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An architecture for elastic resource allocation in Fog Computing

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Abstract: Cloud computing is an amazing technology that uses an internet and central remote server to maintain data in different applications .This technology allows delivery of computing resources over the internet. Cloud offers scalability, availability, elasticity and multitenancy.The most fundamental issue in cloud computing is virtualization .Virtualization is a technique which allows to run multiple virtual machines on a single hardware. In cloud computing, virtualization is used to create a virtual version of a device or resources such as server, storage devices, network or an operating system where the resources are divided into one or more execution environment. Its main motive is to optimize the usage of resources, maximizing throughput, minimizing response time. Beyond this cloud computing has number of limitations. To overcome the limitations of cloud computing there is a new approach as fog computing. In this paper we are submitting here a survey on virtualization methods and its techniques; identifying various issues, possible threats and attacks with virtualization and proposing cloud-fog architecture for elastic resource allocation.
Key Words: Cloud Computing, Fog Computing, hypervisor, resource allocation, virtual machine and virtualization layer.

Introduction

Virtualization can be described as the creation of the multiple virtual machines to run on a single physical computer and hypervisor is a physical server that contains hardware and virtualization layer software for hosting virtual machines. Each virtual machine has its own virtual CPU, network interfaces, storage and operating system. The resources of each virtual machine can be shared between different virtual machines. Virtualization dividing the resources into multiple execution environments. Each virtual machine is a hardware which runs software and software can install multiple operating systems which are able to run simultaneously and independently in the secure environment with minimal reduction in performance. The main objective of virtualization is to increase use of hardware resources and reduce management and resources cost. It also improves business flexibility and security in reduced respondent time. Virtualization is mainly categorized in three major types. 1) Server Virtualization, 2) Client Virtualization, 3) Storage Virtualization. In Server Virtualization, partition the resources of single server into multi environment so the single server can accomplish the task of many servers. Server virtualization overcome the deficiencies of static data centers and provides dynamic solution. The major problem with static data center is , if there is high load on the data center occasionally, then how it can be manage, hence there is great achievement to remove this problem is server virtualization. The main motive for the server virtualization is to design a data center that can dynamically control the load and share all available resources over their data centers. So server virtualization is the concept which is used in many load balancing techniques to enhance the overall performance of the cloud computing environment. Main components of server virtualization are virtual machines which give services to the client as the real server.

In client virtualization the system administrator can monitor and update the client machines .The storage virtualization is the abstraction between logical storage to physical storage. Virtualization is the driving technology of the cloud computing environment .Here we have some core benefits of virtualization:

- Reduced infrastructure cost- we don't have to buy as much computing hardware, virtualization offers significant cost benefits as a result of shared resources.
- Elastic scalability- we can add additional capacity whenever we need it and easily decommission it when we don't.
- Redundancy and Reliability-virtualization gives us an additional layer of flexibility to quickly respond to challenges like hardware failure, network connection drops or many more.
- Server consolidation- virtualization at its most basic level, we can use one server in situation where we have needed two, four, six or even more.
- Reducing complexity- Virtualization helps us to reduce the number of servers we need to manage every day.

We are consider the above parameter and discuss about cloud computing and its challenges in section II. Section III describes about the related works in the field and in section IV there is an overview of fog computing over cloud computing concepts. Finally, Section V and VI concludes the paper and discusses future work

Overview of cloud computing and its challenges

Cloud is a mechanism which provides "Any thing as a service anywhere", eg. Google it has made cloud like structure to provide services and fulfill all end user requirements anywhere. Traditionally all the computing resources are stored in the individual device and these resources are accessed by only the authenticated user. But in cloud computing all the resources are stored in the centralized manner and accessed on demand basis .Five key attributes of cloud computing are on demand self service , broad network access , resource pooling , rapid elasticity and measured service/pay as you go . The examples of cloud computing are Gmail , Amazon , Google Appengine , Window Azure , Simple DB , and network in the computer itself is the cloud. In Fig 1 if we linked our apps , network , databases , servers and mobile all are interconnected by cloud computing and access them according to our requirements.

