Synology®
Solution Guide

Synology Expansion Units Solution Guide

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Introduction

In today's business environment, the demand for data storage is ever-increasing along with companies' growth. How to manage growing data is undoubtedly a huge business challenge. To solve the storage problem, Synology focuses on scalability regarding data storage and data backup and aims to provide customers a storage solution of high capacity and flexibility. With this background, Synology expansion units are developed to meet any storage demand.

Synology expansion units can be paired with a Synology NAS main unit to increase the storage volume and serve as an ideal backup location. Users can easily create and manage storage pools and volumes on both the Synology NAS main unit and the expansion units. As Synology expansion units are connected to their Synology NAS main units with a dedicated expansion cable, some concerns over whether the performance is affected are raised. This solution guide demonstrates some common scenarios collected from user feedback and provides suggested system configurations for performance optimization.

User Scenario Simulations

System Configuration

We chose RackStation RS18017xs+, as it supports up to seven RX1217sas expansion units and 96 3.5" SAS/SATA drives. We simulated different user scenarios through various combinations of drives and storage volumes.

Other key system configuration includes:

- **DSM version**: 6.2.1-23824
- **SATA drive**: Seagate Exos ST2000NM0125
- **SAS drive**: Seagate Exos ST2000NM0135
- **SAS SSD**: HGST Ultrastar SSD800MH.B
- **RAID**: RAID 5
- **File system**: Btrfs
- **Network adapter**: RS18017xs+ native 10GbE NIC and Intel® X540-T2
- **Switch**: Netgear M4300-24X24F
- **Client PC**: Intel® Core™ i7-4790 3.60GHz; 4GB DDR3-1600; Intel® 520 series 120GB SSD; Synology E10G17-F2 NIC; MTU 9000; Windows 7 64 bit
- **IOMeter configuration**: Continuously read from/write to a single 16GB file for three minutes; Block size: 64 KB for sequential throughput tests; 4 KB for IOPS tests; read-write ratios are set to 100% respectively.

Scenario 1: Comparison of Independent Volumes on Different Units

A storage volume created solely on the installed drives of a Synology NAS main unit or an expansion unit is called "**independent volume**". Because Synology expansion units are not built-in devices, customer inquiries on whether there is any performance difference between the independent volumes on the main unit and the expansion units often raise.

This section compares the sequential throughput of independent volumes created on the main unit with the one on the expansion units to check if connecting more expansion units would decrease the overall performance.

Simulation procedures:

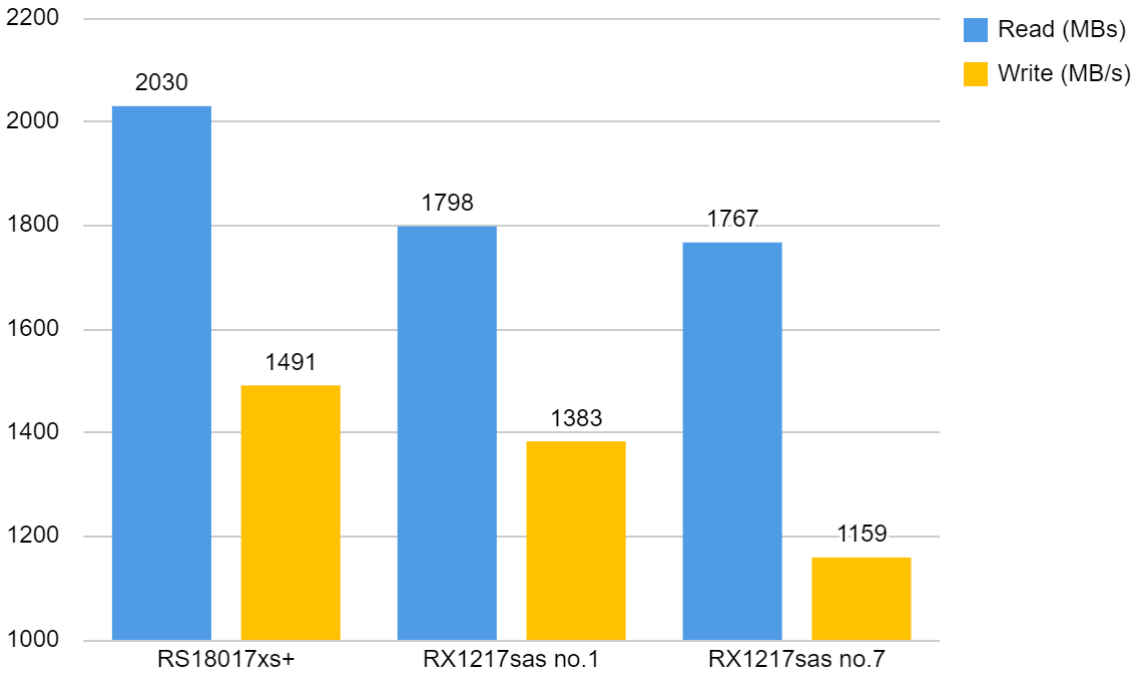
1. Installed 12 SATA drives in RS18017xs+.
2. Created two RAID 5 volumes, each of which consisted of six drives. (Figure. 1)
3. Ran a data transmission test with IOMeter.
4. Deleted all the volumes and moved all the drives to RX1217sas no. 1.
5. Created two RAID 5 volumes, each of which consisted of six drives.
6. Ran a data transmission test with IOMeter.
7. Deleted all the volumes and moved all the drives to RX1217sas no. 7.
8. Created two RAID 5 volumes, each of which consisted of six drives.
9. Ran a data transmission test with IOMeter.

