Troubleshooting Performance Issues

Problem

You can use this guide as a reference to help determine where performance bottlenecks may be stemming from.

Finding and diagnosing performance bottlenecks with SoftNAS involves examination of a few components.

- **Network:** The IO limits of the network interface on the SoftNAS and the IO limits of the network interface of the client consuming the storage endpoints.
- **Disk:** The IO limits of the disk device type that the storage pools reside on (Block or Object).
- **RAM:** Available RAM on the SoftNAS instance.
- **CPU:** CPU bottlenecks and load.
- **Client Types and Protocols:** What OS configurations and mount options should we consider on the client?
- **Throttling**: Any throttles in the pipeline?
- **Housekeeping**: Disk space issues, logs, zfs fragmentation

Network, Load, and IO Wait

CPU load is an indicator of how many processes are waiting in the CPU execution queue. As load increases, time to execution increases, therefore making things 'slow'.

As a general rule, I start looking at CPU load and how that compares to IO wait and the number of processes running.

IO wait is a condition where the CPU is waiting on acknowledgement of an IO operation. In SoftNAS context, this will be a disk operation (read or write to object or blob) or a network operation like get, put, send, or recv.

In public cloud, everything is the network. In public cloud, a disk attached to a SoftNAS is provided over the network to a SAN in the provider data center, so even the throughput to disk is affected by network on certain instance types. This network connection has to serve clients, serve the object puts and gets, and serve the reads and writes to the block devices.

Network IO will always be limited to the slowest device in the process chain. If the client accessing the shared storage on SoftNAS is an instance type that only has moderate network performance or burst-able network performance, then you should expect moderate or burst-able throughput from that instance when accessing the SoftNAS shares.

You can verify network throughput by looking at 'SUM' values over time in the cloud provider portal (Cloudwatch for AWS, Metrics for Azure) and verify if the throughput is what you expect for the instance type.

We can assume to get somewhere around 50Mb/s on instances that are rated 'low' network performance.

We can assume to get somewhere between 150Mb - 300Mb/s burst on instances with 'moderate' network performance depending on the class type. (c4, m4, r4, etc)

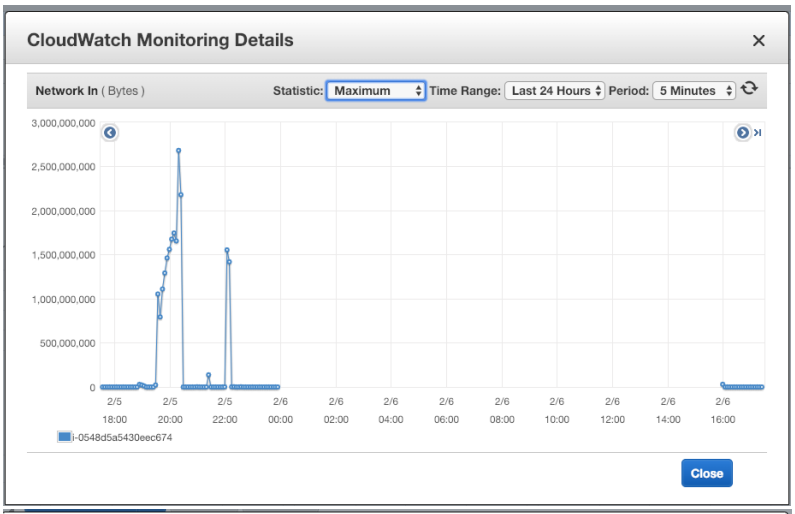
We can assume to get somewhere around 1Gb/s on instances with 'high' network performance.

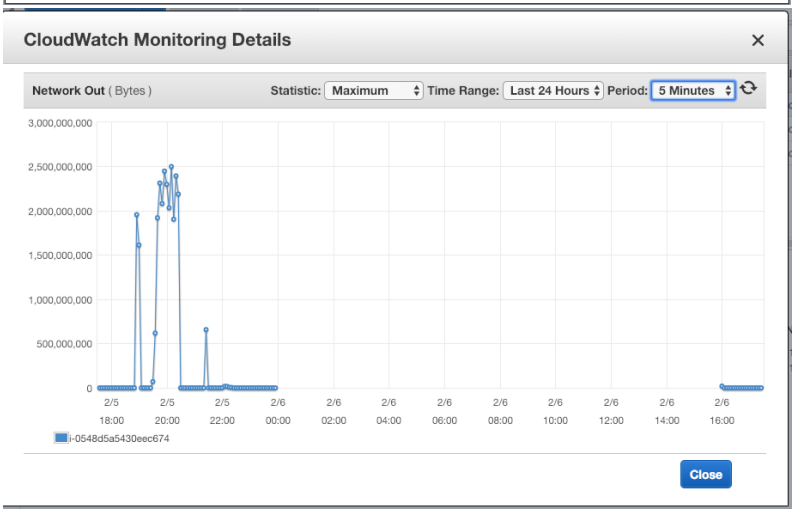
Instances rated at *up to 10Gb are burst-able up to 10Gb at some times, not dedicated 10Gb throughput. Expect a baseline performance around 1200Mb/s

Instances rated at 10Gb network are SLA'd at that level by the cloud provider.

