
QNAP
QTS 4.3.5 Preview
Dive Deep Into Storage Technology
Software-defined Additional SSD Over-provisioning and Advanced SSD Cache
Storage Space Management and Monitoring
Remote Snapshot Vault Restore and Export

Boost efficiency with 10GbE Networking

- When transferring a 50 GB file with 1GbE (110MBps) = 8 min.
- With 10GbE, < 2 min.
- With 10GbE around the corner, are you fully ready?

Your first 10GbE switch:
QSW-1208-8C

Is your SSD Cache fast enough for 10GbE?

Is your storage space flexible and safe enough to store all the files?

Is your backup and recovery plan utilizing 10GbE?


QNAP
QTS 4.3.5
Preview
Software-defined Additional SSD Over-provisioning and Advanced SSD Cache

SSD Awareness Storage:

- Software-defined SSD Additional Over-provisioning
- SSD Write-only Cache
- SSD Cache Supports Single/RAID 0/1/5/6/10

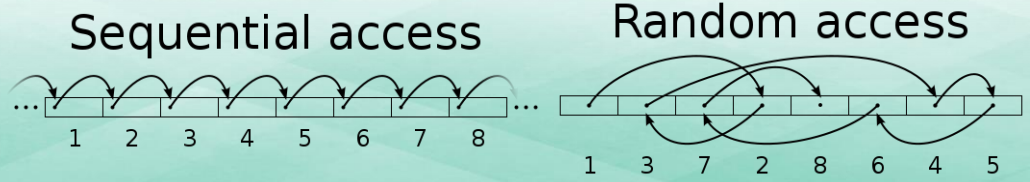
Challenge

SSD Cache performance is not as expected in 10GbE or Thunderbolt environments?

SSD Usage in Network Attach Storage

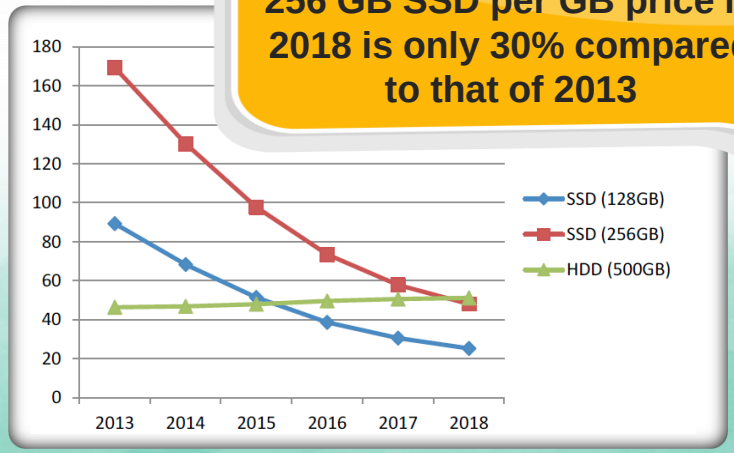
- SSD can provide high random IOPS for multi-client sync and business applications that can not be achieved with HDD.
- In 2018, SSD price also comes close to the sweet spot.
- You need not only choose the right SSD, but also choose right NAS!

Drive Type	Sequential Access (MB/s)	Random Access (IOPS)
HDD	100	350
SSD	300	60000



https://www.sandisk.com/business/datacenter/resources/white-papers/the-ssd-enabled-pc-total-cost-of-ownership

SanDisk estimates the 256 GB SSD per GB price in 2018 is only 30% compared to that of 2013

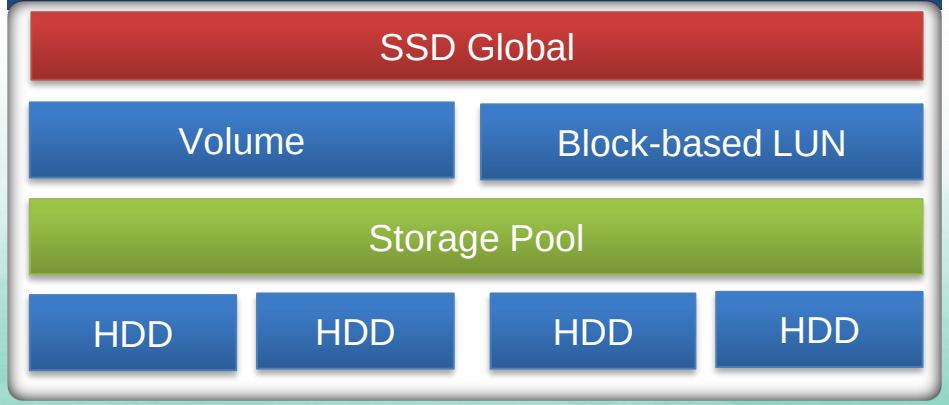


SanDisk's Statistic for Global SSD/HDD Price Trend

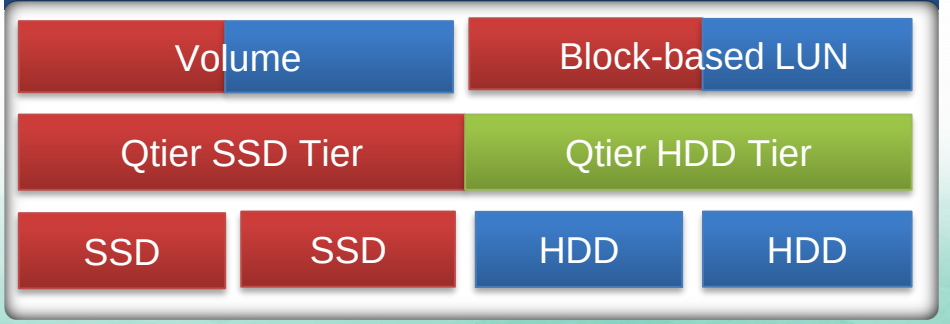
QNAP SSD Global Cache and Qtier

- **For real-time performance boost, deploy SSD Global Cache or All flash storage**
- **For continuous data tiering between hot and cold data, deploy the Hybrid Storage Qtier™ Auto Tiering**

SSD Cache lets all data enter cache and read hot data from the storage in real time



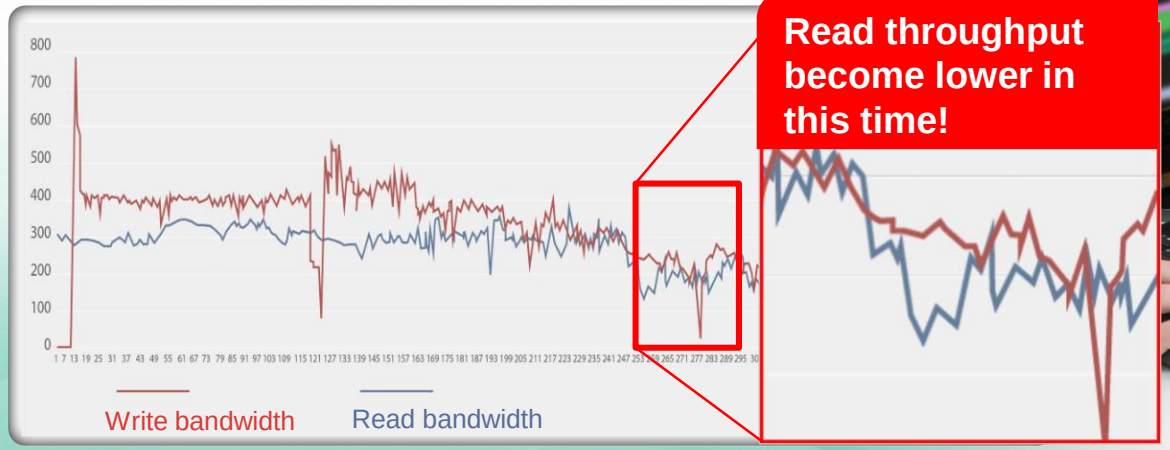
Qtier utilizes SSD space and let data block be reallocated based on hot or cold in the storage



When SSD Cache Performance Degraded

True user story:

Spain TV Stations use SSD Cache to increase the material upload speed for multiple workstations while editing at the same time for urgent news.

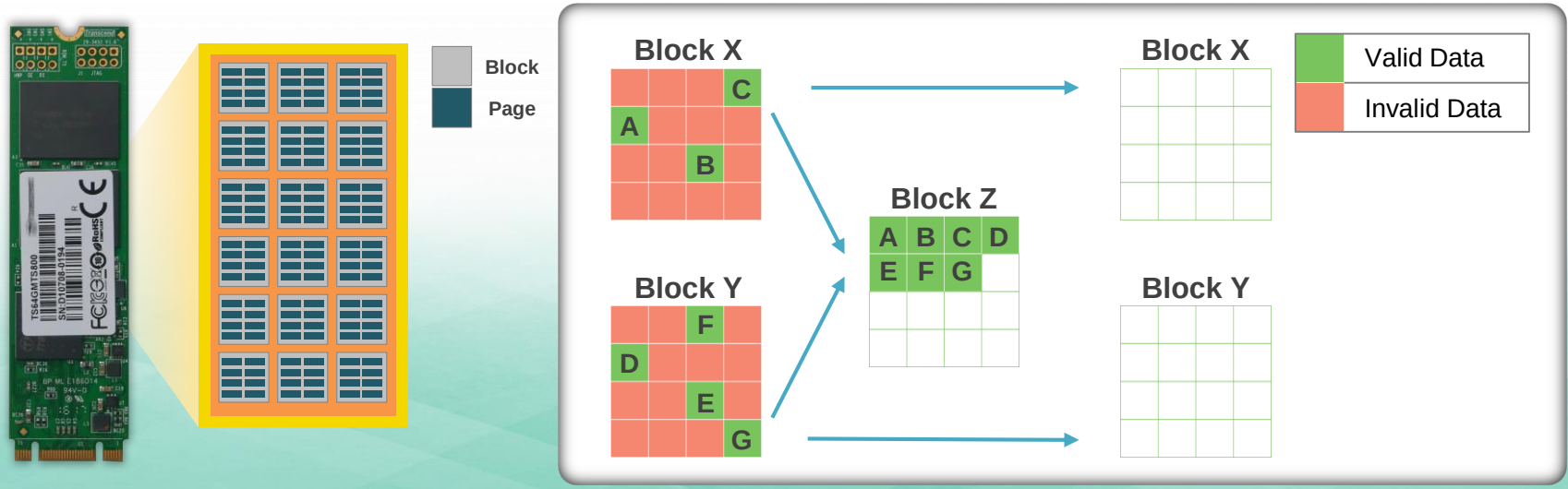


Read throughput become lower in this time!

After writing actions started, editing stations can't have a smooth editing work. what happened?

The SSD Works Differently from HDD

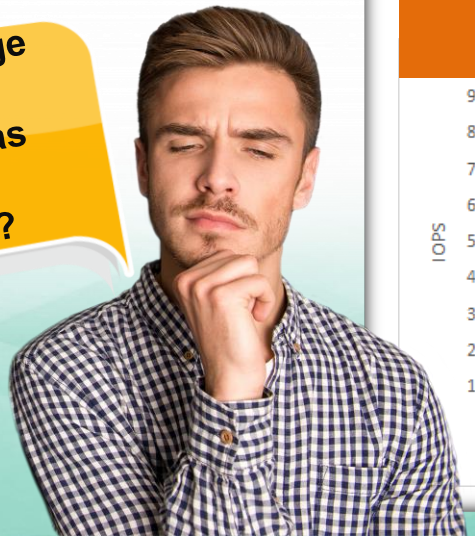
- When HDD write new data: Overwrite the existed sector directly.
- When SSD write new data: SSD need to clear whole block first.
- Result: The SSD must collect valid page and rewrite them into new block before new data can be written (Garbage Collection).



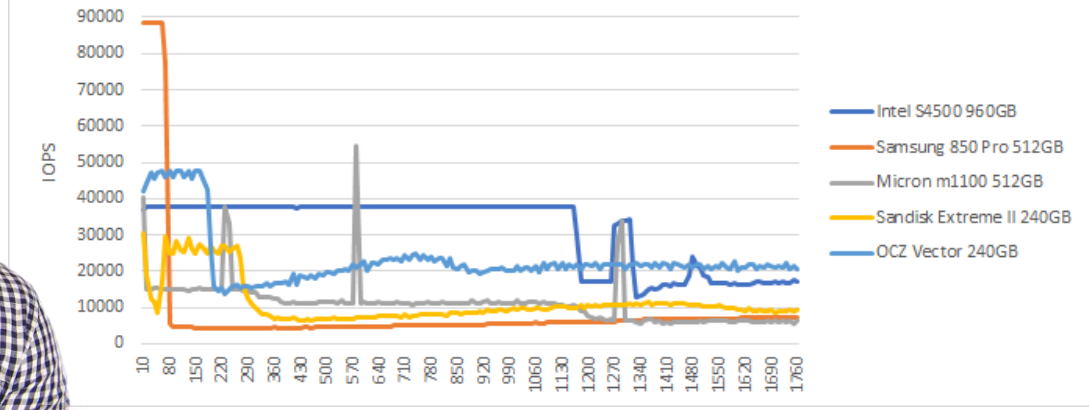
Different SSDs have Different Performance!

- In QNAP Lab, engineers use FIO to test different SSDs, and all SSD have showed consistent write performance degrade.
- Different SSD controllers' algorithm and Garbage Collection mechanism will affect the long term performance

How can storage vendor help to ensure SSD has expected performance ?



