Improving Cloud Data Storage Performance Based on Calculating Score using Data Transfer Rate Between the Internetwork Drives

G Sreeram, Manoj Kumar Kanumuri, Meghana Bodduluri

Abstract*: Cloud storage performance is heavily dependent on the performance of the storage architecture it is using, it is observed when the connected network bandwidth is greater than the sustainable transfer rates of the storage drives.To maintain the privacy of the data Personal Cloud Device (PCD) can be used, many corporations like WD, Seagate, Apple, Q-NAP, etc., are providing PCD's with different storage capacities. A PCD stores the data in the storage drive installed in it, which can be HDD, SSD, SSHD or NAS. PCD achieves more privacy than that of personal cloud offered by service providers because PCD connected to the network doesn't necessarily need to be connected to the internet since PCD can be accessed within its connected network without being online.Cloud storage performance is heavily dependent on the performance of the storage architecture it is using, it is observed when the connected network bandwidth is greater than the sustainable transfer rates of the storage drives. In this paper, we will discuss different types of storage drives, their performance and how drives can bottleneck the cloud storage performance.

Index Terms*: PCD (Personal Cloud Device), bps (bits per second), Bps (Bytes per second), performance.

I. INTRODUCTION

Cloud computing today is dominated by many third-party service providers. However, many people don't realize that despite being held in the "cloud" every data still needs to be physically stored on a device somewhere. Cloud storage is a service in which user's data is stored in one of the storage devices in the "server farm" which is a warehouse filled with servers which are up and running 24/7.

These server farms are spread across the globe, the service provider may be based in Europe but servers might be in Japan or anywhere else in the world.Data outsourcing increases confidentiality and privacy apprehension for a user[15]. Most corporate companies outsource their server farms to different parts of the world to reduce costs. So, it is a bit complicated to know where is your data is stored, and the cloud service provider may not necessarily disclose this information [1].

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PCD (Personal Cloud Device) is just a system to transfer data from the hard drive through connection port, which helps PCD to connect to a network as well. Many companies like WD, Seagate, Apple, Synology, etc. are offering PCD's with storage options up to 180 TB. A PCD will have a drive slot to insert a storage drive and some PCD's support expansion bays. A PCD connected to a network can be accessed within that network even if the network is not connected tothe internet.

Internet users are growing every day and it is a matter of time the transfer rates exceed the transfer speeds of the storagedrive, so drives will pose a direct bottleneck to the networking speeds.

Since PDC's are connected to your local network its access is restricted to the network it is connected. Since the user himself maintains the PDC's there is no third person to get their hands on your data.

II. LITERATURE SURVEY

Types of Personal Clouds

Online Cloud:

The online cloud is also known as the public cloud. Online resources like software and data storage are made available over the Internet by a service provider via an online cloud.the most common pricing model to be pay per use, in which customers pay a static price for a unit as they use it[12].

NAS Device Cloud:

A network-attached storage (NAS) device is a mini computer connected to a network that provides data storage services to other devices on the network. NAS device allows other software to operate the device, it is not a substitute for a general-purpose server. Cloud NAS is remote storage that is accessed over the Internet as if it were local[2]. Distributed computing alludes to the conveyance of registering assets over the Internet [13].

Server Device Cloud:

Server Device Cloud works as physical servers in a way,the difference between both can be observed at a functioning level. Typically, the Service device cloud is an on-premises device that is connected to the Internet and offers services available inthe online cloud but with the added benefit of security andkernel level file control.

Home-Made Cloud:

Category	Transfer rate
Cat 1	Up to 1Mbps
Cat 2	Up to 4Mbps
Cat 3	Up to 10Mbps
Cat 4	Up to 16Mbps
Cat 5	Up to 100Mbps
Cat5e	Up to 1Gbps
Cat 6, Cat 6a, Cat 7	Up to 10Gbps

A home-made cloud system can be created by connecting an external USB hard drive to a Wi-Fi router. Many routers come with a USB slot, this enables both wired and wireless computers to access the USB hard drive connected to the router and use it for storage or for retrieving files.

