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Analysis of Network Attached Storage Performance with NFS Protocol in Integrated Business Start-Up

Guntoro Barovih[1)*], Surahmat[2)], Febrianty[3)]
[1)]Institut Teknologi dan Bisnis PalComTech, Indonesia
[2)]Politeknik Negeri Sriwijaya, Indonesia
[3)]Institut Teknologi dan Bisnis PalComTech, Indonesia
[1)]guntoro@palcomtech.ac.id, [2)]surahmat@polsri.ac.id, [3)]febrianty@palcomtech.ac.id,

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Abstract: The need for data storage due to individual and group computing work is increasing, so storage media with reliable capabilities and good performance are needed. The way that can be solution is shared storage, which is using one storage to be used together. One of the commonly used shared storage is NAS (Network Attached Storage). IBS (Integrated Business Start Up) uses NAS as a backup storage medium that will store important data that supports the performance of IBS services as a whole, so it is necessary to analyze to find out how the performance of the NAS system uses the NFS Protocol as the basis of the service. whereas in this study the focus of performance testing was carried out by looking at the results of measuring packet loss, throughput, CPU usage, and memory usage on the NAS server used. the performance level of the system used is running well, as seen from the results of the throughput test of 1.1 GB, packet loss of around 0%, CPU usage of 0.5%, and memory usage of 382.5Mb. The results of this performance test are also by Telecommunications standards and Internet Protocol Harmonization Through Networks.

Keywords: LAN; NAS; NFS; Performance analysis; Share storage;

INTRODUCTION

The need for data storage as a result of individual and group computing work is now increasing, so storage media with reliable capabilities and good performance are needed. The method that can be a solution is shared storage, which uses one storage to be used together (Suharyanto & Maulana, 2020). One of the commonly used shared storage is NAS (Network Attached Storage). A network-attached storage device that enables storage and retrieval of data from a central location for network users and clients. NAS systems are flexible and scalable, which means when you need additional storage, you can add it to your existing devices. NAS (Network Attached Storage) is a dedicated data storage server technology that is well-known for reliable and stable data storage. NAS has a variety of operating systems, such as Unix-based FreeNAS and NAS4Free, and Linux-based OpenFiler (Kalaena & Bagye, 2018). NAS can be a solution to problems in terms of data sharing, data storage, and data security.

IBS (Integrated Business Start Up) uses NAS as a storage backup media that will store important data that supports the performance of IBS services as a whole, thus it is necessary to analyze to find out how the performance of the NAS system uses the NFS protocol as the basis of the service. given because if the capability or performance of this NAS server is not yet known, then there is a concern that the existing performance may negatively affect the capability of the Integrated Business Start-Up. Network Attached Storage on IBS, is in a local network and has a server system that is separate from the main system so that the storage owned by the IBS NAS server can be added as needed (Hadiwijaya & Barovih,

* Guntoro Barovih

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2021), currently the available storage is 1 terabyte, which is allocated as storage media The secondary from the IBS server is also used as a backup data storage medium.

Previous research that discussed the performance of NAS was research that analyzed the use of network-attached storage as a data storage center (Sidik & Putra, 2018) then other research also discussed the comparative analysis of the performance of FreeNAS and nas4free which focused on the ability of NAS as a data storage center and the use of inexpensive software in data storage and sharing (A. Kurniawan et al., 2018). In addition, there is also research that discusses the use of NAS using FreeNAS. This research compares the performance of the NFS and ISCSI protocols (Masiana et al., 2022), to test the capabilities of the NFS technology itself as a storage area, see research on persistent data storage on Docker Swarm. the NFS protocol is can provide persistent data storage in Docker Swarm even after restarting the machine (Frederius, 2019). whereas in this study the focus on performance testing was carried out by looking at the results of measuring packet loss, throughput, CPU usage, and memory usage on the NAS server used. by using several testing tools in the form of, perf, and dynamic real-time view with top.

LITERATURE REVIEW

A NAS system is a storage device that is connected to a network that allows data retrieval and storage to be carried out with a centralized system with adjustable data access settings based on access control (Lita et al., 2021). The Network File System was first developed by Sun Microsystems(De & Panjwani, 2021), as a medium for sharing data in a diskless network. with NFS a file can be accessed from a machine just as the machine accesses its local storage.

Performance testing is a non-functional test that is carried out to determine the ability of a system when faced with various situations that aim to find out how far a machine can operate and how much load the machine can handle to minimize the risk of system downtime(Tirta & Shidik, 2017).

In the performance testing conducted in this study, several factors are the focus of the test, namely speed, stability, and scalability. In the speed test, it will be measured by looking at the results of throughput, for Stability, the results of packet loss will be measured, then for Scalability, it will be seen from the results of CPU and memory usage.

