SoftNAS Cloud® Performance Evaluation on Microsoft Azure

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SoftNAS Cloud® Overview

SoftNAS Cloud® is a software-defined, enterprise-class NAS filer delivered as a virtual appliance for public, private and hybrid clouds. It supports multiple protocols such as NFS, CIFS/SMB, iSCSI, and AFP and makes them available to applications as a POSIX compliant file system. With Active Directory and LDAP integration, SoftNAS Cloud runs in the Microsoft Azure, AWS, CenturyLink Cloud public cloud platforms, as well as, in your own data center on VMware vSphere. SoftNAS Cloud is hardware agnostic and requires neither proprietary hardware nor Users having prior storage experience. SoftNAS Cloud can easily scale up or scale down, so a customer only pays for what cloud resources are used.

Introduction

SoftNAS®, Inc. commissioned this 3rd party, independent testing effort, to gather impartial technical insights to help customers with sizing of their cloud storage options. As with any benchmarking tests, the combinations will vary widely, depending on a multitude of variables used in real-world environments. **The information presented in this white paper provides general guidance and should not be taken as an indication nor guarantee of absolute performance metrics.** Customers should always use their own workloads (running on a cloud platform) to ensure satisfactory results. SoftNAS Solutions Architects (SAs) can offer their valuable and extensive expertise to help assess the right infrastructure to match a customer's workloads and cost objectives.

The general guidance covered within this document summarizes a comprehensive set of independent, third-party tests conducted using SoftNAS Cloud. The tests conducted, involved varying cloud platform instance sizes (compute), storage options and networking speeds. Options representative of entry, mid-level and higher-end configurations were used to provide general guidance. SoftNAS sales experts can provide recommendations on many other options available.

Using the cloud for infrastructure, offers unique capabilities not easily accomplished with traditional on-premises storage options. The flexibility to choose different combinations of compute that host the SoftNAS Cloud virtual storage controller and the options for different storage media, makes cloud options extremely flexible and cost effective. Hence the reason for commissioning this testing project to help with the cloud platform choices available to customers.

Unlike conventional on-premises infrastructure, once you purchase a storage appliance, it remains fairly fixed until it is ultimately replaced. Using cloud infrastructure, enables a customer to make flexible and dynamic changes throughout an application workload's

lifecycle. Compute and storage combinations can be easily adapted as use cases change, decrease, or expand. Unlike traditional storage appliances, these changes can occur without creating a new capital expense request; you simply switch the cloud infrastructure combinations to those better suited for your current workloads. The cloud architecture remains malleable and adjustments can occur without any data loss – unlike an on-premises solution.

Cloud infrastructure as a service (IaaS) is constantly changing, evolving, and adapting to new technology as it becomes available. Cloud platform service providers must remain competitive with their offerings, so they are always investing in the latest technology updates (instead of you needing to do so). This fluidity of offerings enables customers to take advantage of the latest computing infrastructure without all the costs and risks. Where else can you get the benefits of running (or switching) to the latest CPUs; getting the best cost or highest performing storage media; or using the latest networking connectivity without a new CapEx budget to overhaul your data center? SoftNAS will always have these evolving resources available to constantly improve our software-based storage solutions.

Executive Summary

Performance of SoftNAS Cloud on Azure is a result of interplay between several variable choices as outlined in Fig 1.

