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Building Scalable Networks on the Cloud based on Network Storage Virtualization Secure Model (NVSM)

Benard O. Osero
Lecturer, Department of Computer science, Chuka University, P.O. Box 109-60400, Chuka, Kenya
ongerab@yahoo.com

ABSTRACT

This paper provides a literature review of the cloud computing trends and its advantages and how they can be effectively utilized to provide a cost effective and secure storage model. This paradigm is a demonstration of how scalability and high performance are achieved through cloud computing and storage virtualization.

We demonstrate through experimentation a Network storage virtualization model(NVSM), utilizing the network attached devices that have a capability of allowing the client to independently access data directly from the storage area networks (SAN) through the independent drive object services provided thus providing high performance and scalable virtual environments than Non-virtualized environments. To fully realize the full potential of this technology security challenges paused by interaction models are carefully analyzed and provide a security implementation model and thus ensuring security and data privacy.

Keywords: *Virtualization, Cloud Computing, Platform as service (Paas), Communication as a service (Caas), Platform as a service (Paas), Hardware as a service (Hhaas), Data as a service (Daas).*

1. INTRODUCTION

The current cloud systems can withstand high processing requirements that they were initially designed to handle. Although the client-server processing that exist in most systems including the cloud, are essentially characterized by storing and forwarding processes which are slow due to the fact that the requests are processed one at a time; therefore the file server in this case acts as a bottleneck. These bottlenecks arise because a single "server" computer receives data from the storage (peripheral) network and forwards it to the client (local area) network while adding functions such as concurrency control and metadata consistency [4].

1.1 Research Questions

a. Do virtualized network devices attached on a network help in improving performance?
b. How are scalable networks different from other types of networks?
c. To what extent does virtualization contribute to scalability in a network?
d. Are virtualized scalable networks better than the non-virtualized ones?

1.2 Problem Definition

A good cloud system model should exhibit high performance and high scalability to withstand exponentially increasing demands, the current distributed networked systems fall short of such salient features; instead they are encumbered by low speeds, and can't scale considerably to cater for the user's needs.

The above short comings are currently solved by manual techniques and administrators those are not properly equipped to undertake such complex optimizations and configuration maneuvers. It is worth to note that human expertise is scarce and expensive making the storage management process a costly undertaking.

2. DEFINITION OF CLOUD COMPUTING

The definition by [8] can be used to understand cloud computing in an easy manner. It can be understood that, cloud computing is set of computers and network devices that are remotely connected across the world, comprising of an end user, who can access and download the required data by indefinite virtue of virtualization, providing instant computer power. Figure 1 provides a non-exhaustive view on the main aspects forming a cloud system.

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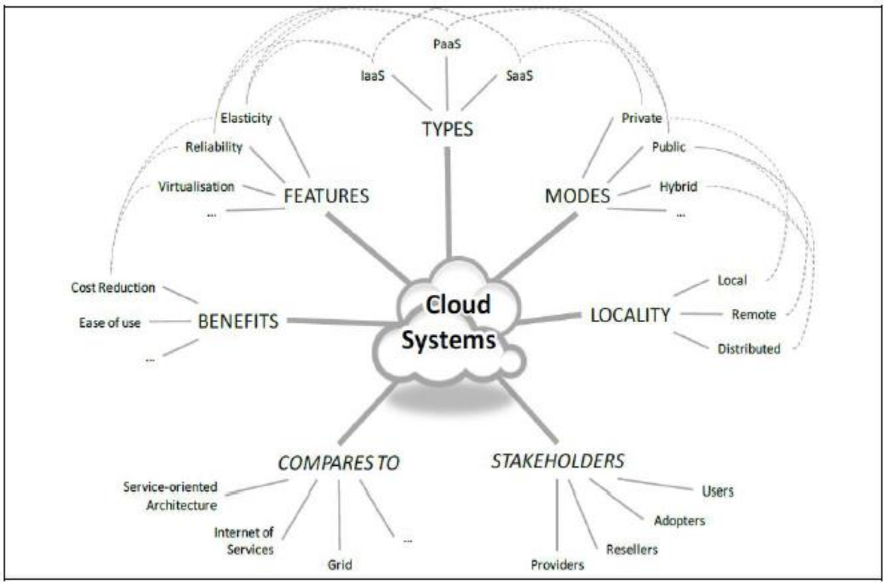

Figure 1: Non-exhaustive view on the main aspects forming a cloud system [3]

2.1 Virtualization

Virtualization is one of the primary features of cloud computing, which perpetuates the functioning of the cloud. It makes the cloud as virtual machines (VMs) due to the abstraction of physical resources. These VMs can be instantly generated, stored, migrated and / or terminated, which invariably makes the cloud computing elastic and reliable resource.