Figure 1: Two RAID 5 volumes created on RS18017xs+

The results are shown in the table and chart below:

Aggregated 10GbE SMB - Sequential throughput (64KB) - SATA drives

	RS18017xs+	RX1217sas no. 1	RX1217sas no. 7
Read (MB/s)	2,030	1,798 (-11.4%)	1,767 (-12.9%)
Write (MB/s)	1,491	1,383 (-7.2%)	1,159 (-22.2%)



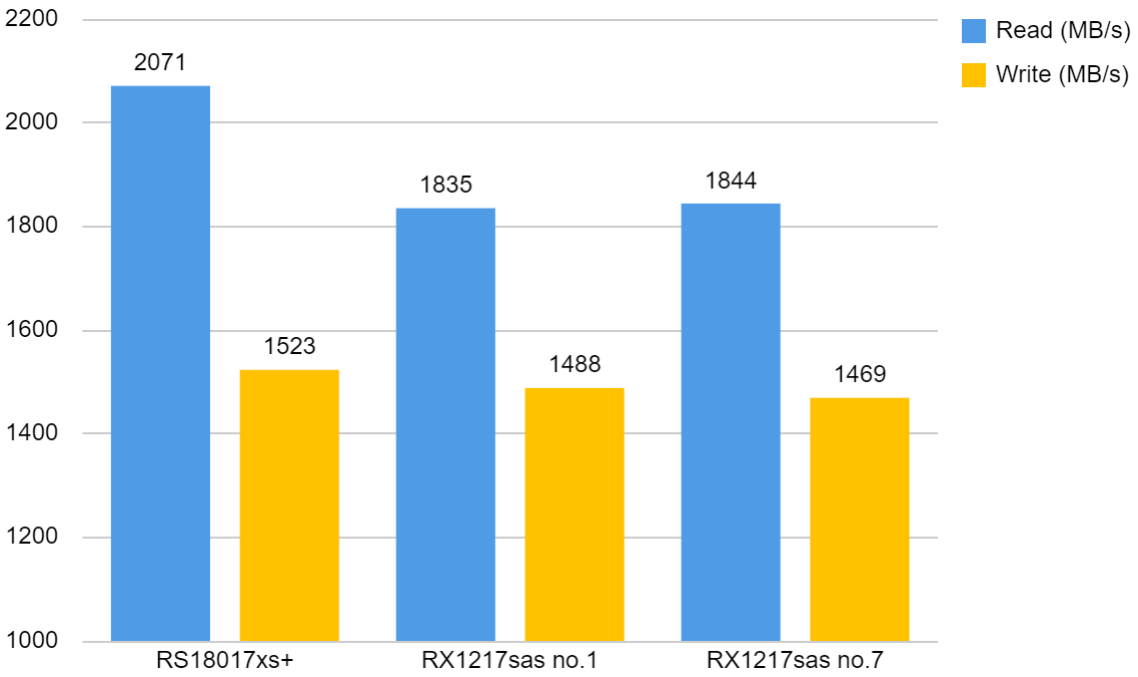
The results showed that the independent volumes on the RS18017xs+ main unit had better sequential throughput. There was a roughly **11.4**% drop in the read performance and a **7.2**% drop in the write performance of SATA volume on the expansion unit no. 1 compared with the one on the main unit. As for the expansion unit no. 1 and no. 7, there was no significant difference in the read performance. However, the write performance of SATA volume on the expansion unit no. 7 dropped by **22.2**% in comparison to the one on the main unit.