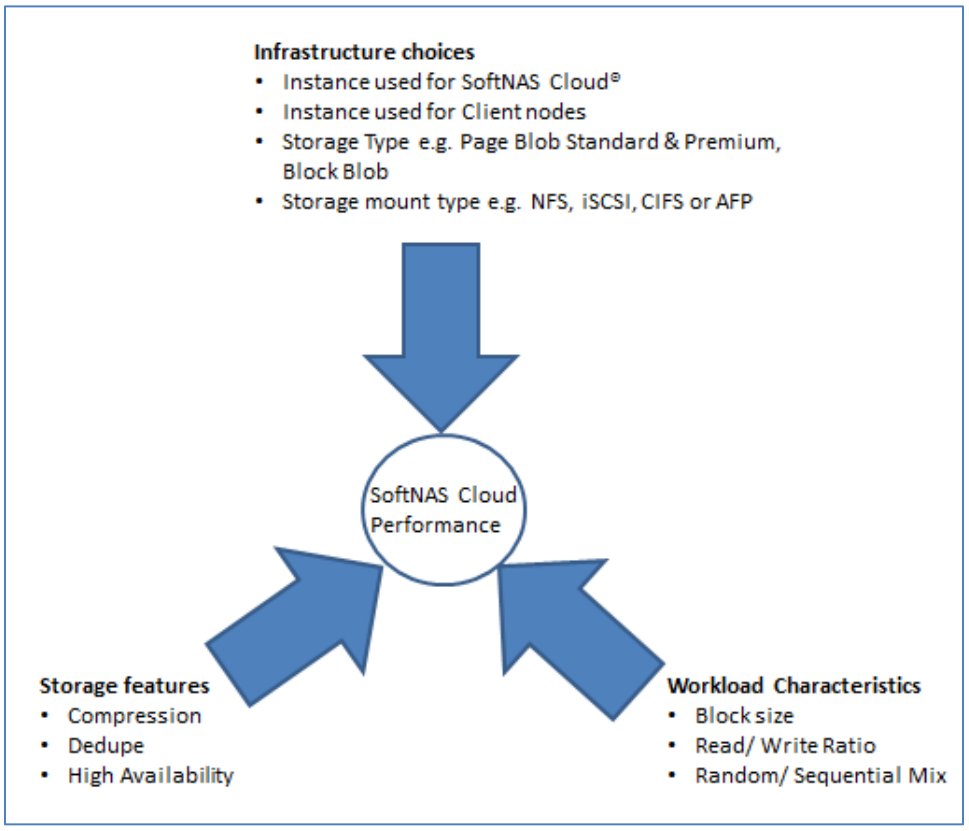


Fig 1: Factors impacting SoftNAS Cloud performance on a public cloud

This White Paper provides users with **guidelines** on the potential performance results based on the different combinations of controlled tests that were carried out to characterize the SoftNAS Cloud performance on Microsoft Azure. Three instance types: from low latency and high I/O instances **to** high latency and low I/O instances, were selected for these tests. SoftNAS Cloud was installed on each of the three instance types and then Page Blob and Block Blob were used as the storage backend for each those three instance types. The system performance was measured using the FIO (Flexible I/O Tester Synthetic Benchmark) benchmark tool for all the different workload types. This tool was chosen because of its capability to evaluate performance with all the features available in SoftNAS Cloud (*e.g.,* deduplication, compression, various file protocols, iSCSI, and high availability).

Key Findings for Azure:

- Instance sizes can have a significant impact on the SoftNAS Cloud performance. Key factors that impact the performance are: the instance's CPU, Cache, and Storage Throughput characteristics. While network bandwidth is an important consideration for other clouds, it is not a limiting factor in the case of the Azure cloud, where most instance types have high network bandwidth limits. **Users will need to ensure that the cloud platform instance that they choose for SoftNAS Cloud, is one of the recommended choices to provide the required IOPS and throughput.**

- As important as it is to choose the right Azure instance for SoftNAS Cloud, it is equally important to choose the right instance for client nodes as well. Since client nodes interact with SoftNAS Cloud over the network, the peak storage throughput a client can achieve is limited by its network bandwidth. Ideally, both SoftNAS Cloud and client node should be of the same size.

- SoftNAS Cloud significantly boosts performance for both read and writes performance of Page Blob Standard Storage. Page Blob Standard provides 500 IOPS per disk, and the overall performance of a storage pool is approximately equal to 500 IOPS x number of disks. SoftNAS Cloud boosts the read performance by a factor of 3-6 times and write performance by a factor of 2-3 times because of caching and other optimizations within the SoftNAS Cloud product.

- On a standalone basis, Page Blob Premium provides a significantly higher peak IOPS as compared to Page Blob Standard, and is therefore priced at a significant premium. However, when both these Page Blob options are used with SoftNAS Cloud, Page Blob Standard performed on par with Page Blob Premium for read

operations. This improvement in performance was due to caching of the data by SoftNAS Cloud for reads. **The implication for SoftNAS Cloud users, is that for read intensive workloads, the users may want to consider using Page Blob Standard with SoftNAS Cloud instead of using the more expensive Page Blob Premium.**

- Storage Throughput is a very important requirement for sequential workloads that utilize Block Blob based object storage. SoftNAS Cloud boosts the storage throughput above the stipulated limits of Azure because of caching and other optimizations within the SoftNAS Cloud product. This makes SoftNAS Cloud especially suitable for sequential workloads such as: file operations, OLAP, Hadoop, video streaming, log aggregation, etc.

- When features such as dedupe and compression are used in SoftNAS Cloud, the performance of write operations was found to drop by 25-30%. This behavior is due to SoftNAS Cloud having to dedicate part of the Azure CPU and RAM capacity for inline processing for these features. **As a rule of thumb, SoftNAS Cloud customers should use an instance size one level higher than the base, when these features are enabled.** Furthermore, if replication is also switched on, in addition to dedupe and compression features, SoftNAS Cloud customers should use larger instance sizes such as DS14_V2 and above, for high performance workloads.