The actual functionality of virtualization makes it a mature technology and hypervisor technology is a classic example for the same [6]. “The hypervisor technology, for example, is widely used as an open source software such as Xen and KVM or proprietary software such as VMware SXi and Oracle Virtual Box.” Moreover, an organization can choose appropriate virtualization option, depending on its physical infrastructure and virtualization plan [6].

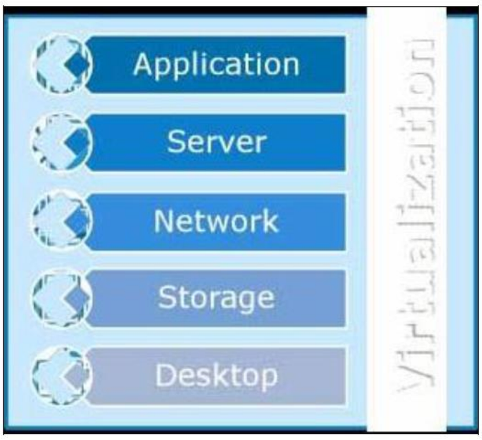

Figure 2: Different types of virtualization [5]

Figure 2 highlights the various types of virtualization such as network, storage, server, desktop and application exist in the market today.

Application virtualization ensures the smooth functioning of the cloud, making sure that the applications do not conflict with each other. Server Virtualization works on the fundamental principle of clouds and allocates certain space to the end users, based on their demand and availability of space in the shared infrastructure. Vendors such as VMware, Citrix with Xen in the UNIX and Windows environment, and also Microsoft have stepped forward to contribute in this area [5].

Network Virtualization is the virtualization of networks such as Wide Area Networks (WANs), which have always been owned and managed by organizations at high capital and maintenance costs. The pay-per-use services on the basis of demand offered by the cloud vendors are the characteristic feature of virtualized cloud networks. Virtualization of networks and sharing the use of the existing infrastructure of networks with other organizations has tremendously reduced the costs for organizations across the world [5].

Storage Virtualization is the storage of data on virtualized networks which is shared and accessed by the end users’ demand and requirement. “Sites such as Flicker, Slide share and Twitter now use storage virtualization services as well…. Apple’s Mobile Me service and Microsoft’s equivalent, Skydive, offer a single disk in the cloud for consumers” [5].

Desktop Virtualization has become highly popular due to the efforts Citrix platform.

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This is a typical cloud sharing platform, where the end users' desktop uses software that is installed in the virtual machine located in remote servers [5].

2.2 Cloud Mechanism

IT corporations today need to ensure the accessibility and availability of relevant hardware and software devices and applications to accomplish their goals and objectives. Apart from purchasing computing machines, they need to buy appropriate software licenses and tools for each and every employee in the organization [7]. Moreover, additional hiring of staff requires instant increase in infrastructure. Not only stressful and cumbersome, the entire process increases the purchase and maintenance costs of the organization.

Cloud computing systems can manage heavy workload depending on the perennial demand for hardware and software from the users' side. The end-user has to run cloud computing interface software, which is indefinitely an uncomplicated task.

Thus, as simple as running a web browser, the cloud networks take control of the subsequent tasks, making the entire process commodious and effortless. Resultantly, the company can run everything from email to complex data analysis programs, without any obvious hazards [7]. Figure 3 highlights the typical structure of a cloud computing system.

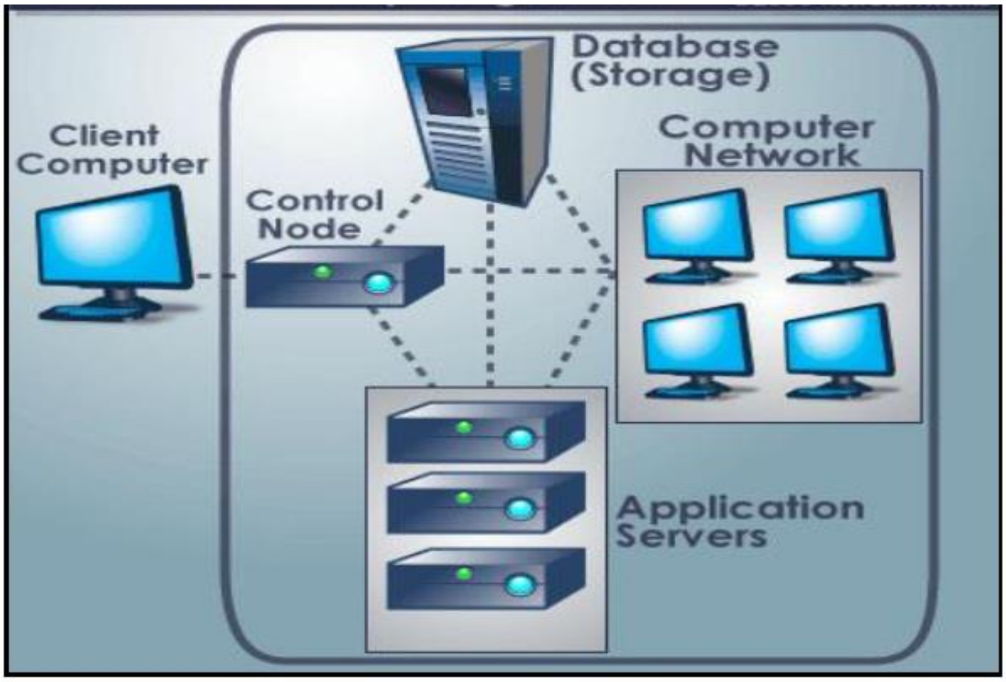

Figure 3: Typical structure of cloud computing system [7]