Types of Storage Drives

The different types of storage drive for personal cloud are HDD, SSD, SSHD, and NAS.

HDD (Hard Disk Drive):

A hard disk drive (HDD) is a data storage device that uses magnetic storage mechanism to store and retrieve data using read/write head attached to actuator responsible for the movement of head over rotating disks (platter) coated with magnetic material [3].

SSD (Solid State Drive):

A solid-state drive (SSD) is a solid-state storage device that uses IC's like NAND assemblies as memory to store data persistently [4].

SSHD (Solid State Hybrid Drive):

SSHDs combine a small, fast and affordable amount of NAND flash memory with a traditional hard drive [5].

NAS (Network Attached Storage):

Network-attached storage is a file-level computer data storage server connected to a computer network providing data access to a heterogeneous group of clients [6].

Networking Cables

Networking cables are hardware used to connect one device to other devices. The different types of networking cables are

Coaxial Cable

Coaxial Cables are made up of copper wire shielded with different components like plastic and braided shield, the most common use for coaxial cables is for television and other signals with a bandwidth ranging from several hundred megahertz to gigahertz.

Theoretical transfer rate: up to 225 Mbps.

Optical Fiber Cable

An optical fiber cable is also known as fiber optic cable, contains one or more optical fibers known as single fiber and multi-fiber, that are used to carry light. Theoptical fiber elements are covered with plastic layers to eliminate bleeding of light,the entire apparatus is placed in a protective tube,which can sustainthe environment where the cable is being deployed.

Theoretical transfer rate: Up to 1 Pbps [11].

Twisted Pair Cable

Twisted pair cabling is a type of wiring in which two conductors of a single circuit are twisted together for thepurposes of improving electromagnetic compatibility.

Its building infrastructures are Level 1, Level 2, Cat 3, Cat 4, Cat 5, Cat 5e, Cat 6, Cat 6a, Cat 7, Cat 7a while Cat 8/8.1 and Cat 8.2 are in development. And are available with and without shielding [11].

Category 7 is not recognized by the TIA/EIA, Category 8 is designed only for data centers. It is not intended for general office cabling.

Theoretical transfer rate: Up to 10 Gbps.

Patch Cable

A patch cable is an electrical or optical cable used to connect one electronic or optical device to another or to building infrastructure for signal routing. A patch cable is the same as Cat cable but is relatively short, no longer than a few meters. These are used to connect a network device to another network device which is generally in the same room or house.

Theoretical transfer rate: up to 10 Gbps

Bandwidth of network

Bandwidth is the maximum rate of data transfer across a given path. The bandwidth of a network depends on your internet plan provided by your ISP.

As of 2019, the fastest bandwidth provided by an ISP for home consumer is up to 1 or 2Gbps

Theoretical transfer rate: Up to 2Gbps.

Personal Cloud Device (PCD)

A Personal Cloud Device is a book-sized system with just enough resources of RAM, Processor, Circuit board to run a storage drive, for accessing it over a network. Many PCD's come with their manufactures software to access PCD via a network cable, Wi-Fi or internet. Many PCD's today have their own ethernet modem which can sustain up to 1Gbps.

PCD's have a bay slot to insert a storage drive, preferably a NAS drive is used but any other drive can also be used like HDD, SSD, SSHD.

III. METHODOLOGY

While clock speed of the processor, frequency, and latency of RAM and version of SATA cable also affect the transfer rate it is unfeasible to calculate for the delay in transfer by them because they are many processors with different clock speeds and many RAMs with various frequencies and latencies. While SATA 3 cable can support transfer rate up to 6 Gbps. Various people use their systems with different specifications and different processes in the background and they only cause a delay in Nano or microseconds. So, we will not consider delay due to system configuration