Different SSD in QNAP NAS's FIO consistent performance (IOpattern: RW-4K):



SSD Internal Over-provisioning

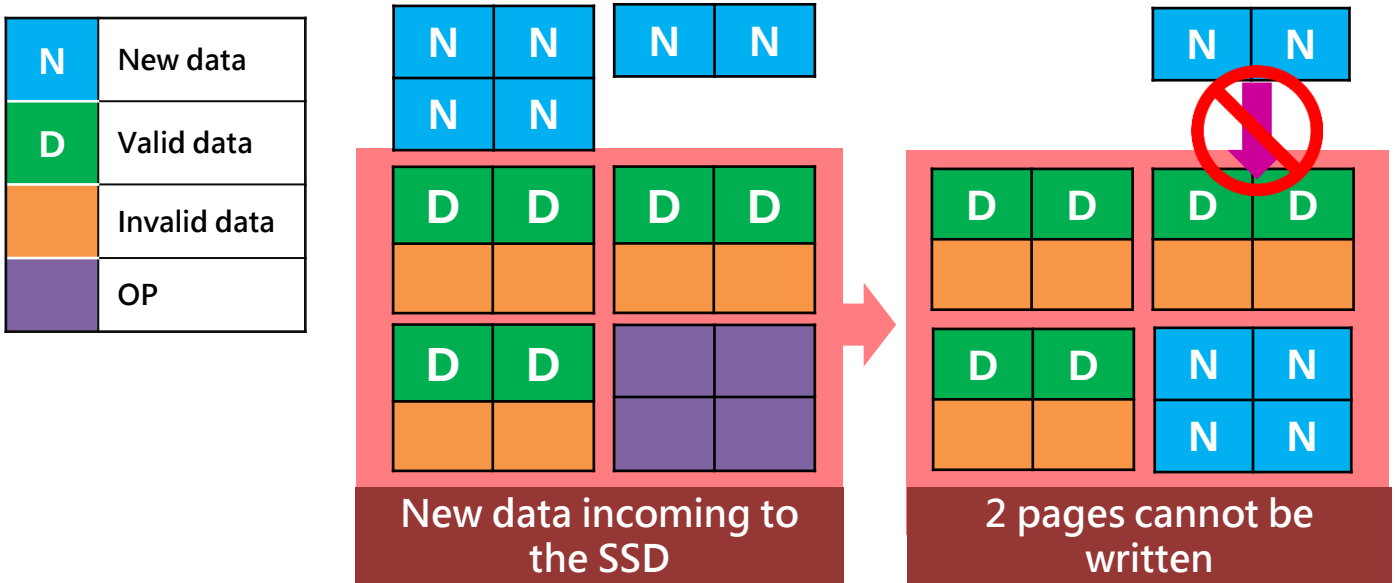
- SSD as Flash storage, it capacity should be presented with Gibibyte (GiB) 2^30 = 1,073,741,824 Bytes。
- As storage device, SSD actually report it's capacity back with Gigabyte (GB) 10^9 = 1,000,000,000 Bytes。
- Every GB in SSD contain 73,741,824 Bytes(7.37%) for the Garbage Collection operation, and enterprise SSD may reserved more!

SSD actual size (GiB)	SSD present size (GB)	Vendor designed OP %	Actual internal OP %	Size show in the NAS (GiB)
256 GB	256 GB	0%	7%	238 GB
256 GB	240 GB	7%	15%	223 GB
256 GB	200 GB	28%	37%	186 GB

In the NAS system, all capacity are actually be calculated and showed in the GiB format
https://www.seagate.com/tw/zh/tech-insights/ssd-over-provisioning-benefits-master-ti/

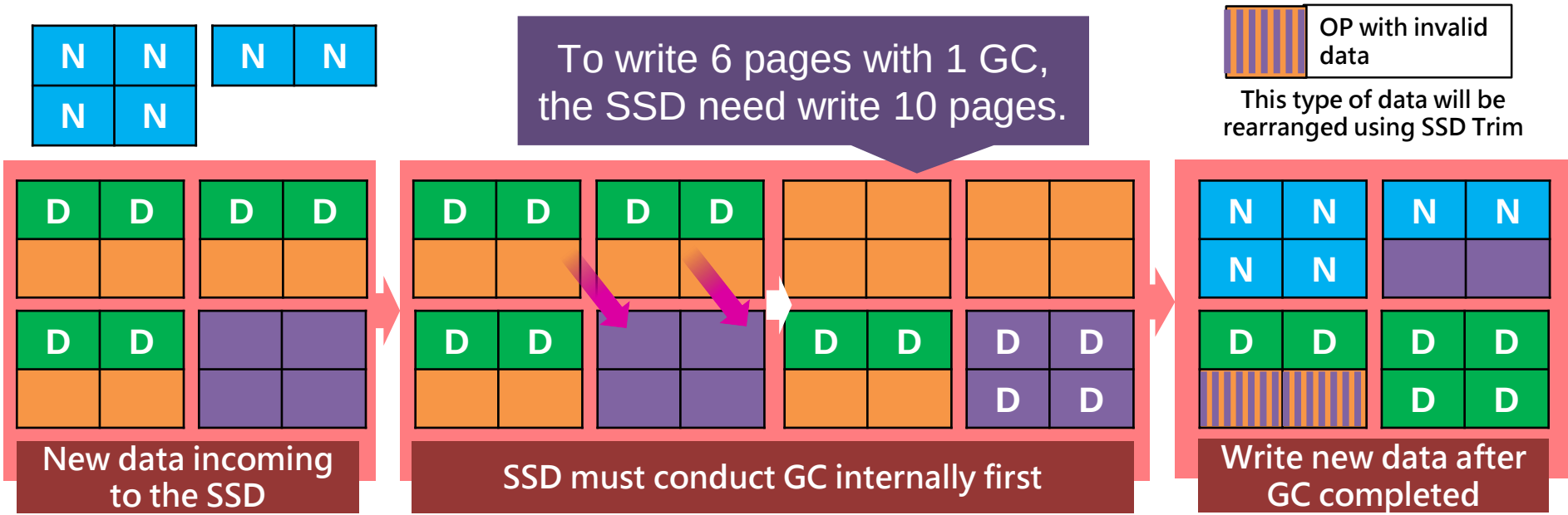
How Over-provisioning can Affect SSD Performance and Endurance (1)

- In below simplified example, SSD contains 1 block as OP and 3 blocks contain both valid and invalid data.
- If 4 pages of new data are directly written to the last OP block first, the remaining 2 pages cannot be written anymore.



How Over-provisioning can Affect SSD Performance and Endurance (2)

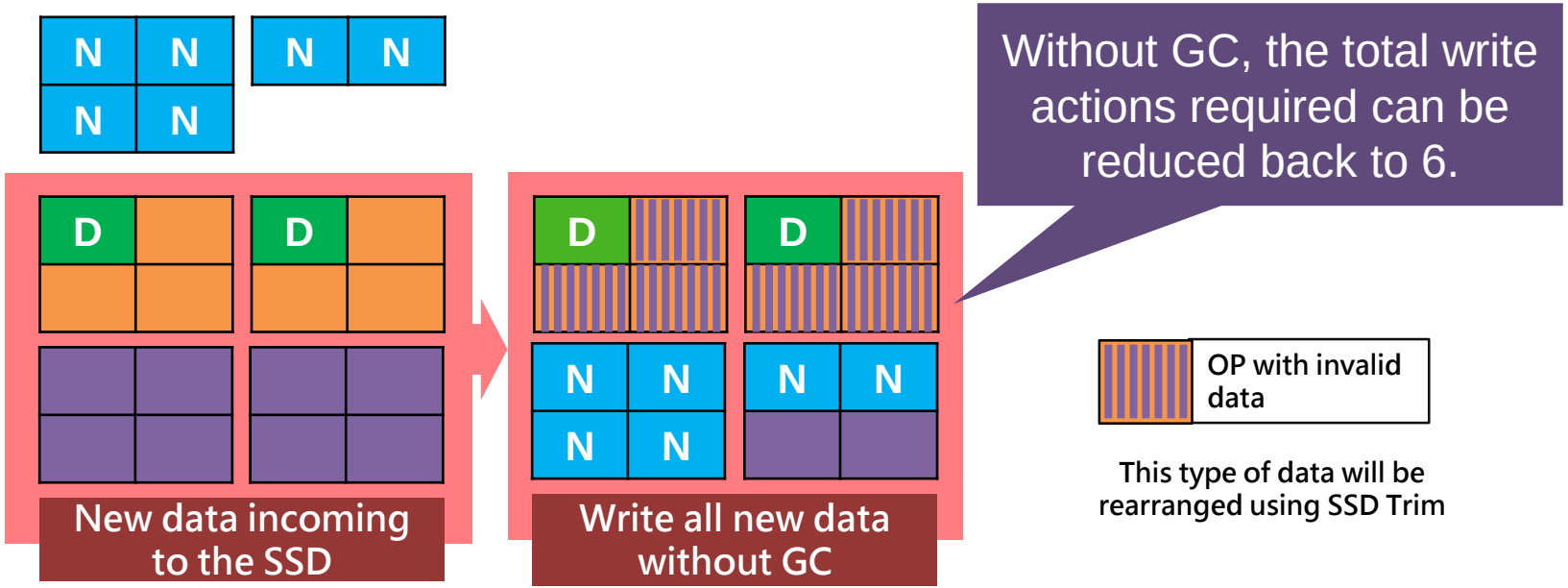
- To write all new data into SSD, the SSD must conduct GC first.
- During the GC, more write actions need to be taken, and this is known as “Write Amplification.”



https://en.wikipedia.org/wiki/Write_amplification

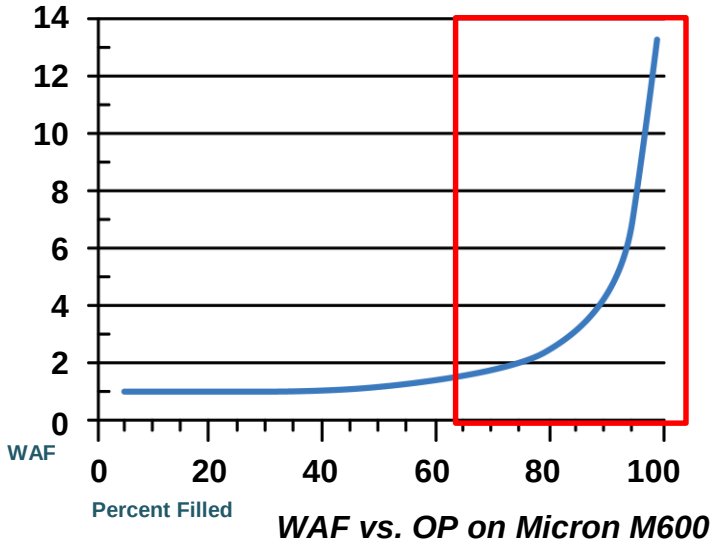
How Over-provisioning can Affect SSD Performance and Endurance (3)

- When more space is reserved for Over-provisioning, data can be written directly without Garbage collection.
- Write Amplification has be reduced.

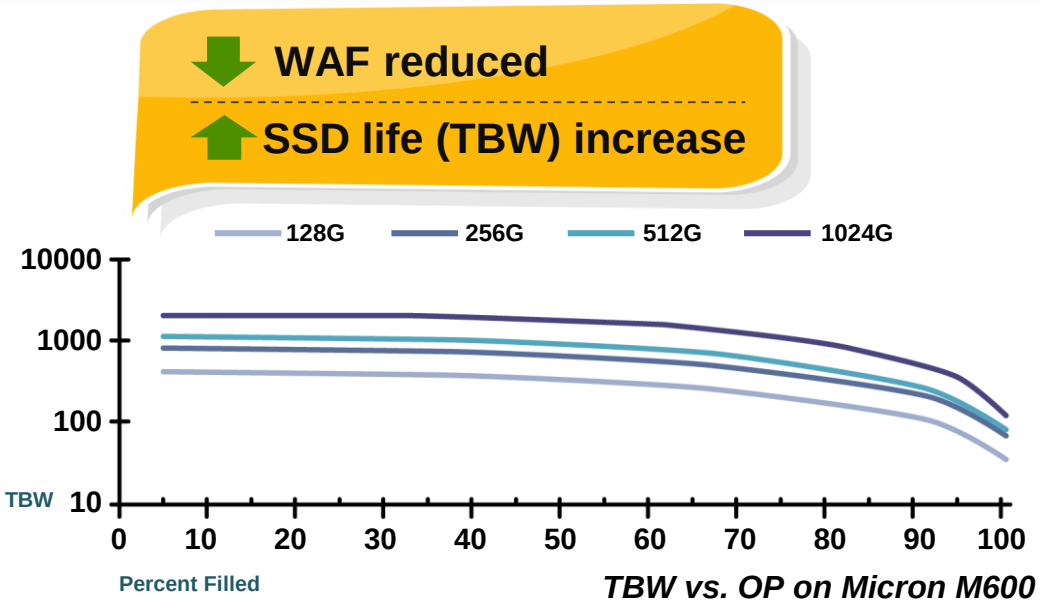


How Over-provisioning can Effect SSD Performance and Endurance (4)

With the additional Over-provisioning, the Write Amplification can be reduce dramatically. And with reduced write actions, SSD endurance can be increased.



WAF vs. OP on Micron M600



TBW vs. OP on Micron M600

https://www.micron.com/~/media/documents/products/technical-marketing-brief/over_provisioning_m600_for_data_center_tech_brief.pdf

SSD Additional Over-provisioning effect on performance

- In QNAP Lab, a TVS-882 uses 2 Micron1100
  512GB SSD as Cache with RAID 1.
- **Random IOPS can increase to 300%**
- **This result can also apply to different brand of SSD**

Test condition:
Configure SSD RAID with different additional OP and test its performance when cache is filled.