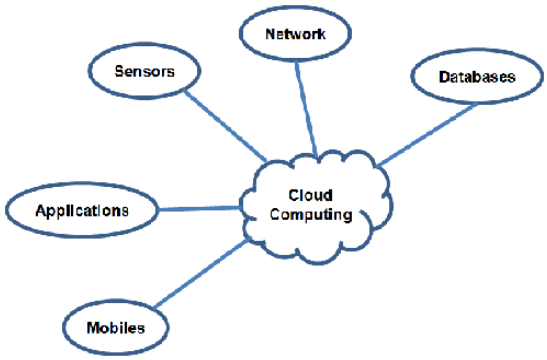

Figure 1. Cloud Computing Serving applications

Cloud computing is a combination of –,Infrastructure as a service (IaaS) , Software as a service (SaaS) and Platform as a service (PaaS) .These are the three delivery models of cloud computing .As IaaS ,it provides hardware and network facility to end users . As SaaS, software, hardware, and network facility is offered to end users .As PaaS, platform is offered to end users to develop the applications. There are three types of clouds which are mostly used in cloud computing. 1) Public Cloud, 2) Private Cloud, 3) Hybrid Cloud. As public cloud it is a multi-tenant model which is highly scalable. Amazon is the largest public cloud provider. As private cloud it is a single-tenant model which is highly secure. Cloud services are given to some specific number of users. As hybrid cloud it is a combination of public cloud and private cloud .Hybrid cloud allows high scalability of public cloud and high security of private cloud.

A. Cloud computing system has number of benefits

i. Reduced Cost: The billing is pay as per usage; the infrastructure is not purchased thus lowering maintenance.
ii. Increased Storage: cloud can scale dynamically, with the massive infrastructure is offered by cloud provider storage and maintenance of large volume of data is a reality.
iii. Flexibility: cloud computing allows users to switch applications easily and rapidly using the one that suits their needs best.
iv. Reduced time for implementation: cloud computing provides the processing power and data storage as needed at the capacity required.
v. Shortened development life cycle: cloud computing adopts the service oriented architecture (SOA) development approach which has shorter development life cycle that required by the traditional development approach.

B. Important factors of cloud computing

i. Cloud Migration: Cloud migration is the process of transferring or moving data, applications and different elements from an organization's computers to the cloud or moving them from one cloud environment to another cloud environment. So cloud migration sometimes involves moving data between cloud environments, which is called as cloud-to-cloud migration.

ii. Cloud Storage : Cloud storage is a service model in which data is maintained , managed and backed up remotely and made available to users over a network as web or typically the internet.

C. Cloud computing model challenges

i. Security and Privacy: The main challenge to cloud computing is how it addresses the security and privacy. As we know that whole data reside outside the corporate firewall. Hacking and various attacks to the cloud affect multiple clients. So cloud should have security applications, encrypted file system and data loss software.
ii. Service Delivery and Billing: The service level agreements (SLAs) of the provider are not adequate to guarantee the availability and scalability. Businesses will be reluctant to switch to cloud without a service quality guarantee.
iii. Interoperability and Portability: Businesses should have the leverage of migrating in and out of the cloud and switching provides whenever they want, and these should be no lock-in period.
iv. Reliability and Availability: It is important to monitor the service being provided using internal or third party tools. We should plans to supervise usage, SLAs, performance and robustness.
v. Performance and Bandwidth Cost: Business can save money on the hardware but they have to spend more for the bandwidth. Delivering intensive and complex data over the network requires sufficient bandwidth.

It is important to give serious consideration to these issues and find the possible ways before adopting the technology.

Related Works

In this section we study or review about the research of other authors. Many researches on virtualization in cloud computing has already been proposed. In order to utilize the benefits of fog computing completely, an efficient architecture for resource virtualization is required. Many resource virtualization techniques had been proposed earlier but it has always been a challenge to realize quality of service in terms of delay, power consumption, low latency, location awareness and mobility.

