

QUALITY OF SERVICE ANALYSIS OF CLOUD STORAGE ON NEXTCLOUD AND PYDIO

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Abstract--The development of information technology greatly influences the development of current storage media, such as cloud-based storage (cloud). Nextcloud and Pydio are part of an open-based cloud computing system, where both platforms have become popular in the domain of cloud storage and file collaboration. Nextcloud and Pydio both offer similar features, such as file storage, synchronization, collaborative sharing, encryption, and integration with third-party applications. Measurement of service quality can be seen from the aspects of throughput, delay, jitter, and packet loss. The purpose of this research is to compare upload and download speeds between Nextcloud servers and Pydio servers. The research method used is based on several methodologies to describe how the research flow process is carried out, including literature studies, system requirements analysis, system design, installation and configuration, application testing and analysis of application comparison results. The Nextcloud and Pydio services were each tested for upload and download 5 times with different file types and file sizes. The file types used consist of .doc files (1,377KB), .pdf files (1,256 KB), .exe files (75,647 KB), .jpeg files (85 KB), and .mp4 files (1,301 KB). The test results show that the nextcloud server is superior to the pydio server in terms of uploads and downloads. Overall, Nextcloud is the better choice for most users, as it offers better performance, security, and features. However, Pydio might be a better choice for users who need a lighter and more customizable solution.

Keywords: *Quality of Service; clouds; Storage; Nextcloud; Pydio.*

I. INTRODUCTION

The development of computer network technology is currently growing very rapidly. Several services in the network field were developed to help providing convenience for internet service users in supporting work scalability. One of the services that has been successfully developed is the utilization of data storage services. The term storage in English is known as data storage which is a data warehouse for data management ranging from collection, processing, storage, to rediscovery of new data

that provides support for decision making. Currently data storage is more developed in the form of cloud storage or better known as cloud computing [1].

Cloud computing is a service with a client-server model system, where all resources such as servers, storage, network and software can be seen as services with remote access patterns by users. This cloud technology has several advantages for users because they no longer need to pay large amounts of money for software and data applications as well as maintenance on physical servers. By using cloud computing, each user can access any stored data anywhere, anytime, and with any device [2].

Cloud storage is a digital data storage technology that utilizes virtual servers as storage media. Unlike common hardware storage media such as CDs or hard disks, cloud storage technology does not require any additional devices. All that is needed to access digital files is a computer or gadget equipped with internet services. Among the advantages of using cloud storage services is that users do not need to carry storage media for files that have been stored in cloud storage, because everything can be accessed from anywhere via the internet [3].

In today's modern era, there are many cloud data storage services based on open source, including nextcloud, google drive, dropbox, owncloud, pydio, and many more. From some of these services and after conducting previous literature studies, the authors are interested in conducting performance testing research on nextcloud and pydio services, both of which have not been studied much by how they compare their performance in storing data (quality of services) [4].

Nextcloud and Pydio are two popular open-source platforms in the field of cloud storage and file collaboration. Although they both have a

similar goal, namely to provide a secure and flexible file storage and sharing solution, there are several differences between the two, namely Nextcloud: it is fully featured by offering a variety of features such as file synchronization, calendar, contacts, task manager, and real-time collaboration. Time with Nextcloud Talk, has a broad ecosystem with many additional applications that can be installed to extend its functionality, has a focus on privacy and security, for example end-to-end encryption and flexible user control, has scalability that can be installed on a local server or on public cloud, thereby providing flexibility in terms of scale and operational environment [5]. Whereas Pydio (formerly known as AjaXplorer): has an attractive, modern and user-friendly user interface with easy-to-use drag-and-drop features, has a focus on strong collaboration, including file and folder sharing with team members, access control, and comments, has a robust file management system that offers strong file management capabilities, including advanced search capabilities and integration with third-party applications, has scalability that can be installed on local servers as well as in cloud environments, thus also providing flexibility in terms of scale and operational environment [6]. The choice between Nextcloud and Pydio depends on the specific needs and preferences of the user [7]. Table I summarizes the key differences between Nextcloud and Pydio.

There are several previous studies, one of it measured the performance tests of two cloud storage services, namely pydio and owncloud based on analysis criteria which included Uptime, Utilization, Memory Utilization, Swap Usage, and QoS [8]. Another research concerned a Comparison of the Implementation of Cloud Storage with the Owncloud and Nextcloud Methods Publicly Based on Software as a Service (SaaS) at the Depok City Communication and Informatics Office. In this study, cloud storage services can be compared based on different variable criteria [9]. Furthermore, there is also a research which regarded the performance of cloud storage service applications as measured using several criteria, such as; testing the speed of file transfers from client to server, testing CPU usage, testing memory usage, and testing network interfaces [10]. Another study used Beta testing, Blackbox testing and Apache Bench testing methods [11].