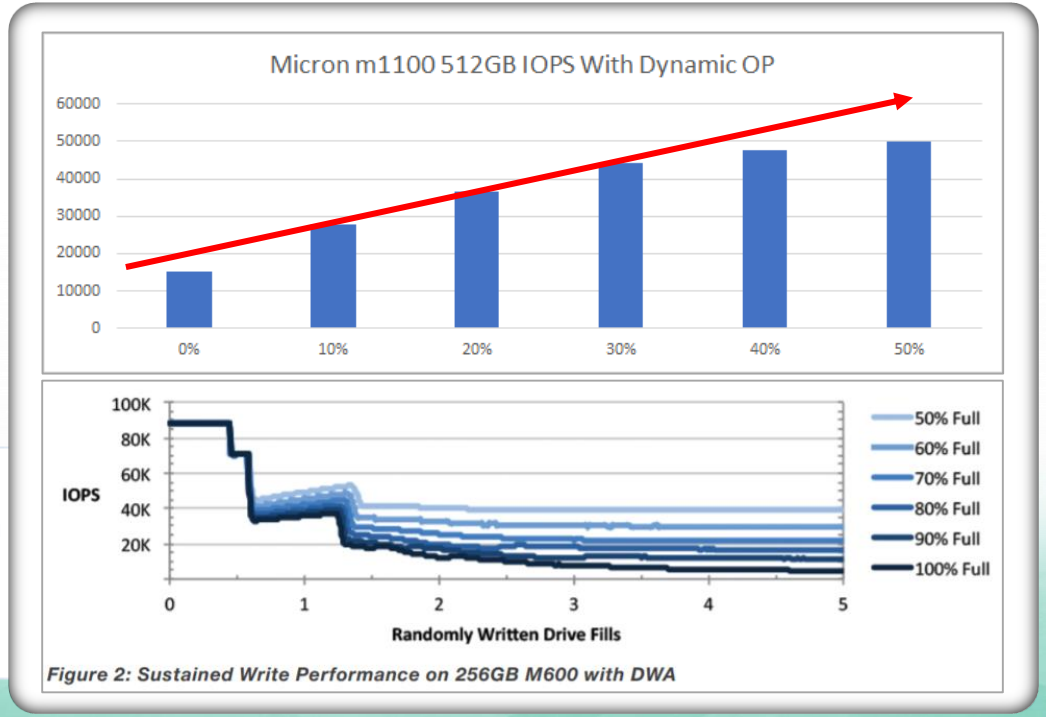
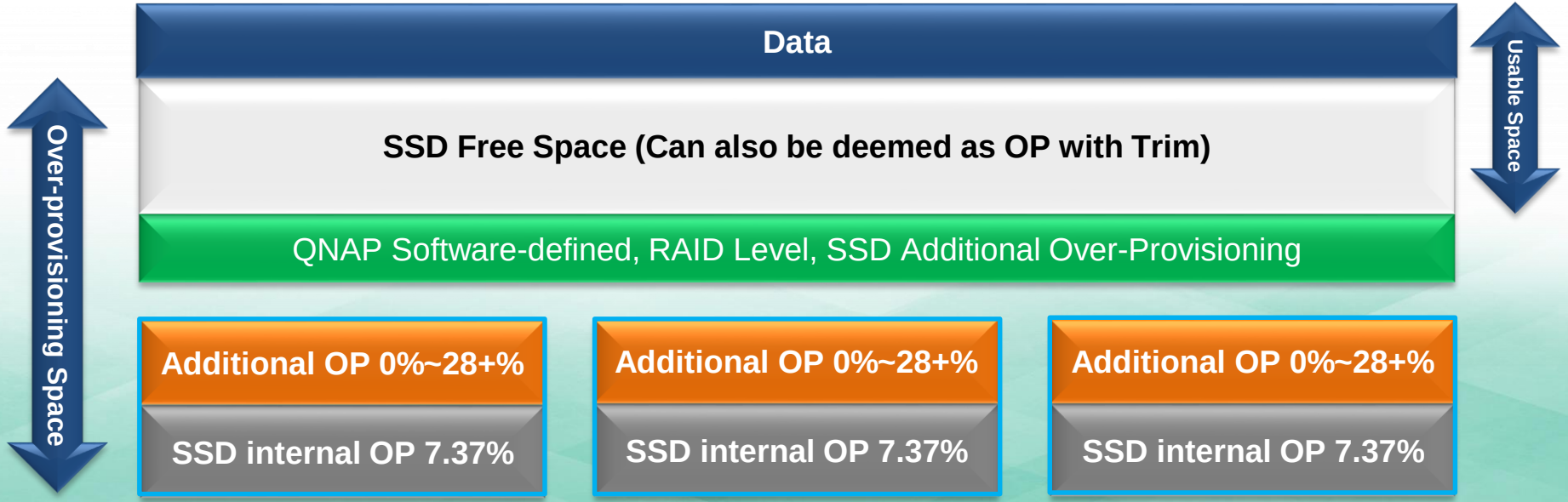


Figure 2: Sustained Write Performance on 256GB M600 with DWA

Using FIO for the test with --direct=0 --bs= 4k(random)1M(sequential), --io depth=1(random) 32(sequential), --file size= 90G

QNAP Software-defined SSD Additional Over-Provisioning

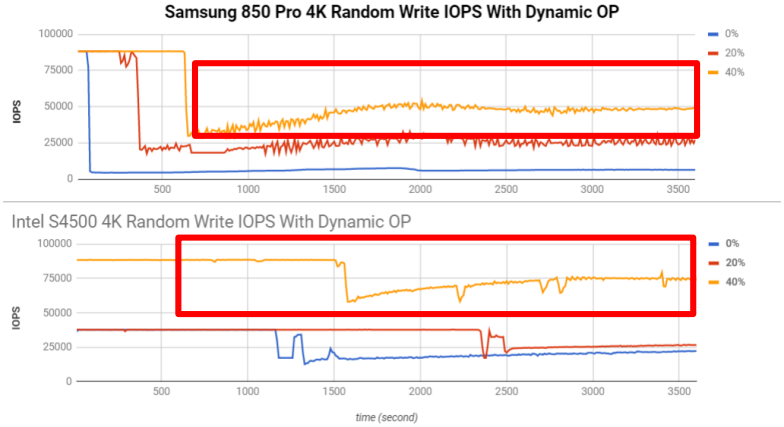
- **Having more over-provisioning is proven to be beneficial.**
- **Besides SSD internal Over-provisioning, QTS introduces the additional Over-provisioning that can be adjusted based on usage.**

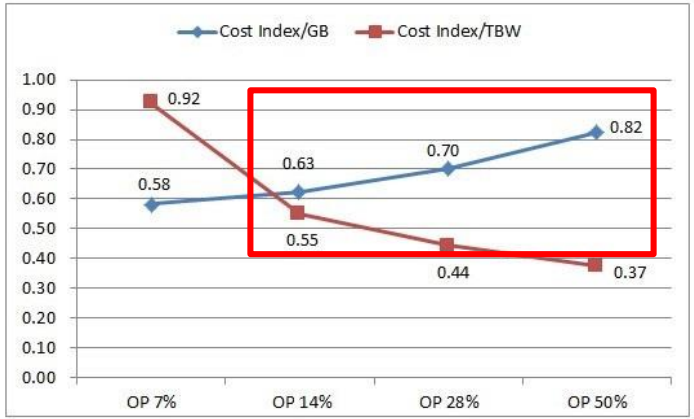


The Advantage of Software-defined Over-provisioning

- **Performance and endurance of SSD can be increased.**
- **Let consumer SSD reach enterprise SSD performance, and further enhance enterprise SSD advantage, reduce TCO (Total Cost of Ownership)**

  (Although usable space is reduced, actual used space is unchanged.)



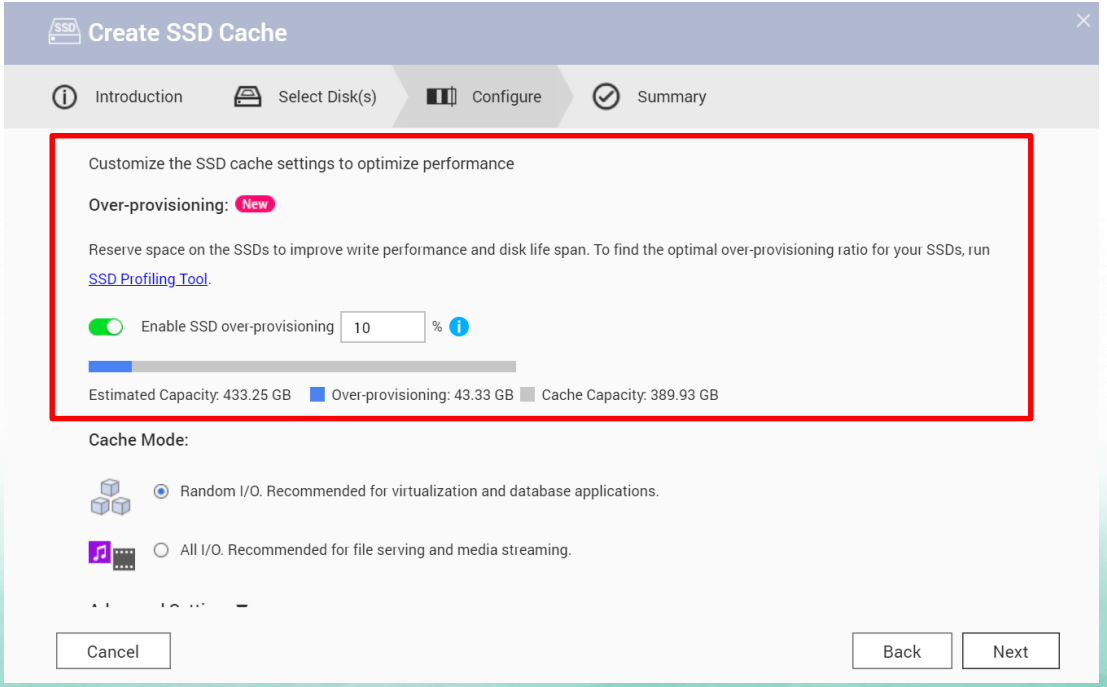


http://www.atpinc.com/technology/ssd-over-provisioning-benefits-configure

Configure the Software-defined SSD Additional Over-provisioning

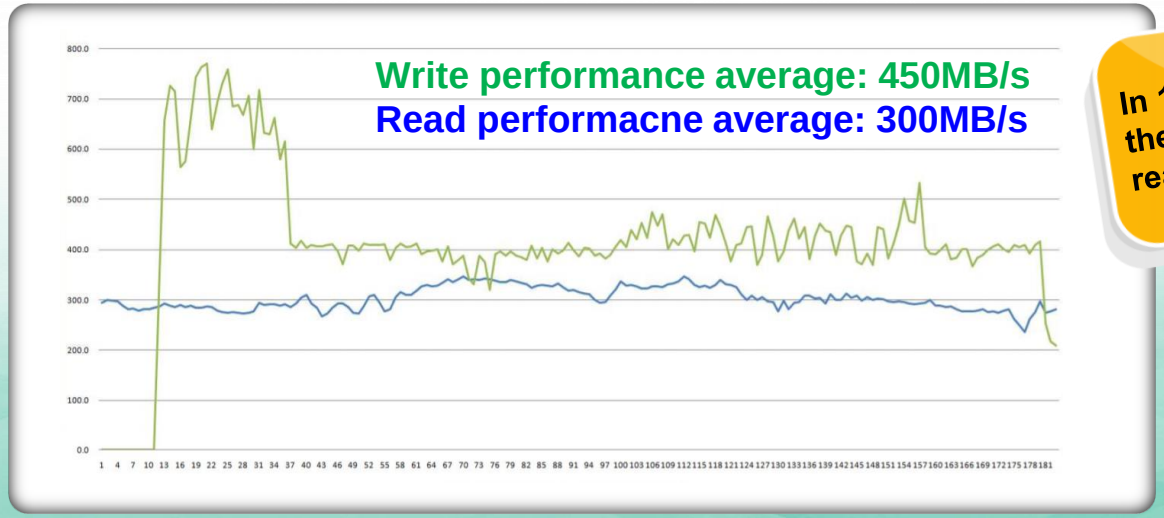
- **After QTS 4.3.5, user can decide OP amount for SSD cache, Qtier pool and static volume.**
- **A number between 1% to 60% in addition to vendor defined amount**

Note:
The over-provisioning can only be configured when a storage space is created and cannot be enabled for existing cache/volume unless recreating the storage.



Choose SSD is Hard, Choose QNAP is Simple

- SSD sustained performance can only be observed after used over time
- With the SSD additional Over-provisioning, the TV station editors gain a smooth editing experience
- Achieve the goal of investing 10GbE and SSD



Is All SSD Support / Require The additional Over-provisioning?

