



White paper

QNAP Turbo NAS with SSD Cache

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Introduction

Audience

This White Paper is intended for QNAP users, partners, and customers who are considering using QNAP NAS systems. In this White Paper we will introduce SSD caching technology and show how this feature can improve your IT system performance.

Terminology

SSD- A Solid State Drive is a data storage device using integrated circuit assemblies as memory to store data persistently. This enables a much faster transfer speed than HDD.

HIT Rate- How often a searched-for item is actually found in the cache. The greater the number of requests that can be served from the cache, the faster the overall system performance becomes.

IOPS- Input / Output Operations Per Second, is a common performance measurement used to benchmark computer storage devices.

SSD cache technology

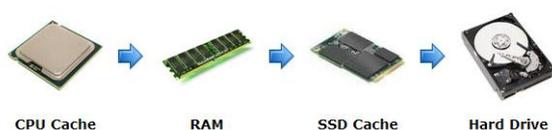
QNAP solid-state drive (SSD) cache technology is based on disk I/O reading caches. When the applications of the Turbo NAS access the hard drive(s), the data will be stored in the SSD. When the same data are accessed by the applications again, they will be read from the SSD cache instead of the hard drive(s). The commonly accessed data are stored in the SSD cache. The hard drive(s) will only be accessed when the data could not be found from the SSD.



Traditional data access method

When the CPU needs to process data, it will follow the steps below:

1. Check CPU Cache
2. If not found in CPU Cache, check RAM
3. If not found in RAM, get from hard drives, and copy to RAM.



SSD cache data access method

When the CPU needs to process data, it will follow the steps below:

1. Check CPU Cache
2. If not found in CPU Cache, check RAM
3. If not found in RAM, check SSD Cache.
4. If not found in SSD Cache, get from hard drives, and copy to SSD Cache.

Since the SSD supports high-speed data transfer and has no mechanical properties or moving parts, if the applications require more random read requests, the SSD cache can significantly improve access speeds.

QNAP SSD cache technology provides two algorithms:

(1)LRU (Default): Higher HIT rate, but requires more CPU resources.

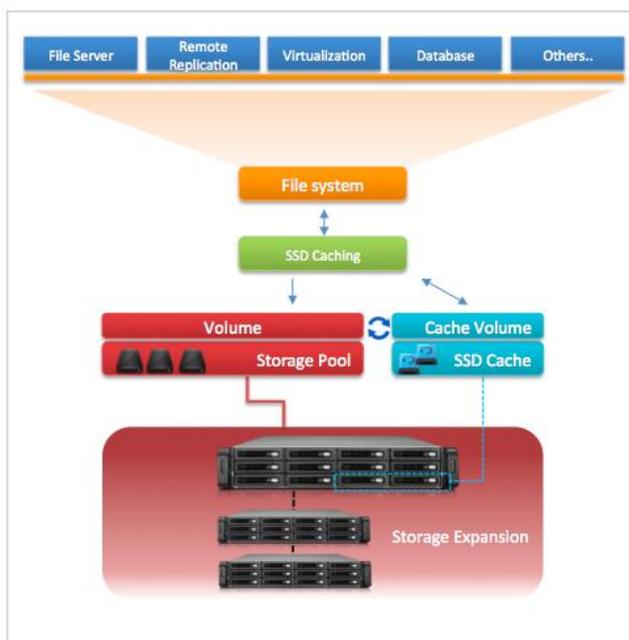
When the cache is full, LRU discards the least-used items first. As the system needs to track the cached data to ensure the algorithm always discards the least recently used data, it requires more CPU resources but provides a higher Hit rate.

(2)FIFO: Requires less CPU resources, but lower HIT rate.

When the cache is full, FIFO discards the oldest data in cache. This reduces the HIT rate but does not require too much CPU resources.

Applications and benefits

- Database: MySQL, MS SQL Server, etc.
- Virtual machine: VMware, Hyper-V, XenServer, etc.



The SSD transmission speed is high, but the unit cost is higher than that of the hard disk drive (HDD). Using the SSD cache technology, we can significantly improve the IOPS and I/O speed, and maintain a relatively low unit cost in order to satisfy the demand for utilized space and transmission speed.

Limitations

The SSD cache technology applies to a select number QNAP Turbo NAS models with a specific amount of memory required.

Series Models	SSD Tray
TS-x79U-SAS	All
TS-x79U	Disk 3, Disk 4
TS-x79 Pro	Disk 7, Disk 8
TS-x70U	Disk 3, Disk 4
TS-x70/TS-x70 Pro	The last two disks

Memory requirement:

NAS RAM	Cache capacity options
1GB<=RAM<4 GB	512 GB
4<=RAM<8 GB	1 TB
8GB<=RAM<16 GB	2 TB
RAM>=16GB	4 TB

Note: Before using the SSD cache technology, please ensure your Turbo NAS models have sufficient RAM.