TABLE I
 Summarizes the key differences between Nextcloud and Pydio

Feature	Nextcloud	Pydio
Performance	Faster - Nextcloud is generally faster than Pydio, especially for large file transfers.	Slower - Pydio is more lightweight than Nextcloud, so it may perform better on less powerful devices.
Security	More features - Both Nextcloud and Pydio are secure, but Nextcloud offers a wider range of security features.	Less features - Pydio is open source, so it can be more easily audited for security vulnerabilities.
Features	More features - Nextcloud has a wider range of features than Pydio, including document editing, calendar, and contact management.	Fewer features - Pydio is more focused on file sharing, so it has better support for large file transfers.
Ease of use	More user-friendly interface - Both Nextcloud and Pydio are easy to use, but Nextcloud has a more user-friendly interface.	Less user-friendly interface - Pydio is more customizable than Nextcloud, so you can tailor it to your specific needs.
Customization	Less customizable	More customizable

The purpose of this study is to test the performance of two cloud storage application services, so that a performance comparison is obtained between nextcloud and pydio which can be used as a consideration for users in choosing the appropriate cloud storage service for use in a variety of resources in cloud computing including storage. data, databases, servers, networks, and more. Fig. 1 is a diagram of the research framework that was carried out.

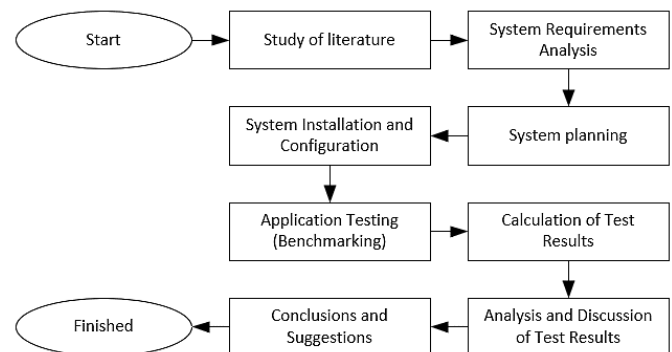


Fig. 1. Research Thinking Framework

II. METHOD

The research method used is based on several methodologies to describe how the research flow process is carried out, including:

A. Literature Study

At this stage, research library data was collected on cloud storage which was used as a reference in the research conducted.

B. Analysis of System Requirements

At this stage, an analysis of the system requirements used, including hardware and software to support the research, is carried out. The system requirements for testing the Nextcloud and Pydio service applications are shown in Tabel II.

TABLE II
System Requirements

Nr	Requirement Type	Information
Nextcloud		
1	Software	Nextcloud 22, VMWare Workstation 16 Pro, Wireshark, Apache, MariaDB 10.3, Firefox
2	Hardware	Laptop with Windows 11 OS
3	Operating system	Linux Centos 7
Pydio		
1	Software	Pydio 1.0, VMWare Workstation 16 Pro, Wireshark, Apache, MariaDB 10.3, Firefox
2	Hardware	Laptop with Windows 11 OS
3	Operating system	Linux Centos 7

C. System Design

In this stage, the system design is described in the performance test flowchart, installation and configuration. Fig. 2 a flowchart for application testing.

D. Installation and Configuration

At this stage, hardware and software installations carried out and configuration is carried out according to the needs of the research.

E. Application Testing (Benchmarking)

This stage is testing the performance of the Nextcloud and Pydio service applications based on aspects that exist in QoS including Throughput, Packet Loss, Delay, and Jitter by testing network packets when uploading and downloading files on each cloud storage service application tested.