- **Not all SSDs' performance are increased in QNAP Lab test.**
- **SSD with higher internal over-provisioning or special controllor design, additional over-provisioning may not be needed.**
- **Intel® Optane™: With 3D Xpoint™ technology, the M.2 SSD can reach a sustained performance higher than data center SSD.**

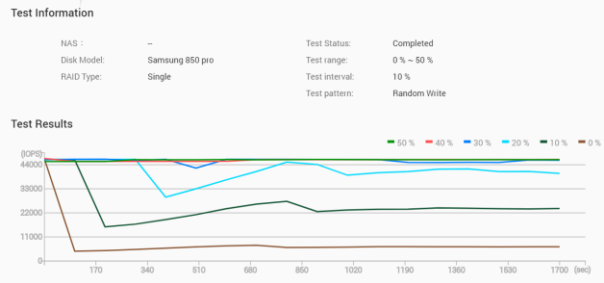
Model	Size	Random Read IOPS (100% Span)	Random Write IOPS (100% Span)
Intel® Optane™ M.2 SSD	16GB	240K	65K
Intel® SSD DC S4600 2.5 SSD	240GB	72K	38K

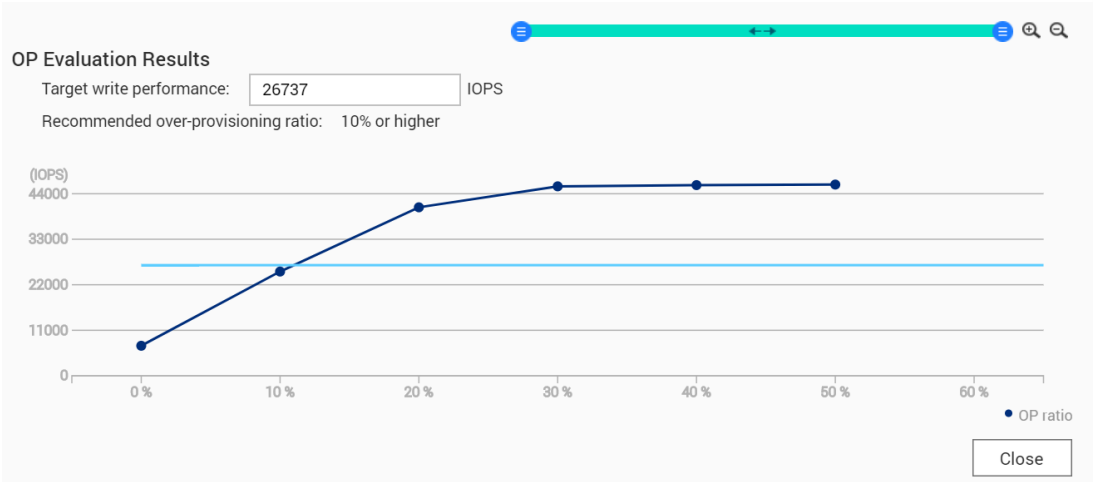
https://ark.intel.com, https://www.intel.com.tw/content/www/tw/zh/architecture-and-technology/optane-memory.html

Use SSD Profiling Tool to measure the Best Additional OP Amount On Your NAS

- **Capacity still matters! For example, more space in the read cache mean more data can be boosted at the same time**
- **The upcoming App will give advice for the best configuration based on your required IOPS**

Intel® SSD
DC S4600 2.5 SSD





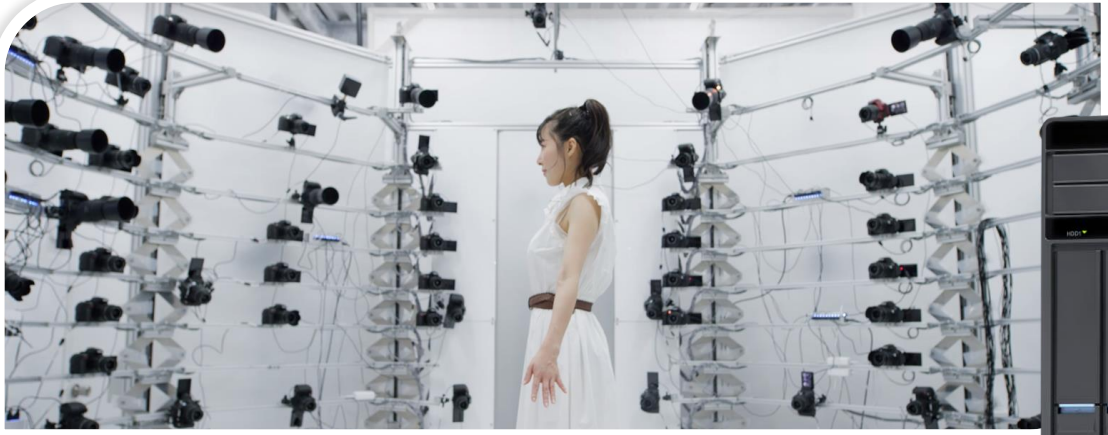
Demo

Use SSD Profiling Tool to Measure the Best SSD Additional Over-provisioning amount

In Intensive Write Environment, SSD Over-provisioning is a Must

Multi-Cams 3D Scanning With Thunderbolt NAS

1. Ensure multi-client combined write IOPS requirement can be met.
2. Ensure the SSD lifespan in high workload environment.



https://portal.jp-seagate-mktg.com/user_testimonials/rowland_kirishima/

QNAP Global SSD Cache

- **The QNAP SSD Cache can be applied to multiple volume / LUN**
  - Cache Type:
  - Store hot data for accessing (Read-Cache)
  - Allow new data be written. (Read-write Cache)

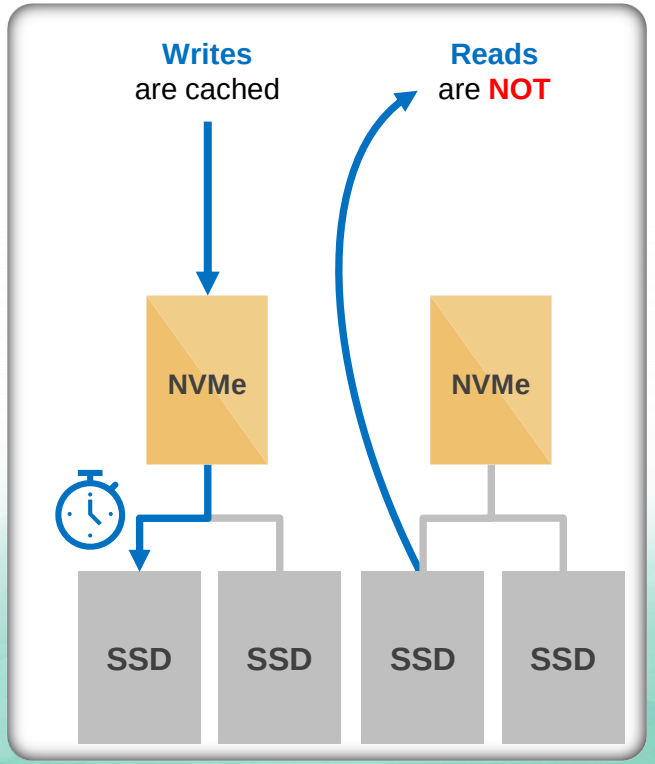
  - RAID configuration: Single, RAID 0, RAID 1, RAID 10
  - SSD type: SATA, SAS, M.2, PCIe SSD

How Read-write Cache work: Data from clients and storage will both be cached

The Write-only Cache Increase ROI of SSD Cache with high Writing Demand

- Write-only cache is promoted by Microsoft for endurance control.
- QNAP believe Write-only Cache can increase the ROI of purchasing SSD in below scenario:

1. File Server focusing on write operations
2. Database with more write operation (Such as IoT monitoring server)
3. Use high endurance SSD (Intel Optane™) with other SSD



https://docs.microsoft.com/en-us/windows-server/storage/storage-spaces/understand-the-cache

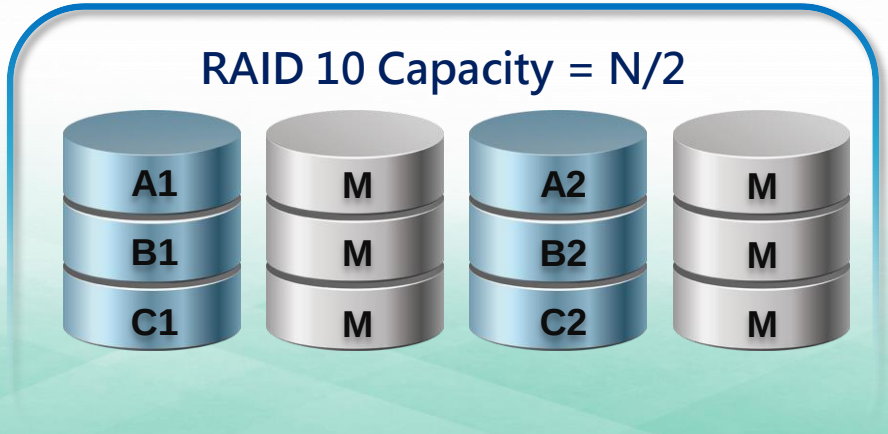
Combining Write-only Cache & Over-provisioning with All Flash Storage

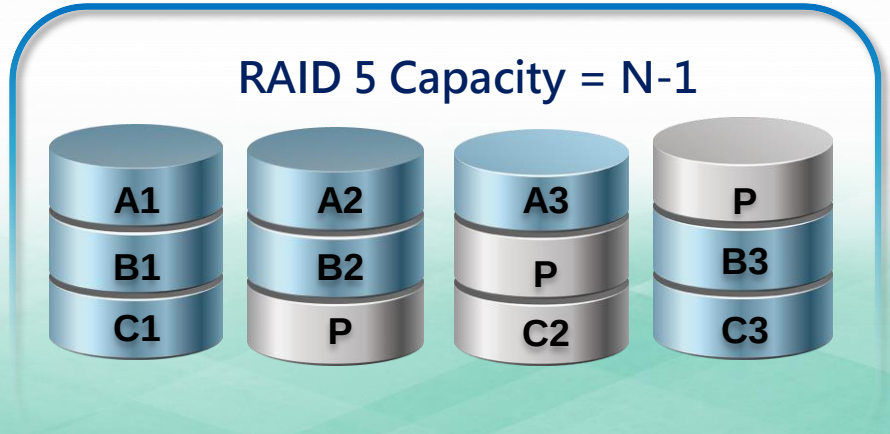
- **In RAID 5/6 All Flash Storage, Add Write-only cache to avoid write penalty**
- **For example, The TES-3085U with all flash RAID 60 can pair with RAID 10 SSD Write-only Cache.**
- **Add the SSD additional Over-provisioning on the RAID 10 to create a 3H (high capacity, high performance, high endurance) all flash storage array.**

Using Samsung 850 Pro, FIO For the test: --direct=0 --bs= 4k(random)1M(sequential), --io depth=1(random) 32(sequential), --file size= 90G

SSD Cache Support RAID 5/6
Increase ROI for Read-only Cache

- **What is RAID 5/6 write penalty？ RMW (Read Modify Write)**
  1 Write= Read Parity+Read Data+Calculate Parity+Write Parity+Write Data
- **However, if the SSD will only be used as Read-only Cache, the write action will be limited and RAID 5/6 can increase Cache capacity**

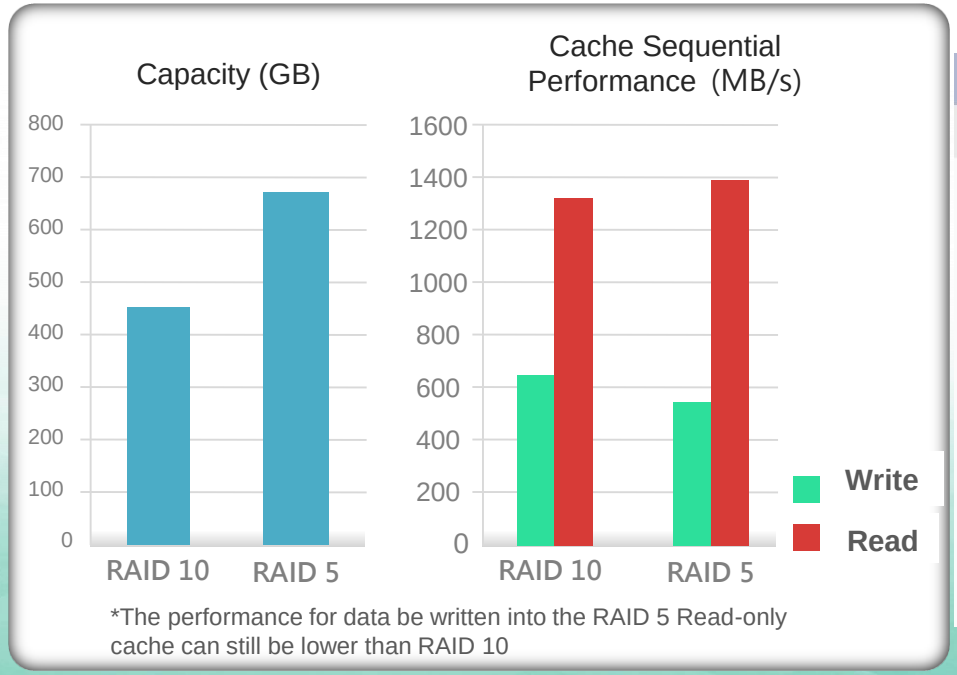




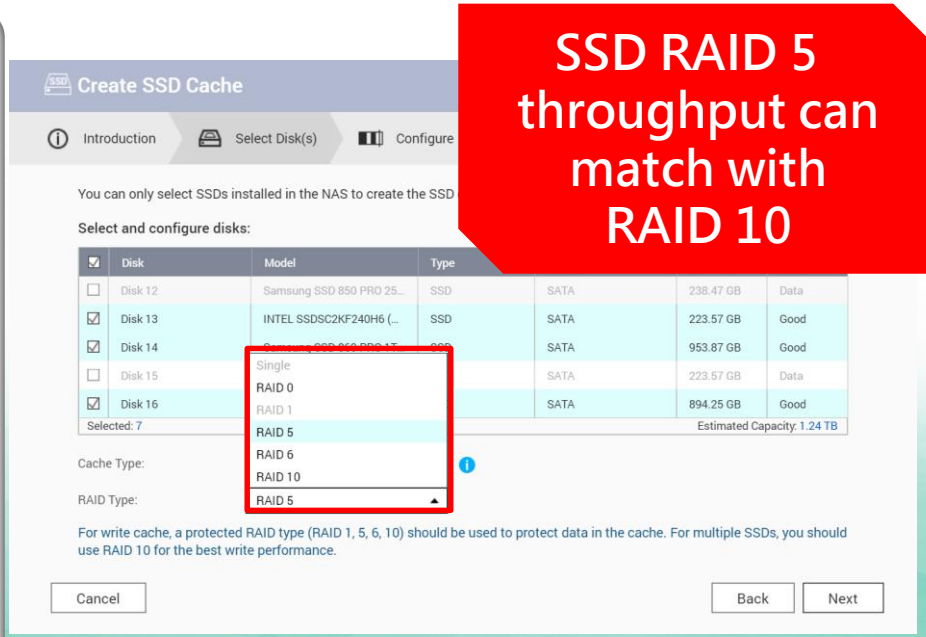
Also, the write penalty is proved to be less obvious on sequential access, in which not all chunk will need to be checked.

