International Journal of Computer Applications (0975 – 8887)
Volume 176 – No. 37, July 2020

Virtualization and Cloud Computing

Richard Amankwah
Presbyterian College of Educ
Akropong-Akuapem-Ghana

Rosemond Asianoa
Mount Mary College of Educ
Somanya-Ghana

Beatrice Birago
Offinso College of Education
Offinso
Offinso-Ghana

ABSTRACT
Virtualization has been suggested by researchers as one of the ways to go in cloud computing because of the rampant growth and advancement. The phenomena are rapidly gaining interest in the domain of cloud computing due partly to its inherent benefits such as better resource utilization and ease of system manageability. Virtualization refers to the act of creating a virtual (rather than actual) version of something, including virtual computer hardware platforms, operating systems, storage devices, and computer network resources. This concept has created lots of open opportunities for technology users as well as network administrators to make good use of technology at affordable cost. In this paper, we present a systematic review of the various types of virtualization, the advantages and disadvantages associated with running traditional operating system on a single hardware using server virtualization approach. Our findings show a paradigm of computing system been driven by economies of scale, in which a pool of abstracted, virtualized, dynamically-scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet.

General Terms
Internet of Things, Cloud Computing, Software Security

Keywords
Virtualization, Cloud computing, Virtual Machines, server virtualization, Virtual Machine Monitor (VMM)

1. INTRODUCTION
Virtualization has become popular recently because of the enormous advantage is brings to technology the world. As technology matures and advances are made, there are more options open to administrators and more cost saving virtualization projects that can be implemented. Virtualization refers to technologies designed to provide a layer of abstraction between computer hardware systems and the software running on them [1]. Virtualization machines concept was first developed by IBM in the 1960s to provide concurrent, iterative access to a mainframe computer. Each virtual machine is a replica of the original machine and users are given the impression of running applications and tasks directly on the physical machine. The virtual machines provides lots of advantages such as isolation, resource sharing and the ability to run multiple flavors and configuration of operating systems with different set of software technology and configuration [2].

In computing, Virtualization is an act of creating a virtual version of a product. It includes the hardware virtualization and software virtualization. It's also referred as Client Virtualization and Server Virtualization. Mostly, the virtual environment (or virtual machine) presents a misleading image of a machine (or resource) that has more (or less) capability compared to the physical machine (or resource) underneath for various reasons [3]. Virtualization technology is the base of cloud computing. An efficient, flexible, trusted VMM is a basic requirement. Thus, an application of virtualization is cloud computing. Virtualization techniques are the bases of the Cloud computing since they render flexible and scalable hardware services. Virtualization has changed the way we do computing; for instance, many datacenters are entirely virtualized to provide quick access, spill-over to the cloud, and improved availability during periods of disaster recovery [4-6]. Cloud computing refers to the use of Internet ("cloud") based computer technology for a variety of services. It is a style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet. Conceptually, users obtain computing platforms or IT infrastructures from cloud computing and then perform different tasks in in the cloud. Therefore, computing Clouds render users with services to access hardware, software and data resources, thereafter an integrated computing platform as a service, in a transparent way: SaaS (Software as a Service), PaaS (Platform as Service), IaaS (Infrastructure as a Service) [6, 7]. This paper presents a presents a systematic review of the various types of virtualization, the advantages and disadvantages associated with running traditional operating system on a single hardware using server virtualization approach

In this paper we make the following contributions:

1. Classify the types of virtualization
2. Propose a technique for addressing the various disadvantages associated running traditional operating systems on a single hardware using server virtualization approach
3. Discuss the advantages associated with server virtualization

With the above-mentioned contributions, we complement previous studies on virtualization approach.

The remaining sections of the paper are structured as follows. Section 2 presents a review of related work in the field of virtualization. Section 3 present the types of virtualization. Section 4 presents cloud computing and its functionalities Section 5 provides an overview of sever virtualization. Section 6 present the evaluation of impact of server virtualization. Section 7 conclude the study and provides future research directions.