Test Methodology

- Tests were conducted on SoftNAS Cloud in Azure with various combinations of control parameters:
  - Three instance types: DS3_V2, DS4-V2 and DS14_V2
  - Three storage options: Page Blob Standard, Page Blob Premium and Block Blob
  - Three volume mount options in SoftNAS Cloud: NFS, iSCSI and CIFS
  - Dedupe On/Off for a volume in SoftNAS Cloud
  - Snap Replication On/Off in SoftNAS Cloud

- The Topology used for the testbed is outlined in Fig 2 below:

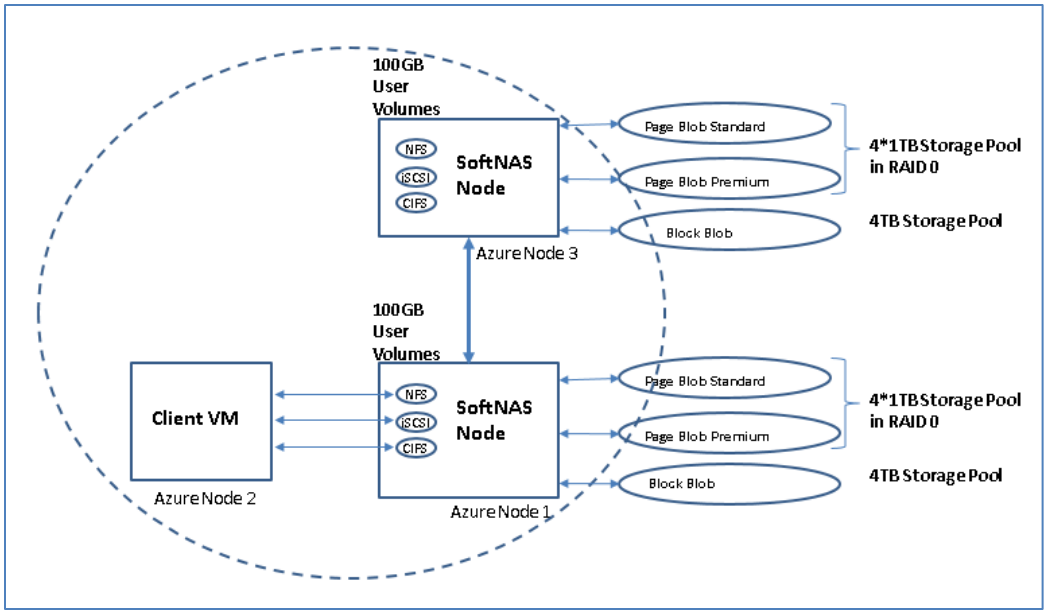


Fig 2: Overview of SoftNAS Cloud test setup on Azure

- Choice of Azure instance types, DS3_V2, DS4_V2 and DS14_V2, was based on the mix of CPU, RAM and SSD profiles. Specifications of the nodes are summarized in Table 1:

Azure Instance Type	Number of Cores	RAM (GB)	Local SSD (GB)	Max Network Bandwidth (Mbps)	Max Storage Throughput (MB/s)
DS4_V2	4	14	28GB	3,000	128
DS4_V2	8	28	56GB	6,000	256
DS14_V2	16	112	224GB	6,000	512

Table 1: Azure Instance Details

- Separate 4 TB storage pools were created in SoftNAS Cloud for Page Blob Standard, Page Blob Premium and Block Blob. The largest disk size available for Page Blob is: 1 TB and therefore a 4x1 TB configuration was used for Page Blob storage. On the other hand, Block Blobs are available as 4 TB disks and therefore 1x4TB configuration is used for Block Blob storage. 4x1 TB Page Blob **Standard** configuration can provide peak IOPS of 2,000; while 4x1 TB Page Blob **Premium** configuration provides peak IOPS of 20,000. However, to actually achieve these rated IOPS, depends upon the network and storage throughput supported by the participating Azure nodes. For example:
    - Storage Throughput = IOPS x Block Size
    - The storage throughput limit should be the greater than the network bandwidth allowed by both the SoftNAS Cloud and Client instances.

- Volumes of 100 GB size were carved out in SoftNAS Cloud for each of iSCSI, NFS and CIFS protocols. In the case of iSCSI, the volumes were not formatted with a file system and raw disks were used for the tests. Dedupe and Replication were enabled for respective tests as needed.

- The Azure instance size of the Client VM was the same size as that of SoftNAS Cloud ensuring that both nodes supported similar network bandwidths and therefore any bottlenecks in performance were not due to network limitations between the Client and the SoftNAS Cloud instance. **This is a very important consideration.**

- The Client VMs used CentOS for iSCSI and NFS tests, as well as, Windows for the CIFS tests – the volumes were not formatted with a file system and raw volumes were directly used.

- All tests were conducted with a MTU of 4,000, which is the max allowed MTU by Azure.

- FIO was used to generate load for the tests.
  - 32 KB block size was used for all Page Blob tests.
  - 1 MB block size was used for Block Blob tests.
  - 10GB FIO file size was used Page Blob tests.
  - 2GB FIO file size was used for Block Blob tests.
  - IO Queue depth = 16
  - Random and Sequential tests with R/W Ratio of: 0%, 20%, 50%, 80% and 100% were carried out for each combination.
  - Dedupe tests were conducted with 40% dedupable blocks.
  - 3 tests were conducted for each combination and average results were reported.