Create SSD Cache With RAID 5/6

- **In QNAP Lab，four 240GB Samsung SSD 850 Pro is used as Cache**
- **Compare the performance between RAID 5 and RAID 10 with 100% Cache hit rate***



*The performance for data be written into the RAID 5 Read-only cache can still be lower than RAID 10

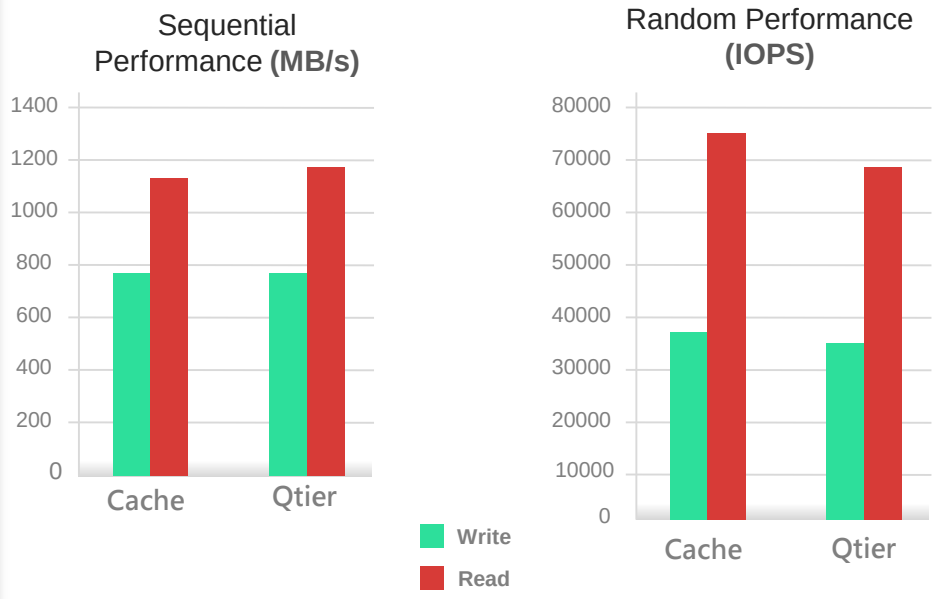


SSD RAID 5 throughput can match with RAID 10

QNAP NAS Provide the Most Flexible SSD Cache Settings

Scenarios	File/ Application Server	Web Server	Online Media Editing Station	Media Material Storage	Business Database Storage
Cache Mode	Read-write C	Read-Only	Read-write	Write-only	Read-write
Cache RAID	RAID 10	RAID 5	RAID 5	RAID 10	RAID 10
SSD additional Over-provisioning	20%	10%	30%	30%	30%
Recommended / reference model	TS-877	TS-963X	TVS-1282T3	TS-1685 TS-1635	TS-EC2480U R2

SSD Cache or Qtier™, Which is Better?



TVS-871T-i7-16G with QM2 2P Card ADATA SX8000NP 512GB as SSD Cache and Qtier

Global SSD Cache

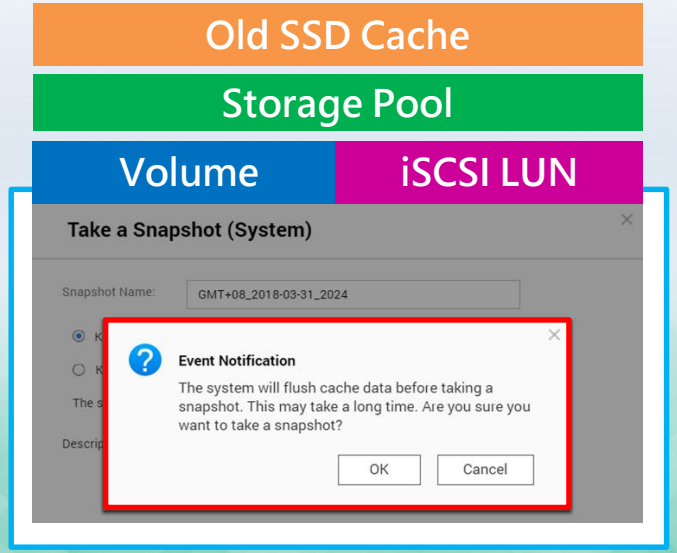
Real time performance boost
1. Burst read and write requirement such as news editing.
2. The cache can be disabled and adjusted at any time.

Qtier 2.0

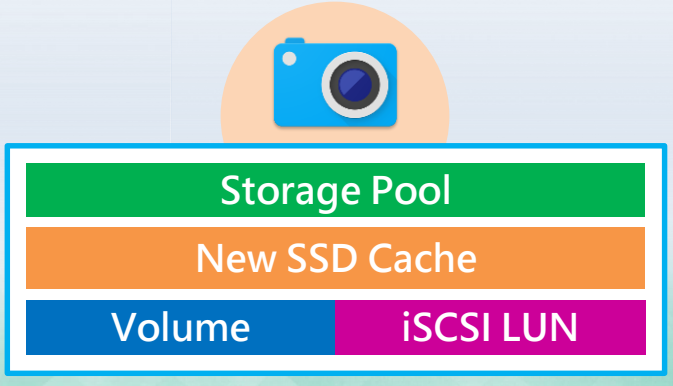
Fully utilize the SSD capacity
1. For data with hot and cold access pattern to conduct tiering
2. Pair with Qtier IO-aware can also be used on databases.

Storage Structure Change For Snapshots to Include Cache Content

Old SSD Cache: Taking Snapshot must flush SSD Cache data first and may take up to 30 min.



- **New SSD Cache: Taking snapshots no longer require flushing, enabling high frequency snapshots with SSD cache included.**




QNAP
QTS 4.3.5 Preview
Storage Space Management and Monitoring

Flexibility Storage Management

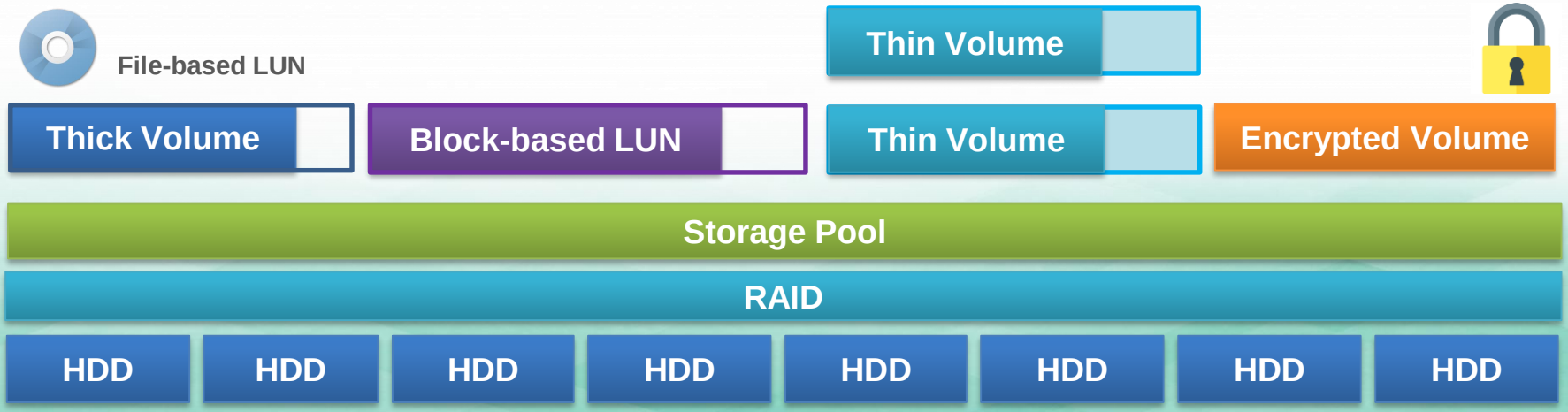
- Volume Shrink and Convert
- VJBOD Support iSER
- Seagate IronWolf Health Management

Challenge

My storage space is not enough to store both data & snapshots?
My HDD become abnormal but the status still shows good?

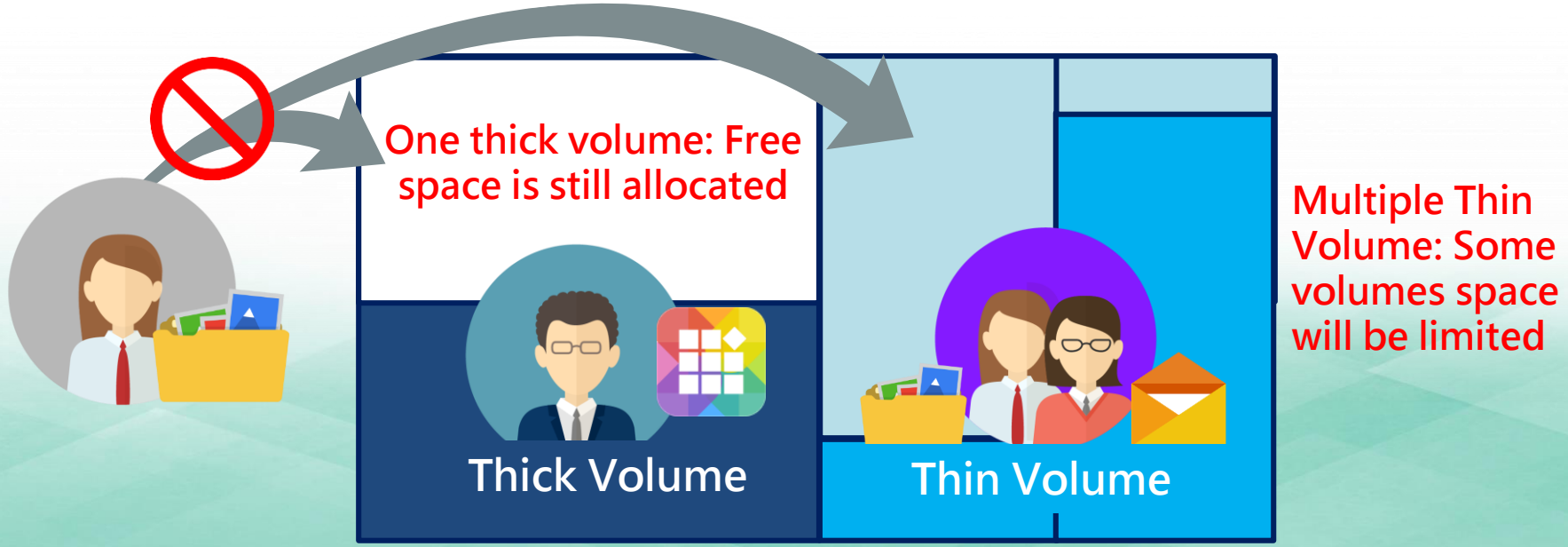
QNAP Flexibility Storage Configuration

- **Already support various configurations with storage pool**
  Guaranteed Space：Think volume and Block-based iSCSI LUN
  Thin-provisioning：Thin Volume and Block-based iSCSI LUN
  Other functions：Encryption of Thick/Thin Volume and File-based iSCSI LUN



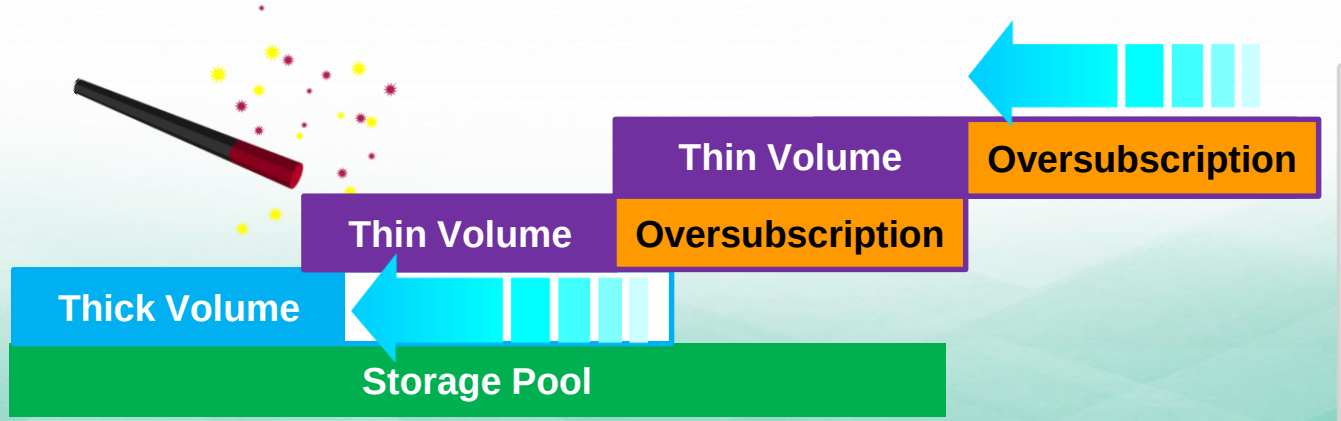
In the Past, Space Allocation Need to be Careful

- Allocate all space to thick volume: free space cannot be utilized
- Over-subscripted space to thin volume: some volume cannot be used
- When Storage Pool Space is limited, snapshot can be auto recycled



Introduce Resize Volume Wizard

- The Thick and Thin Volumes now support Resize Volume Wizard.
- Reduce the allocated thick volume space to free space for the storage pool, other volumes, LUN or Snapshot.
- Reduce the planned thin volume space to avoid risk of “Oversubscription”.

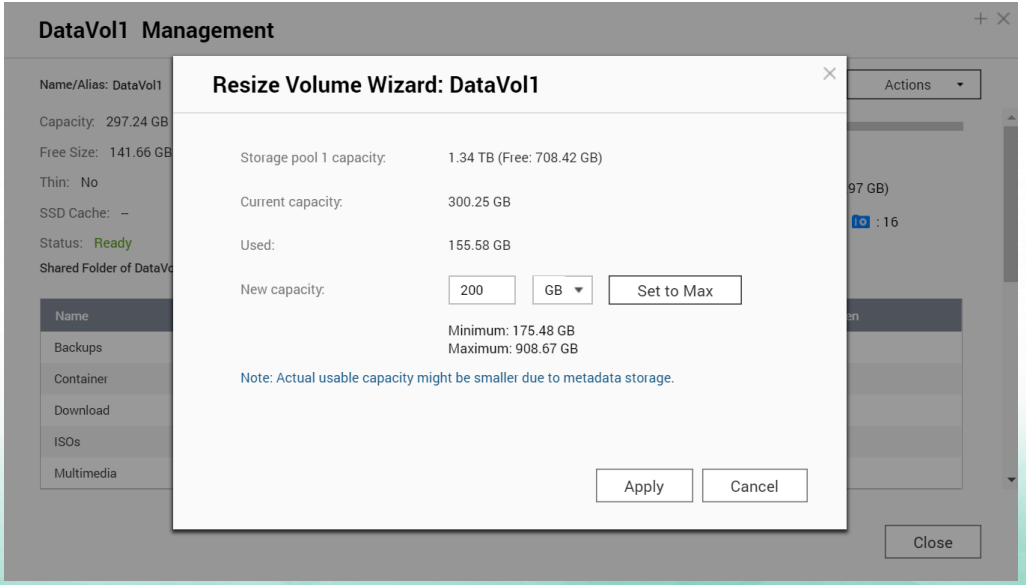


Oversubscription

The space that thin volume has planned but its storage pool cannot currently provide.