2. RELATED WORK
The concept of visualization has used in diverse areas of research. In this paper, I present a review on some of the use of virtualization especially in cloud computing. Hong et al. [8] uses virtual machines to optimize cloud gaming experience. They developed an optimization model or algorithm to maximize the cloud gaming provider's total profit while achieving just well enough quality of experience. By so doing, measurement studies to derive the quality of experience and performance models was conducted. They made mention of

cloud gaming services been commercially- viable, however, very challenging in terms of financial difficulties. This research was motivated by the main challenge for cloud gaming providers, where cloud gaming provides have to find the best trade-off between reducing the hardware investment and increasing the gaming Quality of Experience. This is due to the fact that satisfactory gaming Quality of Experience requires high end hardware which can incur huge financial burden. By so doing they studied the problem of efficiently applying virtualized servers by consolidating multiple cloud gaming servers on a physical machine using modern virtual machines (VMs), such as VMware and VirtualBox in order to provide high gaming Quality of Experience in a cost-effective way. Belle and Desai [9] looked at virtualization from another perspective. Beyond the hypervisor platform alone, they look at how virtual host tie into the rest of your environment, like SAN with a look at storage virtualization. Hemanth et al.[10] applied the concept of virtualization, to be precise server virtualization to help enhance the educational system in India. Considering the upward trend growth to the access to internet services, looking at the rate of illiteracy in India and also knowing very well that access to quality education in the rural areas is far behind.

3. TYPES OF VIRTUALIZATION

Current approaches to virtualization can be classified into:

(a) Full virtualization (b) Paravirtualization, and (c) Software emulation. Further explanations on these current approaches is given below [3, 5].

3.1 Full Virtualization

Almost complete simulation of the actual hardware to allow software, which typically consists of a guest operating system, to run unmodified. This model is developed by VMware, the virtual machine executes on the CPU, instead of emulated processor. When privilege instructions are identified, the CPU will place a trap that could be managed by the hypervisor and emulated. But x86 instructions like pushf/popf do not trap. To manage these instructions a method called Binary Translation was introduced. In this technique, the hypervisor glances over the virtual machine memory and taps these system calls before they are carried out and dynamically modifies the code in memory. The kernel of the operating system is incognizant of the change and works normally.

This mixture of trap-and-execute and binary translation permits any x86 operating systems to run unmodified on the hypervisor. Even though it has intricacy in implementation, it resulted in significant performance advantages compared to full emulating the CPU.

3.2 Paravirtualization

Some but not all of the target environment attributes are simulated. As a result, some guest programs may need modifications to run in such virtual environments. Paravirtualization uses split drivers to handle I/O requests. A backend driver is installed in a privileged VM (Driver Domain) to access physical device. It provides special virtual interfaces to other VMs for I/O accesses. A frontend driver is installed in Guest OS. The driver handles Guest's I/O requests and passes them to backend driver, which will interpret the I/O requests and map them to physical devices. Physical device drivers in Driver Domain will drive the devices to handle the requests. In recent times, Xen is the most accepted paravirtualization implemented. Due to paravirtualization, there exist guests as independent operating systems. Guests typically exhibits less performance overhead, approximating near-native performance. Resource management mainly exists in the form of memory allocation and CPU allocation. Xen file storage can exist as either a single file on the host file system (file backed storage) or in logical volumes or partition forms

3.3 Software emulation

Software emulation is often used in host based VMM. Host based VMM is a normal application and it can't totally control hardware, so I/O requests should be handled by Host OS. Software emulation is often used in host based VMM. Host based VMM is a normal application and it can't totally control hardware, so I/O requests should be handled by Host OS. I/O requests raised in Guest OS will be intercepted by VMM, and passed to an application in Host OS, which handles I/O requests via system call to Host OS. The main overhead in this approach is context switch, including switch between Guest OS and VMM, switch between kernel space (VMM) and user space (emulation application), and switch between emulation application and Host OS kernel.