Primarily, cloud computing resources are located in a distinct data center managed by the respective vendors or third party enterprises. Secondly, infrastructure for cloud computing is often shared, and resources are available on demand and are usually subscription or pay-per-usage based. Thirdly, the resources leverage virtualization, provisioning multiple user interfaces that are easy to use [2].

The architecture of cloud computing can be comprehended as an extension of the seven layered Open Systems Interconnection (OSI) model. The OSI model is a way of describing how different applications and protocols interact on network-aware devices [1].

The typical layer of the cloud model consists of the client layer, which provides active interfaces between the cloud applications and end users. Subsequently, cloud applications that run the cloud de facto follow the client layer. This stratum is generally used by application developers [2].

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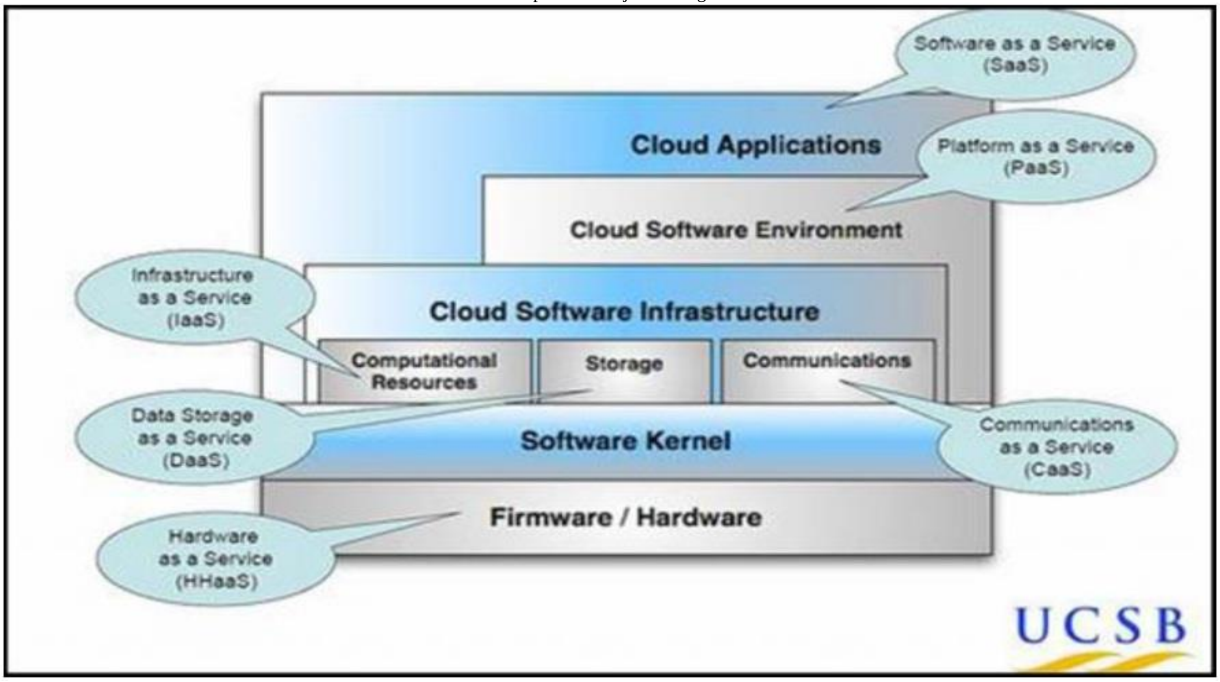

Figure 4: Different layers of cloud computing [9]

The client layer is the infrastructure layer, which constitutes aspects pertinent to services, storage, computing and communications. Subsequent to this, software and hardware layers reside in the cloud environment. The software layer consists of the kernel that establishes active communication between the cloud applications and cloud hardware [2]. Generally, this kernel includes a hypervisor that enables the virtualization discussed in 2.0. Ultimately, a hardware system with components such as processor, memory, storage, and communications, underpins the other cloud layers and enables the smooth functioning of cloud computing [2]. Figure 4 provides a gist of the different layers of cloud computing.