The work proposes in [1], how virtualization helps to improve the elasticity of resources in cloud computing environment .There are number of techniques used by virtualization that are emulation, virtual machine monitor or hypervisor, para-virtualiztion, full-virtualization [2,3]. It presents the definition of server virtualization, client virtualization and storage virtualization. These are the main category of resource virtualization. It also presents the number of obstacles come in the development of virtualization. These are data leakage, virtualization security threats, and data remancence issue, privacy and elastic resource management [4]. There are number of issues in elastic resource management such as resource allocation, resource provisioning, resource mapping, and resource adaptation. If we take all these obstacles under consideration than high performance of cloud can be achieved through implementing effective elastic resource management techniques. This paper also presents the comparison of different hypervisor models with different virtualization techniques.

In 2010, Timur Mirzoev et.al. [5] focuses on virtual datacenters and evaluated the functionality of the basic components of virtual datacenter. Identified the major risks to data infrastructure and represent several solutions for overcoming potential threats to virtual infrastructure. The major components of virtualized datacenter include virtual machines, hypervisors, and network resources and data stores. Next they discuss the security threats to datacenter components in cloud virtualized environment. There are several virtualization specific threats require the attention of datacenter administrators; these are suspended virtual machine, resource contention and virtual machine sprawl. Next they address the possible security threats to hypervisor. These are virtual machine root kit (VMPR) attack and Blue Pill attack. These attacks are difficult to detect. Next they address the possible security threats of virtual infrastructure; that is single point of control, physical access and discuss about license server. In last there are some virtual networks threats, that should also be consider. The major challenges are the capability tools and sound designs of network configuration. The author also proposes some practical solutions for hardening virtualized environment.

In 2011, Vaquero LM et al [6] explore a new approach based on dynamically scaling server applications in the cloud. The most notable initiative towards whole application scalability in cloud environment are presented in the paper. This document discusses about the scalability in IaaS clouds in two categories such as server scalability and network scalability. The server scalability can be achieved by two techniques such as by using the elasticity controller and other one is by using feeding controller with rules and policies. The elastic controller has some limitations. Automated scaling features are included by some vendors but the rules and policies they allow to express still deal with individual VM [7]. In the feeding controller technique user defined rules are the chosen mechanism. There is a limitation in IaaS cloud that the number of VMs are balanced by a single load balancer (LB), even amazon does not provide mechanism to scale LBs. Next, they address the

scaling the plateforms. Past cloud offers a ready to use execution environment along with convenient services for applications. There are two core layers of PaaS platform – the container level and database level. The container is the software platform where user's component deployed and run but database level provides data persistence support.

The work proposes in [8] , present the design and implementation of an architecture for resource management in a hosting center, with an emphasis on energy. This paper investigates the policies for allocating resources in a hosting center. There is an implementation of a Muse – which is flexible resource management architecture. This system has an adaptive resource management that incorporates power and energy as primary resources of a hosting center. Muse can respond to the, datacenter vulnerability to overloading of thermal system due to cooling failure or high system load, by automatically back power demand and avoid inefficient use of energy and server resources.
There is the four major elements of the Muse architecture, such as generic server appliances, Reconfigurable network switching febric, load monitoring and estimation modules and the executive. Muse allocates to each service a suitable share of the server resources that it needs to serve its load [9]. Muse defines a mechanism to achieve the reconfigurable switching architecture and policies for adaptively varying the active server sets and the number of on power servers.
The Muse resource economy is based on executable utility functions that quantify the value of performance for each co-hosted service. The system plans resource assignment to maximize "profit" by balancing the cost of each resource unit. This paper also evaluates the MSRP resource allocation, for allocating resources using an incremental greedy algorithm. The property of this algorithm is to conserves resources during period of low demand. Resources are not sold at a price below cost. This paper also explains the Muse prototype which includes a user level executive server and two load label kernel modules for the FreeBSD operating system, implementing a host based redirecting server switch and load monitoring extensions for the servers. It describes the experiment of Muse prototype and its result demonstrates the potential to adapt service provisioning to respond dynamically varying resource availability and cost in a server cluster. The prototype can reduce server energy consumption by 29% - 78% for given web work load.