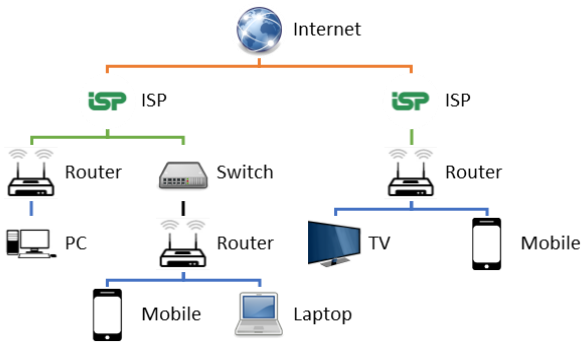


Figure 1:Working onthe Internet

Devices are connected to router or switch which may be again connected to switch which are connected to the ISP (Internet Service Provider) which are connected to the internet.
Here internet is connected to ISP by the optical fiber cable, ISP is connected to router or switch by fiber or cat depending on the cable and from the router to the device, a patch cable is used preferably Cat 6.

We need to calculate the limiting speed, that is the minimum transfer rate of the above connections. Mostly it will be the plan you opted that is provided by your ISP. Check the speed provided by your ISP and the transfer rate of your patch cable.
Minimum (ISP speed, patch cable transfer speed), this will be the limit of your transfer rate. Now according to your storage device class (HDD or SSD or SSHD or NAS) and the transfer rate provided with the storage drive specifications, we need to calculate the transfer rate of the drive.
We can calculate it by dividing the acquired transfer rate from Minimum (ISP speed, patch cable transfer speed) by 8
M = Minimum (ISP Bandwidth, Patch Cable transfer speed)
MTR = M/8
DTR = Transfer rate of the storage drive
TR = Minimum (MTR, DTR)
TR is the bottleneck of the transfer rate you can achieve.
To calculate time taken to download a 1GB file covert GB into the units of the transfer rate which is mostly in MBps, FS = 1GB = 1024MB
Now divide obtained file size (FS) by the TR
Time Taken (TT) = FS/TR sec
Obtained time will be in seconds.

IV. THEORETICAL ANALYSIS

The performance of the storage drive depends on the many factors like clock speed of your processor, latency, and frequency of your RAM, version of your SATA cable, no of background processes and a storage drive connected to a network adds a bandwidth of the network, type of networking cable to the existing factors. many cryptographic approach like ACV-BGK[14] been proposed, but any thing connected to grid is potentially compromisable. We will take a top-down approach to evaluate the performance of the storage drive.

Drive Transfer rates

Hard Disk Drive (HDD):

An HDD is a general use storage drive, most preferably used for general computing. The transfer rate of the drive depends on the data density and the RPM of the drive.
Available space capacities: Up to 14 TB [7]

- Seagate: Max. Sustained Transfer rate – 210 MBps [7]
- WD: Max. Sustained Transfer rate – 150 MBps

Solid State Drive (SSD):

An SSD is a high-performance drive, most preferably used for performance-intensive work stations. The transfer rate of the drive depends on the implemented architecture in the drive.
Available space capacities: Up to 2 TB [8]

- Read rate – 550 MBps [8]
- Write rate – 525 MBps [8]

Solid State Hybrid Drive (SSHD):

An SSHD is a drive with a capacity of HDD and performance of SSD, it is a performance drive, most preferably used for applications like games. The transfer rate of the drive will be similar to that of HDD.
Available space capacities: Up to 6 TB [9]

- Seagate: Max. Sustained Transfer rate – 210 MBps [9]
- WD: Max. Sustained Transfer rate – 150 MBps

Network Attached Storage (NAS):

A NAS is a drive tailored to sustain heavy write operations 24/7, most preferably used in surveillance and cloud storage. Transfer rates of the drive relatively lower than other drives.
Available space capacities: up to 14 TB [10]

- Seagate: Max. Sustained Transfer rate – 180 MBps [10]
- WD: Max. Sustained Transfer rate – 144 MBps