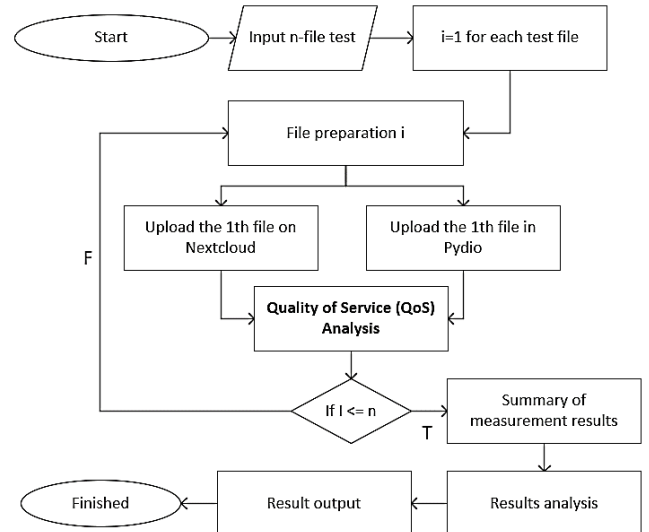


Fig. 2. Flowchart Pengujian Aplikasi

1. Troughput

Throughput is the speed of data transfer. Throughput is the total number of successful packet arrivals observed at the destination during a certain time interval divided by the duration of the time interval [12]. The throughput category according to TIPHON is in Table III.

TABLE III
Category Throughput Value

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

The formula for calculating the throughput value is as follows:

$$\text{Throughput} = \frac{(\text{Jumlah data yang diterima})}{(\text{Waktu Pengiriman data})} \quad (1)$$

2. Packet Loss

Packet Loss is the number of packets that fail to reach the destination where the packet will be sent [12]. The Packet Loss categories according to TIPHON is shown in Table IV.

TABLE IV
Packet Loss value categories

Category	Packet Loss (%)	Indeks
Poor	>25	1
Medium	12 – 24	2
Good	3 – 14	3
Perfect	0 – 2	4

The formula for calculating the packet loss value is as follows:

$$\text{Packet loss} = \frac{\text{paket dikirim} - \text{paket diterima}}{\text{paket dikirim}} \times 100\% \quad (2)$$

3. Delay

Delay is the time it takes data to travel the distance from origin to destination. Delay can be affected by physical media distance, congestion or long processing time [12]. The delay categories according to TIPHON are shown in Table V.

TABLE V
Delay value category

Category	Delay (ms)	Indeks
Poor	>450	1
Medium	300 - 450	2
Good	150 - 300	3
Perfect	<150	4

The formula for calculating the delay value is as follows:

$$\text{Rata - rata delay} = \frac{\text{waktu pengiriman paket}}{\text{total paket yang diterima}} \quad (3)$$

4. Jitter

Jitter is defined as a delay variation caused by the length of the queue in a data processing and reassemble of data packets at the end of the delivery due to previous failures [12].

TABLE VI
Jitter value category

Category	Jitter (ms)	Indeks
Poor	125 - 225	1
Medium	75 - 125	2
Good	0 - 75	3
Perfect	0	4

The formula for calculating the jitter value is as follows:

$$\text{Jitter} = \frac{\text{Total variasi delay}}{\text{Total paket yang diterima}} - 1 \quad (4)$$

TABLE VII
Test File Type and Capacity

File dan Kapasitas Uji Coba			
Nr	Uji Coba	Jenis File	Kapasitas File
1	First	.doc	1.377 KB
2	Second	.pdf	1.256 KB
3	Third	.exe	75.647 KB
4	Fourth	.jpeg	85 KB
5	Fifth	.mp4	1.301 KB

F. Benchmarking Test Results

At this stage, the results were analyzed to obtain conclusions based on the criteria used in this study.

III. RESULT AND DISCUSSION

In this simulation, the design is carried out, including the design of the trial network, the design of the IP address, the design of the system workflow, and the results of the trials. The trial design used is simulated with VMware Workstation running on a computer with the Windows 11 operating system as the host and client machine to access Nextcloud and Pydio services.

VMware Workstation has two virtual machines. One VM is allocated as central cloud storage installed on NextCloud server and one VM is allocated as central cloud storage installed on Pydio server. This topology design has two computers consisting of a Windows 11 client which is used to access the server, and Centos 7 which is used to install the Nextcloud and Pydio servers, while one switch is used to connect the Windows client to the server. There is also one server as the main server for Nextcloud and Pydio cloud storage.

a. IP address Configuration

TABLE VIII
IP Address

Nr	Server	Interface	Tipe	IP Address
1	Nextcloud	VMNet1	Host-only	192.168.10.200
2	Pydio	VMNet1	Host-only	192.168.10.100
3	Client	VMNet1	Host-only	192.168.10.2

b. System Workflow Design

The system process or workflow is designed according to the needs as shown in Fig. 3.