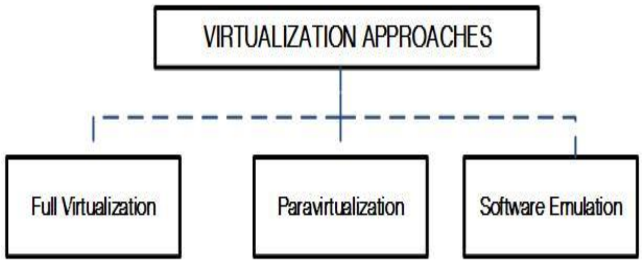

Fig. 1 Virtualization approaches

3.4 Advantages of Virtualization

There are several advantages of virtualization. One of the principal advantages of virtualization is that it requires less hardware to run the same type and amount of software, other advantages are as follows [3, 5, 6]

1. Virtualization enhances simple data recovery. For example, if the virtual server suddenly becomes corrupted, simply delete it and restore if using its virtual backup. This saves lot of time because less effort and time is required in restoring the entire system and also from the latest updates.
2. Virtualization provides safe platform to test various software configurations and on variety platforms prior to deployment.
3. Virtualization has extremely boost IT productivities, efficiency, agility and responsiveness.
4. Virtualization has been immensely used to support business continuity and disaster recovery and has also reduce capital and operating costs drastically.

4. CLOUD COMPUTING AND ITS FUNCTIONALITIES

Cloud computing is a large-scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted, virtualized, dynamically-scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet [11]. A computing Cloud is a set of networks enabled services, providing scalable, Quality of Service (QoS) guaranteed, normally personalized, inexpensive computing infrastructures on demand, which could be accessed in a simple and pervasive way. Lately, there has been a rising number of Internet services on demand. Prominent providers such as Amazon, Google, Sun, IBM, Oracle, and Salesforce have extended their computing infrastructures and platforms to provide top-level services for computation, storage, databases, and applications, including those for email, MS Office programs, finance, media, and data processing [12]. Cloud deployment approaches adopt specific types of virtualization. Thus, ways by which cloud delivers services (i.e., software, platform, and infrastructure as services) is dependent on how and what virtualization approach is implemented. Some functionalities of Cloud services may be tied to virtualization approaches [6, 13]:

4.1 Multi-tenant virtualization software-as-a-service (SaaS)

Software or applications are hosted as services and available to customers across the Internet. This eliminates the need to install and run the application on the customer's local computers. SaaS therefore eases the customer's burden of software maintenance including updates, and reduces the expense of software purchases by on-demand pricing. An early example of the SaaS is the Application Service Provider (ASP). ASP provides subscriptions to software that is hosted or delivered over the Internet. Also, Google's Chrome browser gives an interesting SaaS scenario, a new desktop could be offered through which applications can be delivered (either locally or remotely) in addition to the traditional Web browsing experience[14, 15].

4.2 Container-Based Virtualization Platform-as-a-service (PaaS)

It is the big idea to provide developers with the platform including all the systems and environments comprising the end-to-end life cycle of developing, testing, deploying and hosting of sophisticated web applications as a service delivered by cloud based, Platform as a Service (PaaS). Principal examples are GAE, Azure by Microsoft. This strategy can slash development time, offer hundreds of readily available tools and services and quick scale [6, 14]

4.3 Hardware Virtualization – Infrastructure-as-a-service (Iaas)

IaaS is the delivery of computer infrastructure as a service. Aside from the higher flexibility, a key benefit of IaaS is the usage-based payment scheme. This allows customers to pay as they grow. As the result of rapid advances in hardware virtualization, IT automation and usage metering & pricing, users could buy IT hardware, or even an entire data center, as a pay-as-you-go subscription service. Customers can achieve a much faster service delivery and time to market. Some examples are GoGrid, Flexiscale, layered Technologies, Joyent and Mosso or Rackspace etcetera [7,14].

4.4 Storage Virtualization –Data Storage-As-A Service (Dsaas)

With dSaaS, data in different formats and from multiple sources could be accessed via services by users on the network. Users can remotely manipulate their data in the same way as manipulating data on the physical machine and also access data in a semantic way using the internet. The dSaaS could also be found at some popular IT services, example Google Docs and Adobe Buzzword. Elastic Drive is a distributed remote storage application which allows users to mount a remote storage resource such as Amazon S3 as a local storage device [6]. The cloud computing architecture is made up of layers. Each layer is loosely coupled with the layers above and below, allowing each layer to evolve separately. This is similar to the design of the OSI model for network protocols. The architectural modularity allows cloud computing to support a wide range of application requirements while reducing management and maintenance overhead.