To address the problem of "Virtual machine image sprawl" in [10] proposes the Mirage image format (MIF), a new storage format that exposes the rich semantic information currently buried in disk-image files. In general, the virtualization sprawl or virtual machine sprawl is a phenomenon that occurs when the number of virtual machines on a network reaches a point where the administrator can no longer manage them effectively. MIF is the decoupling of the file name to file content appears in more than one image or in multiple files of the same image.
This paper is motivated by three software tasks – inventory control, customized deployment and update. In the inventory control scenario images are searched for particular programs; In the customized deployment scenario a cluster of servers is set up; and in the update scenario, a new package is installed on a number of clients. Then they describe the design and implementation of MIF and Mirage repository. The goal of the Mirage project is to build a scalable repository for efficiently storing and managing large numbers of virtual machine images .

This paper is focuses on [11], fog computing environment and prove that it is definitely the future of cloud computing environment. Fog computing is a newly proposed model of cloud computing. Fog supports emerging IoT applications. The internet of things is the network of different types of physical objects that are assessed through the internet .These objects contains embedded technology to sense or interact with the internal states or the outer environment. So fog is a vehicle for IoT. This paper focuses on the limitations of the cloud computing model. It suffers from some shortcoming such as high bandwidth, client access link, high latency and security [12]. Fog computing provides data security and integrity and these are the two most important keys which are demanded in every internet applications. So fog fulfill all the demands but it is not the replacement of cloud computing. Both technologies are complement to each other.

Fog computing over cloud computing

Cloud computing can be defined as a tool that provides enormous benefits to its users. However being a tool, it also having a set of problems and inefficiencies. To address the issues of cloud computing, there is a new computing concept which is known as fog computing it is introduced by CISCO system. Fog is nothing but cloud that is closer to the ground. Both are made up of virtual systems providing the flexibility to server, storage and network resources. Fog computing improves the Quality of Service (QoS) and reduces latency. The main task of fog is to deliver data and place it closer to the user. Fog computing provide wireless data transfer to distributed devices in the Internet of Things (IoT) network system.
Internet applications demanded to data consistency and data integrity. Longer the data stays on the route, more vulnerable it is for attacks. Hence it is always desirable to have few hops between clients and servers. Fog

computing provides the shortest path between clients and servers. Hence Fog computing is preferred over cloud computing in such situation.

A. Characterization of Fog computing

i. Edge location, location awareness and low latency: Fog provides these qualities as in gaming, video streaming, and in augmented realty.
ii. Geographical distribution: Cloud is centralized in nature but fog is distributed geographically. So it play active role in delivery of high quality data.
iii. Fog supports large scale sensor networks to monitor the environment.
iv. Very large number of nodes, as a consequences of the wide geo-distribution.
v. Support for mobility: Fog supports the applications to communicate directly with mobile devices so it supports mobility technique.
vi. Real time interaction: Fog provides real time interaction rather than batch processing.
vii. Heterogeneity: Fog computing is heterogeneous in nature and support variety of environments.
viii. Fog support for on-line analytic and interplay with the cloud.
ix. Predominance of wireless access: Wireless sensor networks have been widely deployed in many environment related applications, which are supported by fog computing rather than cloud computing.

