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Role of virtualization in cloud computing

Kamyab Khajehei
Islamic Azad University
Dashtestan Branch
Borazjan
Iran

Abstract: ***Cloud computing in these days is the hottest area for research because of the major issues such as reducing costs, and also its scalability and flexibility in computer services. When we talk about the cloud computing technology and its characteristics like high availability or pool of resources or even when we talk about different instances in cloud computing, we should not forget that how it can achieve in cloud technology. The virtualization technology (server, network and storage virtualization technologies) is not a new concept in hardware and software development, it used for developing new concepts like cloud computing technology in an IT global application.***

Keywords: Cloud Computing; Virtualization technology; Server Virtualization; Network Virtualization; Storage Virtualization.

I. INTRODUCTION

In these days all the software developers are creating packages based on the cloud computing technology, and for cloud providers, it is a good opportunity to use strobe bond systems with low cost [1]. Cloud computing is an internet based computing with the ability to share resources (hardware, software, storage, network) on-demand and dynamically, but most of the IT people do not pay attention to one point and it is the evolution of cloud computing could not be possible without existing of other technologies like virtualization technology.

We can see the footprint of virtualization technology in most of the major abilities which provides by cloud computing technology. In this article we attempt to understand what virtualization is, what is the relation between virtualization and cloud computing and at the end where virtualization can stand in cloud computing concept.

II. HISTORY OF SERVER VIRTUALIZATION

In the 1960's, when the data center technicians had problems with traditional data centers (static data centers), the dynamic solution was the solution to their problems [2].

The major problem was very simple, if they had high load on their data center occasionally, they could not manage it easily, hence the greatest achievement was the new technology called as server virtualization [3].

It was a long way from completely static data centers to dynamic data centers that can provide dynamic resource allocation for IT environment providers.

They designed the software which creates different isolated boxes and shares all of the hardware resources between them and give them resources as they need. These boxes as they called virtual machines (VM), acts and services the clients like real servers with their strength and their weakness.

The server virtualization conceptually designed for data centers that they can dynamically control and share all available resources over their data centers and it could be increased or decreased on-demand.

The data centers service providers reached to the ability of controlling their resources as they needed and when they needed. This controlling ability gave them that idea which they can share this ability with other organization if they pay for that. The idea was the starting of creation of the cloud computing concept.

With the help of virtualization technology, we can easily create different virtual machines (not physically) and share all available resources between these virtual machines. Each virtual machine can have its own resources based on the duty which defined for it [4].

III. VIRTUAL MACHINE

If we want to define virtual a machine simply as we stated before there are isolated boxes which shared hardware between them. These boxes are carefully separated to each other and act like different physical computers, which can be connected via same network or not.

"A virtual machine (VM) is an abstraction layer or the environment between hardware components and the end-user [3]." Virtual machines have an ability to run any operating systems on them and in special cases it referred to as virtual hosts.

The interaction between the guest operating systems which are running in virtual machines (VM's) and resources which are available for sharing between virtual machines, provided in two ways. One is by using the host operating system, or another, a piece of software which called as the hypervisor and acts like mini operating system, can run many virtual machines. Hypervisor also call as virtual machine monitors (VMM). They are able to share system hardware components such as CPUs, controllers, disk, memory, and I/O among virtual servers [3].

Modern VMMs are no longer "small" in an absolute sense. For example, Xen has approximately 150,000 lines of code [5].

IV. HYPERVISORS

In virtualization technology, there is one piece of software that allows the physical servers can have multiple instances of virtual machines and it called as Hypervisor.

These instances are virtual machines that create in virtualization environment and the hypervisor is responsible for supervising and controlling these machines o communication, resource sharing and reallocating the virtual machines.

This connection between virtual parts and physical parts is very important in a cloud computing environment and it is the only path to the dynamic data centers which was our solution for new data centers [6].