Performance Summary and Sizing Recommendations

Page Blob Tests

- Peak Read and Write IOPS obtained for SoftNAS Cloud with Page Blob Storage and FIO workload of 32KB block size are summarized in Tables 2 and 3:

	Read IOPS	Write IOPS
iSCSI	8,500	4,700
NFS 3.6.4	12,800	5,400
CIFS	6,210	4,030

Table 2: Page Blob Standard

	Read IOPS	Write IOPS
iSCSI	10,800	6,600
NFS 3.6.4	14,000	8,800
CIFS	6,300	6,000

Table 3: Page Blob Premium

- On a stand-alone basis, Page Blob Premium is expected to outperform Page Blob Standard. However, when these Page Blob options were used with SoftNAS Cloud, performance of read operations for Page Blob Standard was very close to the performance of Page Blob Premium. This improvement in performance was due to caching of data by SoftNAS Cloud for reads. **The implication for SoftNAS Cloud users is that for read intensive workloads, the users can consider using Page Blob Standard with SoftNAS Cloud instead of using the expensive Page Blob Premium.**

- SoftNAS Cloud significantly boosts performance for both read and writes performance of Page Blob Standard Storage. Page Blob Standard provides 500 IOPS per disk, and the overall performance of a storage pool for 4x1 TB is approximately equal to 2,000 IOPS. SoftNAS Cloud boosts the read performance by a factor of 3-6 times and write performance by a factor of 2-3 times, because of caching and other optimizations within the SoftNAS Cloud product.

- The choice of Azure Instance Size has a big impact on SoftNAS Cloud performance. Key factors that impact the performance are: Azure instance's CPU, Cache, and Storage Throughput characteristics. While the network bandwidth is an important consideration for other clouds, it is not a limiting factor in the case of the Azure cloud where most Azure's instance types already have high network limits. Based on the observations from the tests, the recommended Azure instance choices for 32 KB block sizes are summarized in Table 4.

	IOPS	Storage Throughput (MB/s)	Azure Recommended Node
1	< 4,096	<128 MB/s	DS3_V2
2	4,096 – 8,192	128 - 256 MB/s	DS4_V2
3	8,193 – 16,000	256 - 512 MB/s	DS14_V2

Table 4: Recommended Azure Node Sizes for Page Blob

Note: The recommendations are based on tests conducted with 32 KB block sizes in FIO. Higher IOPS will be observed on smaller nodes when smaller block sizes are used. **Users need to evaluate the throughput limits to refine the choice of nodes.**

Block Blob Tests

- The Block Blob tests were conducted with a FIO block size of 1 MB. Since larger block sizes were used, the IOPS obtained for these tests were lower, because the performance was determined by Azure's network and storage quotas. However, the storage throughput was consistently high across all the tests due to the large block sizes. Peak Read and Write throughput obtained for Block Blob are summarized in Table 5.

	Read Throughput(MB/s)	Write Throughput (MB/s)
NFS 3.6.4	911	990
CIFS	438	849

Table 5: Block Blob Peak IOPS across all tests

- Storage Throughput is a very important requirement for sequential workloads that utilize Block Blob based object storage. SoftNAS Cloud boosts the storage throughput above the stipulated limits of Azure because of caching and other optimizations within SoftNAS Cloud. This makes SoftNAS Cloud especially suitable for sequential workloads such as: file operations, OLAP, Hadoop, video streaming, log aggregation, etc.

- Based on observations from Block Blob tests, the recommended Azure instance choices for 1 MB block sizes are summarized in Table 6.

	IOPS	Storage Throughput (MB/s)	Azure Recommended Node
1	< 128	<128 MB/s	DS3_V2
2	128 – 256	128 - 256 MB/s	DS4_V2
3	256 - 512	256 - 512 MB/s	DS14_V2

Table 6: Recommended Azure Node Sizes for Block Blob

Note: The CPU Utilization for some Block Blob tests on D3_V2 instances ran higher than recommended levels when the storage throughout reached closer to 128MB/s. **Production workloads should use D4_V2 or larger.**

Other Observations

- **Right Sizing the Client VMs**: As important as it is to choose the right Azure instance for SoftNAS Cloud, it is equally important to choose the right instance for the client nodes as well. Since client nodes interact with SoftNAS Cloud over the network, the peak storage throughput that client can achieve is limited by its network bandwidth. **Ideally both SoftNAS Cloud and the client nodes should be of the same size.**

- **Impact of Dedupe, Compression and High-Availability (HA)**: When features such as dedupe and compression are used in SoftNAS Cloud, performance of write operations was found to drop by 25-30%. This behavior is due to SoftNAS Cloud having to dedicate part of the Azure CPU and RAM capacity, for inline processing for these features. **As a rule of thumb, users should use an Azure instance size one notch higher than base when these features are enabled.** If replication is also used, in addition to dedupe and compression, users should use larger instance sizes such as DS14_V2 and above for high performance workloads.