Scenario 2: Comparison between SAS and SATA Drives

In Scenario 1, we used SATA drives to simulate the performance. As RS18017xs+ and RX1217sas support SAS drives, and many users question the difference between SAS and SATA drives, we ran the simulation again using SAS drives. Other system configuration remained the same as Scenario 1.

Aggregated 10GbE SMB - Sequential throughput (64KB) - SAS drives

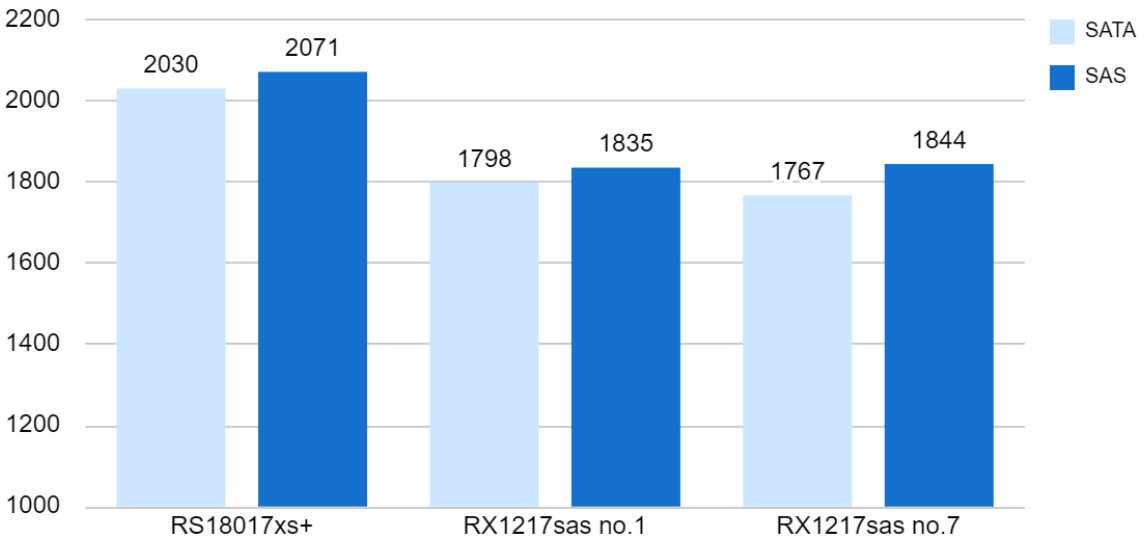
	RS18017xs+	RX1217sas no. 1	RX1217sas no. 7
Read (MB/s)	2,071	1,835 (-11.4%)	1,844 (-10.9%)
Write (MB/s)	1,523	1,488 (-2.2%)	1,469 (-3.5%)