Refer to the below example using an M4.Large which has 'moderate' network throughput:

Network in + out = ~5,000,000,000 Bytes (5 GByte) over 5 Mins (1GByte Min avg roughly)





At the same time on the SoftNAS, in the SAR logs, I see a high number in TCP transmit-wait (TCP-TW is the last column)

```
10:00:01 AM       714        25        24         0         0         4
10:10:01 AM       736        35        24         0         0         7
10:20:01 AM       743        46        24         0         0       123
10:30:01 AM       765        43        24         0         0       124
10:40:01 AM       741        43        24         0         0       108
10:50:01 AM       749        42        24         0         0         7
11:00:01 AM       741        38        24         0         0         4
11:10:01 AM       732        45        24         0         0         4
```

High number of tcp-tw during same time

Conclusion regarding network bottleneck:

- Based on what I think I should be getting at network speed for this instance, what the platform monitoring is telling me, and the fact that operations are being held up waiting on network transmit, I can assume that my performance bottleneck is currently the network speed of the instance-type where I have deployed SoftNAS.
- **Enabling encryption in flight** also has network performance implications. Encrypted replication streams cause the network transfer to become dependent on CPU cycles rather than available bandwidth. This may become a performance bottleneck during the initial-sync of a large volume.
- Use **jumbo frames** whenever possible (**mtu 9001 not applicable in Azure**)
- If using **Azure**, provision instances that have the **Accelerated Networking** feature whenever possible.

Disk, IO Wait, and Storage Type.

In the same way that congested networks can cause IO Wait, exhausted disk devices will cause the same.

Each cloud platform provider provides different storage options of different characteristics.

In general, the slower the medium (object, blob, HDD) the less expensive it is.

Your storage type will determine how fast data can be written and accessed by SoftNAS and is ultimately your read/write performance.

Block Storage Devices

Block storage refers to SSD's HDD's and most managed disk types.

Block storage is typically allocated at an SLA'd throughput for the premium types (i.e. 250 MB) or guaranteed at a number of IOPS (3 IOPS per GB).

To diagnose issues with block device throughput we can use '**iostat**' along with metrics provided by the cloud platform.

The telemetry data that we will look for is **%iowait** and **%util** for any block devices.

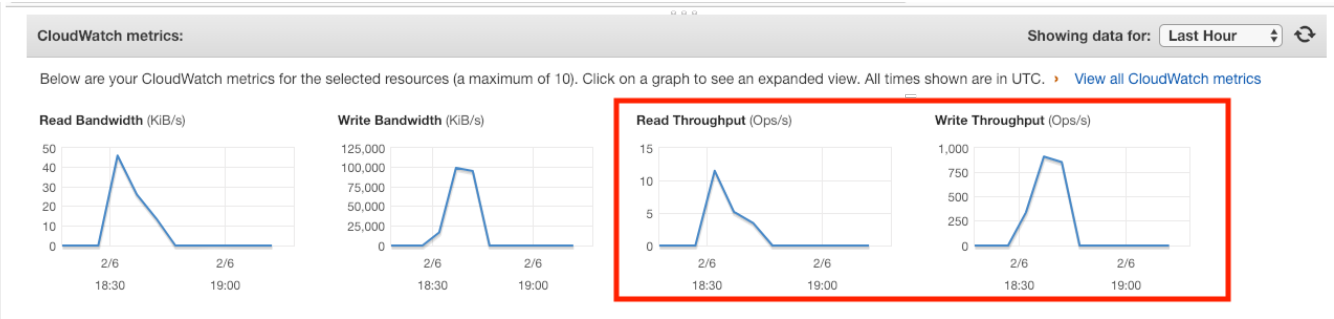
`'iostat -x 1' will show you block device statistics for all devices, updated every 1 second`