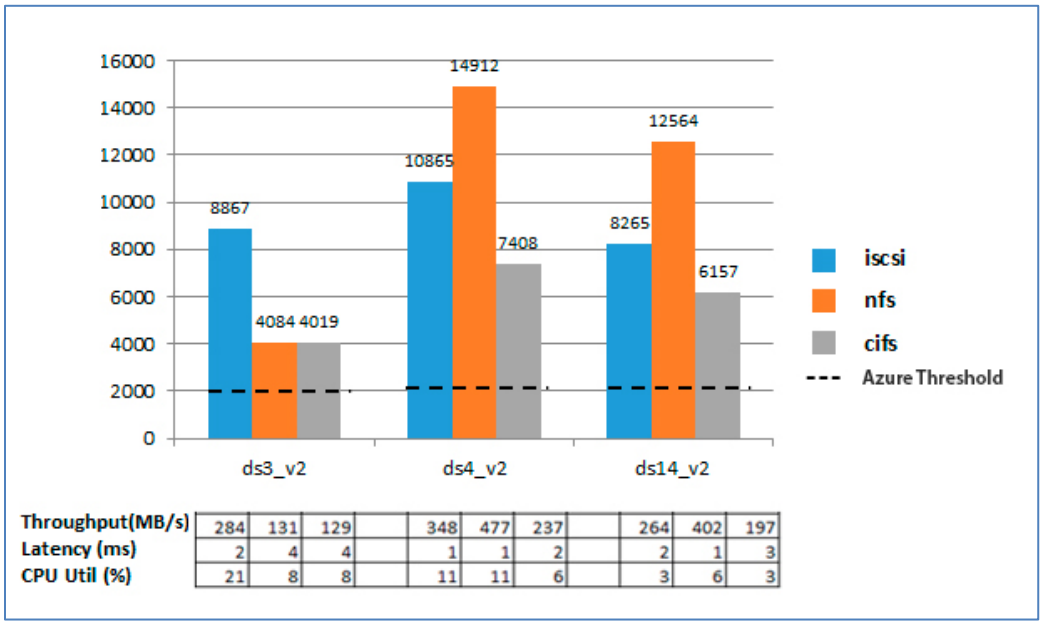
Key Results

- **Page Blob Standard:** Figures 4 and 5 outline the results for 100% sequential read and 100% sequential write performance for Page Blob Standard, for different instance sizes and volume types.

  The dotted lines indicate the expected IOPS for a given instance based on the limits imposed by disks, network, and storage bandwidth limits available from the used Azure infrastructure.

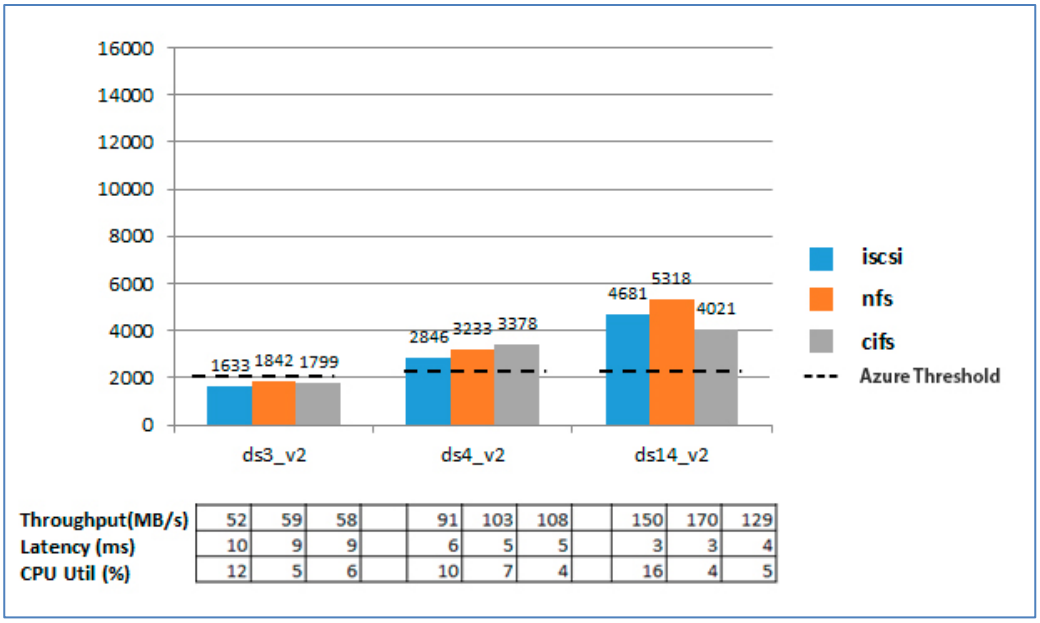
  The expected IOPS for 4x1 TB Page Blob Standard configuration is 2,000 IOPS.

