

QNAP



QNAP NAS Solution
Snapshots
White Paper

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1. Introduction to Snapshots

Data backup and recovery times are extremely important to both home and business users. A survey of 300 enterprise and small-medium businesses in Taiwan (“Taiwan IThome survey 2017”) found the following:

- 60% of businesses used remote replication for backups.
- 50% of businesses expected data recovery to take less than 1 hour.
- 50% of businesses experienced data recovery times of more than 1 day.

Snapshots help to reduce backup and recovery times. Instead of copying data to another location, snapshots freeze data blocks in a volume or LUN, preventing them from being modified. When a volume or LUN needs to be recovered, the system can mount the unmodified data blocks directly. Restoring all data in a volume using snapshots is up to 10 times faster than restoring the data by copying it from a backup source.

Snapshots are also a differential backup solution. This means that they only use additional space when data is modified. The frequency of backups can be increased while reducing space requirements.

2. QTS Snapshot Advantages

QNAP has developed its own proprietary ext4-based snapshot technology in QTS that reduces RTO (Recovery Time Objective) and RPO (Recovery Point Objective). QNAP snapshots have several advantages over the open-source Btrfs snapshot technology used by competitors.

Ext4 is Fast

Ext4 has less I/O latency than Btrfs. In the same test environment, file transfers using Samba on an ext4-based QNAP NAS were 61.5% faster than another brand's Btrfs-based NAS. Benchmark tests from Phoronix, a leading website for Linux hardware reviews, show similar results.

<https://www.youtube.com/watch?v=IES4KEDGSc0>

<https://www.phoronix.com/scan.php?page=article&item=linux414-fs-compare>

Block-Based Snapshots Protect Your Data Against Ransomware

Ransomware is a type of malware that denies you access to your data until you pay the creators. Ransomware attacks, such as the high-profile WannaCry outbreak, can affect both home users and businesses. QTS block-based snapshots store their data at the block-level, which file-level ransomware cannot access or modify.

Data and Snapshots are Stored Separately

QTS stores snapshots outside of the volume, in unallocated storage pool space. This enables you to better utilize the free space on your NAS, and prevents snapshots filling up all the space on a volume. On Btrfs-based NAS devices, snapshots are stored in the volume and occupy the same space as user data.

3. How QTS Snapshots Work

3.1. Block-Based Snapshots

A block-based snapshot records the state of all blocks in a volume or LUN at the time the snapshot was created. Modifications to data on the volume can then be tracked and reverted, and the state of the volume restored to a previous point in time.

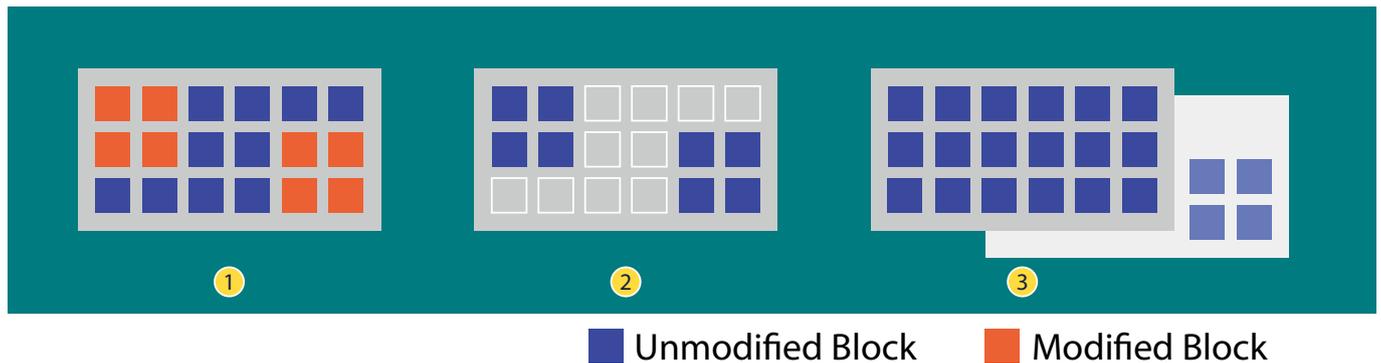


Figure 1: QNAP Snapshot Revert

Figure 1 shows the a QTS volume with a snapshot being reverted.

1. After taking a snapshot, data is modified on the volume. QTS modifies the data blocks.
2. The snapshot records the unmodified data blocks.
3. When reverting the volume, QTS discards the modifications and mounts all unmodified blocks.

3.2. Snapshot Creation

There are two main methods to create snapshots; Copy-on-write (COW) and Redirect-on-write (ROW). QNAP snapshots use a combination of both methods.

3.2.1. Copy-on-Write (COW)

In copy-on-write snapshots, a block is copied to another location before being overwritten.