B. Proposed Cloud – Fog Computing model

Fog does not replace the cloud computing but it extends the cloud computing. These two concepts of computing can be integrated into single platform to achieve the best of both these techniques. Figure 2 gives the description of both the computing techniques that how they can be integrated into a single technique. Integration of cloud and fog architecture is difficult to manage because numbers of physical and logical changes are to be made. So, virtualization layer will be required between the cloud layer and fog layer.
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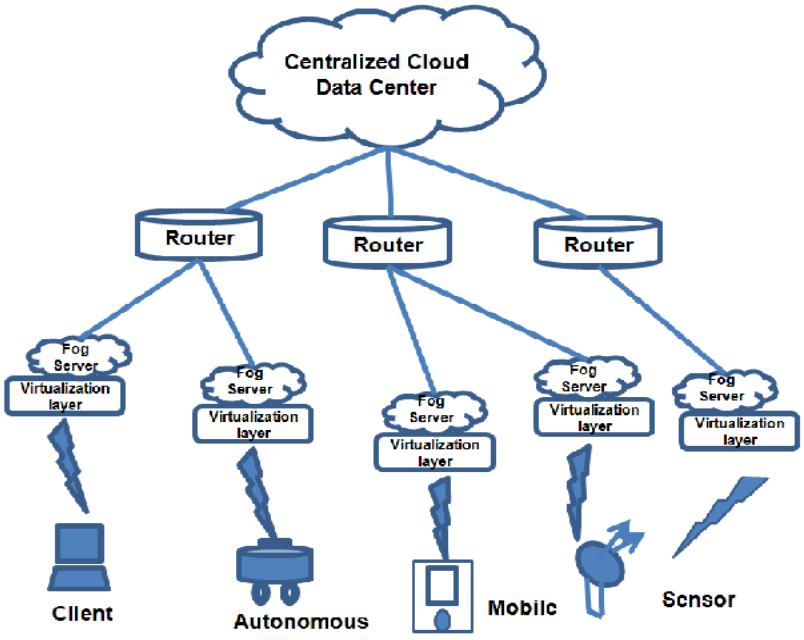

Figure 2. Proposed architecture for Cloud-Fog Computing

Fog computing requires geographically distributed implementation, the single nodes cannot handle large amount of resources, but batch processing jobs would requires large amount of resources, these type of jobs can be tackle by only cloud computing [11]. Thus, cloud computing and fog computing serving side by side and complement to each other. For integration of fog and cloud there is a great need of server virtualization, because server virtualization allows a single server to take the role of multiple servers. Server virtualization is a long route from static data centers to dynamic data centers that can provide dynamic and elastic resource allocation

Server virtualization software creates and provides different virtual machines and shares all of the hardware resources between them and provides the resources as they needed. The server virtualization is mainly designed for data centers that they can dynamically control and share all resources on demand basis. There are many issues with server virtualization like server availability, data consistency, load balancing and data replication. Resource allocation is one of the major issue now a days with cloud computing which can be best resolved by having an efficient architecture for fog computing. The performance of cloud can be increased by implementing elastic resource allocation techniques. Figure 2 is a proposed architecture for resource allocation.

We will use sever clustering technique in the proposed architecture. This technique can be used to combine the distributed resources in one place virtually. This technique consists of a set of connected servers that work together so that they can be viewed s a single system. They are usually deployed to improve the performance and server availability over that of single server. This architecture has different types of components such as centralized cloud data center, fog servers and different types of users that will use this architecture. Centralized cloud data center is a centralized repository for the storage, management and provide broadcasting of data and information. Fog server operate within a client-server architecture where servers are computer programs running to serve the request of clients. This may be share data, information or hardware and software resources. Virtualization is the foundation for the cloud-fog concept, since it is the enabling technology so in our proposed architecture we have virtualization layer for each fog server. This virtualization layer is used to make possible to run multiple operating systems and multiple applications on the same fog server at the same time. The virtualization technique can be implemented with the help of hypervisor technology. The hypervisor can be a computer software or hardware that creates and runs virtual machines. The main goal of this proposed architecture is to optimize the usage of resources by using the elastic resource allocation technique. It will maximize the throughput and minimize the response time.