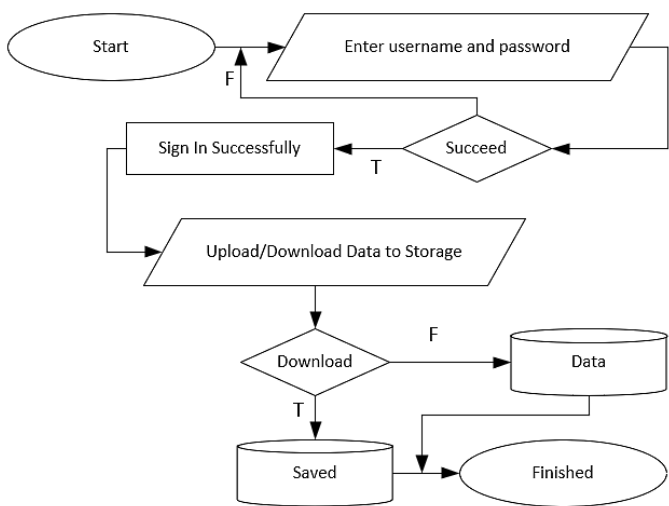


Fig. 3. System Workflow

c. The result of installing and configuring Linux CentOS 7 Server

Server Nextcloud

The following is the result of the installation and configuration on the nextcloud server as shown in Fig. 4.

```

TYPE=Ethernet
PROXY_METHOD=none
BROWSER_ONLY=no
BOOTPROTO=static
DEFROUTE=yes
IPV4_FAILURE_FATAL=no
IPV6INIT=yes
IPV6_AUTOCONF=yes
IPV6_DEFROUTE=yes
IPV6_FAILURE_FATAL=no
IPV6_ADDR_GEN_MODE=stable-privacy
NAME=ens33
UUID=e87ca21a-0f68-4b33-b318-505fe882cfe3
DEVICE=ens33
ONBOOT=yes
IPADDR=192.168.10.200
PREFIX=24
DNS1=0.0.0.0
DOMAIN=utmmataram.local
IPV6_PRIVACY=no
NETMASK=255.255.255.0
GATEWAY=192.168.10.2
  
```

Fig. 4. Nextcloud Server IP Addresses

```

[root@nextcloud ~]# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: ens33: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 00:0c:29:a9:3c:a6 brd ff:ff:ff:ff:ff:ff
    inet 192.168.10.200/24 brd 192.168.10.255 scope global noprefixroute ens33
        valid_lft forever preferred_lft forever
    inet6 fe80::7325:8056:f42e:9fa1/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
[root@nextcloud ~]#
  
```

Fig. 5. Nextcloud Server IP configuration results

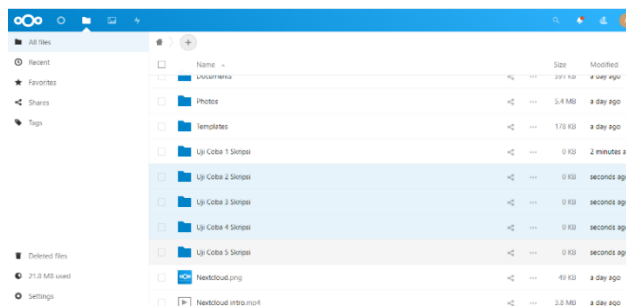


Fig. 6. Results of Making 5 Trial Folders Nextcloud servers

```

TYPE=Ethernet
PROXY_METHOD=none
BROWSER_ONLY=no
BOOTPROTO=static
DEFROUTE=yes
IPV4_FAILURE_FATAL=no
IPV6INIT=yes
IPV6_AUTOCONF=yes
IPV6_DEFROUTE=yes
IPV6_FAILURE_FATAL=no
IPV6_ADDR_GEN_MODE=stable-privacy
NAME=ens33
UUID=e87ca21a-0f68-4b33-b318-505fe882cfe3
DEVICE=ens33
ONBOOT=yes
IPADDR=192.168.10.100
PREFIX=24
DNS1=0.0.0.0
DOMAIN=utmmataram.local
IPV6_PRIVACY=no
NETMASK=255.255.255.0
GATEWAY=192.168.10.2
  
```

Fig. 7. Pydio Server IP Addresses

Fig. 8 shows the result of the installation and configuration on the paydio server.

```

root@pydio ~# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: ens33: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 00:0c:29:1a:a8:ef brd ff:ff:ff:ff:ff:ff
    inet 192.168.10.100/24 brd 192.168.10.255 scope global noprefixroute ens33
        valid_lft forever preferred_lft forever
    inet6 fe80::7325:8056:f42e:9fa1/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
root@pydio ~#
  