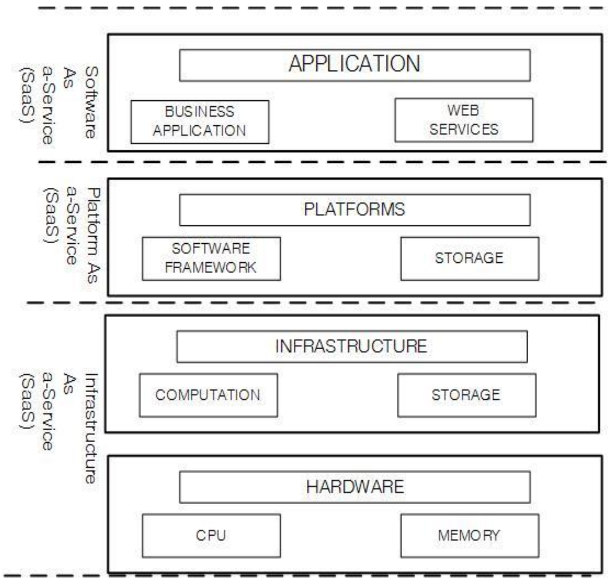

Fig. 2 Cloud computing architecture

5. SERVER VIRTUALIZATION

Server virtualization is the masking of server resources, including the number and identity of individual physical servers, processors, and operating systems, from server users. The server administrator uses a software application to divide one physical server into multiple isolated virtual environments. The server process or program listens for client requests that are transmitted via the network. Servers receive those requests and perform actions such as database queries and reading files. Server processes typically run on powerful PCs, workstations or on mainframe computers. Traditionally, data centers use dedicated servers to run applications, resulting in poor server utilization and high operational cost. The situation improved with the emergence of server virtualization technologies (e.g., VMware, Xen), which allow multiple virtual machines (VMs) to be co-located on a single physical machine. These technologies can provide performance isolation between collocated VMs to improve application performance and prevent interference attacks [16-18]. Server virtualization opens up a range of new possibilities for autonomic datacenter management, through the availability of new automation mechanisms that can be exploited to control and monitor tasks running within virtual machines [19]. Virtual servers generate hardware cost savings by allowing devices to be used to their full potential. Most distributed computing environments underutilize server capacity. Estimates for distributed, Windows-based servers indicate average capacity of 8 to 12 percent; UNIX servers use 25 to 30 percent of their capacity on average [20]. Virtual server technology unlocks unused capacity and allows the CPU, memory, disk, and controllers to be maximized for each physical device. Based on performance measurements, testing, estimates, and trial and error, any number of virtual servers can be added to a physical device, thereby increasing server utilization to sustainable levels. Instead of purchasing expensive servers with unused or excess capacity, a new virtual machine could be created for an application. Maintenance costs are avoided on the idle servers, and floor space is freed for virtual server hosts. A manageable growth plan can be created to add virtual servers, host servers, and related services [21]. Virtual servers provide platforms for software consolidation and reduced licensing costs. A Forrester study concludes Windows licenses and maintenance costs total $5,800 per year. Adapting to new virtual machine technology, many vendors have changed their licensing models to a "cost per instance" model instead of the "cost per processor" model [22]. However, virtual servers offer the ability to consolidate similar systems and software packages on common platforms to recognize license cost savings [21]. The diagram below shows the architecture of server virtualization from windows perspective.