There are two types of hypervisor. The first is called as "Bare Metal Hypervisor" and the second one is called as "Hosted Hypervisor" [4].

As shown in figure 1, the first type is directly installs on the hardware and controls all the resources. The hypervisor shares resources among the virtual machines and divided them as the policies are defining it.

In figure 2, we can see other type of virtualization, which is we can install it on the traditional system with normal stack of hardware and software.

Our focus is on the type one hypervisor that used for data centers. A hypervisor or virtual machine manager (VMM) is a piece of software which we can install it on hardware to allow us to use multiple operating system on hardware (type one). When we talk about the high availability of cloud computing and moving instances (VM's) between the servers, we must know that the virtualization has a major role in this ability of cloud computing [7].

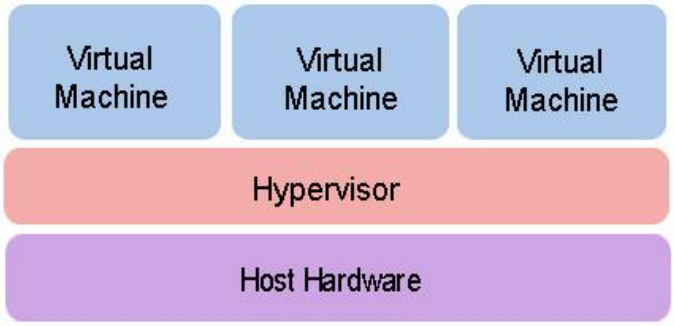

Figure 1: Hardware virtual machines

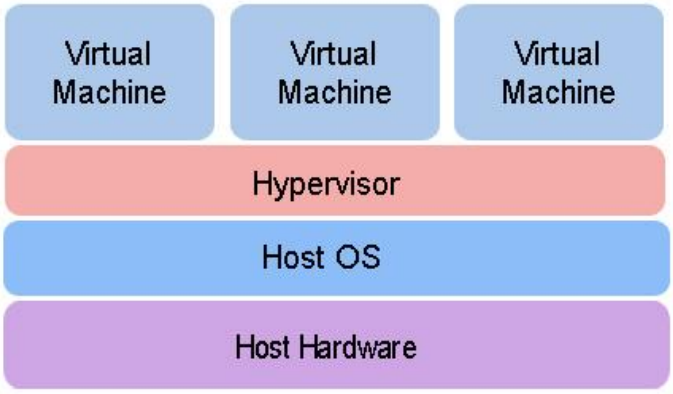

Figure 2: Software virtual machines

This piece of software actually controls the all incoming and outgoing actions and it is a connector between hardware layer and virtual machines.

As shown it figure 3 which is Xen hypervisors designing, all the resources, converted into the virtual resources and manage them and it will give virtual resources to each the virtual machine [8].

These resources comprise a virtual processor (vCPU), virtual network, virtual storage and etc.

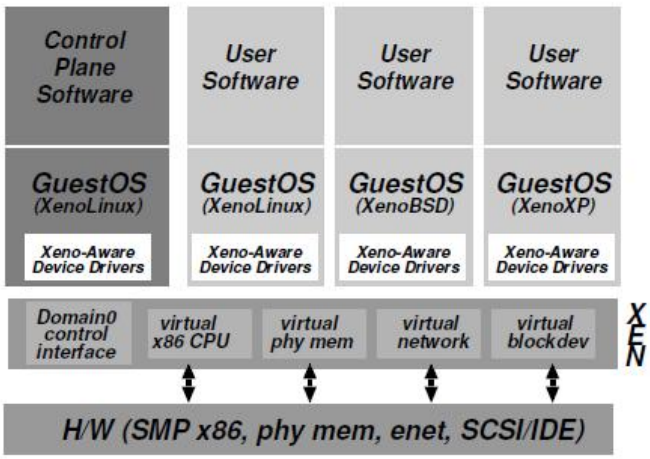

Figure 3: The structure of machine running the Xen hypervisor [8].