```

Fig. 8. Pydio Server IP Configuration Results

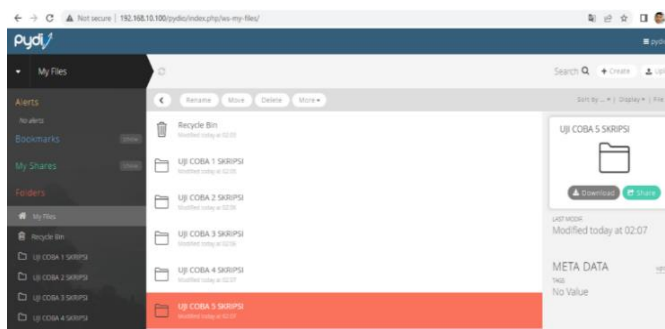


Fig. 9. Results of Making 5 Trial Folders

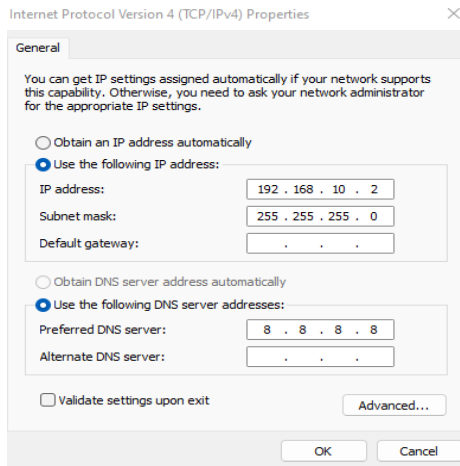


Fig. 10. Client Configuration Results

a. Nextcloud Server Upload And Download Measurement Table

TABLE IX
Nextcloud Server Measurement Results

Server Nextcloud					
	Trials	Through-put (kbps)	Packet Loss (%)	Delay (ms)	Jitter (ms)
Upload	P1	151	0	333,331	375,366
	P2	142	0	545,038	545,002
	P3	9126	0	19,811	19,8
	P4	16	0	214,370	214
	P5	238	0	0,377	0,108
Total		9.673	0	1,112,927	1,154,276
Average		1.934,6	0	222,585	230,855
Down-load	P1	1.010	0	126,782	1262,486
	P2	396	0	310,593	311
	P3	4.891	0	18,325	18,312
	P4	26	0	58,947	58,9
	P5	337	0	145,641	146
Total		6.660	0	660,288	660,698
Average		1.332	0	132,057	132,139

Based on the data in Table 7 above, it can be calculated the average upload and download values related to the QoS parameters in the form of throughput, packet loss, delay, and jitter. The average value of each QoS parameter is obtained by adding up the total value of the measurement results in each trial divided by the total trials conducted, namely five trials. From the calculation results, the average uploaded QoS value from the throughput parameter is 293.4 kbps (Bad), 0% packet loss (Perfect), 264.85 ms delay (Good), and 160.56 ms jitter (Poor). While the average QoS value of the download based on throughput parameters is 597 kbps (Poor), 0% packet loss (Perfect), 182.205 ms delay (Good), and 181.899 ms jitter (Poor).

b. Pydio Server Upload and Download Measurement Table

TABLE X
Pydio Server Measurement Results

Server Pydio					
	Trials	Through-put (kbps)	Packet Loss (%)	Delay (ms)	Jitter (ms)
Upload	P1	763	0	317,627	318
	P2	238	0	154,444	164,229
	P3	0	0	0	0
	P4	35	0	427,264	0,011
	P5	431	0	160,065	160
Total		1.467	0	1,059,4	642,24
Average		293,4	0	264,85	160,56
Download	P1	544	0	93,627	93,277
	P2	1303	0	281,704	280,321
	P3	0	0	0	0
	P4	34	0	164,894	165
	P5	507	0	188,595	189
Total		2.388	0	728,82	727,598
Average		597	0	182,205	181,899

Based on the data in Table 8 above, the average upload and download values related to QoS parameters in the form of throughput, packet loss, delay, and jitter can be calculated. The average value of each QoS parameter is obtained by adding up the total value of the measurement results in each experiment divided by the total number of experiments carried out, namely five trials.

From the calculation results, the average upload QoS value from the throughput parameter is 293.4 kbps (Bad), 0% packet loss (Perfect), delay 264.85 ms (Good), and jitter 160.56 ms (Poor). While the average download QoS value based on throughput parameters is 597 kbps (Poor), 0% packet loss (Perfect), 182,205 ms delay (Good), and 181,899 ms jitter (Poor).

c. Measurement results of Nextcloud and Pydio server comparison analysis.