3. VIRTUAL ENVIRONMENT ARCHTECTURE

[4] VM-ware technology provides a fundamentally better way to manage storage resources for a virtual infrastructure implemented as Data as a service (DAAS) as depicted in figure 4 above [9], giving an organization the ability to:

- Improve storage resource utilization and flexibility.
- Reduce management overhead and increase application uptime.
- Leverage and compliment existing storage infrastructure.

The conceptual design in figure 5 below was implemented and tested [10].

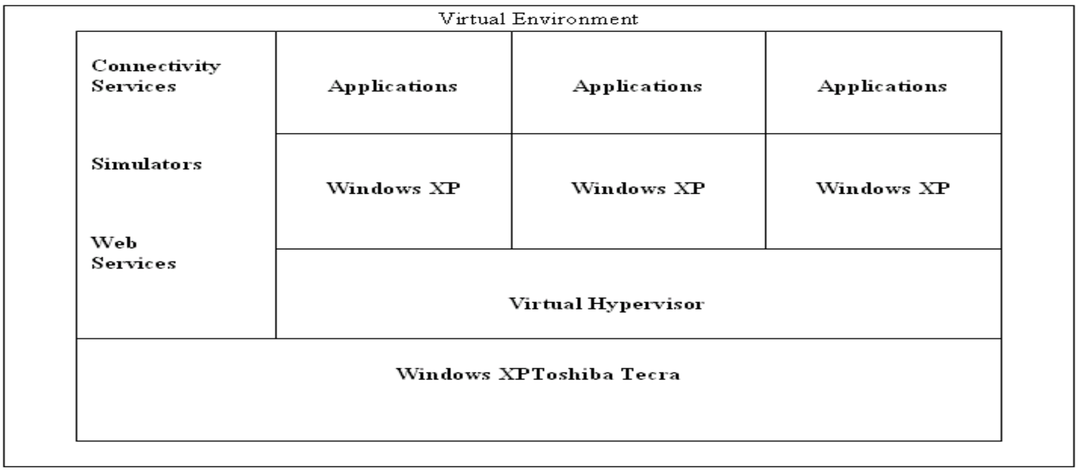

Figure 5: Virtual environment design

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The V-model environment discussed in this paper was, implemented on the windows XP platform virtual Storage model.

3.1 Interaction Design

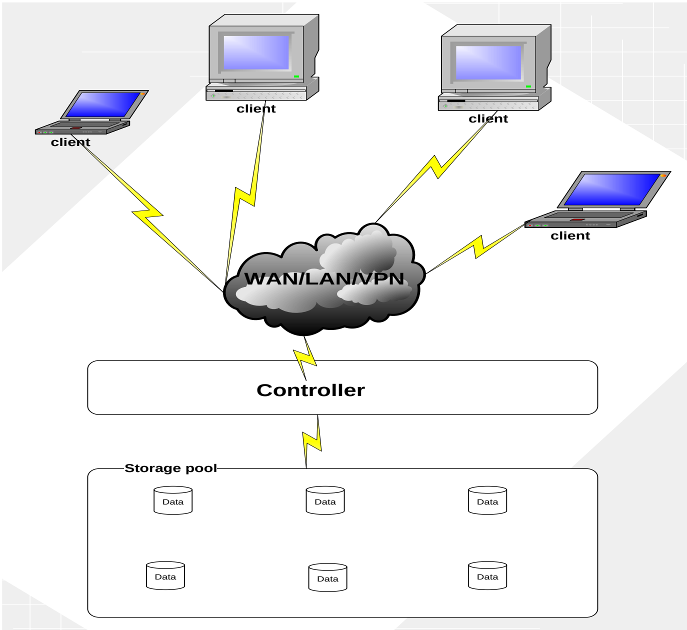

Figure 6: Interaction design

Figure 6 above show the interaction that take place between a clients distributed on a network and the virtual server/controller that eventually provides virtual access to the data/information repository.

4. THE SECURE DISKS ARCHITECTURE LAYOUT

This architecture changes the server's role from being actively involved in every request to a management role of providing high level application-specific semantics to clients. The server is eliminated from the data path and its responsibilities have changes bringing about a new functionality called the file manager. The file manager is responsible of policy definition regarding who can access the storage and other high level functions such as cache consistency and namespace management. A file manager could be the management portion of any other application such as a database.

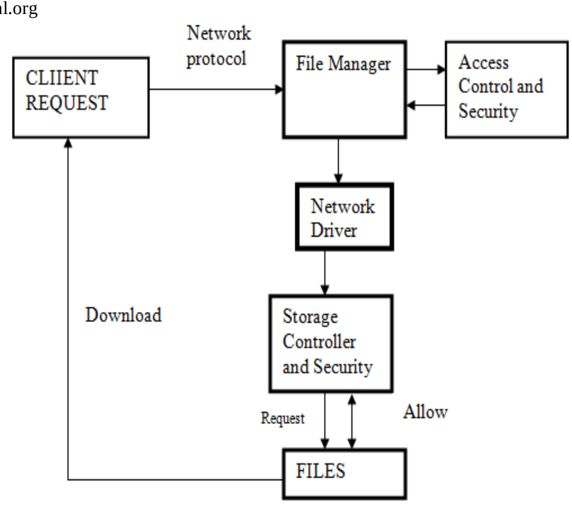

Figure 7: The NSVM Flow diagram

The NSVM architecture discussed in this paper tends to separate management and application level semantics from general data movement operations. The server handles the former while a low-level storage device focuses on the latter.