If you refer to the below output you can see that there is a high **%iowait, %w_await**, and **%util** for my device labeled '**nvme1n1'**.

```
root@nas1:~# iostat -x 1
Linux 4.14.34 (nas1)    02/06/2019      _x86_64_        (2 CPU)

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.60    0.00    1.26    0.43    0.00   97.71

Device:         rrqm/s   wrqm/s     r/s     w/s   rsec/s   wsec/s avgrq-sz avgqu-sz   await r_await w_await  svctm  %util
nvme2n1           0.00     0.00    0.27    0.00     4.53     0.00    16.78     0.00    0.27    0.27    0.00   0.01   0.00
nvme1n1           0.00     3.38    0.57   22.68     6.08  3626.88   156.22     0.11    4.86    0.79    4.96   0.34   0.78
nvme0n1           0.00     2.02    8.05    1.77  1156.66   108.11   128.85     0.01    1.34    1.40    1.06   0.36   0.35

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.00    0.00   62.76   18.88    0.00   18.37

Device:         rrqm/s   wrqm/s     r/s     w/s   rsec/s   wsec/s avgrq-sz avgqu-sz   await r_await w_await  svctm  %util
nvme2n1           0.00     0.00    0.00    0.00     0.00     0.00     0.00     0.00    0.00    0.00    0.00   0.00   0.00
nvme1n1           0.00    87.00    4.00 1170.00     0.00 262088.00   223.24    14.25   12.98    0.00   13.02   0.84  98.70
nvme0n1           0.00     0.00    0.00    1.00     0.00   128.00   128.00     0.00    1.00    0.00    1.00   0.00   0.00

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.50    0.00   63.18   18.41    0.00   17.91

Device:         rrqm/s   wrqm/s     r/s     w/s   rsec/s   wsec/s avgrq-sz avgqu-sz   await r_await w_await  svctm  %util
nvme2n1           0.00     0.00    0.00    0.00     0.00     0.00     0.00     0.00    0.00    0.00    0.00   0.00   0.00
nvme1n1           0.00    61.00    4.00 1192.00     0.00 262608.00   219.57    14.39   12.86    0.00   12.91   0.83  99.10
nvme0n1           0.00     6.00    0.00    2.00     0.00    64.00    32.00     0.00    0.50    0.00    0.50   0.00   0.00

avg-cpu:  %user   %nice %system %iowait  %steal   %idle
           0.50    0.00   59.30   20.60    0.00   19.60

Device:         rrqm/s   wrqm/s     r/s     w/s   rsec/s   wsec/s avgrq-sz avgqu-sz   await r_await w_await  svctm  %util
nvme2n1           0.00     0.00    0.00    0.00     0.00     0.00     0.00     0.00    0.00    0.00    0.00   0.00   0.00
nvme1n1           0.00   117.00    8.00 1135.00    32.00 262624.00   229.80    13.79   12.94    7.38   12.98   0.87  99.30
nvme0n1           0.00     0.00    0.00    1.00     0.00   128.00   128.00     0.00    1.00    0.00    1.00   0.00   0.00
```

I know that the disk is 50GB so I should get around 150 IOPS (3 IOP's per GB)

The below graph from the cloud provider shows that I pushed ~900 IOP/ sec over 5 minutes avg.



Conclusion regarding block device throughput:

Divide that 900 IOPS avg by the 5 mins and you see that we got ~180 IOP/sec which is about what our disk should max out at.

Based on the **%util** from the **iostat** output and some confirmation from the cloud provider metrics I can confirm that my bottleneck is the disk that my pool is deployed on. I am exceeding the allowed IOPS for that block device.

Object Storage Devices

Object storage devices refer to S3, Azure Blob, and OpenStack Swift containers being used as disk devices.

Reading and writing is handled via HTTP GET request (for reads) and HTTP PUT request (for writes).

The public cloud platforms each limit the throughput of a blob object to around 500 requests or just under 60MB/sec depending on which platform.

The best way to diagnose any performance issues related object storage devices is to refer to the SoftNAS logs.