TABLE XI
Nextcloud and Pydio
Server Measurement Comparison Results

Bench-marking	QoS	Nextcloud	Pydio
Upload	Troughput	1.934,6 kbps	293,4 kbps
	Packet loss	0%	0%
	Delay	222,585 ms	264,85 ms
	Jitter	230,855 ms	160,56 ms
Download	Troughput	1,332 kbps	597 kbps
	Packet loss	0%	0%
	Delay	132,057 ms	182,205 ms
	Jitter	132,139 ms	181,899 ms

d. Nextcloud and Pydio Upload Comparison Chart

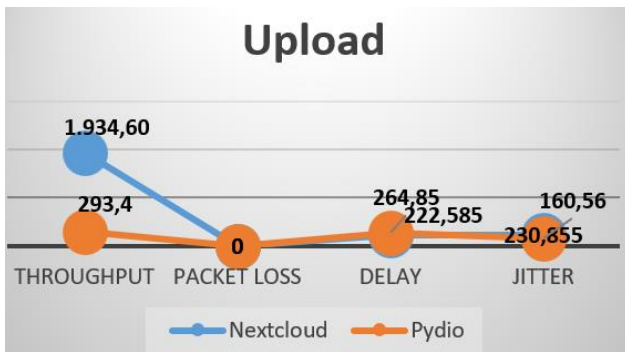


Fig. 11. Upload Comparison Chart

e. Nextcloud and Pydio Download Comparison Chart

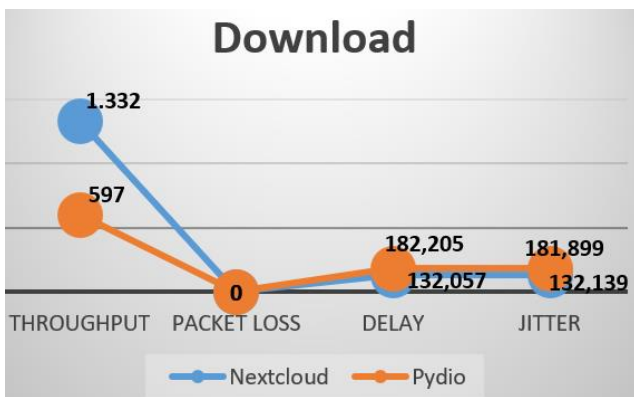


Fig. 12. Download Comparison Chart

Based on Table IX, it can be concluded the cloud storage that has the highest average throughput in terms of uploading files of different types and capacities is the Nextcloud server at 1,934.6 kbps. Then the cloud storage that has the lowest average packet loss value is balanced, because the two cloud storages get the same packet loss value of 0%. The cloud storage that has the lowest average file upload delay is the Nextcloud server at 222.585 ms. The cloud storage that gets the lowest jitter value is the pydio server of 160.56 ms. Meanwhile, in terms of downloading files that have the highest average throughput value, the nextcloud server is 1,332 kbps. Furthermore, the cloud storage that has the lowest average packet loss value is balanced, because both of them obtain the same packet loss value of 0%.

Then the cloud storage that has the lowest average download delay value is the Nextcloud server at 132.057 ms. The cloud storage that has the lowest jitter is the Nextcloud server at 132.139 ms.

The results of trials carried out by uploading and downloading, obtained the total and average values of throughput, packet loss, delay, and jitter parameters from each cloud storage server.

It should be noted that the greater the throughput value obtained, the better the QoS of the cloud storage, conversely the lower the packet loss, delay, and jitter values obtained, the better the QoS of the cloud storage [13].

IV. CONCLUSION

Based on the analysis of the results of the trials that have been carried out, it is concluded that the Nextcloud service has proven to have advantages over the Pydio service for QoS testing in terms of measuring the performance of uploading and downloading files. From the test results, the value of uploading and downloading files on Nextcloud is much better than the Pydio service. For file uploads, Nextcloud has a throughput value of 1,934.6 Kbps compared to Pydio which has a value of 293.4 Kbps. Likewise for Packet loss, Delay and Jitter values, Nextcloud gets better measurement values than Pydio. For file downloads, Nextcloud has an average throughput value of 1,332 kbps compared to Pydio which has a value of 597 Kbps. Likewise for Packet loss, Delay and Jitter values, Nextcloud gets better measurement values than Pydio. In general it can be said that Nextcloud is superior to Pydio in terms of uploads and downloads. This result is in line with the results of previous studies.

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