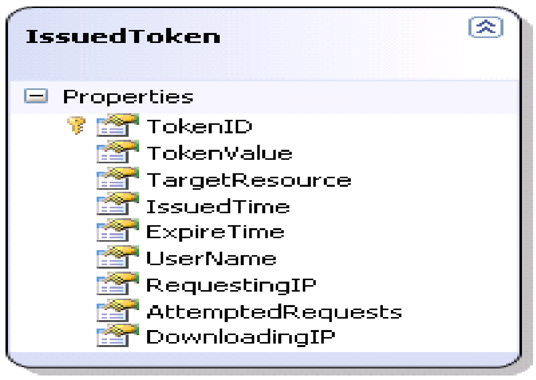

Figure 8: Structure of a NSVM Token object's attributes

5. SECURITY DESIGN

The security architecture discussed in this paper employs cryptographic capabilities issued by the file manager and checked by drives with minimal hardware support.

The separation between issuing and verifying capabilities enables the separation of file storage from file management —they may be done by machines separated by distance and with only indirect communication. Access rights control is managed through the cryptographic information stored in the capabilities.

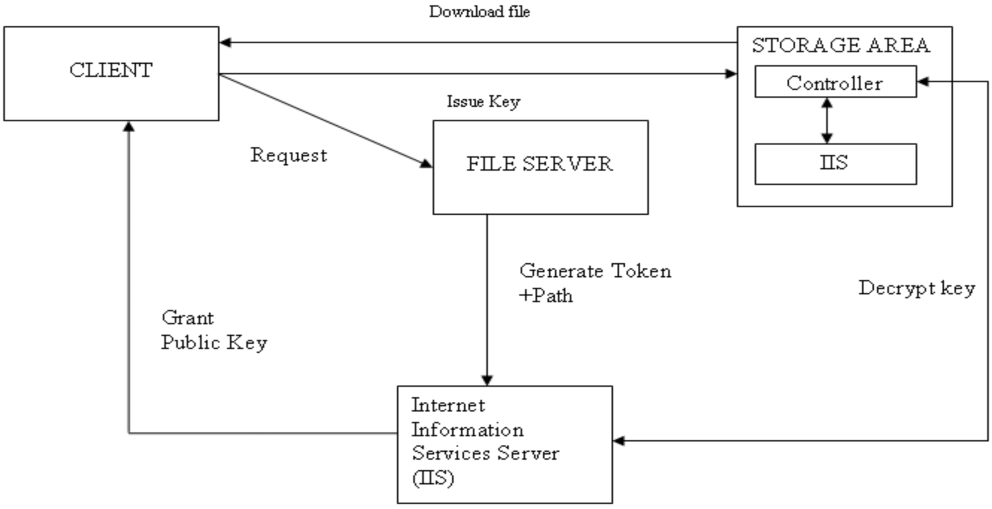

Figure 9: SSL control flow diagram

Secure sockets layers (SSL) allow encryption of the data and provide a secure communication link between the client and the server this technology is provided by the IIS security implementation framework.; for the NSVM technology to be effective two IIS servers are used, first one residing in the storage area for encrypting the data and the token and the second one residing in the client side for decrypting the token and storage path provided by the File server. Therefore the first IIS server provides public key to the server/controller generated token and path and the former provides a secret key for decryption

The figure below illustrates a detailed design layout of a virtual secured system