  It is evident from the following results that both read and write IOPS are significantly boosted by SoftNAS Cloud due to caching and other optimizations.



Throughput(MB/s)	284	131	129		348	477	237		264	402	197
Latency (ms)	2	4	4		1	1	2		2	1	3
CPU Util (%)	21	8	8		11	11	6		3	6	3

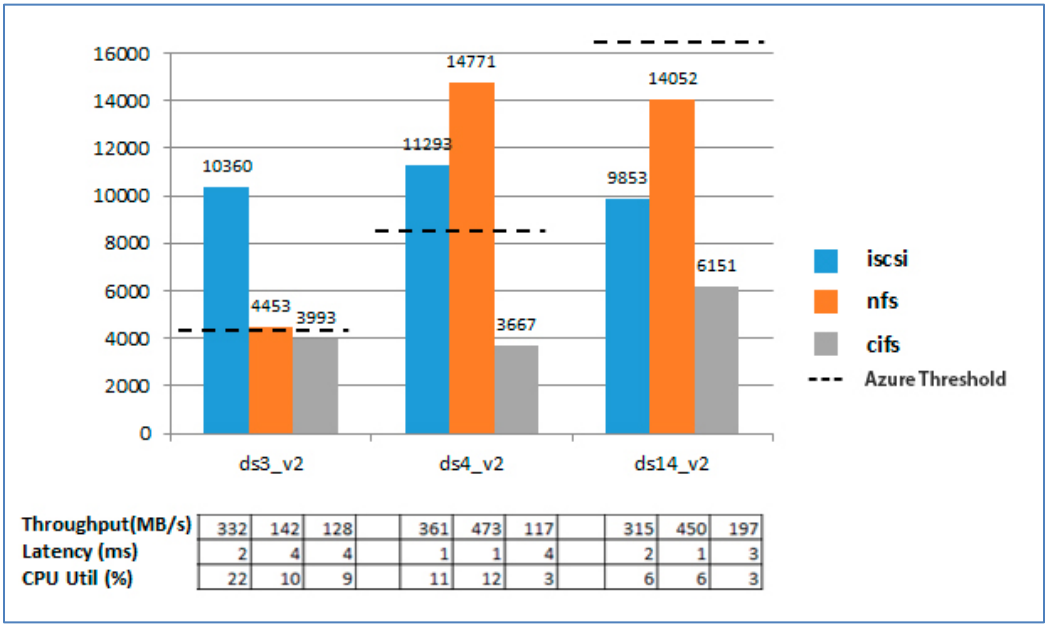
Fig 4: Sequential 100% Read IOPS for Page Blob Standard



Throughput(MB/s)	52	59	58	91	103	108	150	170	129
Latency (ms)	10	9	9	6	5	5	3	3	4
CPU Util (%)	12	5	6	10	7	4	16	4	5

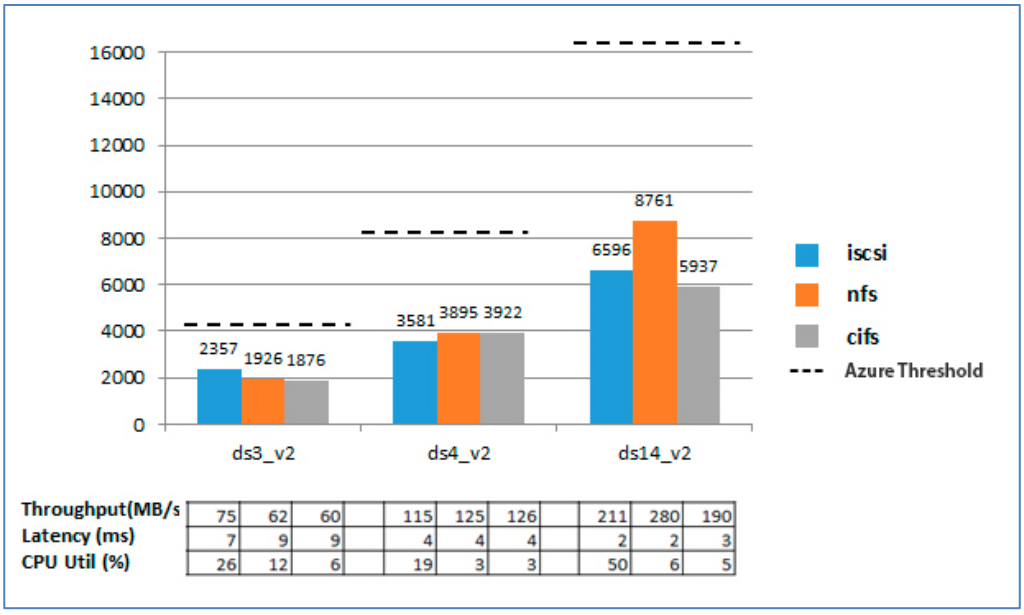
Fig 5: Sequential 100% Write IOPS for Page Blob Standard IOPS

- **Page Blob Premium:** The read performance of Page Blob Premium is boosted for smaller nodes and diminished for larger nodes. The write performance somewhat diminished in all the tested cases.



