Solid State Drive (SSD) Cache: Accelerating and Maximizing Storage System Performance

Abstract:
This white paper introduces Storageflex Solid State Drive (SSD) Cache technology, SSD Cache leverages the high speed and low latency of solid state drives in delivering faster read performance. It covers SSD Cache key benefits and detail operations to help readers better understand SSD Cache. In addition, the requirement details for SSD Cache are also provided in this paper in order to assist readers to implement this feature more efficiently and effectively.
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Introduction

With the continuous development of enterprise businesses, the performance of workload-intensive application is often constrained by existing hard disk drives (HDDs). While the capacity of HDDs increased dramatically, the random input/output (I/O) performances have not improved at the same rate. However, now it is possible to accelerate performance of read-intensive workloads, such as On-Line Transaction Processing (OLTP), Web Server, File Server, or Database, by deploying Storageflex new caching technology, SSD Cache, which leverages the high speed and low latency of solid state drives in delivering faster read performance for frequently accessed high demand and vital data. Compared to HDD data read speed, SSD is significantly faster and therefore, SSD Cache can considerably improve random read performance and reduce response time.

Products covered by this document

HA3969 DS family

What is SSD Cache?

Cache is a component that transparently stores data so that future requests for the data could be served more efficient. It is fundamental to storage, especially for read-intensive applications. Before the launch of SSD Cache, the capacity of controller memory cache is limited. SSD Cache allows fast SSD to be used to extend the cache pool capacity of storage systems and stores frequently accessed data. While the capacity of SSD Cache has increased, the cache hit rate has also improved. In other words, there might be more and more hot data stored in SSD Cache and the future request for those data could be served more efficient and hence the read performance could be enhanced.

Why Storageflex SSD Cache?

In most of cases, if an application’s workload has high percentage of reads relative to write behaviors and a small amount of data is repetitively read, SSD Cache may have the following benefits:

1. Read performance enhancement

   SSD Cache leverages an intelligent algorithm to accelerate read-intensive workloads such as On-Line Transaction Processing (OLTP) and Database which has highly small random read I/Os. In these scenarios, SSD Cache can greatly improve overall read performance. For example, SSD Cache can enhance 2.5 times IOPS in OLTP workload when compared to the same system without SSD Cache. At the same time, latency is also reduced and therefore, the level of
performance improvement is based on the application’s actual workload and user’s access behavior.

2. **Intelligent firmware and management algorithm**

The Intelligent firmware automatically analyzes data access behavior and recognizes sequential or random read/write I/O behaviors. Data from sequential reads or writes is not written to SSD Cache pool, and only random read data would be stored in the SSD Cache pool in order to make the most effective use of SSDs. More precisely, the firmware would automatically move a copy of the most frequently-accessed read data from controller memory cache to SSD Cache pool at an appropriate time. Those hot data will be read from the SSD Cache if system receives the same read request in the future. A proprietary write algorithm while copying data to SSDs optimizes its cycle duty, so cost-effective SSDs are also applicable. This solution not only improves read performance but also extends life cycle of hard drives by reducing hard drive reads and writes.

3. **Simple and intuitive GUI design**

SSD Cache function is fully integrated into Storageflex’s intuitive SANWatch and Embedded RAIDWatch GUI. It is simple to set up, management, and maintenance. For example, the user can monitor SSD Cache pool status and check the Life Remaining for each SSD with ease.

![Intuitive SANWatch GUI design](image)

**Figure 1: Intuitive SANWatch GUI design**
Storageflex SSD Cache

How Storageflex SSD Cache works

Once SSD Cache has been enabled and running business applications for a while, the intelligent firmware records statistical data and immediately updates the hotness record into controller memory cache. Based on the hotness record, the firmware will automatically copy random and small size frequently-accessed data from controller memory cache to SSD Cache pool at the appropriate time using the sequential write I/O method to avoid data intensively written onto SSDs and therefore, improve SSDs’ life cycle. Before SSD Cache Pool is fully filled up hot data generating from host applications, a pre-copy method to SSD via zone blocks prediction speeds up read performance improvement. For data size that is less or equal than 16KB, the data will be copied to SSD Cache pool directly even if it has been only read once. When the read data size is larger than 16KB and the firmware recognized it as hot data (been read a couple of times), it will then be classified as frequently accessed hot data and cached in the SSD Cache pool. This hot data will have two copies, one in SSD Cache and one in hard drives.