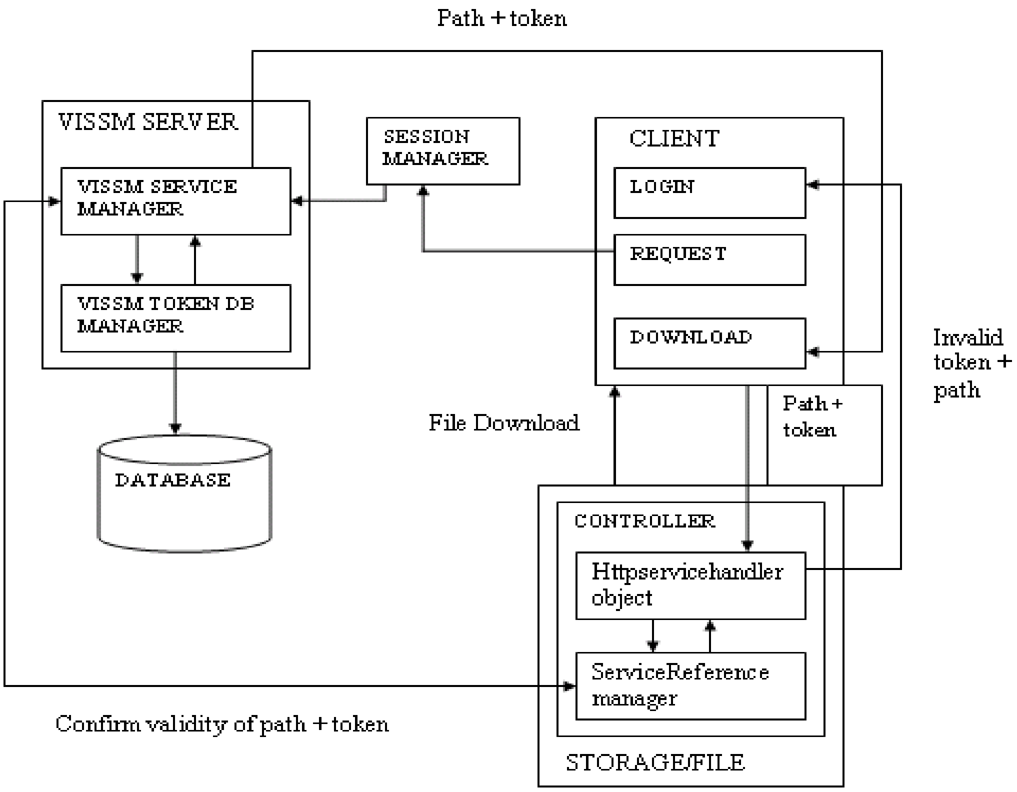

Figure 10: Showing a NSVM system

Figure 10 above is a communication between the file server and the client. The user first log into the web server client interface and then will be prompted to select the file to be downloaded from a list of files provided if he successfully logs in. If the file requested for is valid then the request hits the server and the server generates a time-stamped time-limited token appended with the file location storage path, this is handled by the file server section called NSVM SERVICE MANAGER Object.

Then on receiving the token the NSVM TOKEN MANAGER object is tasked with the responsibility of updating the database on the date and time the token was issued. Then the client receives the token and the path to the file location, as a download event leading the client to the remote controller in the file storage disks, where the client can download the file as many time as possible as long as it remains valid.

At this point the Http-service-handler object is invoked and receives the request capability presented by the client, on receiving this capability (the path and token it forwards) it to a SERVICE REFERENCE MANAGER object which subsequently forwards the issued token and path back to NSVM TOKEN MANAGER object whose sole work is to check the validity of the token and return VALID/INVALID to the SERVICE REFERENCE MANAGER. If the token has expired INVALID is returned and the **Http service handler** Object forces the client to login in afresh, otherwise if the token is marked as VALID then the client will be allowed to DOWNLOAD the file directly without involving the file server.

6. EXPERIMENTAL RESULTS

The NSVM file server Simulator and client were designed from scratch. The client was designed using java APIs and the NSVM file server simulator was designed using Ruby and runs on a TCP/IP protocol layer. The results of this simulation compared the store and forward processes in a traditional web server that included the store and forward processes with the virtualized server environment to show which of the two performed better.

7. SIMULATION RESULTS

Table 1: SAF processes and NSVM performance

	Experiment to show performance in the disks			
No of users(1 file=167 KB)	**Size of file**	**NSVM Time taken(ms)**	**SAF(s)**	**SAF(ms)**
1	167	80	21.801	21801
5	835	400	88.727	88727
10	1670	701	143.646	143646
15	2505	840	205.996	205996
20	3340	972	259.383	259383
25	4175	1031	340.129	340129
30	5010	1102	382.92	382920
35	5845	1152	430.559	430559
40	6680	1262	475.644	475644
45	7515	1302	529.481	529481
50	8350	1341	574.906	574906
55	9185	1362	628.934	628934
60	10020	1471	682.04	682040
65	10855	1491	738.481	738481
70	11690	1562	784.287	784287
75	12525	1672	830.143	830143
80	13360	1672	879.384	879384
85	14195	1722	949.425	949425
90	15030	1772	1017.923	1017923
95	15865	1782	1065.071	1065071
100	16700	1793	1130.575	1130575