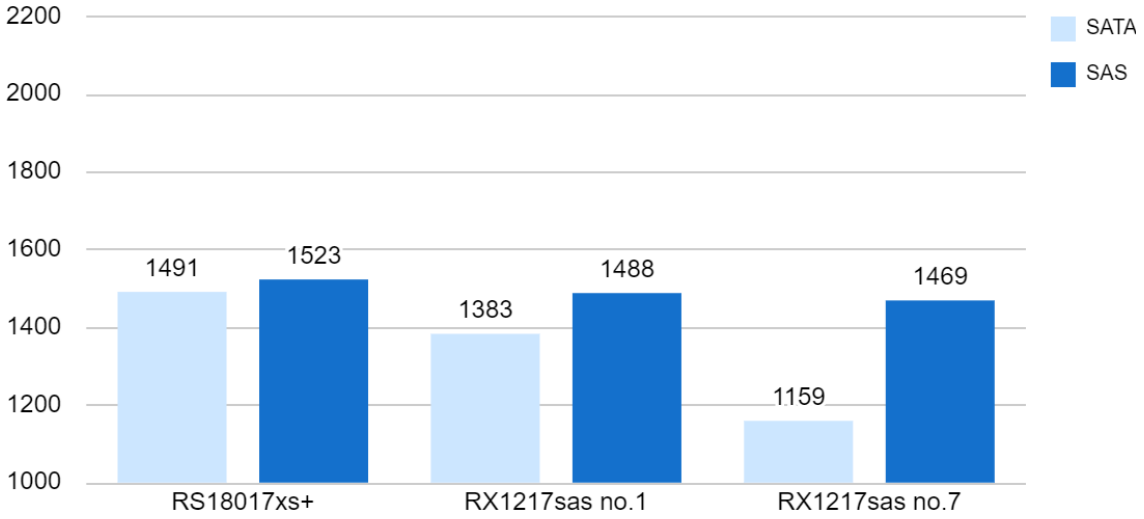
Like SATA volumes, there was an **11.4**% drop in the read performance of the SAS volume on the expansion unit no. 1 when compared with the one on the Synology NAS main unit. There was also no significant difference in the read performance between the SAS volumes on the expansion unit no. 1 and no. 7.

In contrast to SATA volumes, SAS volumes showed a stable write performance, whether they were on the main unit or any of the expansion units. The write performance of the SAS volume on the expansion unit no.1 dropped by **2.2**% when compared with the one on the main unit, and there was only a **3.5**% difference between the SAS volumes on the expansion unit no. 7 and the main unit.

SATA vs SAS volumes - read performance (MB/s)



SATA vs SAS volumes - write performance (MB/s)



By comparing the performance of SATA and SAS volumes in the charts above, it is clear to see that SAS drives provide a more stable output. When seven expansion units in total are connected, we can conclude that the loss of write performance is the nature of the SATA protocol under a long cable connection. The SAS protocol is relatively less affected in the same scenario.

Scenario 3: Comparison of Cross Volumes on Different Units

When a storage volume is created with both drives on the main unit and drives on the expansion units, or with drives on multiple expansion units, it is called "**cross volume**".

This section compares the performance of cross volumes set on different units.

Simulation procedures:

1. Populated RS18017xs+ and RX1217sas no. 1 with 24 SATA drives.
2. Created two RAID 5 cross volumes, each of which consisted of 12 SATA drives (six installed in RS18017xs+ and six in RX1217sas no. 1; Figure 2).
3. Ran a data transmission test with IOMeter.
4. Deleted all the volumes and moved all the drives to RX1217sas no. 6 and no. 7.
5. Created two RAID 5 cross volumes, each of which consisted of 12 SATA drives (six installed in RX1217sas no. 6 and six in no. 7).
6. Ran a data transmission test with IOMeter.