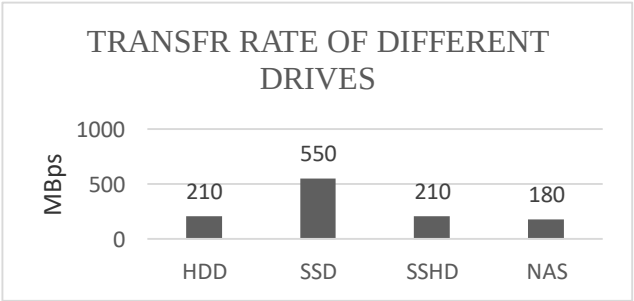


Figure 2: Transfer Rate of Different Drives

Cabling Transfer Rates

Optical Fiber cable:

IAP's also uses optical fibers to connect to another IAP's, these cables are heavily shielded to survive pressure in the ocean bed and can transfer rates are in Tbsp.
ISP's uses optical fiber cable to provide services usually these fibers can sustain up to 2 Gbps (250 MBps)

Patch Cable:

Network Devices are connected to the router through patch cables, generally use patch cable is of cat 5e, cat 6 or cat 6a, while cat 7 can be used it needs its own proprietary connector Tera port to be able to achieve 10 Gbps, since the port is not standardized there is no consumer or prosumer product available to take advantage of cat 7 and a cat 7 cable with rj45 pin is basically a cat 6 cable.

In-Network

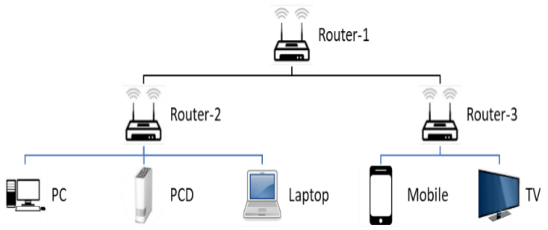


Figure 3: In-Network Implementation

In-network implementation does not require an active internet connection, in this implementation, the PCD can be accessed across the network, any device connected to the router 1,2 or 3 can access the PCD, in the above example PC, Laptop, Mobile and TV can access PCD.

Transfer rates of the system

Theoretical equipment

ISP speed – Null

Patch cable – Cat 6

Storage Drive – HDD, SSD, SSHD, NAS

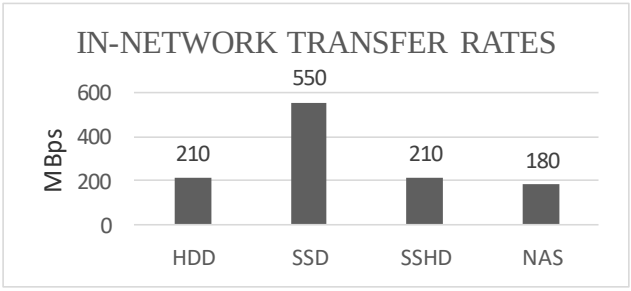


Figure 4: In-Network Transfer Rates

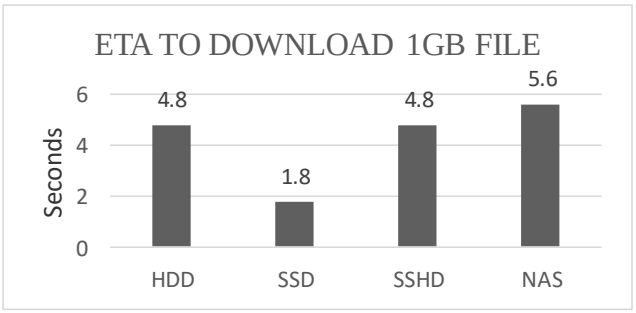


Figure 5: ETA to Download 1 GB file (In-Network)

Out-Network

Out-network implementation requires an active internet connection, in this implementation PCD can be accessed from across the world via the internet, in the above example, every device outside the network can access the PCD. Highest available bandwidth in India is 1Gbps.

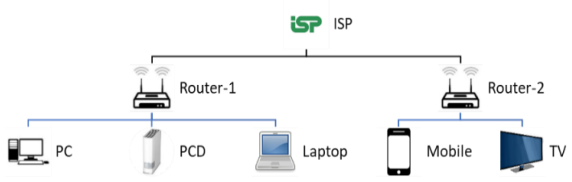


Figure 6: Out-network Implementation

Theoretical equipment:

ISP speed – 1 Gbps, Patch cable – Cat 6, Storage Drive – HDD, SSD, SSHD, NAS.