VMM (Virtual Machine Monitor) provides an isolated environment for VM's to achieve the secure environment for virtual machines, and it is also responsible for communication between VM's which usually called as virtual machines inter-VM communication.

There are some approaches used for high speed inter-VM communication like Socket-Outsourcing [9], XenSockets [10] Xway [11] and XenLoop [12] are using a simple shared memory channel for exchanging network packets.

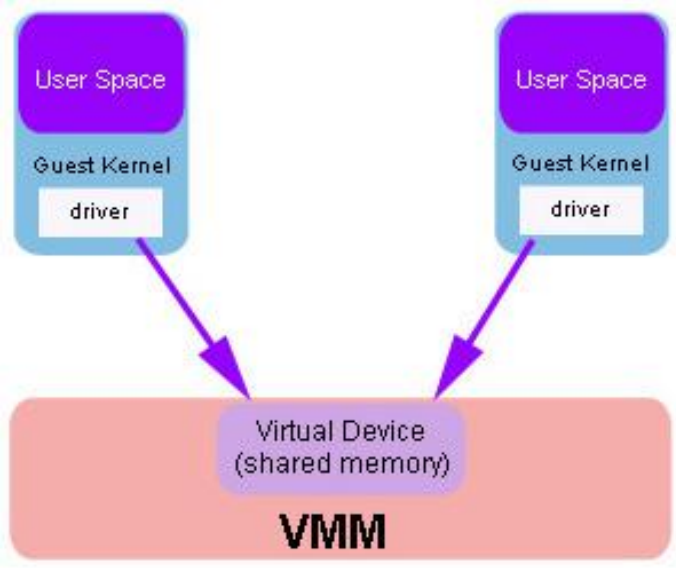

Figure 4: ZIVM Architecture [13]

V. Virtualization and Cloud Computing

One of the principal questions in this concept is: "are virtualization and cloud computing same?" The answer for this question is "No". The virtualization is the ace of the layers in cloud computing architecture, but it has a major role in most of the abilities of cloud systems. Virtualization is one of the technologies that given the ability to create the abstraction of computer with ability to perform all the behavior of the actual computer. With the aid of these concepts, we can create other new technologies and one of them is cloud computing technology.

But we can say these two concepts are closely related to each other. The virtualization is an overall concept that holds lots of abilities for creating a computers or computer groups virtually and make network of these virtual computers. The most important thing is the virtual computer completely acts like real computers and any problem we can visualize for physical computer, can be appears here. For example, if in network with the physical computers we have a serious problem with the attackers of open ports or even unauthorized users, the same problem also here appears itself. It implies that all the security risks and security issues are in physical network, we will face it in virtual network of virtual computers.

With the help of all these facilities that virtualization provided for us, computer scientists took advantage of that and with few changes and controllers developed the cloud computing technology.

VI. Place of Virtualization in Cloud Computing

Virtualization is one of the major components of cloud computing that helps to emergence of cloud computing. To understand cloud computing it is important to understand the concepts like network virtualization or storage virtualization.

The main components of virtualization in the cloud are virtual machines, because all of the operating systems and applications are inside them. They are like a container which isolated and separated from each other, even in the same physical host.

Based on the basic role of cloud as-pay-you-go, the vendors give you that ability to access these provided virtual machines and in some cases they will make these virtual machines like an actual computer and you can purchase them for a limited time and take advantage of this ability without any worries about how they operate. That thing you are purchasing is the availability of these services. Vendors in exchange promise to give you these services without any interrupt that make the availability in high level.

In the next sections, we can see the significance of all words we discuss in this section and trying to interpret them.

VII. High Availability Concept of Cloud

We should know how we can achieve the "high availability" in the cloud concept [14]. As stated before, all the machines we are using here is virtual, it means they are pieces of software that easily we can copy them whenever and anywhere we want. So if any trouble happens to our physical servers or related devices, we can easily move the virtual machines to a new location. It means the virtual machines easily can move across our data center to avoid downtime of the service which that particular virtual machine will provide.