Throughput(MB/s)	332	142	128	361	473	117	315	450	197
Latency (ms)	2	4	4	1	1	4	2	1	3
CPU Util (%)	22	10	9	11	12	3	6	6	3

Fig 6: Sequential 100% Read IOPS for Page Blob Premium IOPS

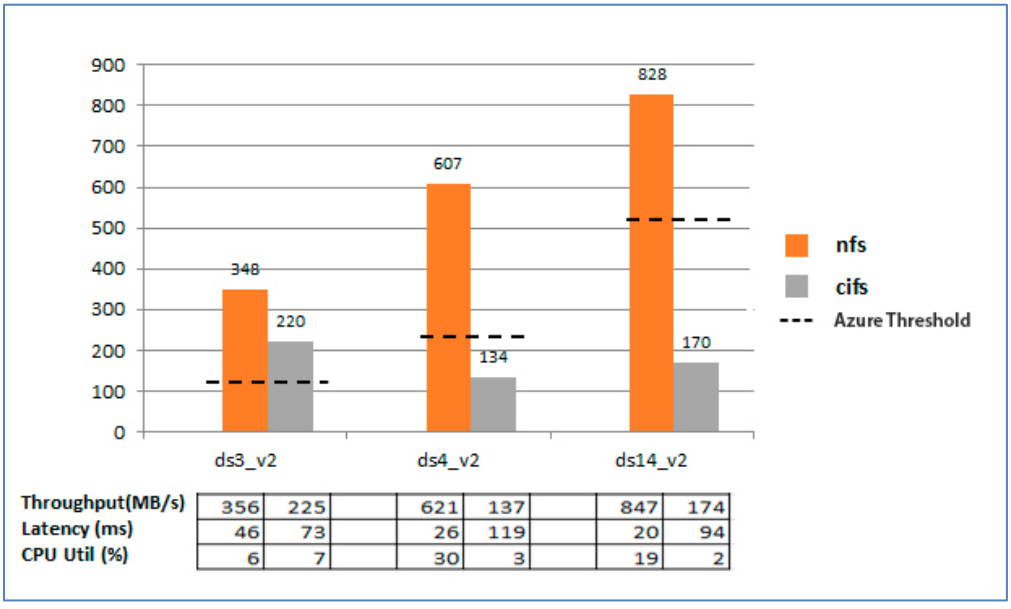


Throughput(MB/s	75	62	60		115	125	126		211	280	190
Latency (ms)	7	9	9		4	4	4		2	2	3
CPU Util (%)	26	12	6		19	3	3		50	6	5

Fig 7: Sequential 100% Write IOPS for Page Blob Premium IOPS

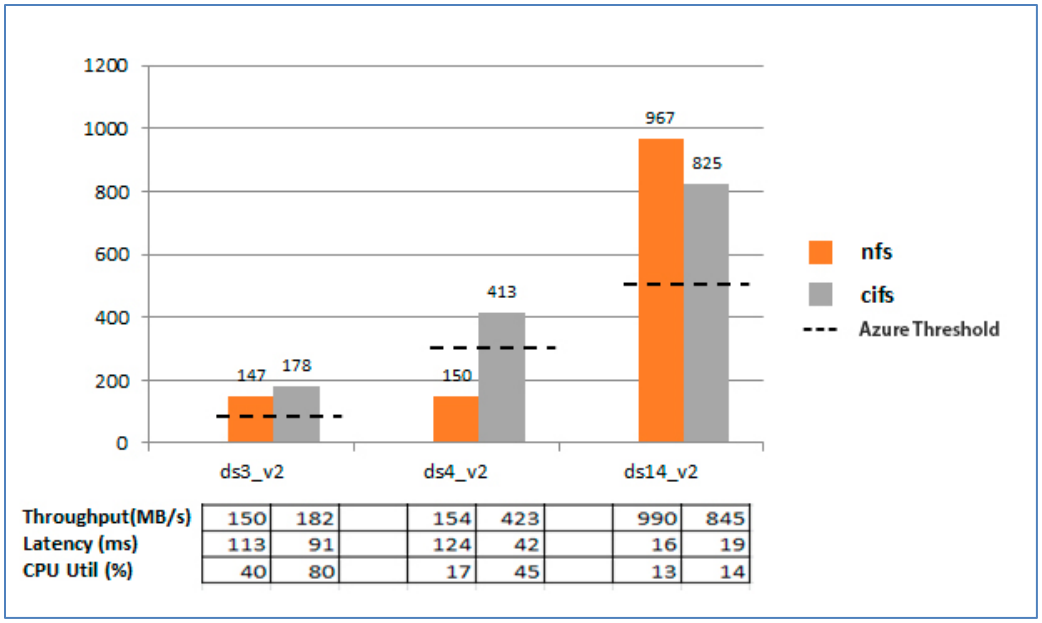
- **Block Blob IOPS:** The performance of Block Blob storage, is limited by the number of puts and gets that are allowed by Azure, for the instance types. The maximum storage throughput is achieved for larger block sizes and therefore Block Blob Tests used a higher block size of 1 MB. The IOPS obtained for these tests, were lower, as the performance was determined by Azure's network and storage quotas. However, the storage throughput achieved was high across all the tests again due to the larger block size used.