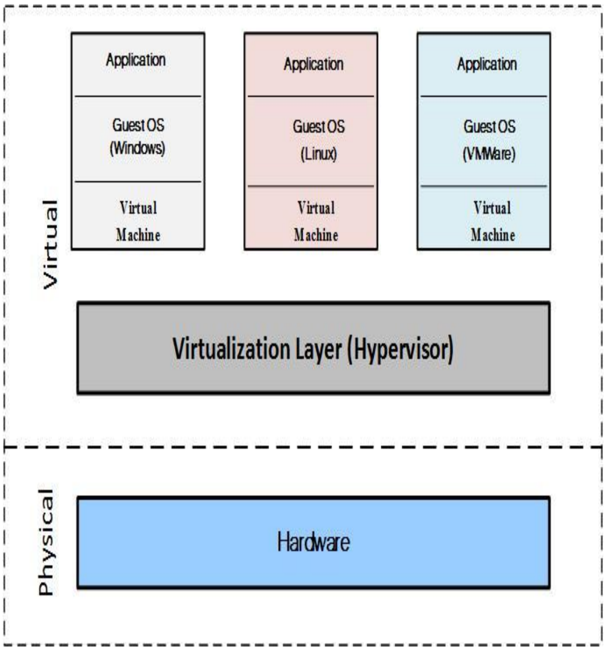

Fig 3 Windows server virtualization architecture

This architecture was presented by Brandon Baker who is the lead security engineer from Microsoft. Implementing server virtualization differs at every organization. What is appropriate for one industry or business may not be favorable to others. Nevertheless, there exists some common implementation techniques that transcend business lines. VMWare is a leading vendor of virtualization products that uses the VMWare Infrastructure Methodology (VIM): assess, plan, build, man- age. The process considers the existing inventory of systems, creates a plan to "virtualize" the systems, install and configure the hosts, and manage the new virtual server infrastructure. Many organizations will follow these steps even if they are outside of the VIM methodology, but the figures, processes, and systems will be different [21].

6. EVALUATION OF THE IMPACT OF SERVER VIRTUALIZATION

The impact of Server virtualization has had a high positive impact on the performance of cloud network though it has a little negative impact. Some of the positive impacts are as follows:

-Server Consolidation and Containment: Eliminate server sprawl by deploying systems into virtual machines. Modern server virtualization technologies are driving a transformation in enterprise data centers. By consolidating multiple physical bare-metal servers into fewer virtualized machines [23].

-Cost Benefits: There exist many tools like that assist enterprises in devising an appropriate consolidation plan for their IT environment. Due to this, lots of enterprises are improving resource utilizations and reducing operational costs [23]. Also, virtual servers generate hardware cost savings by allowing devices to be used to their full potential [21].

-Reduce Power Consumption: Due to the elimination of lots of physical server, power utility is drastically reduced because server virtualization provides the platform for virtual servers to be created on a single or few server(s) [7].

-Energy efficiency in Data Centers: [24] A significant amount of power is consumed even when the physical server is idle, thus opening an opportunity for server consolidation in data centers for reducing energy cost. Server consolidation is touted as an effective way to improve the energy efficiency for the data centers. With this method, idle servers in data centers could be turned off to reduce energy usage by server virtualization.

7. CONCLUSION

In this paper we have discussed about virtualization and Cloud Computing demonstrating a critical and in-depth awareness of the theory, methods, and issues involved in the design, development and deployment of this new phenomenon. Virtualization technology is the base of cloud computing. Thus, this paper discussed virtualization and its advantages and also reviewed some applications of virtualization and further on elaborated on one aspect of virtualization in computing known as the server virtualization: thus, looking at its architecture and how its functions and evaluated its performance on cloud computing in general. In future we will look at how to minimize cost associated with this approach, by classifying the information since the transfer of information to the cloud is expensive, this is because the information been transferred include useful information and non-useful information.

8. REFERENCES

[1] E. Ali, "Optimizing Server Resource by Using Virtualization Technology," Procedia Computer Science, vol. 59, pp. 320-325, 2015.

[2] I. Ali and N. Meghanathan, "Virtual Machines and Networks-Installation, Performance Study, Advantages and Virtualization Options," arXiv preprint arXiv:1105.0061, 2011.

[3] S. Sharma and M. Chawla, "A technical review for efficient virtual machine migration," in Cloud & Ubiquitous Computing & Emerging Technologies (CUBE), 2013 International Conference on, 2013, pp. 20-25.

[4] B. Pfaff, J. Pettit, K. Amidon, M. Casado, T. Koponen, and S. Shenker, "Extending Networking into the Virtualization Layer," in Hotnets, 2009.