Actually, in this case even we do not need to do that, as we know the new servers which used for virtualized data centers, do not have any physical storage that directly attached to the servers and they just do the processing part of all jobs. So if one server failed, we can use the other servers to do processing jobs.

With the help of this great ability of virtualization technology down time of those servers which provides important services even in the case of, maintaining of the hardware which is a very important issue in data centers, become a zero time.

VIII. Scalability of cloud

Scalability of cloud also is one of the achievements which its existence because of virtualization. The dynamic attribute of the virtualization is helping the cloud providers that offer such an environment that any request can respond on-demand.

In cloud computation process, if any of virtual machines need to increase one of the resources, it can be increased by the cloud management system. Even if a user needed to increase any of the resources, as service level agreement, the cloud management system can manage these resources and user environment can be expanded.

This expansion and shrinking the available resources for active virtual machines is ability of dynamic virtualization technology. But now a days, most of the people who are talking about cloud computing, just talks about the scalability of cloud without mentioning anything about virtualization. This way of reviewing the abilities without reviewing the background of it, make it more difficult to understand and discuss.

IX. Network Virtualization

In the old days the data center technicians need to go through in the hard work of cabling, but nowadays by help of virtualization the cables are gone (of course not entirely). Instead of physical connection between two physical computers, we can virtually connect two of virtual computers together. By help if virtualization even cables converted to the virtual cables and it reduced the time which the data center technicians spend on the cabling and maintaining the cables.

The cloud computing systems are essentially using the TCP/IP based protocols on communication. It is like communication in LAN networks. Each computer has one specific, unique IP and they are communicating with each other.

Here also the same with little different, instead of computers we have virtual computers or virtual machines (VM's). The important thing here is the IP's we talking about are differs from the IP's we can configure on operating systems which we can set to our platform if we have that access (in case of IaaS service), statically or dynamically. These IP's are available from pool of network which we have learned about it in network virtualization.

Network virtualization also continues the term of scalability in a cloud environment. The important point also here is a dynamic scalability of network resources [15]. In cloud network communication, the physical devices will connect via the physical connection and they can communicate with their physical NIC's, but virtual devices use the virtual NIC's which is distributed within hosts [16].

If two VMs want to communicate to each other through a network, there are two scenarios. The first scenario is communication between two VM on a same physical host. In this case all devices will be virtualized devices like virtual switches or virtual firewalls. As shown in the figure, the base communication will be through a hypervisor.

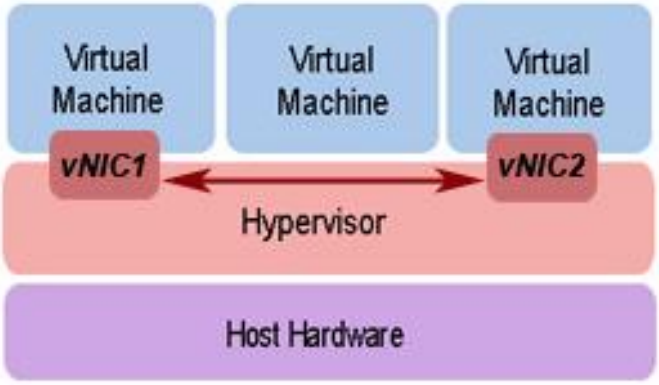

Figure 5: VMs communication on one a physical host.

In the second scenario, two VMs are on different physical host which communication is a combination of physical communication and virtual communication. As shown in the figure, the virtual NIC will be linked to the physical NIC of host one. After that the communication will be between physical NICs and at the last step, the packets will send to another virtual NIC [17].