Throughput is the actual bandwidth, measured in a certain time unit and under certain network conditions, which is used to transfer files of a certain size, while packet loss is a condition where data is lost at the time of transmission so that it is not fully received at the destination. Packet loss is expressed as a percentage of lost packets of the total number sent. While CPU and memory usage is how much CPU and memory are used when a process is in progress (Sitorus et al., 2022).

For measurements of throughput and packet loss (Simargolang & Widarma, 2022), you can look at the standards provided by TIPHON.

Table 1. Throughput

Category	Throughput	Indeks
Bad	0 Mbps -)338 kbps	0
Poor	338 kbps - 700 kbps	1
Fair	700 kbps - 1200 kbps	2
Good	1,2Mbps – 2.1Mbps	3
Excellent	>2.1 Mbps	4

Table 2. Packet Loss

Category	Paket Loss	Indeks
Poor	>25%	1
Medium	12% -24%	2
Good	2% -11%	3
Perfect	0 %-2 %	4

As for CPU measurements and memory usage, you can see the results of the benchmarks when the system is running.

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METHOD

The method used in this study is the Network Development Life Cycle (NDLC) which is a method that relies on previous development processes such as business strategy planning, application development life cycle, and data distribution analysis (Siswanto et al., 2021). The use of this method is because this stage is the development stage of the IBS system as a form of service improvement that is always carried out which is useful for system improvement and stability (Santoso & Muin, 2015). The stages of the NDLC are analysis, design, simulation, implementation, monitoring, and management (R. Kurniawan, 2017) (Idrus, 2020).
The NDLC stages carried out in this study include:

- Analysis at this stage is carried out needs analysis, analysis of problems that arise, analysis of user desires, and analysis of the existing topology/network so that the next stages will be easier to implement.
- The design after the analysis phase of the data obtained from these stages is used as a basis for loading new designs from existing network or system designs to produce better and more efficient new network designs.
- For the implementation phase to run well, a Prototype Simulation stage will be carried out first. A prototype simulation will be made to test the new network or system at this stage.
- Implementation will be carried out in stages based on the simulations that have been carried out previously. This stage is carried out so that at the implantation stage, things that are out of control do not occur which will result in system failure considering that the overall IBS system is already running and only needs development.
- Monitoring The monitoring phase is carried out to ensure that the implementation of the new system is running well and there are no errors in the system.
- Management The management stage is carried out to ensure that the new system that has been implemented can be managed properly and efficiently.

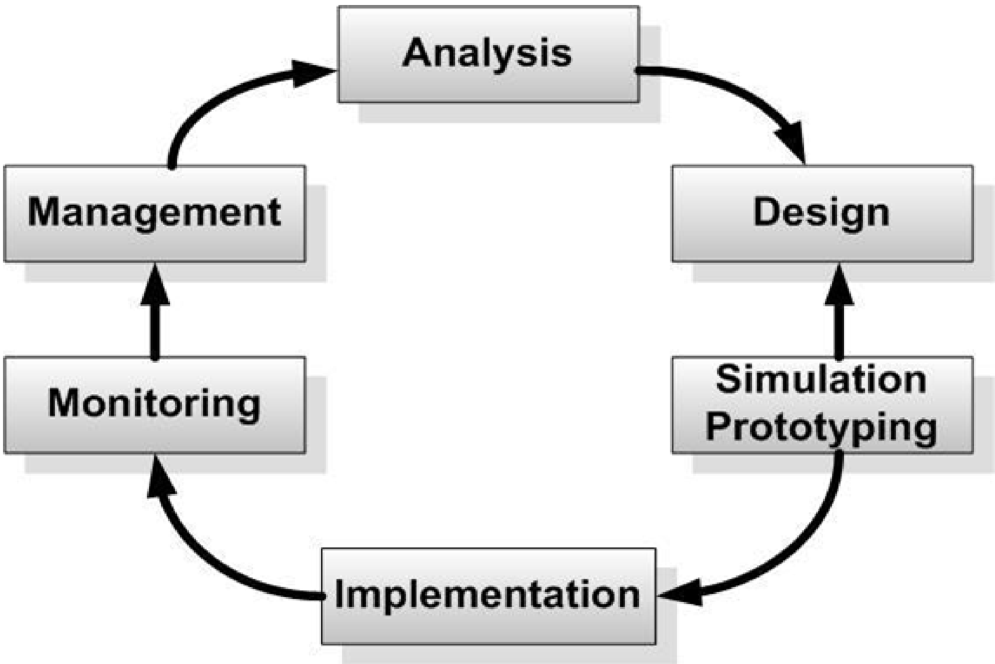

Fig. 1 Network Development Life Cycle (Siswanto et al., 2021)

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RESULT

Analysis

As an initial stage, an analysis of the existing system is carried out to assist in the stages that will be carried out later. Where to check the specifications of the device used and then also the location of the existing device. The operating system used is Linux Ubuntu 20.04 LTS. This analysis phase is very important because it is the initial stage to be able to identify and assess the system as a whole which is used to map and overcome problems that might occur in the system in the future so that prevention, recovery, and improvement processes can be carried out. As shown in Figure 2.