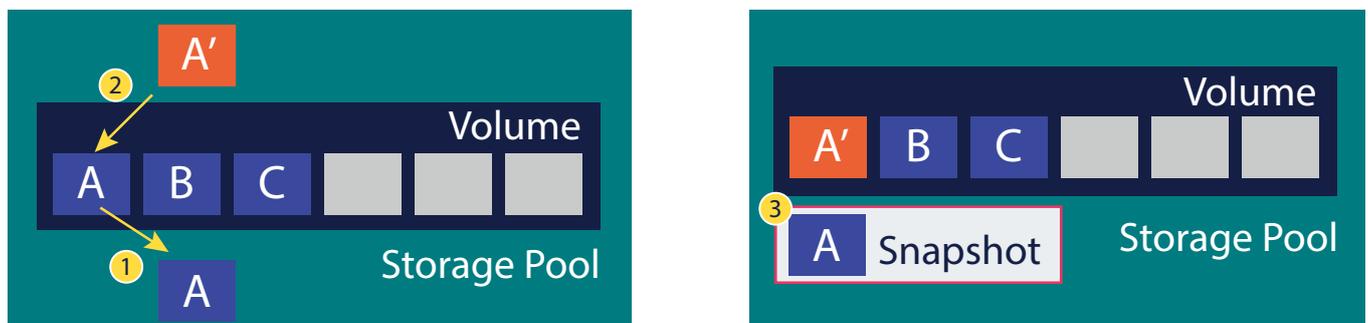


Figure 2: Copy-on-Write

Figure 2 shows a volume after a COW snapshot has been taken. Data is modified on the volume. The system must overwrite block A with modified block A'.

1. The system copies block A to storage pool space, outside of the volume.
2. The system writes new block A' to the volume, overwriting A.
3. When a process reads the snapshot, it sees all of the blocks in the snapshot space (A) and the unmodified blocks in the volume (BC).

3.2.2. Redirect-on-Write (ROW)

In redirect-on-write, modified blocks are written to a different location. The system then creates a pointer from the original unmodified block to the modified block.



Figure 3: Redirect-on-Write

Figure 3 shows a volume after a ROW snapshot has been taken. Data is modified on the volume. The system must overwrite block A with modified block A'.

1. The system writes block A' to storage pool space, outside of the volume.
2. The system creates a pointer from block A to block A'.
3. When a process reads the volume, it sees A'BC. When a process reads the snapshot, it sees ABC.

3.2.3. QTS Snapshots: Redirect-on-Write and Copy-on-Write

QNAP Snapshots use redirect-on-write for space management. Modified blocks are stored outside of the volume in storage pool space. However, in order to ensure data consistency QNAP snapshots use copy-on-write to exchange data blocks.

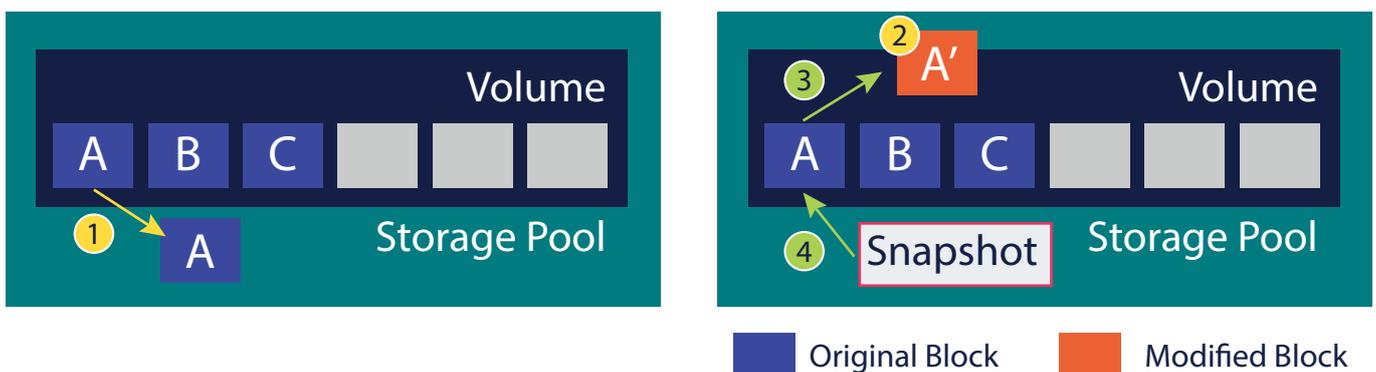


Figure 4: QTS Snapshots

Figure 4 shows a QTS thick volume after a snapshot has been taken. Data is modified on the volume. QTS must overwrite block A with modified block A'.