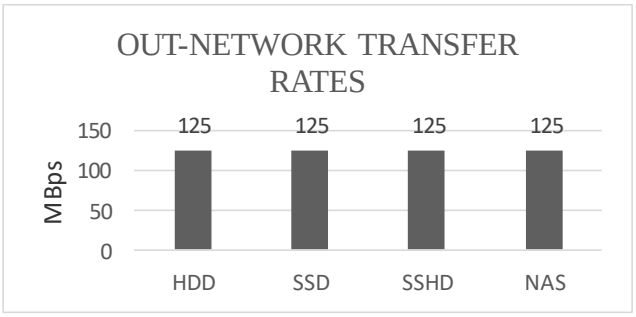


Figure 7: Out-Network Transfer rates

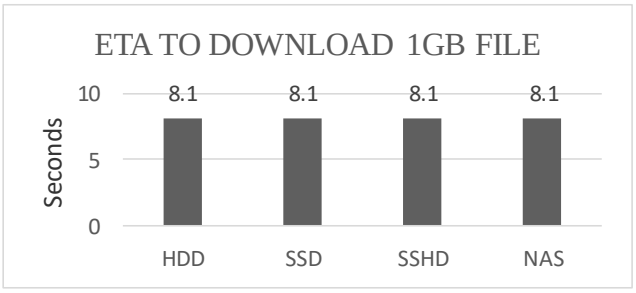


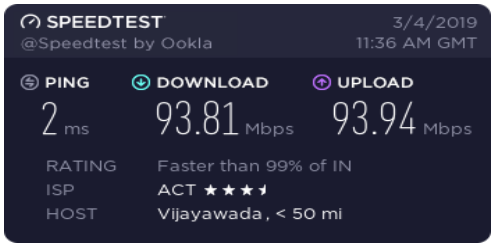
Figure 8: ETA to Download 1 GB file (Out-Network)

From the result it is clear that the transfer rate of the drive has little to none impact on the transfer rate, this the reason why every internet service provider uses NAS drive in their server farms as they are cheaper and can sustain heavy write operations.

V. Experimental Investigation

The theoretical analysis shows that 1 GB file can be downloaded and flushed to disk in not more than 6 seconds, but that's not the case in our day to day life because theoretical values do not consider the delay due to system configuration, packet collision, and traffic in the network cables. Hence the real-time values change from system to system in the network to network.

ISP Bandwidth:



Drive Transfer rates

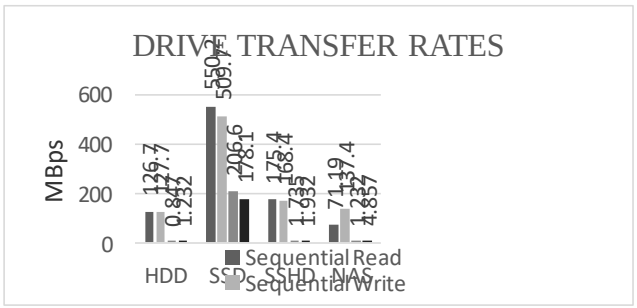


Figure 9: Drive Transfer Rates

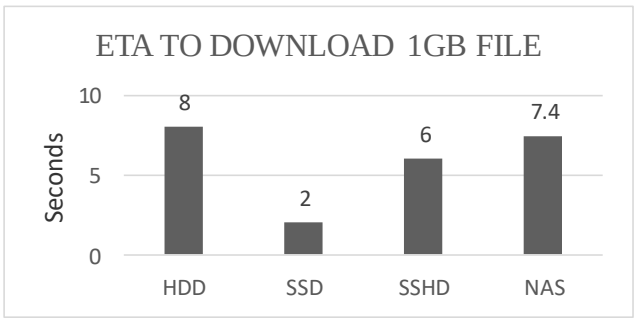


Figure 10: ETA to Download 1 GB file

In-Network

Practical equipment:

ISP speed – Null
Patch cable – Cat 5e
Storage Drive – HDD, SSD, SSHD, NAS

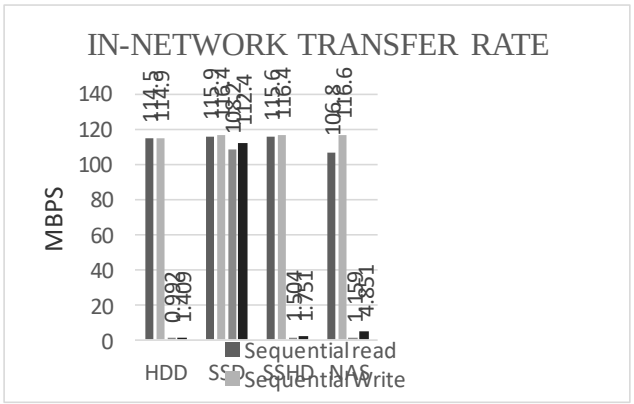


Figure 11: In-Network Transfer Rate

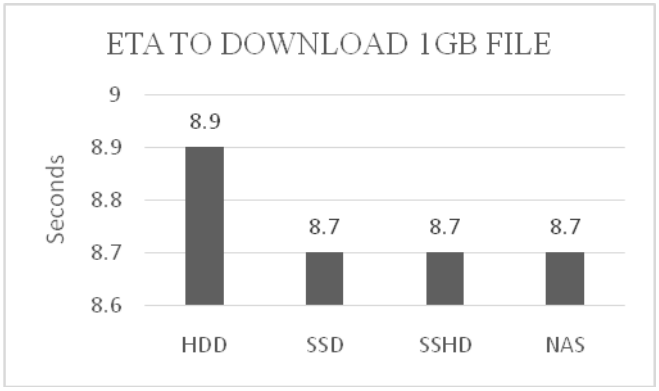


Figure 12: ETA to Download 1 GB file (In-Network)

Out-Network

Practical equipment:

ISP speed – 93.81 Mbps (11.726 MBps)
Patch cable – Cat 5e
Storage Drive – HDD, SSD, SSHD, NAS

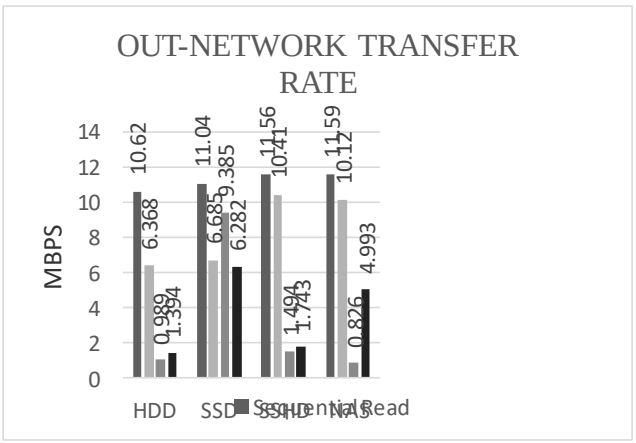


Figure 13: Out-Network Transfer rate

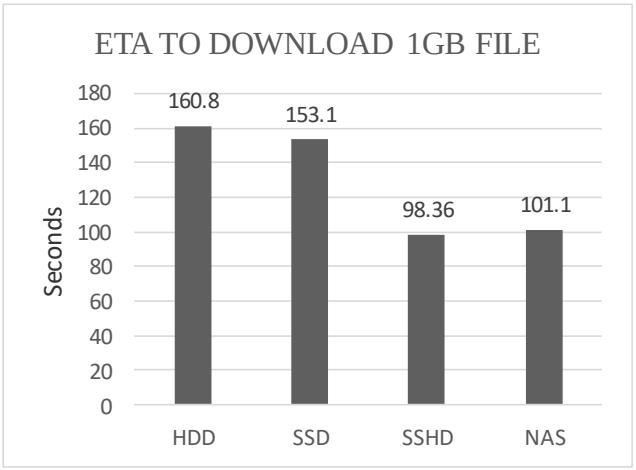


Figure 14: ETA to Download 1 GB file

VI. EXPERIMENTAL RESULTS

Experiment set: 1024 MB (x3) [Interval=5 sec]

