp; cooling cost</b>	\$39,000	\$1,800
<b>Reduction in Total Cost of Ownership (TCO) with MaxCache</b>	93%	



**PMC-Sierra, Inc.**  
 Mission Towers  
 3975 Freedom Circle  
 Santa Clara, CA 95054 USA  
 Tel: +1 (408) 239-8000  
 Fax: +1 (408) 492 9192

World Wide Web: [www.adaptec.com](http://www.adaptec.com)  
**Pre-Sales Support:** **US and Canada:** 1 (800) 442-7274 or (408) 957-7274 or [adaptesales@pmc-sierra.com](mailto:adaptesales@pmc-sierra.com)  
**UK:** +44 1276 854 528 or [uk\\_sales@pmc-sierra.com](mailto:uk_sales@pmc-sierra.com)  
**Australia:** +61-2-95031555  
**Singapore:** +65-92351044



### eCommerce Processing: Assumes incremental need to handle 50,000 IOPS for additional orders

	Without maxCache	With maxCache
<b>Servers required</b>	14	5
<b>Rack space required</b>	28u	5u
<b>3-year power &amp; cooling cost</b>	\$14,700	\$1,000
<b>Reduction in Total Cost of Ownership (TCO) with MaxCache</b>	76%	

As can be seen, the HPHA configuration is equivalent in capacity and better in every other category. Higher total capacity could easily be achieved in the HPHA case since it can take advantage of high capacity SATA drives.

## Conclusion

Data center and cloud-computing environments are under constant and increasing pressure to improve system performance to accommodate more robust applications and larger user bases.

Ideal for high “read” applications, such as web serving, file serving, and databases, Adaptec’s High Performance Hybrid Array technology combines solid state disks (SSDs) along with SATA or SAS hard disk drives (HDDs) to deliver the highest I/Os per dollar at the lowest dollars per gigabyte.

Adaptec’s maxCache SSD Caching Software introduces patent-pending Learned-Path algorithms that identify frequently-read (“hot”) data and copy it directly into an optimized SSD cache pool for faster retrieval. Such a hybrid array can provide close to 20,000 read operations per second without degrading write I/O performance and while remaining completely transparent to the operating system and all running applications.

With 28 years as the global I/O leader, we are at the forefront of developing innovative high-performance solutions that intelligently route, optimize and protect data as it moves through the I/O path.