3 Three Steps to Reduce the Volume Space

1. Ensure all the written actions of the volumes are stopped
2. Storage/Snapshot > Volume Management > Resize > Input the reduced size
3. Waiting for the action to complete and continue usage!

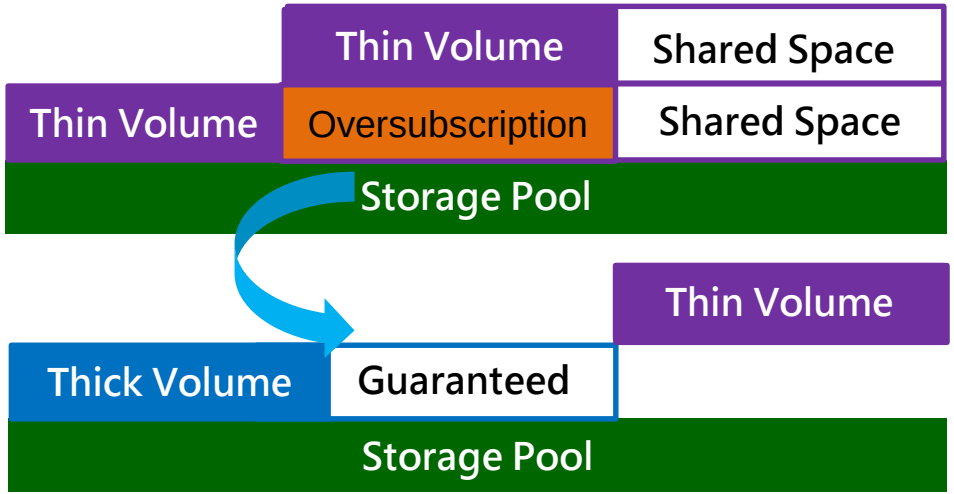


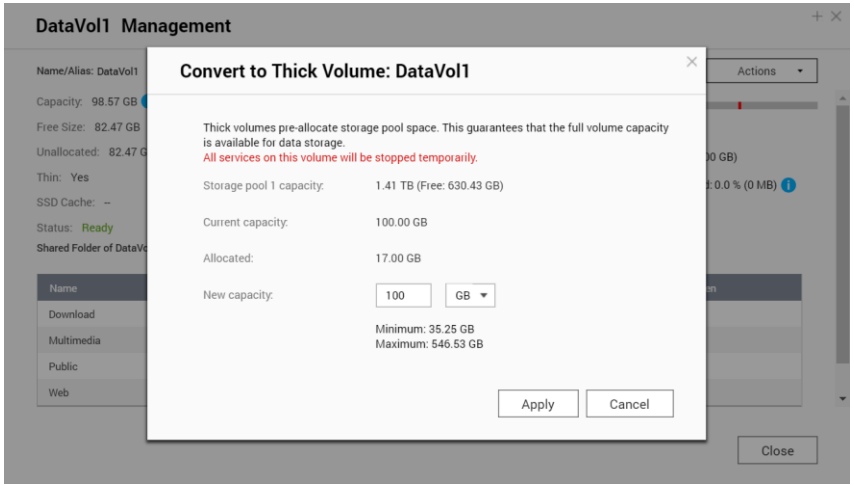
Demo

Shrinking Volume Capacity in 3 Steps

Convert Thin Volume Back to Thick

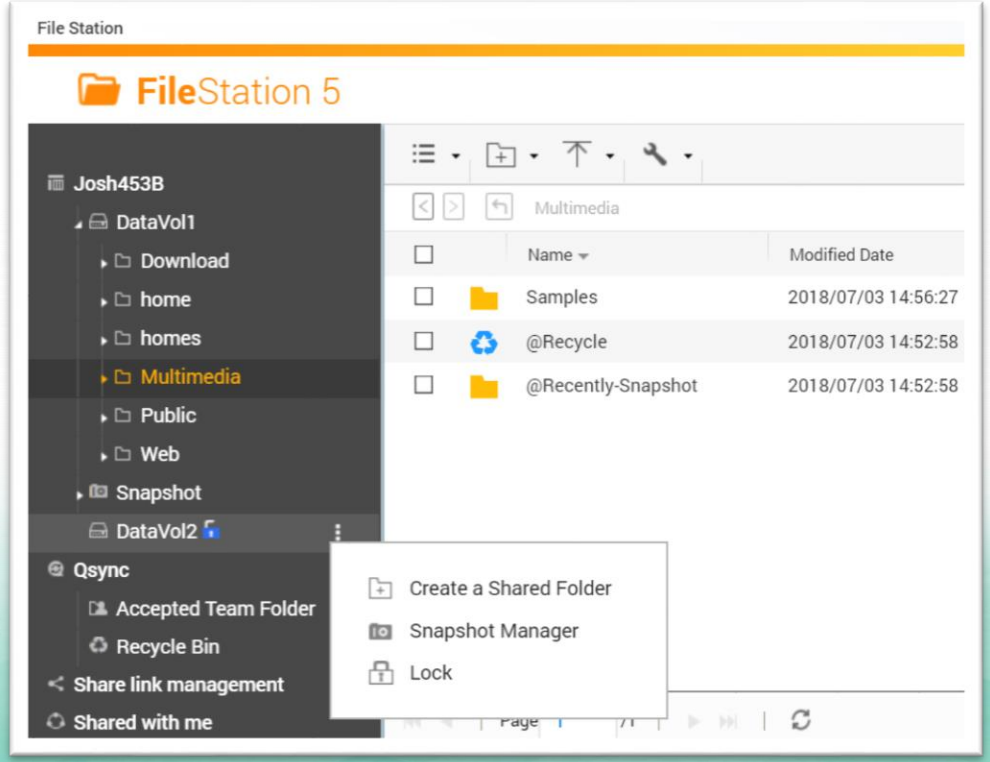
- QTS 4.3.5 now support convert Thin to Thick in contrast to Thick to Thin conversion introduced in QTS 4.3.4.
- The volume space can be converted to guaranteed space or flexible allocation to maximize space allocation efficiency.





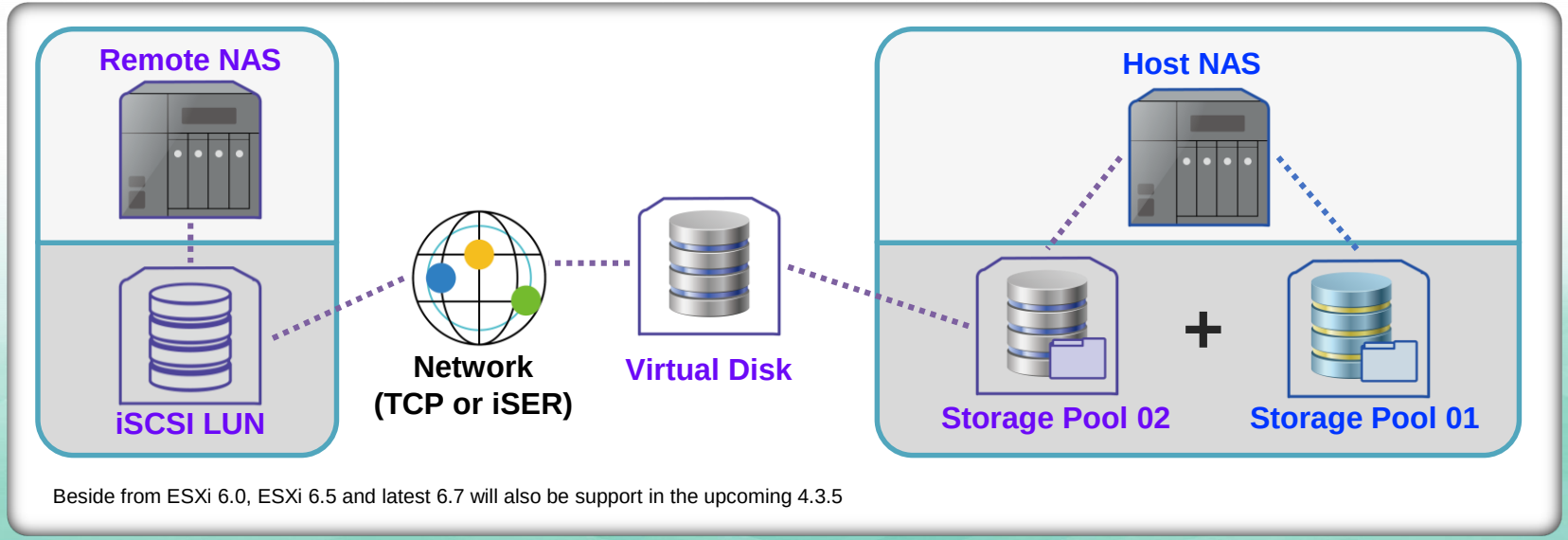
Using File Station to Control Encrypted Volume

- Use can create encrypted thick or thin volume with National Cyber Security certified (FIPS 140-2 CAVP) AES-256 bits encryption.
- In 4.3.5 User can quickly lock a data volume in File Station.



VJBOD Support RoCE-based iSER

- **Earlier in QTS 4.3.3 QNAP and Mellanox collaborated so the QNAP NAS iSCSI target can support RoCE iSER with VMware ESXi**
- **At QTS 4.3.5, The VJBOD that based on iSCSI can also utilize this technology to increase the storage performance**



Beside from ESXi 6.0, ESXi 6.5 and latest 6.7 will also be support in the upcoming 4.3.5

What is iSER (iSCSI Extensions for RDMA)

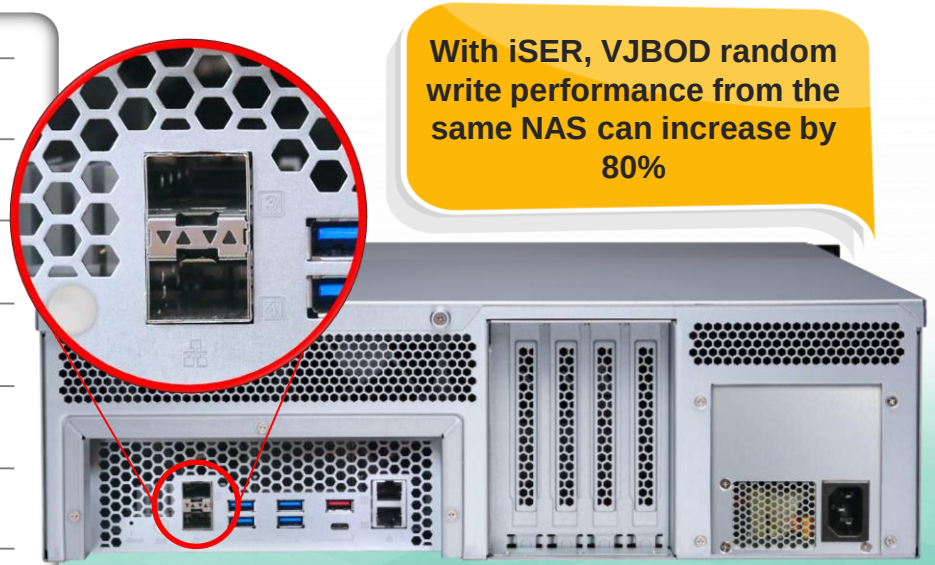
- Based on different technologies (RoCE, iWARP, InfiniBand), the goal of iSER protocol is to allow network data to reach the memory of the systems directly
- RoCE based iSER can be active when both host and remote system used the specific network card, and can increase transferring performance by more than 25%.

Tested in QNAP Lab. Figures may vary by environments.
QNAP RoEC based iSER can only be enabled with specific Mellanox NICs as well as a switch that support Priority Flow Control

Using iSER to Increase VJBOD Performance

In QNAP Lab, the TS-1677XU with built-in Mellanox CX4 10GbE

The disk performance of Virtual Machine that mount iSER VJBOD disks can be faster than other normal VJBOD disk from the same NAS.