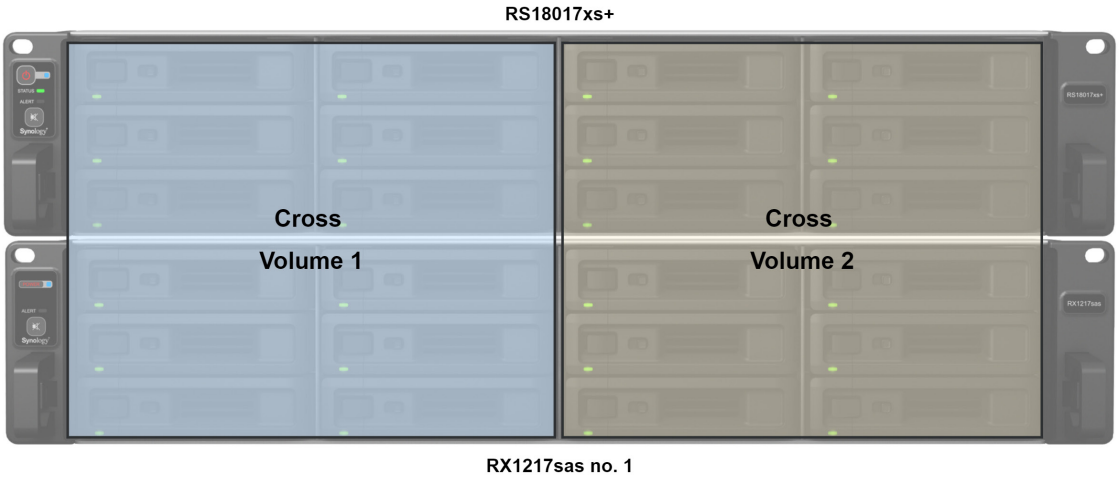
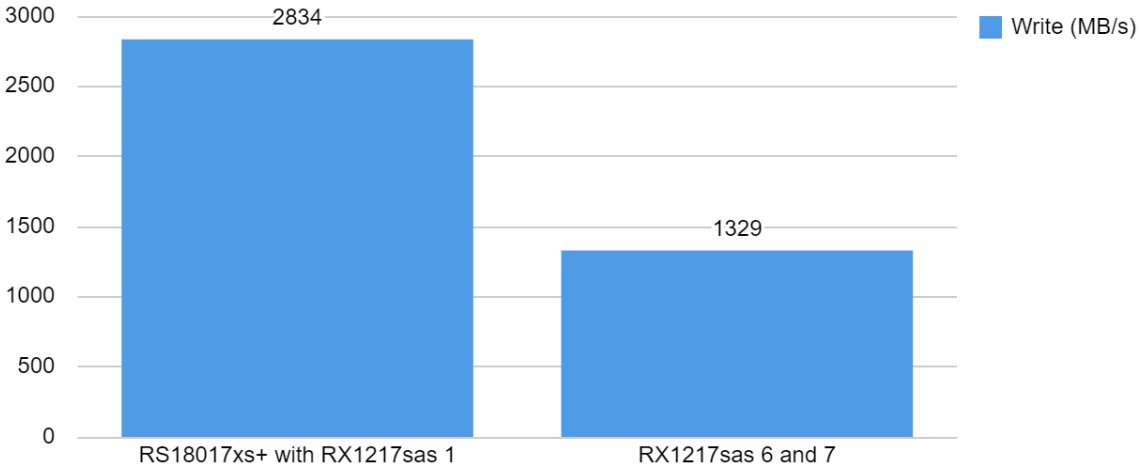


Figure 2: Two cross volumes created on RS18017xs+ and RX1217sas no. 1

The results are shown in the table and chart below:

Aggregated 10GbE SMB - Sequential throughput (64KB) for cross volume comparison

	Cross volumes on RS18017xs+ and RX1217sas no. 1	Cross volumes on RX1217sas no. 6 and no. 7
Read (MB/s)	1,888	1,855 (-0.01%)
Write (MB/s)	2,834	1,329 (-53%)



In this scenario, the read performance of the two volume sets was about the same. The write performance of the cross volumes created on the Synology NAS main unit and expansion unit no. 1 achieved **2,834** MB/s, while the one on the expansion unit no. 6 and no. 7 dropped to **1,329** MB/s. However, the latter was still close to the overall write performance of independent volumes in Scenario 1. Based on the observation from Scenario 2, we can say that the loss of performance is the nature of the SATA protocol under a long cable connection.