1. QTS copies block A to storage pool space outside of the volume.
2. QTS overwrites the copy of block A with modified block A'.
3. QTS creates a pointer from block A to block A'.
4. When a process reads the volume, it sees A'BC. When a process reads the snapshot, it sees ABC.

3.3. Thick Volume and Thin Volume Snapshots

Thick and thin volume snapshots are different in QTS. A thick volume snapshot records the state of all used and unused blocks. A thin volume snapshot records the state of used blocks only. This makes thin volumes more space efficient for both storing data and when using snapshots.

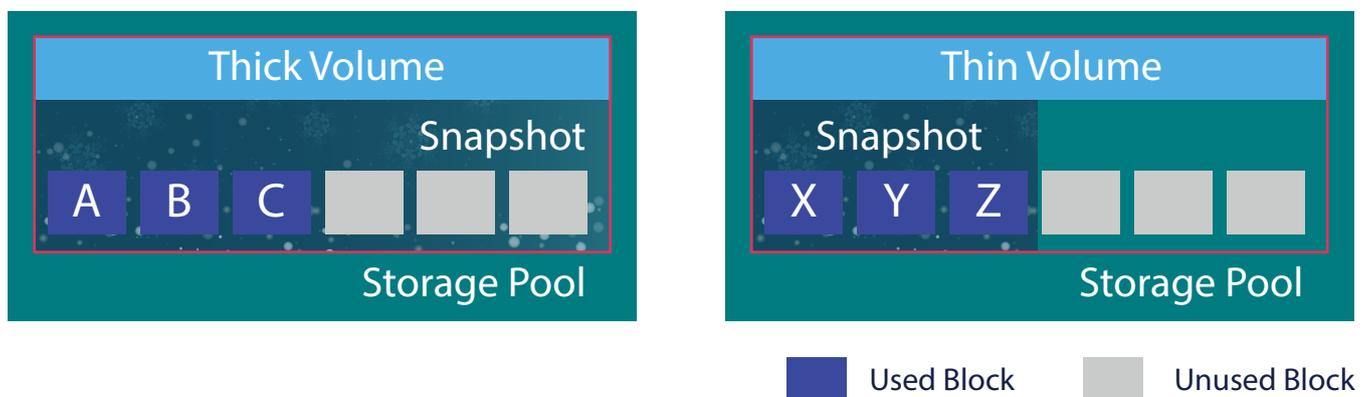


Figure 5: Thick and thin volume snapshots

4. QTS Snapshot Features

Scheduled or Manual Local Snapshots

You can take snapshots manually, or according to a schedule. With **Snapshot Manager** you can quickly restore files, folders or a whole volume or LUN to a previous state if data has been unintentionally modified or deleted.

Important:

- Local snapshots are not full backups. If a storage pool encounters an error that results in data loss such as disk failure, snapshots cannot be used for data recovery.
- In QTS 4.3.5 and later, the lowest allowed interval for scheduled snapshots is 5 minutes.

Application-consistent Snapshots with QNAP Snapshot Agent

QNAP Snapshot Agent enables QTS to take application-consistent snapshots of iSCSI LUNs that are connected to VMware vCenter™ or Windows Server®. Application-consistent snapshots record the state of running applications and data on the LUN.

When QTS takes a LUN snapshot, **QNAP Snapshot Agent** triggers the following actions:

- **Windows Server®**: The server flushes data in memory, logs, and pending I/O transactions to the LUN.
- **VMware vCenter™**: The server takes a virtual machine snapshot.

Snapshot Backup Jobs with Snapshot Replica

Snapshot Replica enables you to back up data to another QNAP NAS using snapshots. Snapshot Vault enables you to store and manage snapshots from another NAS. Using snapshots for backing up reduces storage space and bandwidth requirements.

Support for Windows® Previous Versions

Windows® users can use the “Previous Versions” feature in Windows File Explorer to restore files and folders from QTS snapshots. This makes data recovery faster and simpler, as individual users can restore their own files without the help of the NAS administrator.

5. QTS Snapshot System Requirements

The following QNAP NAS models and series support snapshots:

- All NAS models with an AMD, Intel or Annapurna Labs CPU.
- TS-1635AX, TS-328, TS-x28A, TS-x51, TS-x51+.

5.1. Maximum Number of Snapshots

The maximum number of snapshots a NAS can store is determined by the NAS series, CPU type, and amount of installed memory.