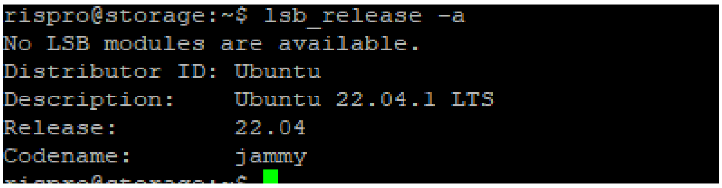

Fig. 2 Operating System

Meanwhile, table 3 shows the specifications of server devices that use HPE ProLiant DL20 Server with specifications.

Table 3. NAS Server device specifications

No	Device	Information
1	CPU	Intel(R) Xeon(R) E-2236 CPU @ 3.40GHz
2	Memori	16GB (1x16GB UDIMM, 2666 MT/s)
3	Hardisk	1TB SATA 7.2K SFF SC DS HDD
4	Network Controller	HPE embedded 1Gb 2-port 361i network Adapter
5	Power Suplay	HPE 500W Redundant Power Supply

The device placement location is placed on a server rack located in the KOMINFO server room in South Sumatra Province. This location was chosen because it has a stable network connection and good server room security where the system security process already has security in terms of hardware and software, besides that there is also an access mechanism for people who want to enter the server room and it is also available 24hour cooling system and electrical system. As shown in Figure 3.

Fig. 3 Server Deployment Location

Design

After analyzing the existing devices, a network topology design will be carried out where the system will be operated to ensure and reduce the risk of system failure in the future (Harahap et al., 2022). The topology of the system built is as follows. As shown in Figure 4.

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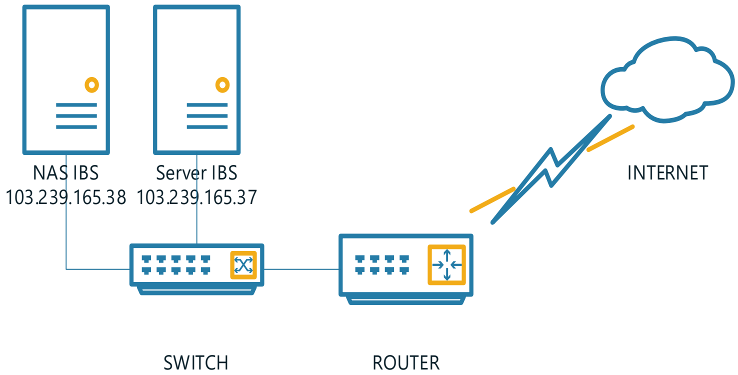


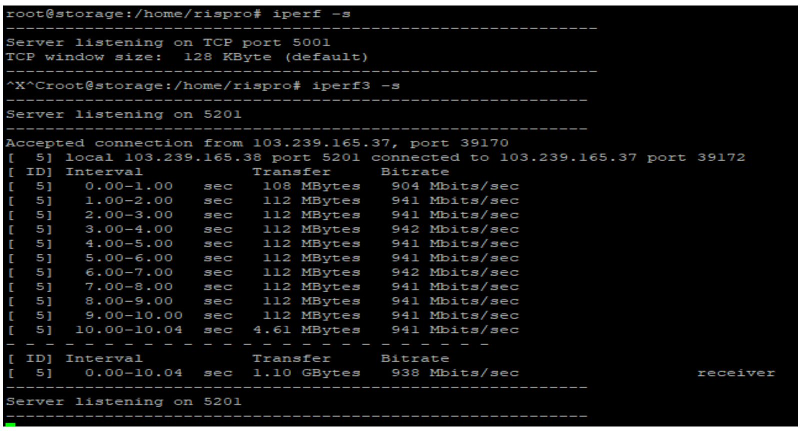
Fig. 4 IBS NAS System Topology

The IP address used on the IBS NAS system is 103.239.165.38. This IP address can only be accessed from the local network for security access using firewalls and access control systems so that data on the system can be more secure. while the IBS system itself has an IP address of 103.239.165.37 with a website address ibs.sumselprov.go.id which can be accessed from the internet network. while access to IBS is itself via a local network via a Cisco switch.