Scenario 4: Comparison of SSD Cache Volumes on Different Units

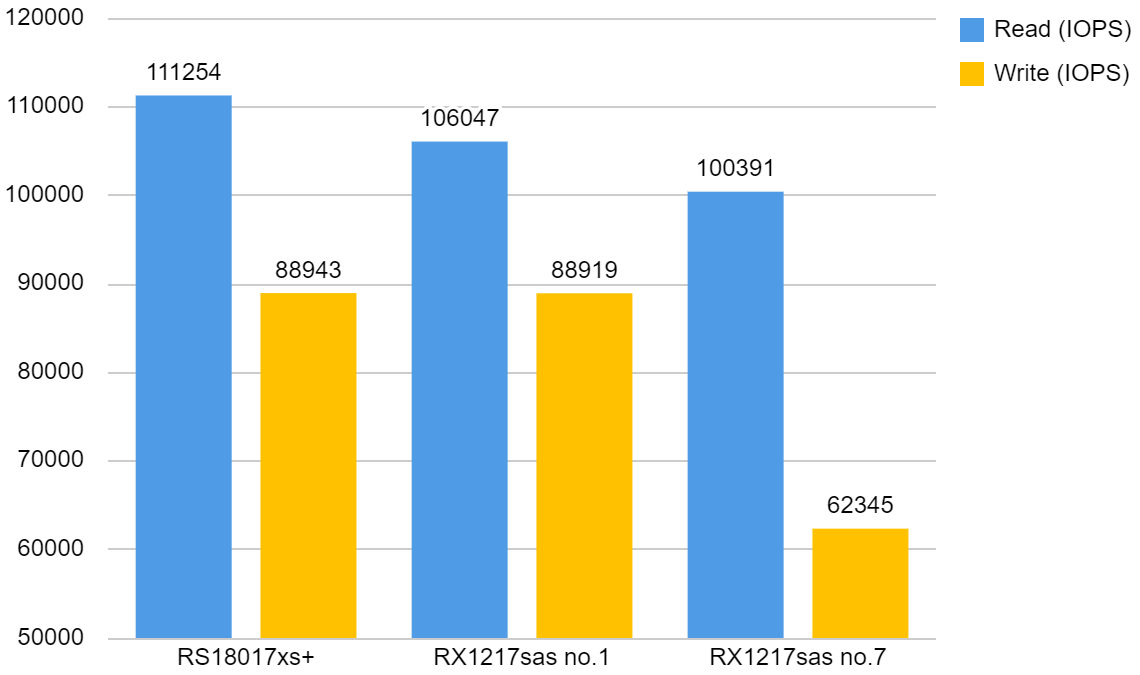
Synology NAS supports SSD cache volumes to boost the overall IOPS. Users can create SSD cache volumes on specific NAS models and expansion units. To see if your model supports SSD cache, please refer to this article. As many users tend to create SSD cache volumes on different units, we tried to figure out the cause of performance differences in this section.

Simulation procedures:

1. Created a single storage volume on 10 SATA drives of RS18017xs+.
2. Installed two SAS SSDs into RS18017xs+. Created an SSD cache volume and mounted it on the storage volume on RS18017xs+.
3. Ran a data transmission test with IOMeter.
4. Deleted the cache volume. Moved the SSDs to RX1217sas no. 1.
5. Created an SSD cache volume and mounted it on the storage volume on RS18017xs+.
6. Ran a data transmission test with IOMeter.
7. Deleted the cache volume. Moved the SSDs to RX1217sas no. 7.
8. Created an SSD cache volume and mounted it on the storage volume on RS18017xs+.
9. Ran a data transmission test with IOMeter.

Aggregated 10 GbE SMB - Random IOPS (4KB)

	RS18017xs+	RX1217sas no. 1	RX1217sas no. 7
Read (IOPS)	111,254	106,047 (-4.6%)	100,391 (-9.7%)
Write (IOPS)	88,943	88,919 (-0.02%)	62,345 (-29.9%)



The result showed that the SSD cache volume built on the Synology NAS main unit had the optimal read-write performance. When the cache volume was moved from the main unit to the expansion unit no. 1, the read performance dropped by **4.6%.** Likewise, when the cache volume was moved from the expansion unit no. 1 to no. 7, the read performance dropped further by **5.1**%.

As for the write performance, when the cache volume was moved from the main unit to the expansion unit no. 1, the write performance remained almost the same. When the cache volume was moved from the expansion unit no. 1 to no. 7, the write performance dropped by **29.9**%.

Conclusion

Scenario Analysis

From the tests above, we can make the following conclusion:

- **Scenario 1 - Comparison of Independent Volumes on Different Units**:

  This section compares the sequential throughput of independent volumes created on the main unit and expansion units respectively. The result showed that there was an 11% drop in the read performance on the expansion unit no. 1, but no further significant drop was observed with more expansion units connected. The write performance, on the other hand, dropped by 7% on the expansion unit no. 1 and dropped further by 22% on the expansion unit no. 7.