NAS CPU or Series	Installed Memory	Per NAS	Per Volume/Block-based LUN
AMD	≥ 1GB	32	16
	≥ 2GB	64	32
	≥ 4GB	1024	256
Annapurna Labs	≥ 1GB	32	16
	≥ 2GB	64	32
	≥ 4GB	256	64
Intel	≥ 1GB	32	16
	≥ 2GB	64	32
	≥ 4GB	1024	256
TS-1635AX	≥ 1GB	32	16
	≥ 2GB	64	32
	≥ 4GB	256	64
TS-328, TS-x28A	≥ 1GB	32	16
	≥ 2GB	64	32
TS-x51, TS-x51+	≥ 1GB	32	16
	≥ 2GB	64	32
	≥ 4GB	256	64

5.2. Snapshot Replica Requirements

To back up a volume to another QNAP NAS using Snapshot Replica, the second NAS must have at least one storage pool with free space equal to or greater than the volume's capacity.

6. QTS Snapshot Space Management

To create a snapshot in QTS, there must be at least 32 GB of free storage space in the volume or LUN's storage pool. If this space is not available, QTS can automatically delete older snapshots to free up space. You can configure automatic snapshot deletion at **Storage & Snapshots > Global Settings > Snapshot > Smart Snapshot Space Management**.

Figure 6 shows how QTS manages space when taking a snapshot.

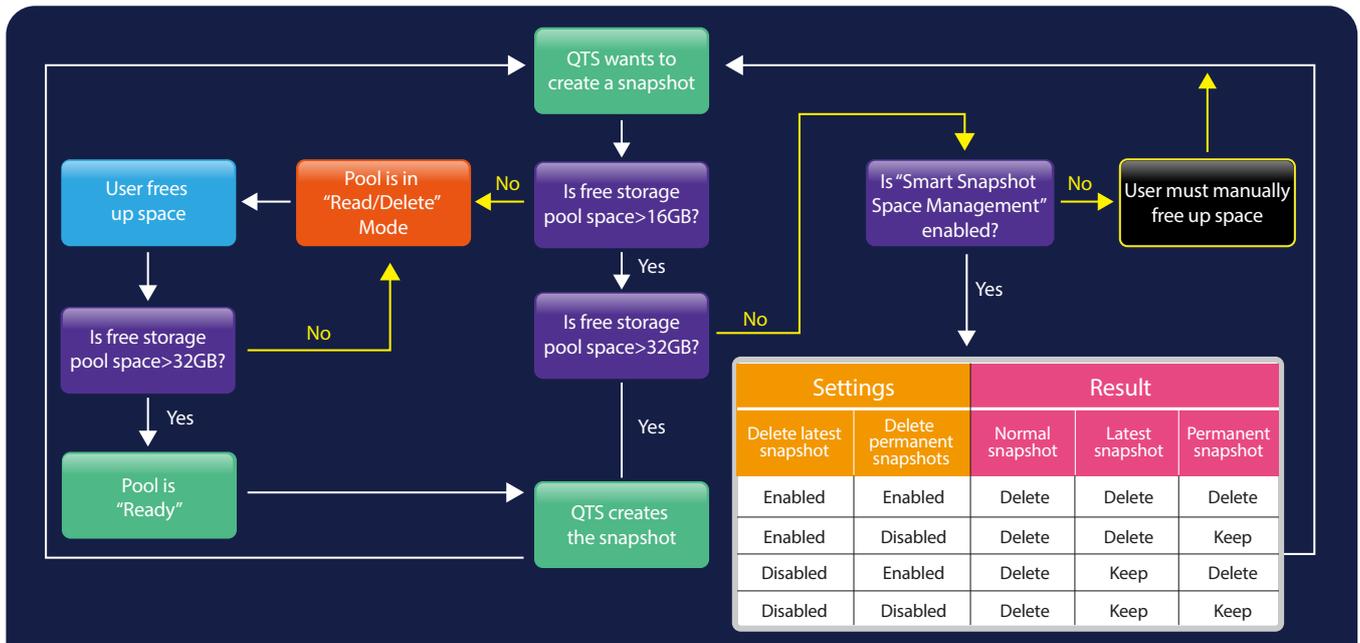


Figure 6: QTS Snapshot Space Management

7. Hybrid Backup Sync and Snapshot Comparison

Hybrid Backup Sync is a backup utility for QTS that offers Real-time Remote Replication (RTRR) and Rsync. Below is a comparison between RTRR, Rsync, and Snapshot Replica.

	Snapshot Replica	RTRR	Rsync
Level	Block-level	File-level	Block-level
Backup Method	Snapshot	File	File
Backup Type	Differential (only differences are transferred)	Full (full file is transferred if files are different)	Differential (only differences are transferred)
Backup Time	Scheduled	Real time or Scheduled	Scheduled
Recovery Methods	Remote recovery, source recovery, import recovery	Remote recovery, synchronization	Remote Recovery
Backup Destination	QNAP NAS	QNAP NAS	Rsync server
Recommended Use Case	Backing up whole volume/LUN containing many small files	Data synchronization	Backing up selected large files such as VM images

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