Look for '**Delaying query**', **'EC',** and **'Error'** messages from the **s3backer** process.

```
root@nas1:/S3pool/S3vol# cat /var/log/messages | grep s3backer
Feb  5 15:09:38 nas1 s3backer[3208]: Error Timeout (http: 200 curl 28) GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/12a5-7c90 #012 req_id: A30
4376AE5AD97BA#015#012 id-2: /GvGtQShwe+biNPmo7xPu6/rXwQ1lumZw4QDbeGDibv8wE+FHchoILBlMBtwIiUNd5YE9gAqaRs=#015#012.
Feb  5 15:09:38 nas1 s3backer[3208]: Response body: IHaezjKRC64koz2KAiqCEzp8ZEIm1rzyWZ+wCD7bQnv3+bft2249m/69Cgk3XfYh#012J4GqxAb/GGEioRYhALu1Lk49CnB1X4
IH+j0YUWJ0Vq+l/hkwm8NU8NKdxlCdOtUZ#012aNSZS3mmJtiHtOyJhh6Bb4hLFtUMGpCAz2fv5JDlNty0VbZ86OQx5Pf6TxCewzV2#012EFR7J1pqvDZnHxeDRAXp/N/WDYf/xN8h9sxq1jAdWu0S
yKsxsxmYLXjgL+Ejr+FPp#0120b8tYM3kVsJW3R58PT2AKU4HyRQ2YPdy4zjKmPOK5AWMFtehTHuU1xucN4lAdy4p#012FVas5SZ+KPnhEDr1qGUDXRpCODZq27/K7asiDX3ZU3P0pfP7TFTVO/InR5
kKSXHF#012zPzd1LOZeiVlzGUmlHne0IzsUQNSq3y6+w+j5yS8UPrMbKn9w6fXpUK+YlZbkRD9#012rL0fEWtKaP9PIg4DsMHHTUq2qj4sY+iqdR4iJOF34RbK
Feb  5 15:09:38 nas1 s3backer[3208]: EC: block 7c90 failure (read returned 110) (try 0) [cur pause 0 , paused so far 0]
Feb  5 15:09:39 nas1 s3backer[3208]: Delaying query 200 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/12a5-7c90
Feb  5 15:09:39 nas1 s3backer[3208]: EC: block 7c90 success after 1 retries 400 ms with checksum confirmed
Feb  5 15:09:39 nas1 s3backer[3208]: Delaying query 190 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/0ebb-7c92
Feb  5 15:09:39 nas1 s3backer[3208]: Delaying query 190 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/30a1-7c91
Feb  5 15:09:39 nas1 s3backer[3208]: Delaying query 180 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/26dd-7c93
Feb  5 15:09:40 nas1 s3backer[3208]: Delaying query 162 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/b46d-7c94
Feb  5 15:09:40 nas1 s3backer[3208]: Delaying query 162 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/9ec6-7c95
Feb  5 15:09:40 nas1 s3backer[3208]: Delaying query 153 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/0bd5-7c96
Feb  5 15:09:40 nas1 s3backer[3208]: Delaying query 137 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/93d1-7c97
Feb  5 15:09:40 nas1 s3backer[3208]: Delaying query 137 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/4201-7c98
Feb  5 15:09:40 nas1 s3backer[3208]: Delaying query 130 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/5ecd-7c99
Feb  5 15:09:40 nas1 s3backer[3208]: Delaying query 116 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/ef7e-7c9a
Feb  5 15:09:40 nas1 s3backer[3208]: Delaying query 116 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/decf-7c9b
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 104 msecs: DELETE https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/facb-7c9c
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 104 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/3238-7c9d
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 104 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/f4ba-7c9e
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 88 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/b503-7c9f
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 88 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/a3ac-7ca0
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 78 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/2503-7ca2
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 78 msecs: DELETE https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/6a00-7ca1
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 70 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/0648-7ca3
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 70 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/1416-7ca5
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 62 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/35fb-7ca6
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 62 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/770c-7ca7
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 62 msecs: DELETE https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/4650-7ca4
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 52 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/a5c4-7ca9
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 52 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/cb11-7caa
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 46 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/4b44-7cac
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 46 msecs: DELETE https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/26f9-7cab
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 40 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/8fcd-7cad
Feb  5 15:09:41 nas1 s3backer[3208]: Delaying query 40 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/92d2-7cae
Feb  5 15:09:42 nas1 s3backer[3208]: Delaying query 38 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/5fbe-7caf
Feb  5 15:09:42 nas1 s3backer[3208]: Delaying query 36 msecs: DELETE https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/fd52-7ca8
Feb  5 15:09:42 nas1 s3backer[3208]: Delaying query 34 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/f3db-7cb0
Feb  5 15:09:42 nas1 s3backer[3208]: Delaying query 32 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/ab7c-7cb3
Feb  5 15:09:42 nas1 s3backer[3208]: Delaying query 30 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/6992-7cb4
Feb  5 15:09:42 nas1 s3backer[3208]: Delaying query 28 msecs: DELETE https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/0b4e-7cb1
Feb  5 15:09:42 nas1 s3backer[3208]: Delaying query 26 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/b8c3-7cb6
Feb  5 15:09:42 nas1 s3backer[3208]: Delaying query 26 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/54ff-7cb7
Feb  5 15:09:42 nas1 s3backer[3208]: Delaying query 22 msecs: GET https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/2965-7cb8
Feb  5 15:09:42 nas1 s3backer[3208]: Delaying query 20 msecs: DELETE https://nas1-7a378ea0.s3.us-east-2.amazonaws.com/3fb3-7cb5
root@nas1:/S3pool/S3vol#
```

Conclusion regarding object device throughput:

The above means that we are overrunning the allowed throughput to the object backend and the platform is telling us to back off with the requests.

In this case you either need to back the load of from your clients if you want to continue to use object disks or move the SoftNAS pools to faster block storage devices with more consistent throughput characteristics.

There is nothing we can do as these throttles are imposed by the platform.