[5] A. Binu and G. S. Kumar, "Virtualization Techniques: A Methodical Review of XEN and KVM," in Advances in Computing and Communications: First International Conference, ACC 2011, Kochi, India, July 22-24, 2011. Proceedings, Part I, A. Abraham, J. Lloret Mauri, J. F. Buford, J. Suzuki, and S. M. Thampi, Eds., ed Berlin, Heidelberg: Springer Berlin Heidelberg, 2011, pp. 399-410.

[6] L. Wang, G. Von Laszewski, A. Younge, X. He, M. Kunze, J. Tao, et al., "Cloud computing: a perspective study," New Generation Computing, vol. 28, pp. 137-146, 2010.

[7] K. Kumar and A. Petal, "Innovation Idea of Virtualization in Cloud Computing," International Journal of Re-

search Review in Engineering Science and Technology, vol. 1, pp. 92-95, 2012.

[8] H.-J. Hong, D.-Y. Chen, C.-Y. Huang, K.-T. Chen, and C.-H. Hsu, "Placing virtual machines to optimize cloud gaming experience," IEEE Transactions on Cloud Computing, vol. 3, pp. 42-53, 2015.

[9] R. Belle and C. Desai, "Review on virtualization: In the light of storage and server virtualization technology," Journal of Information and Operations Management, vol. 3, p. 245, 2012.

[10] G. S. Hemanth and S. N. Mahammad, "An Efficient Virtualization Server Infrastructure for e-Schools of India," in Information Systems Design and Intelligent Applications, ed: Springer, 2016, pp. 89-99.

[11] I. Foster, Y. Zhao, I. Raicu, and S. Lu, "Cloud computing and grid computing 360-degree compared," in 2008 Grid Computing Environments Workshop, 2008, pp. 1-10.

[12] C. Weinhardt, A. Anandasivam, B. Blau, and J. Stosser, "Business models in the service world," IT Professional Magazine, vol. 11, p. 28, 2009.

[13] F. Lombardi and R. Di Pietro, "Virtualization and Cloud Security: Benefits, Caveats, and Future Developments," in Cloud Computing, ed: Springer, 2014, pp. 237-255.

[14] B. P. Rimal, E. Choi, and I. Lumb, "A taxonomy and survey of cloud computing systems," INC, IMS and IDC, pp. 44-51, 2009.

[15] F. Hoch, M. Kerr, and A. Griffith, "Software as a service: Strategic backgrounder," Software & Information Industry Association (SIIA), 2001.

[16] M. F. Bari, R. Boutaba, R. Esteves, L. Z. Granville, M. Podlesny, M. G. Rabbani, et al., "Data center network virtualization: A survey," IEEE Communications Surveys & Tutorials, vol. 15, pp. 909-928, 2013.

[17] D. Hemmendinger, A. Ralston, D. Reilly, and S. Maffeis, "Client/Server Term Definition," 1998 International Thomson Computer Publishing, 1998.

[18] A. Singh, M. Korupolu, and D. Mohapatra, "Server-storage virtualization: integration and load balancing in data centers," in Proceedings of the 2008 ACM/IEEE conference on Supercomputing, 2008, p. 53.

[19] M. Steinder, I. Whalley, D. Carrera, I. Gaweda, and D. Chess, "Server virtualization in autonomic management of heterogeneous workloads," in 2007 10th IFIP/IEEE International Symposium on Integrated Network Management, 2007, pp. 139-148.

[20] B. Day, S. Yates, L. Koetzle, and T. Powell, "Identifying server consolidation cost savings," Forrester Research, Cambridge, MA, 2005.

[21] J. Daniels, "Server virtualization architecture and implementation," Crossroads, vol. 16, pp. 8-12, 2009.

[22] A. R. Park and B. Gammage, "Microsoft updates server licensing to enable virtualization," Gartner research ID, 2005.

[23] M. Cardosa, M. R. Korupolu, and A. Singh, "Shares and utilities-based power consolidation in virtualized server environments," in 2009 IFIP/IEEE International Symposium on Integrated Network Management, 2009, pp. 327-334.

[24] Y. Jin, Y. Wen, Q. Chen, and Z. Zhu, "An empirical investigation of the impact of server virtualization on energy efficiency for green data center," The Computer Journal, vol. 56, pp. 977-990, 2013.