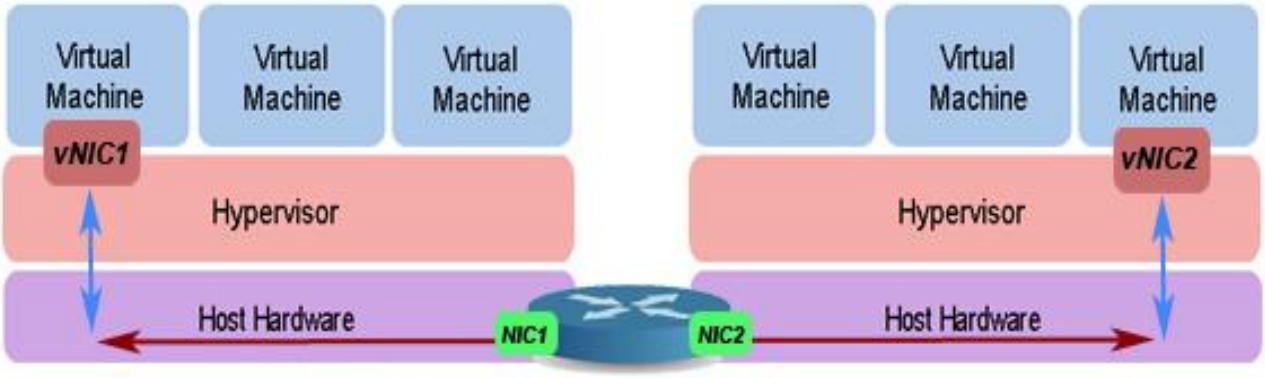

Figure 6: VMs communication on two physical hosts.

But, still there are some difficulties in this environment. One the challenges in the virtualized environment is about the IPs. As mentioned before, the IP of each VM comes from the pool of IPs. In a life cycle of a VM, the assigned IP will be selected from the pool of IPs and after the completion of the life; the assigned IP will be released. The problem will arise within the VM migration process [18]. The migration of VMs is the operation that may happen in different situation like the process of energy efficiency of cloud environment. In this situation the VM needs to migrate from one physical host to another. In this case, the VM needs to release old resources such as network resources and reallocate in the new host. This releasing old IP and reassign new IP from the other network pool may make a problem for us.

Another challenge in such a network is communication between the VMs on the networks with IPv4 with other VMs on IPv6 networks. In some management software designers only considered only IPv6 or vice versa, but most of the heterogeneous data centers are must support both IP versions [19]. Thus, like all other types of networks, virtual network also and its management should consider such difficulties.

X. Storage Virtualization

In data centers the data storage is little different. The physical storages are not directly connected to the servers; they are connected to the servers through the network. One of the most popular protocols use for storage virtualization is a storage area network (SAN) and network attached storage (NAS). For the fast interaction the use fiber channel and the protocol they are using is iSCSI (internet Small Computer System Interface). These protocols allow block storage to be accessible over the network by using a TCP/IP protocol. They use TCP for reliable communication.

The storage virtualization also relies on a Redundant Array of Independent Disk (RAID) technology to protect data from lost in any physical failure occurs [20]. In new virtual storage systems, they use the latest technology which called as Redundant Array of Independent Node (RAIN) rather than RAID. This new technology helps availability of data even if several servers go down [21].

The significant point of the storage virtualization is to hide geographical positions of the data over the cloud environment. For this significant point of the storage virtualization maps the logical storage to the physical storage as blocks of data [22].

In storage virtualization still the management of the data which can be distributed among the network is the one of the important issues in cloud storage [23]. Vendors promise to the scalability and on-demand of their cloud make the most important challenges for cloud providers. Performance and transfer rate became important issues not only for the cloud providers, but it will affect the user experience. To overcome this kind of problems, the bandwidth needs to be increased otherwise it can be a bottleneck for data transfer [4]; and it becomes a serious problem for the providers which affect the cost of services if they do not face the bandwidth limitation.