RAM and SoftNAS Performance

Usable system memory is another key performance factor in how SoftNAS operates.

The SoftNAS kernel is tuned for file services so it does not behave as you would expect a standard virtual machine or file server to behave.

The appliance will always consume whatever physical RAM it has available for file system caching and ZFS metadata operations. Thats a good thing because serving from RAM and L2ARC is faster than serving files from disk.

The general behavior will be that it will consume most of the RAM it can for file operations, however the dynamic back pressure provided by ZFS should never allow it to SWAP.

How much RAM it can give back depends on the number of open file handles, exported mount points, number of connected clients, and the file sharing protocol (NFS or CIFS).

The only way to reclaim any of the RAM that ZFS is currently allocating would be to export and and then re-import the zpools (**zpool export pool_name, z pool import pool_name**).

Exporting and importing a pool would obviously cause an outage for that file system so its not a recommended practice. You will likely hit that same memory threshold again as files are accessed and cached.

If the instance that you are running SoftNAS on is swapping, then that is an indication that you need to scale up RAM on the instance type to handle the current number of file operations.

You can use the command '**free -m**' to quickly see RAM allocation and check to see if the system is swapping: (below)

```
free -m
```

	total	used	free	shared	buffers	cached
Mem:	**32149**	**28322**	**3826**	**0**	**55**	**348**
-/+ buffers/cache:		**27918**	**4230**			
Swap:	**4095**	**1237**	**2858**			

Conclusions regarding RAM resources:

From the above example I can see that I am swapping and need to scale this system beyond 32GB of physical RAM if I want to operate at this current load.

The more RAM you add to a system, the more you can cache from RAM if other dependent resources allow.

Protocols like SAMBA/CIFS consume more RAM due to having to store extended file attributes (x-attr's) like when integrated into Active Directory.

Enabling deduplication on SoftNAS is going to consume more RAM as it has to maintain dedupe-tables.

If you use object-backed pools (Azure Blob, S3, or Swift) you will consume more RAM as the blocks are held in cache while they are being chunked and uploaded or download.

CPU and SoftNAS Performance

CPU load is a measure of how many instructions we have sitting in the system bus queue waiting for the processor to execute.

A true CPU load issue happens when there is not enough total CPU time available to handle the number of concurrent request coming into the system bus.

CPU's work in a FIFO buffer (First In First Out), so lets also keep that in mind.

Typically two things will be affecting your CPU load on SoftNAS:

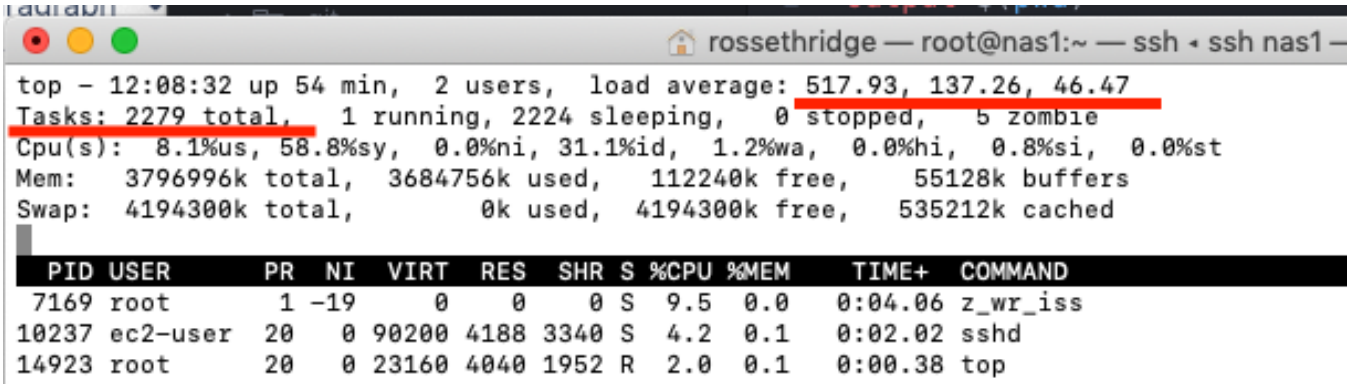
- Number of processes in relation to number/speed of CPU cores. This includes long running processes that stack up on top of each other.
- IO Wait. If the CPU is waiting on IO from network or disk, then processes stack up in the execution queue.

Exhausted CPU:

Check processes in 'top': compare number of tasks, to %wait, %user, and %system.

Refer to the below example showing the output of 'top' regarding number of 'Tasks'.

In this example I have 1001 simultaneous write threads going to 1001 different directories at one time and my SoftNAS only has 2 cores.



The load average is above **517** and that is because there are a total of **2279** tasks running at once.