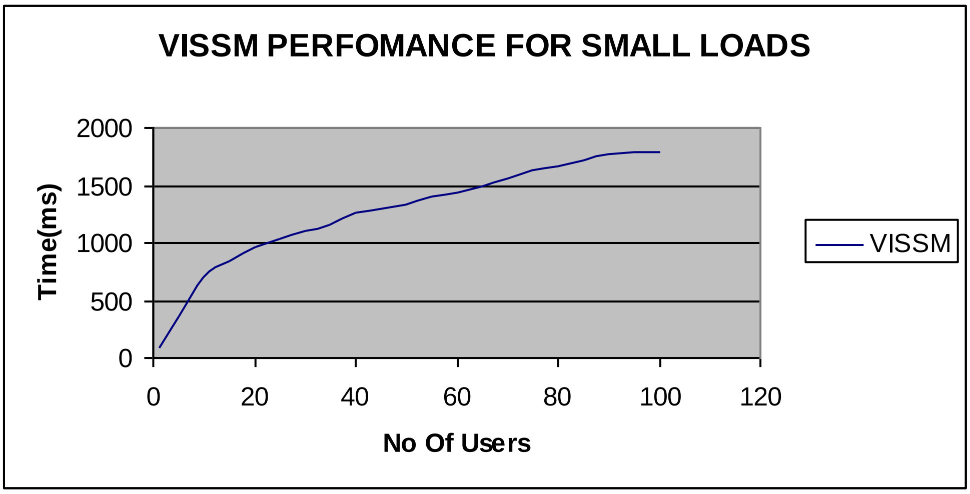

Figure 11: A graph showing the classical SAF (for small load)

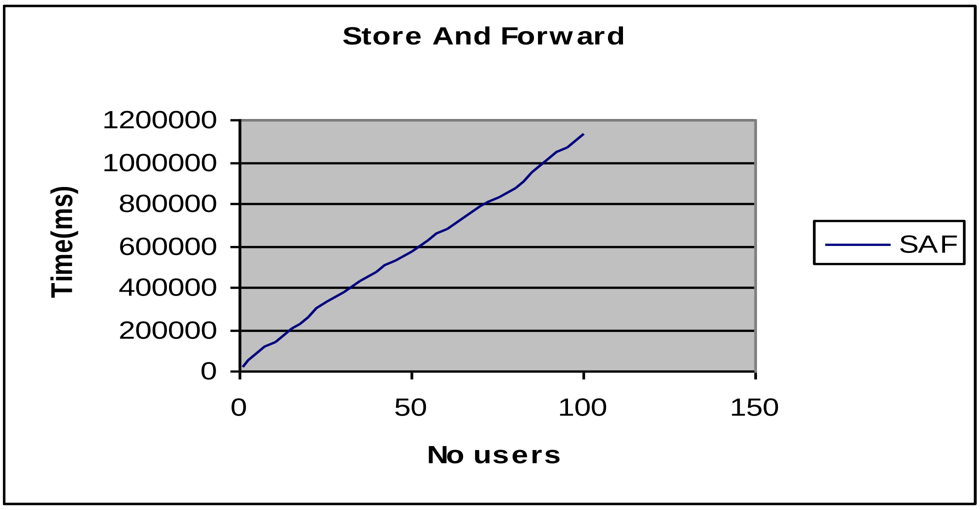

Figure 12: A graph showing the NSVM performance (for smaller load capacities)

Below shows an Experiment Showing performance of both classical SAF and NSVM under very large load capacities.

Table 2: SAF and NSVM under very heavy load capacities

Simulation for Huge file Requests for both SAF and NSVM processes				
No of Users	**Size of file**	**NSVM(ms)**	**SAF(s)**	**SAF(ms)**
1000	167000	2654	1398.711	1398711
10000	1670000	17776	1453.42	1453420
20000	3340000	33959	1611.176	1611176
30000	5010000	50834	1806.697	1806697
40000	6680000	67567	2056.577	2056577
50000	8350000	83720	2371.69	2371690
60000	10020000	99554	2793.877	2793877
70000	11690000	100434	3292.854	3292854
80000	13360000	138499	3832.1	3832100
90000	15030000	160822	4400.537	4400537

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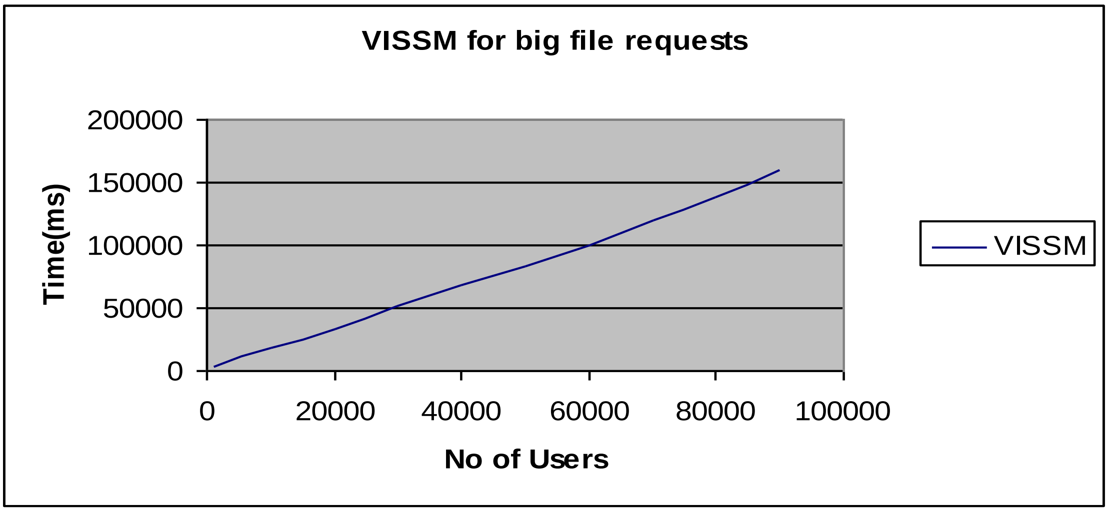