Another key issue for the cloud storage is the data security. Because of the multi tenancy of the cloud, user's data may distribute among the different physical storage or even over other data centers. The management system should controls how own the data and should have access to the data. Transferring data over the network without proper protection may cause the security risk of user data [24].

XI. Memory Virtualization

In virtualization concept also we have a virtual memory environment. The guest operating systems that loaded into different virtual machines, using virtual addresses and these addresses will mapped into the physical memory addresses. But guest operating systems can not directly access to the actual physical memory and responsible for controlling of this operation is a hypervisor.

We can say the hypervisor is the heart of the virtualization which maps virtual devices to the physical ones.

VMs are using the virtual memories based on the paging techniques. In reality, there are three different types of memory we can enumerate here. One is used by the guest OS, we can call it as virtual memory. Another memory is addressed in the hypervisor and we can call it as real memory and the last one is the physical memory [25].

The guest OS map virtual memory to the real memory which controls by the hypervisor. After that, real memory or hypervisor memory maps to the physical memory. It means if an application needs to retrieve the data, before access the exact data, the virtual address should be translated into a physical address and then the VM can use that page of memory. So, the retrieving data take two times more than traditional hardware based systems in the same conditions.

XII. Virtualization and Cloud Services

With the help of virtualizing and creating user access policies, cloud computing services can be provided by cloud vendors. If a user needs a SaaS as service, vendors gave permission to the user to access to just software level and the rest of the layers, software based or hardware based, is supported and manages by cloud providers. Likewise, if you need PaaS or IaaS services, the provider gives the permission to access more layers involves in cloud computing systems. Because the power of virtualization technology it is easy to manage the different layers of the cloud model, virtual machines, virtual networks, and virtual storages [26, 27].