Its difficult for 2 CPU's to handle that many long-running processes so its backed up 517 deep in the queue.

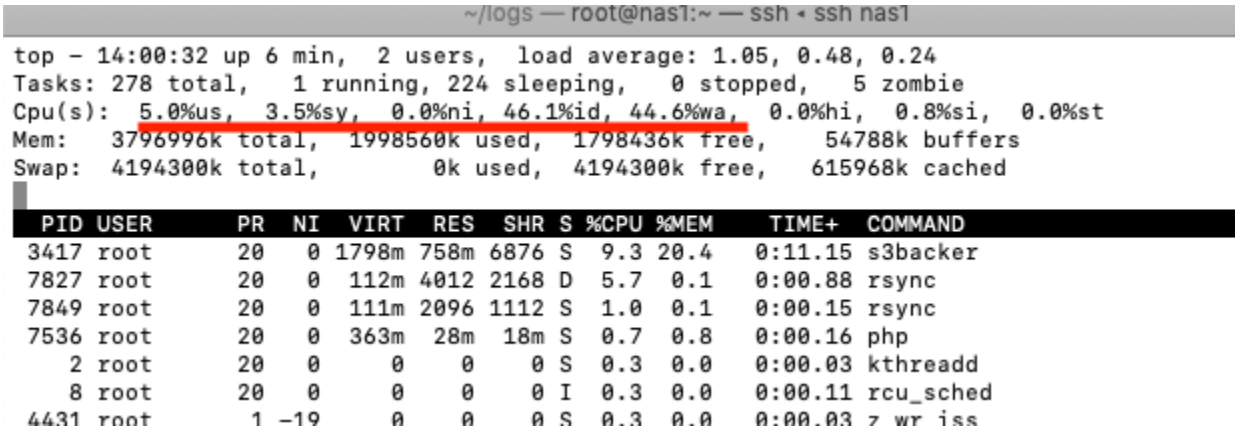
In that example my IO wait is low (**1.2%wa**) and all the CPU time is going to system (**58.8%sy**) and user (**8.1%us**).

This was a classic example of just needing more CPU to handle the number of requests.

Waiting CPU:

CPU waiting on IO request to/from network or to/from disk will also cause a CPU load condition.

Refer to sections one and two of this doc (**Network** and **Disk**) regarding how to diagnose which component is causing the condition.



In the above example you can notice that all my CPU time is going to **%wait** (**44.6%wa**) and **%idle** (**46.1%id**) and my performance is slow.

There are only **278 total tasks** running so the **load average of 1.05** still seems high for 2 CPU's.

In this example I need to go look at **disk throughput** and **network throughput** metrics to understand this CPU wait condition.

Conclusion regarding CPU bottlenecks:

The two frequent conditions regarding CPU bottlenecks are going to be related to number of processes or CPU waiting on an underlying IO subsystem.

The 'number of processes' problem will grow as customers add 'number of volumes' to the replication cycle. When you start reaching a high number of volumes on a deployment, the CPU will become consumed with long-running replication tasks, about 5 tasks per volume.

- snapshot
- zfs send
- zfs recv
- zfs diff
- merge
- repeat next minute for every single volume

Enabling the ZFS compression feature will consume more CPU time.

Enabling the volume encryption feature will consume more CPU time.

Enabling in-flight encryption for replication will consume more CPU time (and also affect network performance).

Client Type, Protocol, and SoftNAS Performance

Different network clients and operating systems will behave differently when accessing the same shared volume on SoftNAS. Sometimes mount options on the client side can help. Sometimes mount options cannot help and it's just a characteristic of that client type. Also choosing the right protocol for the right client becomes important. You would probably not want to use NFS for Windows clients and you probably would not want to use SMB/CIFS for Linux clients. Use **jumbo frames** whenever you can.

NFS

- NFSv3 clients will behave differently than NFSv4 clients.
  - It's a fundamental change from default UDP (v3) to default TCP (v4).
- NFS clients that are *NIX or Solaris based will outperform Windows based NFS clients.
  - Thats more related to NFS being a non-native System32 app in Windows.
- Tuning the **rsize, wsize** for the network and setting options like _**netdev** and **intr** in the mount options on the client will have significant impact.
  - For example, if you have jumbo frames enabled and a rsize and wsize of 8192, I can push line speed of the ec2-instance client in AWS.
- Common NFS client mount options and explanations can be found here:
  - https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/6/html/storage_administration_guide/s1-nfs-client-config-options

CIFS/SMB (and Active Directory)

If we are exporting shares as CIFS/SMB then we can assume its likely for Windows clients. We should also take into consideration whether or not these shares are integrated into Active Directory. Getting extended attributes and checking permissions against an Active Directory server will add to the transaction time.