Conclusion

This paper gives the brief idea about the server virtualization and concept related to it. It is very difficult to realize the cloud computing concept without understanding the concept of virtualization because it provides the number of benefits such as reduced infrastructure cost, elastic scalability, redundancy and reliability, server consolidation and reduce the complexity. This paper gives the introduction to cloud computing and its major challenges. This paper analyze about the obstacles which may occur during virtualization. We survey various existing virtualization techniques and its problems in cloud computing environment. In addition, fog computing technique and its features are given in the paper and introduce a new computing model to resolves the limitations of cloud computing environment. This model is elaborated in figure 2 named as cloud-fog architecture. This model integrates both the techniques to achieve server virtualization. This architecture will resolve the issue of resource allocation in fog environment.

Future work

In the future, we will extend our research by providing implementation and producing results to justify our concepts of elastic resource allocation for fog computing. The concepts we have discussed here will help to build a strong architecture for server virtualization in the field of fog computing by the taking the reference of cloud computing concepts for improving customer satisfaction.

Currently, researchers are still working on resource allocation in server virtualization. By the researcher, we have studied and realized that here is a need to develop an efficient algorithm and architecture that can handle the current demand as well as the future demand of cloud computing vulnerabilities and its obstacles. Thus fog computing provide better quality of service in terms of delay, power consumption, reduced data traffic over the internet.

References

[1] Durairaj.M, Kannan.P, "A Study On Virtualization Techniques And Challenges In Cloud Computing", International Journal of Scientific & Technology Research Volume 3, Issue 11, Nov. 2014

[2] Calheiros RN, Buyya R, De Rose CAF, ―Building an automated and self-configurable emulation testbed for grid applications‖ , Software: Practice and Experience, April 2010; Vol. 40(5), pp. 405–429.

[3] A. Whitaker, M. Shaw, S. D. Gribble, ―Denali: Lightweight virtual machines for distributed and networked applications‖ , Tech. rep. (Feb. 08 2002).

[4] Z. Xiao and Y. Xiao, ―Security and Privacy in Cloud Computing‖ , IEEE Communications Surveys & Tutorials, vol. 15, no. 2, pp. 843–859, 2013.

[5] Timur Mirzoev, Baijian Yang, "Securing Virtualized Datacenters", International Journal of Engineering Research & Innovation, vol. 2, no. 1, spring 2010

[6] Vaquero LM, Luis Rodero-Merino, Rajkumar Buyya, "Dynamically scaling applications in the cloud", In: Proceedings of the ACM SIGCOMM computer communication review, vol.41, no.1; 2011. pp.45–52

[7] H. C. Lim, S. Babu, and J. S. Chase, "Automated control for elastic storage," in *ICAC10*. New York, NY, USA: ACM, 2010, pp. 19–24.

[8] Chase JS, Darrell C Anderson, Prachi N Thakar, Amin M Vahdat, ―Managing energy and server resources in hosting centers‖ , In: Proceedings of 11th IEEE/ACM international conference on grid computing (GRID), vol.12, no.4; 2010. pp.50–2.

[9] Gaurav Banga, Peter Druschel, and Jeffrey C. Mogul. Resource Containers: A New Facility for Resource Management in Server Systems. In Proceedings of the Third Symposium on Operating Systems Design and Implementation (OSDI), February 1999.

[10] Reimer, D., Thomas, A., and et al., "Opening black boxes: using semantic information to combat virtual machine image sprawl", Proceedings of the fourth ACM SIGPLAN/SIGOPS international conference on Virtual extension environments, pp 111-120, 2008.

[11] Mohamed Firdhous, Osman Ghazali and Suhaidi Hassan, "Fog Computing: Will it be the Future of Cloud Computing?" Proceedings of the Third International Conference on Informatics & Applications, Kuala Terengganu, Malaysia, 2014.

[12] F.Bonomi, R.Milito, J.Zhu, and S.Addepalli, "Fog computing and its role in the Internet of Things," in ACM SIGCOMM Workshop on Mobile cloud Computing, Helsinki, Finland, 2012, pp. 13-16.