1. Summary
Cloud computing is emerging as a key application service for the new Data Centers. Scalable resources, technology convergence, compliance, simplified management and reduced cost of ownership are emerging as predominant needs for data center customers.

Hosted applications that are resident within the data center are becoming increasingly intelligent and can exploit direct-attached servers, used as “scale out clusters,” consuming available bandwidth, making I/O pathways bottlenecks to scalability. Traditional rotating media based hard disk drives (HDDs) are proving to be a weak link in this high performance I/O path.

Solid State Drives (SSDs) are emerging as a solution to this problem. High performance, low latency and low power consumption are key attributes of SSDs and are necessary to optimize heavy workload applications. But, SSDs alone cannot completely address these problems. Deploying SSDs and expecting increased I/O bandwidth purely on the merits of SSD specifications will leave most IT managers disheartened. Database applications require performance tuning and I/O tweaking that is time consuming and requires the talents of application-aware wizards. These skill sets are expensive and difficult to scale across data center infrastructure technologies.

The most compelling products will eliminate the need for special installation. Successful solutions will offer transparent SSD layers that provide the same benefit as front-end application tuning without the hassle of application-aware talent, deploying SSD technology as a complement to traditional rotating media and creating a hybrid form of SSD & HDD storage array. These hybrid arrays use SSDs along with SATA or SAS HDDs to combine the best of both worlds: scalable capacities and affordable HDD technologies combined with the lowest latency, highest IOPs and energy-efficiency of 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 management to determine how to most efficiently provision the data between the HDDs and the SSDs.

2. Current Optimization Alternatives
Optimization solutions involving SSDs look even more compelling when cost per I/O is compared with currently popular alternative solutions.

Prior to the advent of SSDs, there were several common approaches to achieving optimization with read-intensive or OLTP applications. Some of them include:

- Short stroking – all the data is kept on the outside spindle of the disk; this reduces disk capacity
- Large stripe sizes – this requires the use of additional drives
- Multi-core CPU servers – expensive multi-core, multi-way CPUs
- Host Memory Caching – expensive and restrictive
- Continuous application tuning

All of these approaches are cost-prohibitive for most application use cases.

3. High-performance Hybrid Arrays (HPHAs)
Built on Adaptec Unified Serial® (SATA/SAS) Series 5 RAID controller technology, High-performance Hybrid Arrays (HPHAs) provide the maximum performance at the lowest capital investment. Depending on performance and capacity needs, an HPHA can consist of any combination of high-capacity, low-cost Serial (ATA) SATA drives or higher-performance Serial Attached SCSI (SAS) drives plus SSDs, to create to create a hybrid storage solution that delivers the lowest cost/GB and lowest cost/I/O.

4. How does HPHA work?
Applications can get very high read random IOPs – close to 40-50K when provisioned directly from a single SSD. That’s the same as 24 SAS HDDs combined. SSD technology alone requires additional steps when writing data that could impact performance over time and jeopardize the reliability of the high performance solution. Neither of these two alternatives are the BEST. HPHAs with Adaptec Intelligent SSD software combine one or more SSDs paired with SATA or SAS disk drives to offer the BEST of both worlds. Adaptec firmware uses SSDs as a read cache pool and can provide close to 20K Random Read IOPs, without degrading the Write I/O performance. That’s up to 5X faster than SAS drive arrays alone.
Adaptec leverages its unique presence in the data path and access to DRAM L2 cache, flash SSD and rotating media, to learn the application I/O pattern and build I/O meta-data. The Adaptec firmware uses this meta-data to progressively move frequently read (hot-read) data blocks to the SSD for faster retrieval during future requests for the same data blocks. SSD data can also be updated at the same time as the rotating media (HDD) to keep the SSD data current. The write data blocks are directed to the rotating media (HDD). Frequently accessed read blocks from the HDD (also considered “hot-read data blocks”) are moved to the SSD for faster retrieval during future requests for the same data blocks. In case of these hot-read data blocks, the SSDs can also be updated at the same time as the rotating media (HDD) to keep the SSD data current.

In future firmware releases, frequently written (hot-write) data blocks will be accessed from the SSDs to enhance write performance as well as read performance. HPHAs with Adaptec technology achieve the best price performance when compared with other alternatives - replacing all HDDs with SSDs (highest cost/IO) or - using all SAS HDDs (highest IO/watt).

HPHAs with Adaptec technology and SATA drives achieve the best price performance when compared with:
- replacing all HDDs with SSDs or
- using all SAS HDDs

### 5. HPHA Total Cost of Ownership

HPHAs with Adaptec technology provide the following benefits:

#### Reduced Capital Expenditures
- Provides a cost-effective storage tier, which can meet the application performance and latency requirements, without the need to replace all of your storage with SSDs

#### Improved OPEX
- Provides high Read IOPs without the need for doing application-specific tuning

#### Improved Data Protection
- Writes are delivered to the rotating media, rather than the SSD media, extending the life of the SSD and eliminating the need for SSD redundancy

#### Improved SSD Write Reliability
- Data is written directly to the HDD and moved in the background to SSD ONLY when frequently accessed during a read request, reducing the number of writes to the SSD

#### Application Optimization
- Optimizes applications without user intervention or IT application knowledge

<table>
<thead>
<tr>
<th></th>
<th>Solution A with conventional RAID controller with 8 750GB SAS Drives</th>
<th>Solution B with HPHA bundle (Adaptec Intelligent controller + 1 SSD and) 7 1 TB SATA drives</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPEX Cost</td>
<td>$7,150</td>
<td>$3,450</td>
<td>$3,700</td>
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<tr>
<td>Acquisition Cost</td>
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<tr>
<td>OPEX Cost</td>
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<td>IOPs/Servers</td>
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<td>25,000 IOPs</td>
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Calculations for CAPEX and Total cost of ownership based on Adaptec data.