- DNS response time and reachability are also very important factors when dealing with AD domain resolution. Any DNS or AD related issues will amplify any performance problem.
- Native Microsoft SMB servers may outperform SoftNAS in some cases if the attached Microsoft clients are taking advantage of the direct memory access and multi-channel capabilities not available in the open-sourced SAMBA service on our appliance. Also the SAMBA daemon runs in 'user space' on our appliance which is inherent of performance and resource restrictions.
- Just like NFS, some tuning can be done on both the SMB client as well as server side to attempt to increase performance. Tweaks to sockets, opportunistic locking, TCP options, and the send and recv buffers. None of this is recommended by the SAMBA organization but these are all options in smb.conf
    - **Refer to this external blog post for a good read regarding the context of changing specific parameters:**
        - https://calomel.org/samba_optimize.html
    - **Refer to this blog post from Samba telling us not to mess with those same parameters:**
        - https://wiki.samba.org/index.php/Performance_Tuning

          "*The Samba team highly-recommends not setting the parameters described in this section without understanding the technical background and knowing the consequences.*

          In most environments, setting these parameters or changing the defaults decreases the Samba network performance."

Throttling

The public cloud pricing model is based on throttles. As you pay more money, you get devices and compute resources with higher limits and less throttles.

As discussed in previous topics, your will hit a maximum throughput number set by the cloud provider for that device or compute instance.

These are the platform throttles that you have to keep in mind and can be verified by referring to the cloud provider SLA:

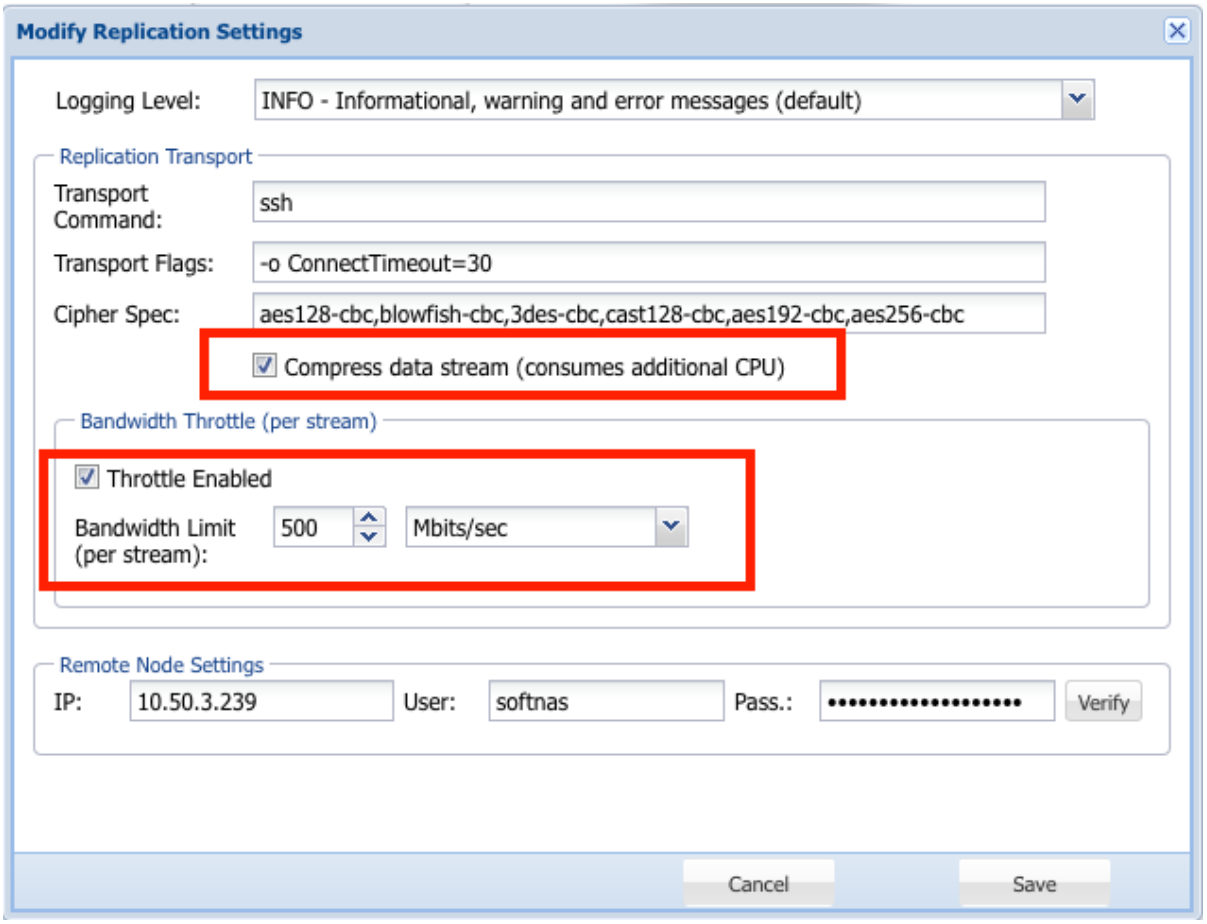
- Max throughput allowed for a disk device type.
- Max throughput allowed for a network interface.
- Max throughput allowed for a virtual machine type.