Performance Test

Test environment and methods

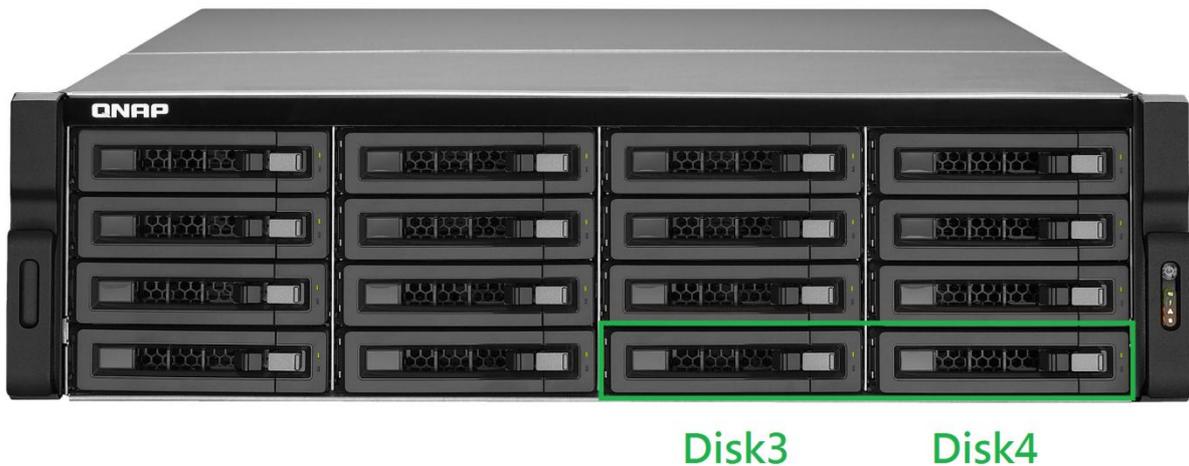
The following two test methods will be described:

- a) **IOmeter SAMBA random read.**
- b) **Virtual machine boot time.**

In these tests we use the TS-EC1679U and two SSD to create a RAID 0 array. Then configure the LRU algorithm.

Configure SSD cache

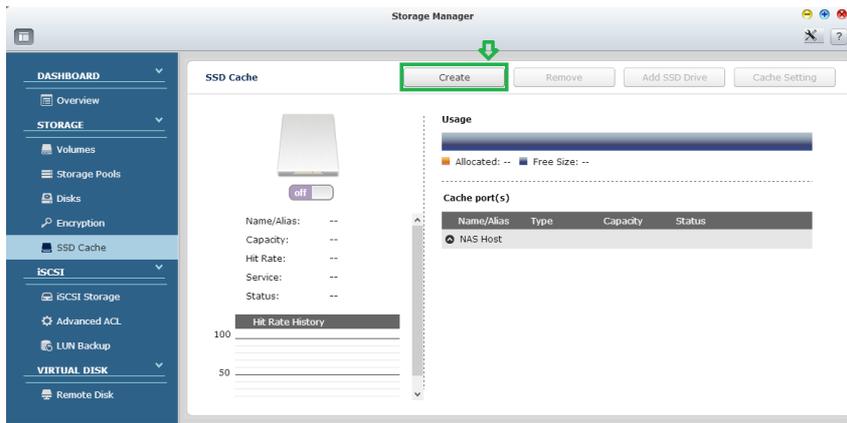
1. Install the SSDs in disk trays 3 and 4 of the Turbo NAS (TS-EC1679U).



2. Login to the Turbo NAS as an administrator, go to "Storage Manager", and then create a storage pool, volume or iSCSI LUN for SSD cache.



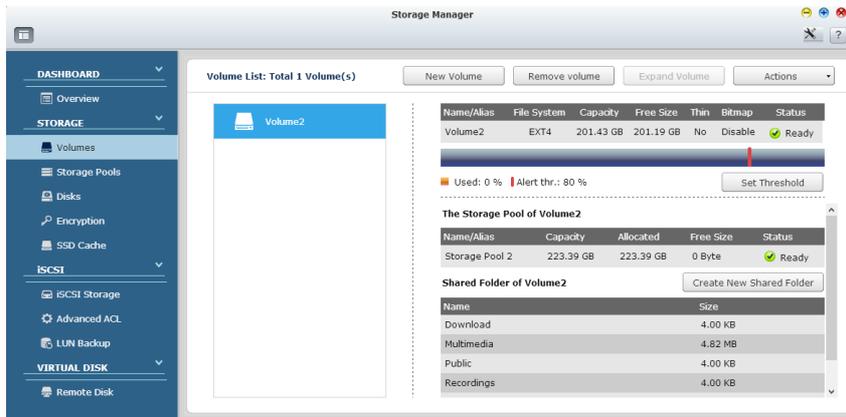
Click "SSD Cache" > "Configure SSD cache" and Click "Create".