  As can be seen in the results, the peak throughput achieved is greater than the stipulated limits of Azure due to caching and optimizations in SoftNAS Cloud.



Throughput(MB/s)	356	225		621	137		847	174
Latency (ms)	46	73		26	119		20	94
CPU Util (%)	6	7		30	3		19	2

Fig 8: Sequential 100% Read IOPS on Block Blob



Throughput(MB/s)	150	182		154	423	990	845
Latency (ms)	113	91		124	42	16	19
CPU Util (%)	40	80		17	45	13	14

Fig 9: Sequential 100% Write IOPS on Block Blob

- **CPU Utilization Analysis**: To help users choose the right instances where multiple features such as: HA, Dedupe and Compression were switched on, sequential write tests were conducted with Page Blob Standard and NFS volume type and the CPU Utilization was measured during the tests. As observed in Figure 10, the CPU Utilization peaks for DS3_V2 and is well within limits for DS4_V2 and DS14_V2.

  Therefore, DS3_V2 is not recommended for use when multiple SoftNAS Cloud features are used. It is recommended for users to use DS4_V2 and DS14_V2 in these types of workload scenarios.

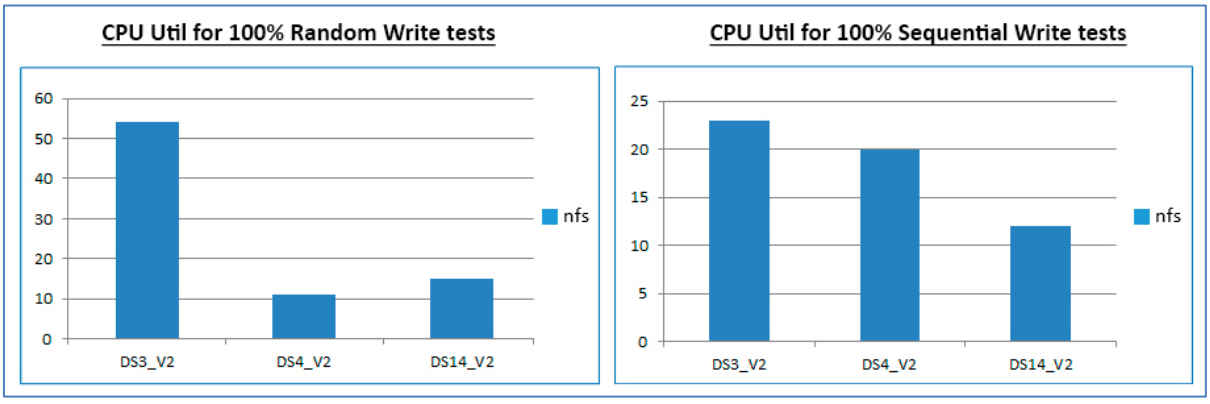


Fig 10: CPU Utilization on SoftNAS Cloud node with HA, Dedupe and Compression switched with NFS on Page Blob Standard

Conclusion

SoftNAS Cloud provides a robust set of features that make using Azure significantly easier, more secure and allows the customer (in some cases) to use less expensive Azure options like Page Blob Standard instead of using the more expensive Page Blob Premium

While testing can't cover every real-world scenario that a customer might have, we believe that these third-party, independent test results show a fair and balanced representation of some of the most common customer workloads. SoftNAS, highly recommends that a customer engage and work closely with one of our Solutions Architects (SAs) to properly design and configure their workloads on Azure using SoftNAS Cloud.

As mentioned in the introduction, Microsoft Azure cloud infrastructure improvements continuously occur. As faster Azure options come to market, the software-based SoftNAS Cloud solutions offer the flexibility that allows customers to use the best of breed ingredients as they become available. These test results reflect offerings that are currently available from SoftNAS and Microsoft Azure and that will change over time.