There are also artificial throttles that can be imposed at the software level on SoftNAS. (see below)

- Bandwidth throttling in the replication settings. (default is 500M)

Some throttles may be unintentional. (see below)

- Enabling data stream compression will unintentionally throttle the network bandwidth throughput as it has to now wait on CPU cycles to compress /decompress every data packet.



Conclusion regarding throttling:

When it comes to throttling it's important to be aware of any limits imposed by the cloud provider, which are beyond our control, and to be mindful of any software throttles that we may have imposed intentionally or unintentionally.

Housekeeping

There are a few housekeeping issues that can also affect SoftNAS performance. The three that you commonly come across are issues related to disk space, logging, and volume fragmentation.

Available disk space on the root drive:

Currently the root volume of SoftNAS only has a 30GB file system. If regular housekeeping and on the root volume is not kept in check, then there is potential for it to become full. When the root volume becomes 100% utilized processes fail and the UI stops responding as it can no longer log authentication attempts. The four main places you may have to truncate at times are:

- The system logs directory: **/var/log**
- The SoftNAS application logs directory: **/var/www/softnas/logs**
- Temporary files from software updates and session files: **/tmp**
- Sometimes root's home directory can contain some hidden surprises: **/root**

To tell how much space the subdirectories in your root volume are consuming you can run the below command at the CLI:

```
du -xh / 2>/dev/null | sort -h -r | head -n 15
```

- Or refer to this link: How to find the directories that are occupying the most space on the system?

Logging:

Logging can also affect performance of the appliance.

- Leave SoftNAS logging levels at '**info**' unless troubleshooting and have a need to set the log level to '**debug**'. The amount of logging provided by debug level can fill up the root volume as well as eat into the allowed IOPs on the smaller root volume. Turn logging levels back to info when you are done debugging.

- If running out of space due to logs is a regular problem then we can look at growing the root file system (**offline procedure**) or adjusting the frequency and expiration of logs being handled by the **logrotate** daemon (**/etc/logrotate.d/**)

Available space in the ZFS pool:

The amount of free space affects how ZFS writes data to the pool devices.

- Keep pool free space above 10% to avoid many metaslabs from reaching the 5% free space threshold to switch from first-fit to best-fit allocation strategies.
    - http://open-zfs.org/wiki/Performance_tuning#Free_Space
- The command '**zdb -mmm $YourPoolName'** will show this information (see below)

```
[root@nas1:~# zdb -mmm EBSpool

Metaslabs:
        vdev          0
        metaslabs   199   offset                spacemap          free
        ---------------   -------------------   ---------------   -------------
        metaslab      0   offset            0   spacemap     71   free     512M
                          segments         47   maxsize    476M   freepct   99%
        In-memory histogram:
```

Fragmentation in the ZFS pool:

The output of '**zpool list**' shows a value of **%FRAG**. The FRAG value is an abstract measure of **how fragmented the *free space* in the pool is**. The FRAG percentage tells you nothing about how fragmented (or not fragmented) your data is, and thus how many seeks it will take to read it back. (see below). Obviously more fragments in free space means you will be doing more random reads and writes moving forward which will have a big impact on how quickly the file system can perform.

```
[root@nas1:~#
[root@nas1:~# zpool list
NAME       SIZE  ALLOC   FREE  EXPANDSZ   FRAG    CAP  DEDUP  HEALTH  ALTROOT
EBSpool  99.5G  1.64M  99.5G         -     0%     0%  1.00x  ONLINE  -
S3pool   99.5G  1.69M  99.5G         -     0%     0%  1.00x  ONLINE  -
root@nas1:~#
```

The above example shows that all the remaining space in my pool is located in contiguous sectors with no fragmentation. It should be this way because this is a newly created pool and I have not deleted any data from it or reclaimed any sectors to be re-written by ZFS.

- If you notice a high level of fragmentation in your zfs pools (above 10%), you should consider re-writing the pool data to new devices using a method like zfs send/recv to self.

Conclusion regarding housekeeping:

Housekeeping issues are not always the most obvious when troubleshooting performance related problems, but as you can tell from above, they can have a huge impact on the performance of the appliance. We need to be mindful of available disk space in the storage pools and the root volume as well as look out for fragmentation on the devices. We also need to be mindful of how we handle logging and log rotation as all of those can impact performance.