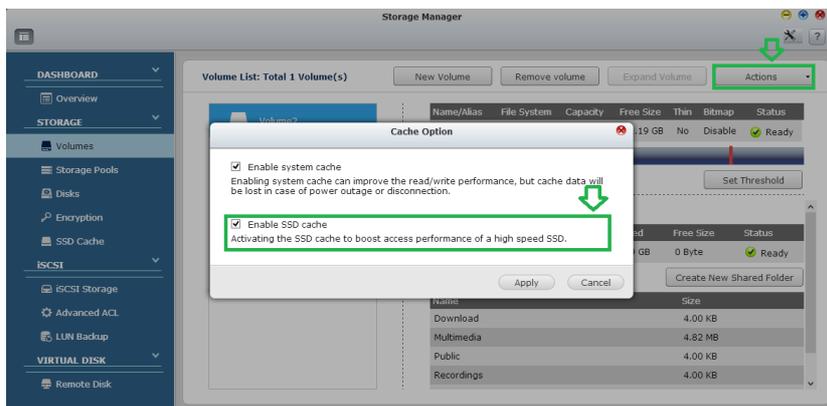
3. Select the SSD settings and click "Create".



4. Click "Volumes" and then select the volume you want to speed up with SSD cache.



5. Click "Actions" > "Cache Setting" and select "Enable SSD Cache". Then click "Apply".

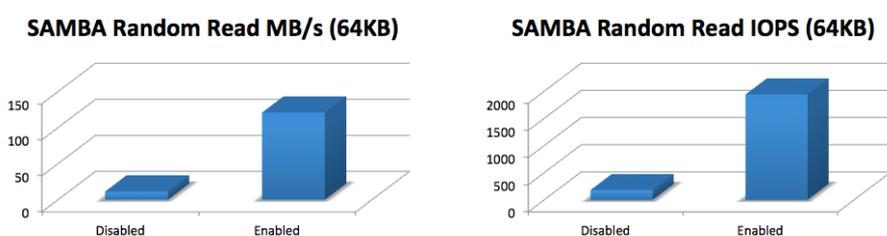


Test results and explanation

a) IOmeter SAMBA random read

Use IOmeter and configure a 64KB random read to test the SAMBA read performance. The average read is 11.4MB/s without the SSD cache; and the average read with the SSD cache enabled is 121.6MB/s.

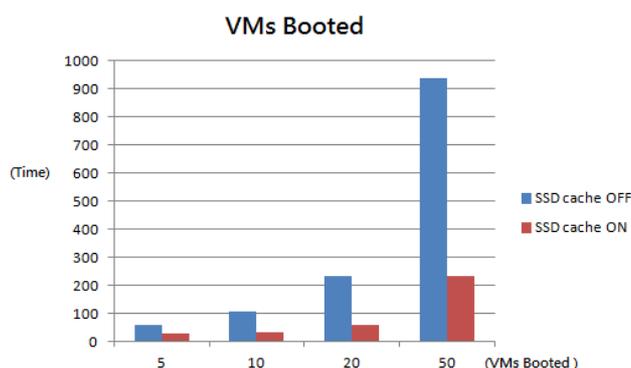
Use IOmeter and configure a 64KB random read to test the SAMBA read IOPS performance. The average IOPS is 183 without SSD cache, and the average IOPS with SSD cache enabled is up to 1946.



b) Virtual machine boot time

The virtual machine boot time is subject to performance of your hard disks. However, with SSD cache enabled the speed at which the virtual machine accesses the boot data will increase. The test result shows that the SSD cache can accelerate the virtual machine boot speed by two times and reduce the boot time by four times.

(VMs/Sec)	SSD cache On	SSD cache Off
5 VMs	27"	61"
10VMs	33"	105"
20VMs	58"	234"
50VMs	233"	938"





Conclusion

With QNAP SSD cache technology, users can enjoy the benefits of accelerated data access to the Turbo NAS. The SSD cache configuration is simple and the performance can be monitored from the control panel. The hard drive(s) can be specified to enable SSD cache in order to optimize the storage efficiency.