Implementation

At this stage, a configuration process is carried out to adjust the IP address of the device so that it is easy in the installation process from the NAS which will be used for the NAS server itself on the IBS NAS server using NFS-Server (Sofyan & Kusuma, 2022), while for the client later NFS-Client will be installed on the server IBS (Ali et al., 2023). At this implantation stage, the performance of the implemented system is also tested by measuring throughput, packet loss, CPU, and memory usage.

Figure 5 shows the results of a throughput test performed on an NFS client by running the command iper3 -c server ip address, while the test result is the result of a throughput test on an IBS NAS server using a 10-second time interval with 100MB of data sent every second. This test is to find out how much bandwidth can be used when transferring data from the IBS system to the IBS NAS.



```
root@storage:/home/rispro# iperf -s
------------------------------------------------------------
Server listening on TCP port 5001
TCP window size:  128 KByte (default)
------------------------------------------------------------
^X^Croot@storage:/home/rispro# iperf3 -s
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
Accepted connection from 103.239.165.37, port 39170
[  5] local 103.239.165.38 port 5201 connected to 103.239.165.37 port 39172
[ ID] Interval           Transfer     Bitrate
[  5]   0.00-1.00   sec   108 MBytes   904 Mbits/sec
[  5]   1.00-2.00   sec   112 MBytes   941 Mbits/sec
[  5]   2.00-3.00   sec   112 MBytes   941 Mbits/sec
[  5]   3.00-4.00   sec   112 MBytes   942 Mbits/sec
[  5]   4.00-5.00   sec   112 MBytes   941 Mbits/sec
[  5]   5.00-6.00   sec   112 MBytes   941 Mbits/sec
[  5]   6.00-7.00   sec   112 MBytes   942 Mbits/sec
[  5]   7.00-8.00   sec   112 MBytes   941 Mbits/sec
[  5]   8.00-9.00   sec   112 MBytes   941 Mbits/sec
[  5]   9.00-10.00  sec   112 MBytes   941 Mbits/sec
[  5]  10.00-10.04  sec  4.61 MBytes   941 Mbits/sec
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bitrate
[  5]   0.00-10.04  sec  1.10 GBytes   938 Mbits/sec                  receiver
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
```

Fig. 5 Throughput Test Results

After that, testing is also carried out using ping to measure packet loss. In this test, a packet loss test is carried out by giving a ping with a count of 10. To see how many data packets are lost when the data is sent to the recipient. By knowing the amount of packet loss that may occur, the process can be done to minimize data loss. As shown in figure 6.

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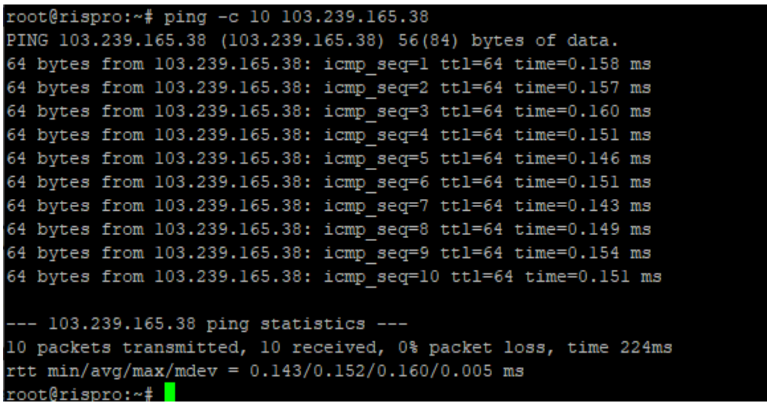
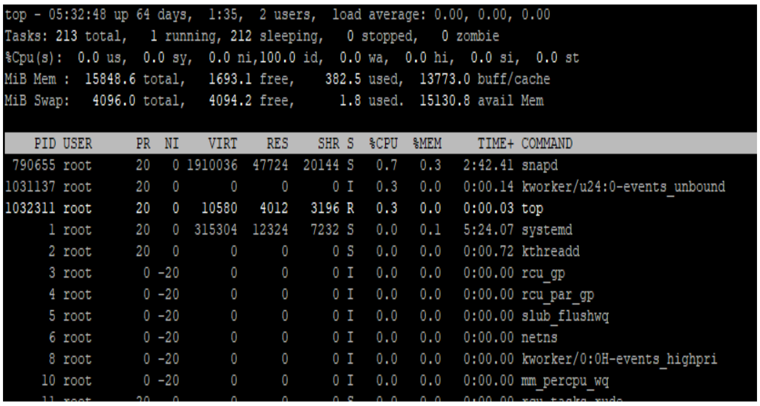


```
root@rispro:~# ping -c 10 103.239.165.38
PING 103.239.165.38 (103.239.165.38) 56(84) bytes of data.
64 bytes from 103.239.165.38: icmp_seq=1 ttl=64 time=0.158 ms
64 bytes from 103.239.165.38: icmp_seq=2 ttl=64 time=0.157 ms
64 bytes from 103.239.165.38: icmp_seq=3 ttl=64 time=0.160 ms
64 bytes from 103.239.165.38: icmp_seq=4 ttl=64 time=0.151 ms
64 bytes from 103.239.165.38: icmp_seq=5 ttl=64 time=0.146 ms
64 bytes from 103.239.165.38: icmp_seq=6 ttl=64 time=0.151 ms
64 bytes from 103.239.165.38: icmp_seq=7 ttl=64 time=0.143 ms
64 bytes from 103.239.165.38: icmp_seq=8 ttl=64 time=0.149 ms
64 bytes from 103.239.165.38: icmp_seq=9 ttl=64 time=0.154 ms
64 bytes from 103.239.165.38: icmp_seq=10 ttl=64 time=0.151 ms

--- 103.239.165.38 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 224ms
rtt min/avg/max/mdev = 0.143/0.152/0.160/0.005 ms
root@rispro:~#
```