Figure 13: A graph showing nsvm under very heavy load capacity

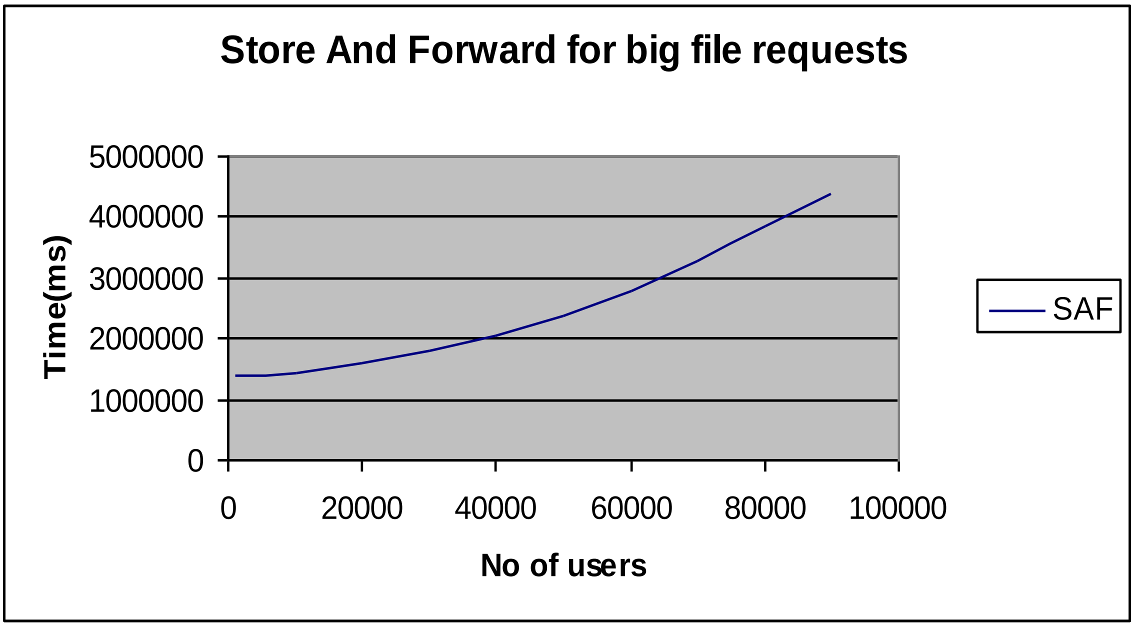

Figure 14: A graph showing classical SAF under very heavy load capacity

8. SUMMARY OF THE OBSERVATIONS

Comparing Figure 11 and 12 above at the face value it is evident that under same loads NSVM scales better than SAF. When the system load 20 users NSVM performance is approximately 1000 ms while at the while with the same number of users SAF performs at about 20000 ms which is actually 20 times higher than the store and forward (SAF) process. With 100 users NSVM performs at 1800 ms while at same of users SAF takes 1100000 ms which is 600 times slower than the NSVM. NSVM has a better performance than the SAF model.

It can be noted that when there are 100 users NSVM scales at 60% while SAF scales at 10%.

Figure 13 and 14 shows that NSVM has a better performance even when there are heavy user requirements. When the system load is 30000 users NSVM takes 50000 ms, at the same load capacity SAF takes 1500000 ms, which is 30 times slower than NSVM. At all these levels of load capacities NSVM performs better.

Table 2 illustrates the comparison of SAF processes and NSVM on big load capacities; The SAF processes seem to be growing linearly with the increase in load but the NSVM time seem to be remaining constant even if the load capacity increases to large levels.

9. CONCLUSION

Virtualization technology, improves the performance and scalability of file server when the server handles the processes of store and forward processes implemented, when using a physical server in cloud based environment.

Elimination of the store and forward file servers will greatly improve performance, scalability and reducing unnecessary storage overhead costs, if implemented in the cloud environment as depicted in the above experiments.

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AUTHOR PROFILE

Benard Osero received his Masters degree in Computer Science from University of Nairobi, in 2010. He has research interests in cloud computing, distributed systems, Artificial Intelligence and decision support systems. Currently, he is a Lecturer at the department of Computer Science Chuka University.