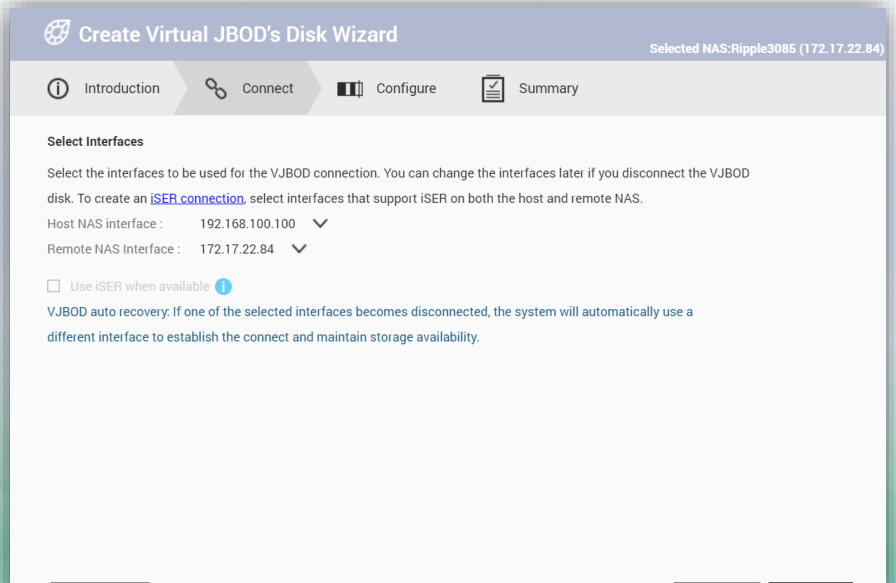


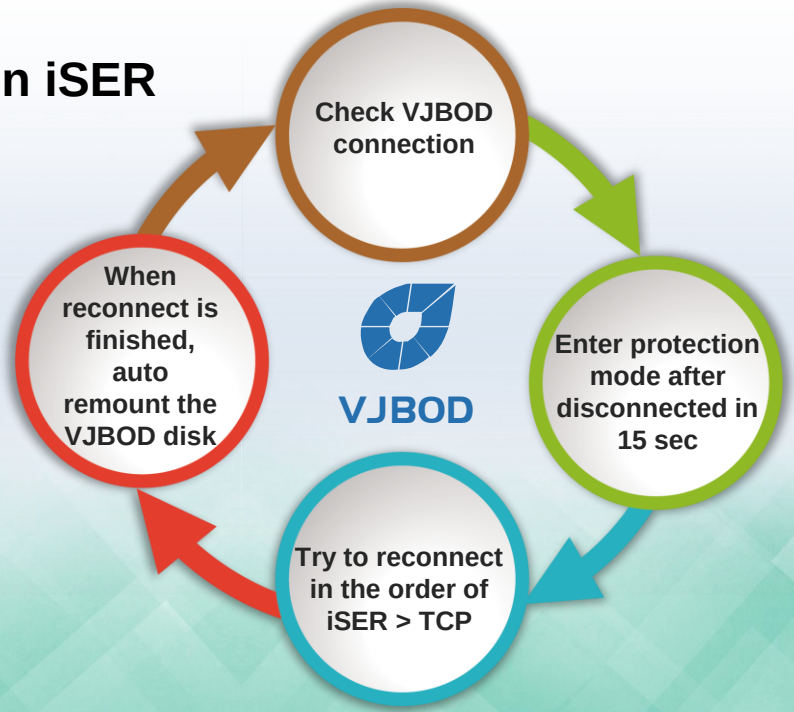
With iSER, VJBOD random write performance from the same NAS can increase by 80%

Test condition: Mount a TES-3085 iSCSI LUN as VJBOD disk and create virtual disk image for a VM on 1677XU to test the disk performance with Iometer, 64GB 4 Outstanding, Standard 4K random read/write test

Easily Enable iSER Connection For VJBOD

- Use iSER in VMware might be hard, but it is one click to go in QTS
- VJBOD connection wizard can easily identify which interface supports iSER for user to select from
- Auto reconnection is also supported in iSER





Demo

Use iSER VJBOD to create a local VM disk and test its performance

How to Intelligently Monitor Disk Condition

- **Disk issue is generally reported by S.M.A.R.T., but S.M.A.R.T. only reported error after it has been detected.**
- **Is there a way to actively analyze disk conditions, to prevent errors from happening such as:**

Bad connection between NAS & Disk

Cause continuous reset

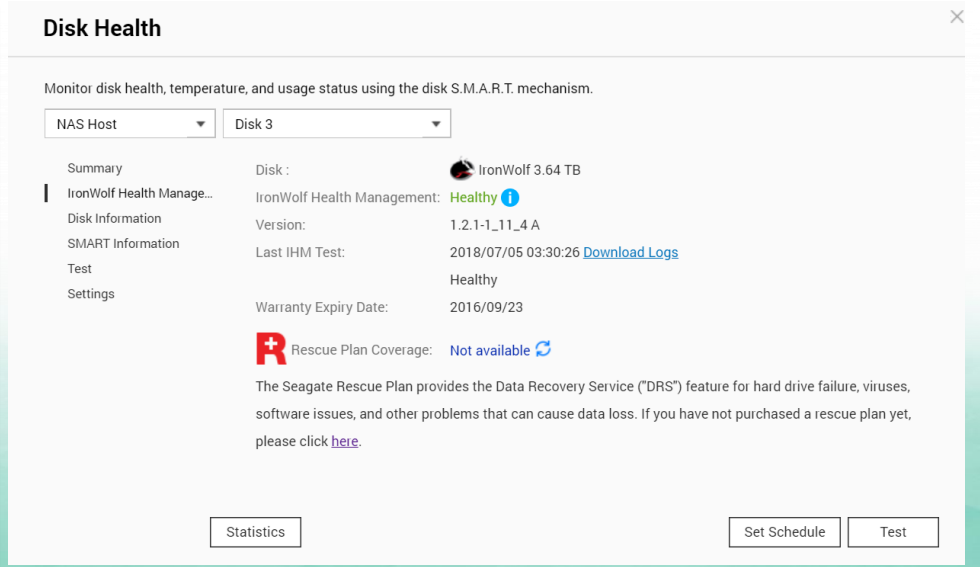
Excessive vibration on the HDD

Cause future bad sector

Seagate IronWolf Health Management

- **IronWolf Health Management is incorporated in QTS 4.3.5**
- **Using the Seagate Official Analysis Tool to find potential risk that might lead to disk abnormality**

The risk that IHM can help to detect:a
Excessive host resets have been detected.
Connection issues on NAS and hard drive interface.
Excessive physical shock to the hard drive.
Excessive vibration on the hard drive.
Abnormally high operating temperature.
Analysis S.M.A.R.T. values for future failurea



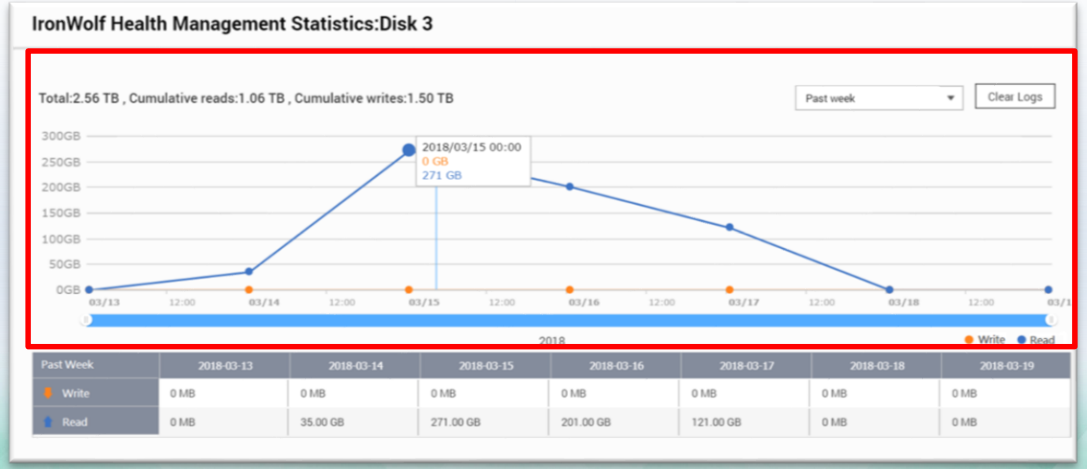
QNAP X Seagate Exclusive Functions

- **QNAP and Seagate are committed to provide more advanced features to protect customer data**

-Default Warranty Expiry Day Provide info on the out of factory warranty for reminding early replacement

- Workload statistic

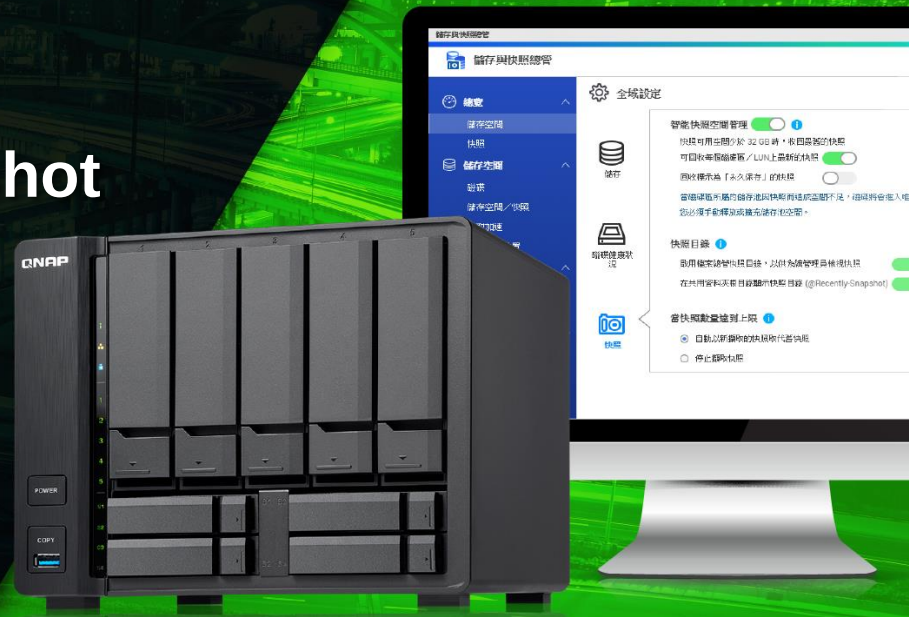
Determine warranty based on total data write while monitoring application workload at disk level




QNAP
QTS 4.3.5
Preview
Snapshot Remote Restore and Export/Import

Snapshot Replica Remote Restore :

- Restore from Remote Snapshot Vault
- Snapshot Export/Import
- Export Snapshot In first Snapshot Replica Task
- LUN Export/Import



Challenge

Backup data recovery can not be completed in time when disaster happens?

Business Need Shorter RTO!

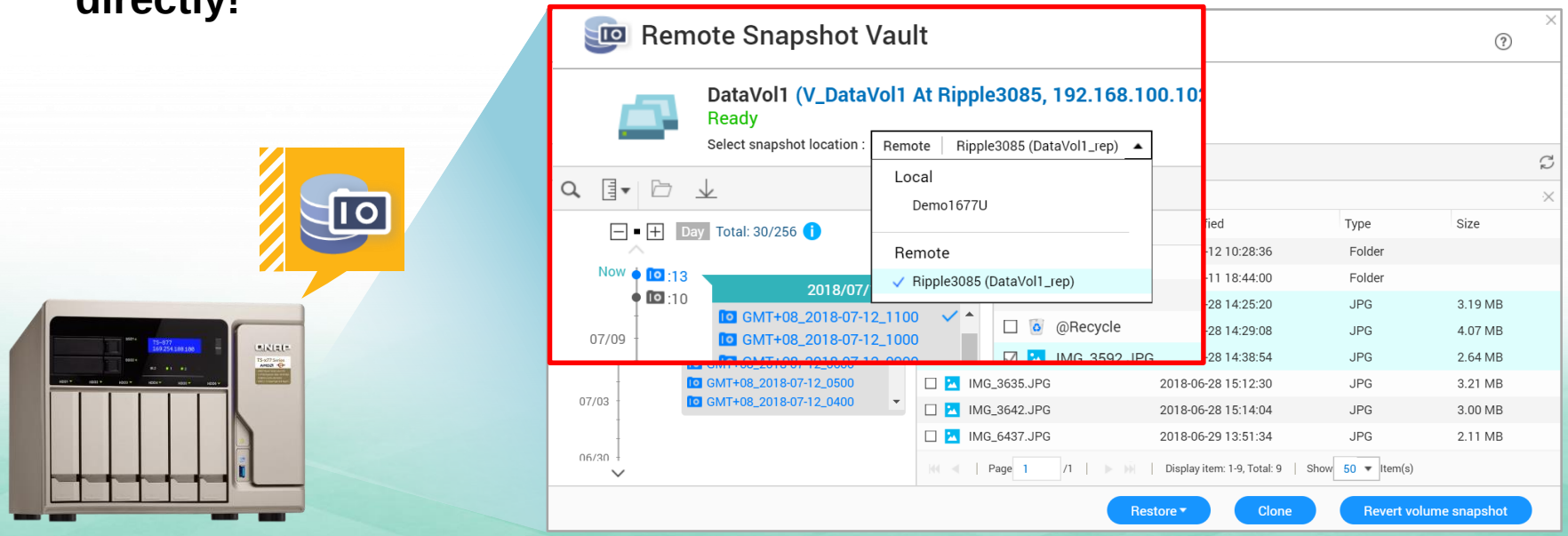
In the survey of 300 Enterprise and SMB at Taiwan:

- **60% have used Remote Replication as Backup Plan.**
- **50%** of business expected the recovering time should be within **1 Hour.**
- But also **50%** of business experience actual recovery time > **1 Day!**

Taiwan IThome survey 2017

Restore From Remote Snapshot Vault

- The Snapshot Manager now actively connected to Snapshot Vault
- Support Monitor and restore select folder and files at the Source NAS directly!

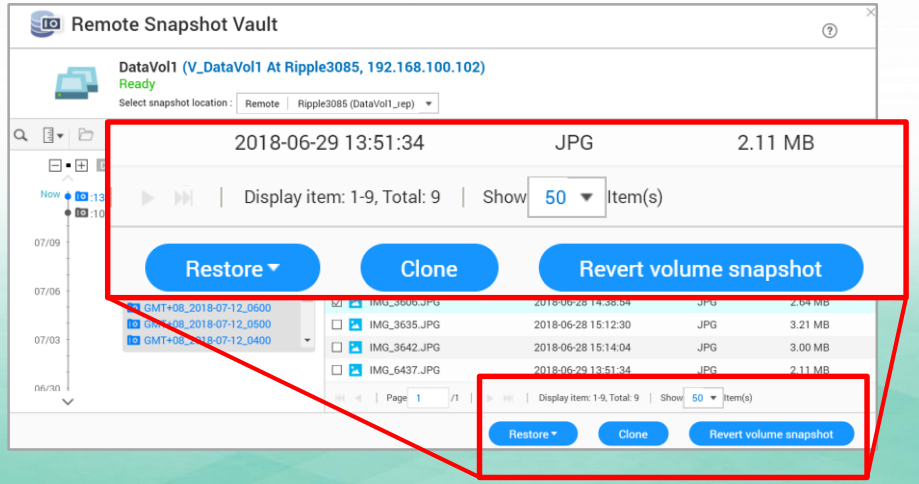


Both the source and destination NAS must be upgraded to 4.3.5 to support this function

Support 3 Types of Restoring

- From the source snapshot manager, user can
  1. Select file and folder to restore back to source
  2. Select and clone remote snapshot as new volume/LUN
  3. Select snapshot and revert the whole volume or LUN from remote

The restore, clone and revert speed is highly depended on the network speed and conditions



Demo

Using QNAP 10GbE Solution to Restore File From Remote

The Forth Way: Snapshot Export/Import

- Export a snapshot from snapshot manager or snapshot vault
- Using external storage device, the exported imaged can be imported to another NAS to create new volume or LUN
- The same image can also be used to revert source volume or LUN

When network speed is unstable, external disk can also be utilized.