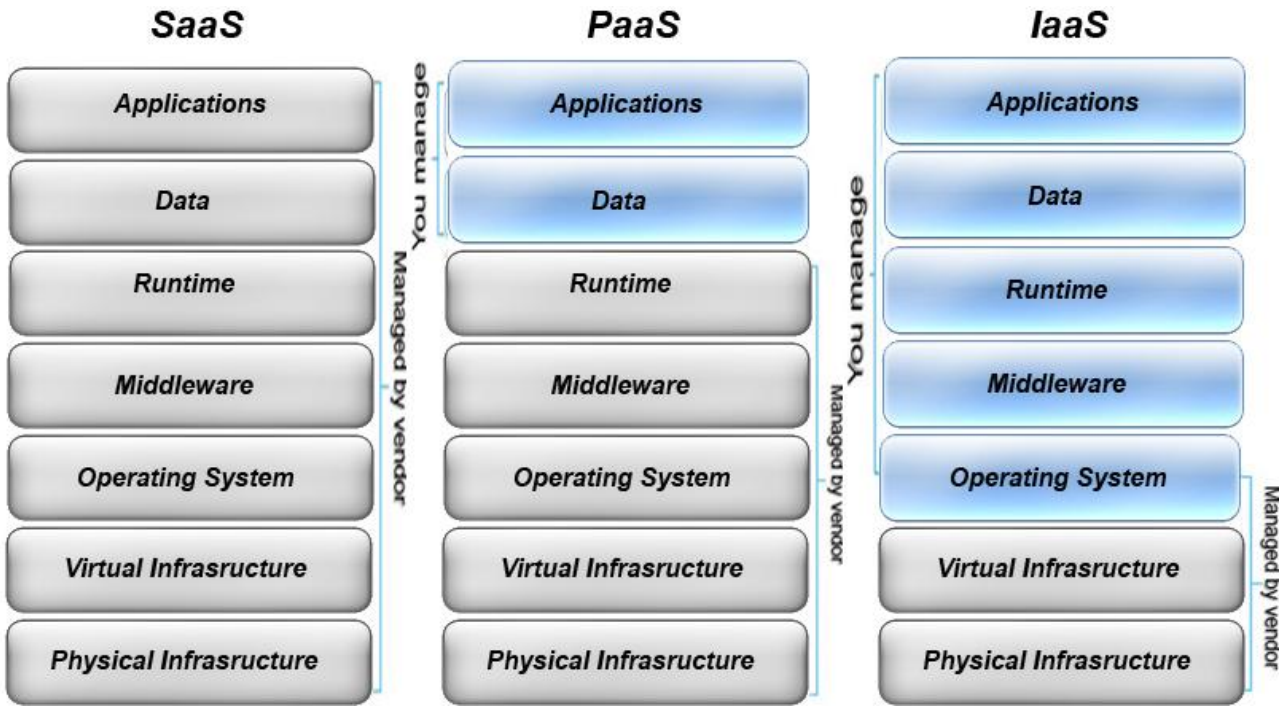

Figure 7: Cloud services managing map

Figure 7 shows the different basic services of cloud computing and their different layers. If user wants a SaaS service, responsible for managing of the layers is the cloud vendor and user have no access to other layers and it is because of this service is running on the upper layer of the cloud stack. In other services, the layers that users can access to, depends on the service, it could be increased. For instance, in IaaS service the user has more access to more layers in the cloud stack and cloud vendors are less involved in the managing the layers.

With understanding these layers, it would be easy to understand the differences between different services in the cloud and where users or vendors are standing in this technology.

XIII. CONCLUSION

In new computer technologies, we cannot push the one concept back and highlight the other one. All concepts in the computer world are intertwined together; we should not break them apart and discuss them individually. In this case by pushing the important concept of virtualization, we broke down the evolutionary chain between of technologies in the computer world and make the confusion. Without understanding the concept of virtualization, it is very difficult to realize the cloud computing concept.

References

1. N. Leavitt, “Is Cloud Computing Really Ready for Prime Time?,” Computer , Vol. 42, p. 15-20, 2009.
2. M. Varian, “VM and the VM community: Past, present, and future”, Office of Computing and Information Technology, Princeton, University, Princeton, NJ, 1997.
3. D. Kreuter, “Where server virtualization was born”, Virtual Strategy Magazine, July 2004.
4. M. Armbrust, A. Fox, R. Griffith, A.D. Joseph, R. Katz, A. Konwinski, G. Lee, D. Patterson, A. Rabkin, I. Stoica, M. Zaharia, “A View of Cloud Computing, Communications of the ACM,” Vol. 53 No. 4, Pages 50-58, April 2010.
5. D. CHISNALL, “The Definitive Guide to the Xen Hypervisor”, 1st ed. Prentice Hall Open Source Software Development Series, 2008.
6. Jinho Hwang, Sai Zeng, Frederick y Wu, and Timothy Wood, \A Component-Based Performance Comparison of Four Hypervisors," 13th IFIP/IEEE International Symposium on Integrated Network Management (IM) Technical Session, 2013.
7. J. Daniels, “Server Virtualization Architecture and Implementation”, Crossroads, Vol. 16, No.1, Fall 2009.
8. P. Barham, B. Dragovic, K. Fraser, S. Hand, T. Harris, A. Ho, R. Neugebauer,I. Pratt, A. Warfield, Xen and the art of virtualization, in: Proc. 19th ACM SymposiumonOperatingSystemsPrinciples,SOSP2003,BoltonLanding,USA, Oct.2003.
9. H. Eiraku, Y. Shinjo, C. Pu, Y. Koh, K. Kato, “Fast Networking with Socket Outsourcing in Hosted Virtual Machine Environments”. In Proceedings of the 24th ACM Symposium on Applied Computing, 2009.