Basically, on receiving a read request, the system will check if relevant data is contained in the controller memory cache. If the requested data is stored in the memory cache, the system will directly return this data to the host. On the other hand, if the requested data is not cached in the memory cache, the system will check SSD Cache pool. If the requested data have been copied into SSD Cache pool based on the real-time hotness record, the storage will directly read the data from SSD Cache pool and return the data to the host. Otherwise, the requested data will be accessed from slower device. Therefore, as more cache hits occur, more frequent requests can be served by SSD Cache and overall performance and average response time improves.

![Figure 2: How SSD Cache works](image)
SSD Cache Requirements

1. Firmware and SANWatch Requirements

<table>
<thead>
<tr>
<th>HA3969 DS family</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firmware</td>
<td>512F12 or later</td>
</tr>
<tr>
<td>SANWatch</td>
<td>3.0.h.14 or later</td>
</tr>
</tbody>
</table>

Table 1: Firmware and SANWatch supported versions

2. SSD Cache License

SSD Cache is a licensed feature. Storageflex also provides a 30-day trial license.

![License Information](Figure 3: HA3969 DS license information)

3. Controller Memory Cache Capacity V.S. Maximum SSD Cache Pool Capacity:

   Once SSD Cache has enabled, the controller memory cache will use a certain percentage of space to store hotness record, and the capacity of hotness record on memory cache will determine the maximum SSD pool size that can be supported. If a user selects the entry combination (2GB per controller), the maximum SSD Cache pool size supported is up to 150GB for the single controller model and 300GB for the redundant model.
<table>
<thead>
<tr>
<th>DRAM</th>
<th>Max SSD Cache pool size</th>
</tr>
</thead>
<tbody>
<tr>
<td>2GB</td>
<td>150GB</td>
</tr>
<tr>
<td>4GB</td>
<td>400GB</td>
</tr>
<tr>
<td>8GB</td>
<td>800GB</td>
</tr>
<tr>
<td>16GB</td>
<td>1600GB</td>
</tr>
</tbody>
</table>

Table 2: DIMM capacity supported per controller for Maximum SSD Cache pool

Compared with SSD, controller memory cache is more economical. In addition, write cache can also be stored in the controller memory cache. Therefore, we recommend HA3969 DS users upgrade their controller memory cache to 16GB per controller and purchase suitable SSDs for cache pool (according to needs and budget) to gain maximum overall performance benefits.

4. Resetting Controller(s) for Action
The final step to enable the SSD Cache function involves resetting the controller(s). By default, the controller memory cache does not allocate any space to store hotness record. Therefore, the controllers need to be reset and initiated to allocate appropriate space in controller memory cache to store the hotness record. After the initial controller reset and SSD Cache function activated, its management is easy. There’s no need to reset or restart the system when adding or removing SSDs to and from the SSD Cache pool. This can be done through the intuitive GUI via SANWatch / Embedded RAIDWatch.
5. SSD requirement

Currently, one controller can support up to 4 SSDs. If you wish to implement the SSD Cache function, please check whether the specific SSD model being used is on the Storageflex Qualified Vendor List (QVL). Only SSD products on our QVL can be applied to enhance performances described in this document.

Conclusions

Storageflex SSD Cache is an intelligent solution that dramatically improves read performances, especially for read-intensive applications, greatly reduces latency and supports large capacity cache pool. It is simply to set up, manage and maintain on Storageflex’s intuitive GUIs. It is highly recommended for use with system application workload that involves high volume read behaviors and small volume of intense-repetitive read actions.

Figure 5: Summary of SSD Cache features and benefits