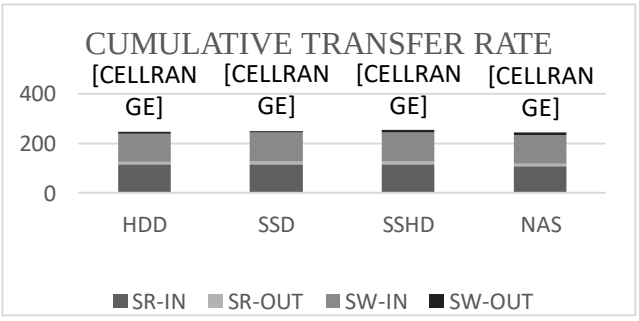


Figure 15: Cumulative Transfer Rate

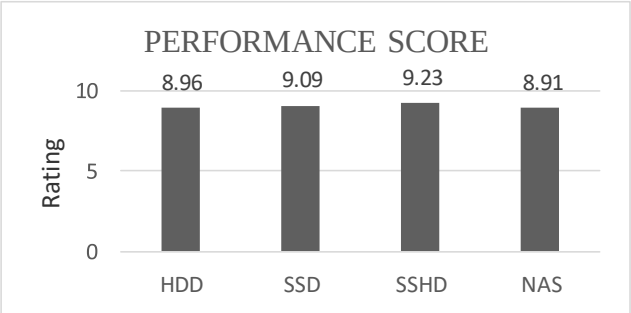


Figure 16: Performance Score

Performance score of the drives are relatively same as opposed to their individual drive transfer rate, and since the NAS drives deliver the almost same performance as other drives and is way cheaper than the other drives, NAS drives are leading cloud storage drives in the use.

HDD is a general, day to day usage hard drive and is cost-effective and have great capacity. SSHD, on the other hand, is a performance drive and is used for heavy applications like games and editing. But for the cloud which has to be run 24/7 can these drive's hold up? both HDD and SSHD have a similar failure rate, that's where NAS comes into the picture it is designed to run 24/7 and have a little less failure rate on the long run compare to HDD and SSHD.

While HDD and SSHD can be used, NAS is preferred overother drives for the sole reason of limited bandwidth in the world which cannot utilize the full potential of any other drive for cloud storage.

VII. Discussion Of Results

As we can see, In-Network values are higher than the Out-Network values given that the cable used is cat 5e or above. In-Network values are bottlenecked by network equipment, Out-Network values are bottlenecked by the network bandwidth.

In-Network:

Transfer rates in the In-Network implementation does not reflect the maximum sustainable transfer rate of the drive, this is due to the network device limitation many network cards in laptops, motherboards and router are designed to sustain only gigabit ethernet i.e. up to 1 Gbps (125MBps), this can be observed in the In-Network transfer rates, which are <125 MBps.

Out-Network:

Transfer rates in the Out-Network implementation are far less than In-Network, this is due to the limitations of network bandwidth offered by ISP, 100Mbps (12.5MBps) network bandwidth is most common plan opted by home consumers and many companies and is reflected in Out-Network transfer rates, which are <12.5 MBps.

VIII. Conclusion

The personal cloud storage device does overcome the privacy issue but it all depends on the data you are going to store, if the data you are going to store is not confidential, then one can just rent personal cloud storage from a service vendor. Many cloud service providers offer up to 100 GB of space and if your data is small, cloud service is the best option rather than spending money on the device.

Overall, our paper provides a methodology to evaluate the performance of the storage drive and gives insights about the performance of the day to day generally used storage drives and the purpose suitable for the drive. HDD's are more suitable for storage and read purpose data, SSD's are more suitable for a boot drive with minimum writes, SSHD's are more suitable for high-performance applications like games and content creation and NAS's are more suitable for long run uses like surveillance and always on the cloud.

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Authors Profile

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