- **Scenario 2 - Comparison between SAS and SATA Drives**:

  The hardware configuration in this section was identical to Scenario 1, but all SATA drives were replaced by SAS drives. The read performance of SAS volumes was similar to SATA volumes, while the write performance showed a minor decline. We can conclude that the write performance might be affected by the increasing number of expansion units, and the performance drop could be minimized through the use of SAS drives.

- **Scenario 3 - Comparison of Cross Volumes on Different Units**:

  This section compares the performance differences of the cross volumes set on different units. The write performance dropped when the volumes were created on the expansion units further from the main unit.

- **Scenario 4 - Comparison of SSD Cache Volumes on Different Units**:

  This section checks if setting up SSD cache volume on different units would result in performance differences. A drop in IOPS was observed when we created an SSD cache volume on the furthest expansion unit (no. 7).

Best Practices for Synology Expansion Units

Based on the above-mentioned simulations, we make the following suggestions to help you better configure your Synology NAS main unit and expansion units:

- Use independent volumes prior to cross volumes.
- If multiple expansion units are required, use SAS drives to minimize the impact on the performance under a long cable connection.
- Deploy SSD cache volumes on the main unit or the expansion unit close to the main unit.
- Cross volumes are convenient for capacity expansion of the existing volumes without removing stored data and are suitable for applications that don't require very high I/O performance, such as data backup or data archiving.

Most Synology NAS models are scalable with Synology expansion units. To know about the compatibility between Synology expansion units and specific Synology NAS models, please check out the product specifications on our official website.

Glossary

Glossary of Technical Terms

- **Synology NAS main unit:** When a Synology expansion unit is connected with a Synology NAS, the connected NAS is called "main unit".
- **SATA drive:** SATA (Serial Advanced Technology Attachment) drives are supported by virtually all the computers sold today. With its most popular revision 3.0, SATA supports a theoretical 6Gb/s data transmission bandwidth. SATA drives are commonly used for their competitive prices and wide compatibility.
- **SAS drive:** SAS (Serial Attached SCSI), with its most popular revision, provides a theoretical 12Gb/s data transmission bandwidth, which is two times faster than the SATA 3.0 standard. SAS supports better fault detection features than SATA and provides high data integrity and reliability. It also supports duplex operation to perform efficient data transmission. However, SAS drives can only work with dedicated SAS controllers, so they are more common at enterprise scale.
- **RAID 5:** RAID (Redundant Array of Independent Disks) is a data storage technology that allows multiple drives to be combined into a single storage space. RAID 5 combines three or more drives, one of which is used for fault tolerance. For details on RAID types, you can refer to this article.
- **Btrfs:** Btrfs is a file system developed by multiple parties and now supported by most Synology NAS models. For details on the advantages of Btrfs, you can refer to this article.
- **IOMeter:** IOMeter is a measurement tool used for input and output (I/O) performance tests.
- **IOPS:** IOPS is the acronym for Input/Output Operations Per Second. IOPS is usually used to measure the performance in random access.
- **Random/sequential throughput:** Throughput is a measurement of drive performance in random or sequential operations. In random operations, data blocks are randomly located and scattered. In sequential operations, data blocks are operated in a collective manner, in which the next block is located directly after the previous one on the same track.
- **Independent volume:** A volume created within a single Synology NAS main unit or an expansion unit is called "independent volume".
- **Cross volume:** A volume created across a Synology NAS and expansion unit is called "cross volume".
- **SSD cache:** SSD is the acronym for Solid State Drive. You can employ part of or whole of an SSD as a cache volume. Both recently and frequently used data will be stored on the SSD cache volume, so they can be quickly accessed and executed.

Reference

FAQ

- Which Synology NAS model can I use with Synology Expansion Units?
- Which Synology NAS models support SSD cache?
- How to choose a suitable HDD for my Synology NAS/IP SAN

Product List

- Synology Expansion Units Models List

White Paper

- Using Synology SSD Technology to Enhance System Performance

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