10. X. Zhang, S. McIntosh, P. Rohatgi, J. L. Griffin. "Xensocket: A high-throughput interdomain transport for virtual machines" Proc. ACM/IFIP/USENIX 8th Int'l Middleware Conf.(Middleware '07), pp. 184-203, November 2007.
11. K. Kim, C. Kim, S. I. Jung, H. S. Shin, J. S. Kim. "Inter-domain Socket Communications Supporting High Performance and Full Binary Compatibility on Xen," Proc. Int'l Conf. Virtual execution environments (VEE '08). pp.11-20, March 2008.
12. J. Wang, K. Wright, and K. Gopalan, XenLoop : A Transparent High Performance Inter-VM Network Loopback, Proc. of International Symposium on High Perfor- mance Distributed Computing (HPDC), Boston, MA, June 2008.
13. H.R. Mohebbi, O. Kashef, M. Sharifi, "Zivm: A zero-copy inter-vm communication mechanism for cloud computing", Computer and Information Science, Vol. 4, No. 6 p18, November 2011.
14. M.F. Mergen, V. Uhlig, O. Krieger, J. Xenidis, "Virtualization for high-performance computing," ACM SIGOPS Operating Systems Review, Volume 40 Issue 2, p 8 – 11, April 2006.
15. N. M. M. K. Chowdhury and R. Boutaba, "A survey of network virtualization", Computer Networks , 54(5):862-876, 2010.
16. J. Carapinha, J. Jimenez, "Network virtualization: a view from the bottom", In Proceedings of the 1st ACM workshop on Virtualized infrastructure systems and architectures. VISA '09, pp. 73–80. ACM, New York, NY, USA, 2009.
17. Z. He and G. Liang, "Research and evaluation of network virtualization in cloud computing environment", in Proceedings of the 3rd International Conference on Networking and Distributed Computing (ICNDC '12), Hangzhou, China, October 2012.
18. F. Hao, T.V. Lakshman, S. Mukherjee, and H. Song, Enhancing Dynamic Cloud-based Services using Network Virtualization, In VISA, 2009.
19. W. MAO, R. BIAN, F. LI, "Network Virtualization Infrastructure (NVI) for Cloud Computing Principle and Realization", DaoliCloud Company, May 2013.
20. K. D. Bowers, A. Juels, A. Oprea, "Hail: a high-availability and integrity layer for cloud storage". In CCS '09: Proceedings of the 16th ACM Conf. on Comp. and comm. security.
21. R. Freeman on behalf of ChannelPro-SMB, "Getting Ready for Cloud Computing: Storage Virtualization Essentials", December 2011.
22. W. Zeng, Y. Zhao, and K. Ou, "Research on Cloud Storage Architecture and key tchnologies", IEEE Internation Conference on Intelligent Computing and Intelligent System (ICIS 2009) November 24-26 2009.
23. B. Rochwerger, D. Breitgand, E. Levy, A. Galis, K. Nagin, I. Llorente, R. Montero, Y. Wolfsthal, E. Elmroth, J. Caceres, M. Ben-Yehuda, W. Emmerich, and F. Galan, "The reservoir model and architecture for open federated cloud computing," IBM J. RES. & DEV. VOL. 53 NO. 4 PAPER 4 2009.
24. H. Li, Y. Dai, L. Tian, and H. Yang, "Identity-based authentication for cloud computing," in The First International Conference on Cloud Computing, pp. 157-166, 2009.
25. Computer Architecture: A Quantitative Approach by John L. Hennessy and David A. Patterson 5th edition published by Morgan Kaufmann, Imprint: Morgan Kaufmann , Release Date: 16 Sep 2011.
26. P. Mell, T. Grance, "The NIST Definition of Cloud Computing", NIST Special Publication 800-145, September 2011.
27. Cloud Security Alliance, "Security Guidance for Critical Areas of Focus in Cloud Computing v3.0", Cloud Security Alliance, 2011.

AUTHOR(S) PROFILE

Kamyab khajehei received the Master degree (Computer Science) from Osmania University, Hyderabad, India. Presently, he is teaching in Islamic Azad University, Dashtestan Branch. His main research interest includes Cloud Computing and Green Cloud.