Fig. 6 Packet Loss Test Results

Ping testing is done after throughput testing with the average test results per second is 0.150 ms, this means there is almost no interference during ping testing to see packet loss that may occur during data transmission. After that, testing was carried out to see the CPU and memory usage of the IBS server using the TOP command. This test produces real-time measurements. The test results can be seen in Figure 7.



```
top - 05:32:48 up 64 days,  1:35,  2 users,  load average: 0.00, 0.00, 0.00
Tasks: 213 total,   1 running, 212 sleeping,   0 stopped,   0 zombie
%Cpu(s):  0.0 us,  0.0 sy,  0.0 ni,100.0 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
MiB Mem :  15848.6 total,   1693.1 free,    382.5 used,  13773.0 buff/cache
MiB Swap:   4096.0 total,   4094.2 free,      1.8 used.  15130.8 avail Mem

    PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM     TIME+ COMMAND
 790655 root      20   0 1910036  47724  20144 S   0.7   0.3   2:42.41 snapd
1031137 root      20   0       0      0      0 I   0.3   0.0   0:00.14 kworker/u24:0-events_unbound
1032311 root      20   0   10580   4012   3196 R   0.3   0.0   0:00.03 top
      1 root      20   0  315304  12324   7232 S   0.0   0.1   5:24.07 systemd
      2 root      20   0       0      0      0 S   0.0   0.0   0:00.72 kthreadd
      3 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 rcu_gp
      4 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 rcu_par_gp
      5 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 slub_flushwq
      6 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 netns
      8 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 kworker/0:0H-events_highpri
     10 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 mm_percpu_wq
```

Fig. 7 Test results for CPU and Memory usage

From the command that is executed (in figure 7), it can be seen what processes are running. In addition, this command also functions as a running monitoring process by identifying processes based on the PID generated from the process, here you can also see CPU usage in the kernel, CPU timeout, and memory usage on the running system.

DISCUSSIONS

From the results of the tests conducted, it is known that testing throughput, packet loss, CPU, and memory usage produces good results. and the test results are presented in tabular form, such as Table 4.

Tabel 4. Testing Result

No	Testing	Result
1	Throughput	1,1 GBytes
2	Paketloss	0%
3	CPU Usage	0.0 sd 0.5
4	Memori Usage	382.5 Mb

The resulting throughput is very good because the NAS server network uses a local area network (LAN) that is connected to a Switch and cable with Gigabit capacity, there is also no loss of use because the local network is very well connected. Meanwhile, the use of memory and CPU is still very minimal used.

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CONCLUSION

Based on the results of performance testing on the NAS storage system that has been carried out, it is known that the performance level of the system used is running well, as can be seen from the results of the throughput test of 1.1 GB, packet loss which is around 0% and very low CPU usage as well as low memory usage. there are still very few NAS systems implemented at Integrated Business Start Up where the server is at KOMINFO, South Sumatra Province, which can work optimally without problems. The results of this test are also by the standards of the Telecommunications and Internet Protocol Harmonization Over Networks.

Another thing that is still a concern is the need for additional security or redundancy mechanisms to guarantee overall system stability to maximize system performance and reduce the possibility of system failure in the future.

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