The exported image file size is same as the source volume or LUN

Multiple Restore Solutions For File Server or iSCSI Storage

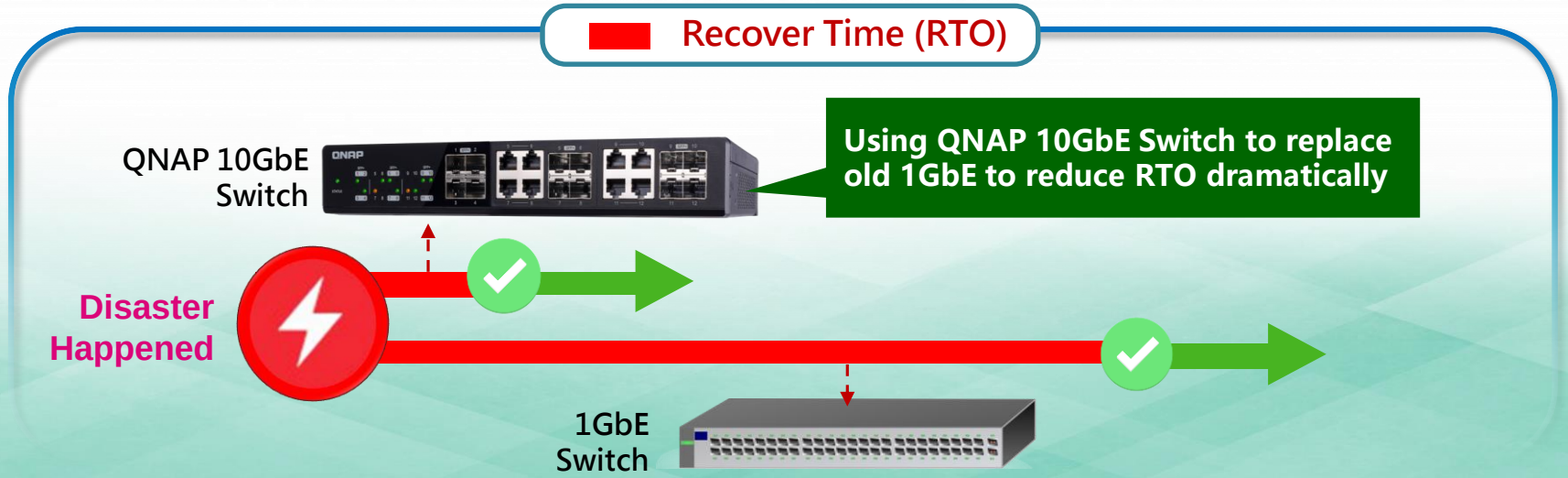
- **File Server:**
  Restore selected data from remote snapshot vault directly
- **iSCSI Storage Server:**
  Revert the iSCSI LUN from remote or clone the LUN at remote end for fast remount.

File-level file restoration from remote

Block-level remote restoration or clone the LUN directly at remote end

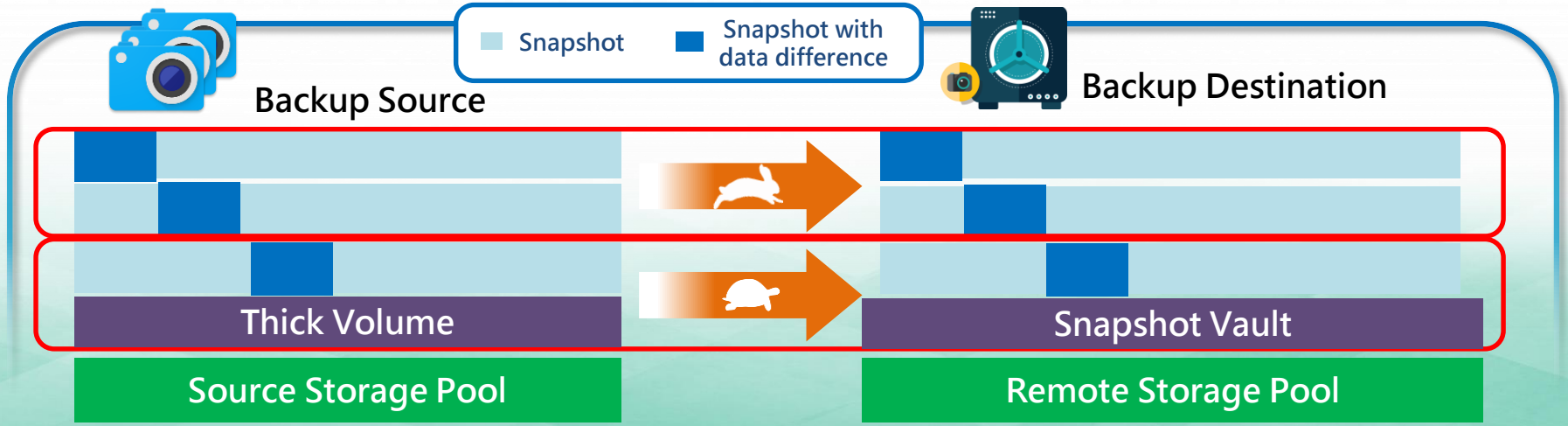
Drastically Reduce Recover Time With 10GbE Network

- The Remote Snapshot Vault Recovering is based on Ethernet service.
- Using 1GbE network, recovering large amount of data still take hours.
- Pair the Snapshot Replica Solution with 10GbE or even faster Network to increase both the backup and recovery speed !



Why First Snapshot Replica Take Longer Time?

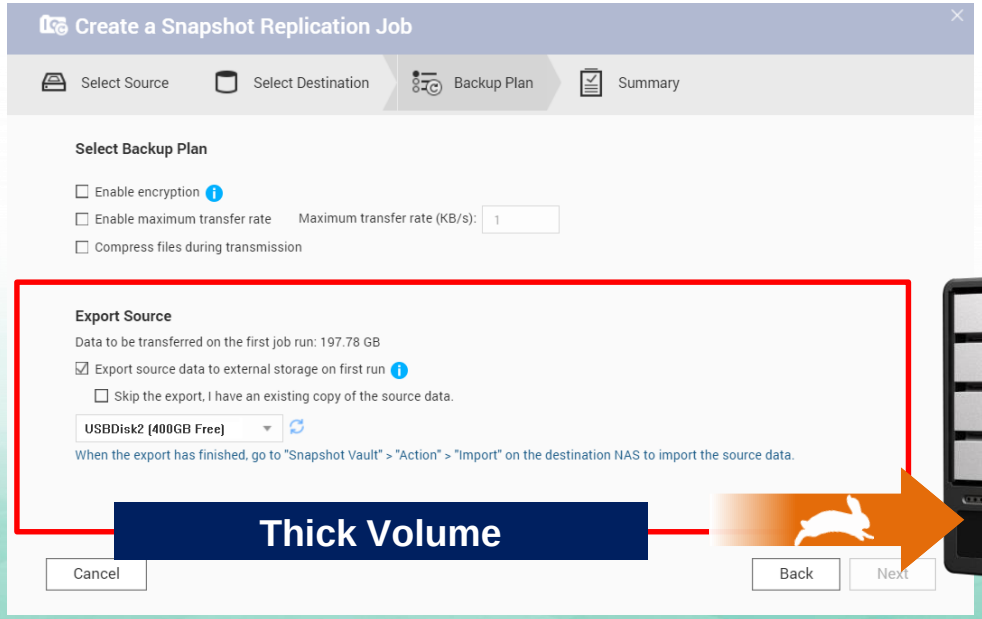
- In the survey, 30% of IT managers do not feel comfortable with the long backup time.
- For Snapshot Replica, the whole Volume and LUN need to be transferred first before snapshot can be backup*
- Without faster network, setting up a backup can take days.



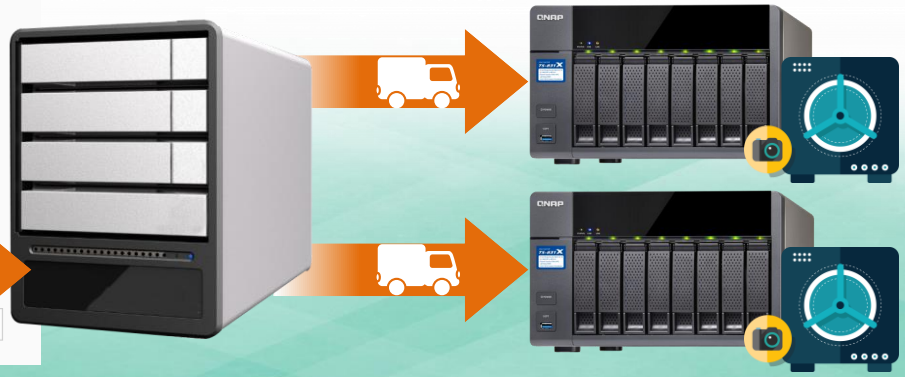
Thin volume or LUN are not limited by this as space will only be allocated after data usage.

Snapshot Replica Support Export/Import

- Snapshot Replica support options to Export Source to External Storage
- Once exported, go to remote side and import image file to the vault



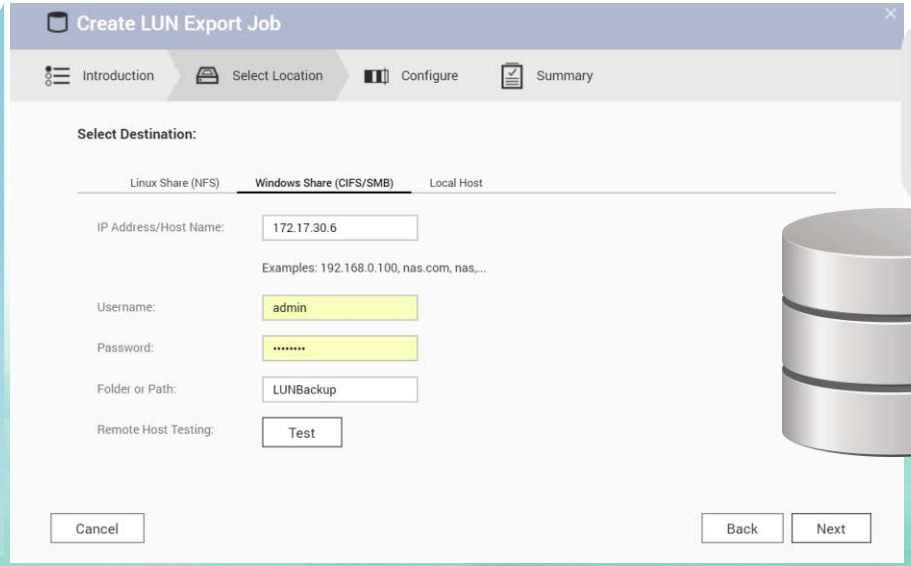
Use External RAID Storage with Snapshot Replica Export to quickly setup multiple backup site.

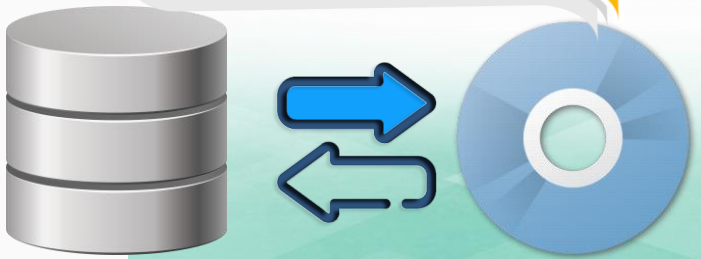


Both the source and destination NAS must be at QTS version equal to or above 4.3.5 to use this function.

iSCSI LUN Support Export/Import

- **Besides using QNAP NAS to do Snapshot Replica, iSCSI LUN can also be exported to an Windows/Linux server**
- **The exported image can be later imported to same or different NAS**





Even when only 1 QNAP NAS present, iSCSI LUN can still be properly backup

Both the source and destination NAS must be at QTS version equal to or above 4.3.5 to use this function.

Work Smart With the Snapshot Replica

With Remote Snapshot Vault Restore, Snapshot Replica is the best option to backup whole volume for file server

Backup Solution	Snapshot Replica	RTRR	Rsync
Backup Method	Block-level snapshot-based	File-level file-based	Block-level file-based
Backup Type	Differential backup (Only Transfer difference)	Overwrite different file (Transfer whole file)	Differential backup (Only Transfer difference)
Backup Time	Schedule	Real time/Schedule	Schedule
Recovery Solution	Remote recovery/Source recovery/ Import recovery	Remote recovery/ Synchronizing	Remote recovery
Backup Destination	NAS	NAS	Rsync Server
Using Scenario	Backup whole volume/LUN with many small files	Data synchronizing	Backup specified large files such as VM images

Work Smarter in the Age of Speed!

1. Software-defined SSD Additional Over-provisioning / SSD Write-only cache / RAID 5, 6 Cache
2. Volume Shrink and covert / VJBOD support RoCE based iSER/ Seagate IronWolf Health Management
3. Remote Snapshot Vault Restoration / Snapshot Export and Import

QNAP NAS

Is Your Best Choose