Institute of Advanced Engineering and Science

International Journal of Cloud Computing and Services Science (IJ-CLOSER)
Vol.1, No.2, June 2012, pp. 67~74
ISSN: 2089-3337

Efficient Architectural Framework for Cloud Computing

Souvik Pal*, Prasant Kumar Pattnaik*
*Department of Computer Engineering, KIIT University, India

Article Info

Article history:

Received April 12th, 2012
Revised May 1th, 2012
Accepted June 3th, 2012

Keyword:

Cloud Computing
Grid
Virtualization
Hypervisor

ABSTRACT

Cloud computing is that enables adaptive, favorable and on-demand network access to a collective pool of adjustable and configurable computing physical resources which networks, servers, bandwidth, storage that can be swiftly provisioned and released with negligible supervision endeavor or service provider interaction. From business prospective, the viable achievements of Cloud Computing and recent developments in Grid computing have brought the platform that has introduced virtualization technology into the era of high performance computing. However, clouds are Internet-based concept and try to disguise complexity overhead for end users. Cloud service providers (CSPs) use many structural designs combined with self-service capabilities and ready-to-use facilities for computing resources, which are enabled through network infrastructure especially the internet which is an important consideration. This paper provides an efficient architectural Framework for cloud computing that may lead to better performance and faster access.

Copyright @ 2012 Institute of Advanced Engineering and Science.
All rights reserved.

Corresponding Author:

First Author,
Department of Computer Engineering, KIIT University, India
Email: souvikpal22@gmail.com

1. INTRODUCTION

Popularly, cloud computing or Internet computing is used for enabling convenient, on-demand network access to a networks, servers, mass storage and application specific services with minimal effort to both service provider and end user [2]. For simplicity, A Cloud itself an infrastructure or framework that comprises a pool of physical computing resources i.e. a set of hardware, processors, memory, storage, networks and bandwidth, which can be organized on Demand into services that can grow or shrink in real-time scenario [1]. In surge of demand of internet and its immense usage all over the globe, Computing has moved from the traditional computing to distributed high performance computing say distributing computing, subsequently Grid Computing and then Computing through clouds. The main reason of inventing Cloud Computing is to reducing cost, reducing time and overhead maintenance of data storage and fast access all over the world.

The advancement of Cloud Computing came up due to fast-growing usage of internet among the people. The Cloud Computing is not a totally new technology; it is basically a journey through distributed, cluster and grid computing. In the case of cluster computing [12], many clusters were formed. A cluster is an aggregation of homogeneous computers interlinked with each other by high-speed networks [14] and allocated in a centralized way. Sometimes, it is not feasible for a single computer to execute massive compute and data intensive tasks. When a huge computational task is needed to execute, the individual computers may form a cluster to share computational workload and they function as a single virtual machine. The advantage is that failure of a node doesn't put any impact over the system because some another standby node will do the needful task. But the drastic changes in the no. of service-oriented requests, lack of sufficient additional resources, centralized resource handling are the issues of cluster computing. We need to discuss the updating issues in Grid Computing [15]. Grid computing is the combination of computers from various administrative domains to meet a common target and may disappear after the completion of the task. It is analogous to power grid [16]. In an electrical grid scenario, there are three phases namely, Generation, Transmission and Distribution. But the users don't need to know either the location of power plant or the process by which users getting the power. Likewise, in grid computing, the end users do not know about the underlying processes and resources. A massive computing task is assigned to a grid and the grid shares out the task into sub tasks, which are independently consigned to a range of nodes. It's all done by Job-scheduling Process [17]. Like cluster computing, Failure of a node doesn't affect the whole process. But it's a different task to organize and maintain heterogeneous systems. The grid resources incur unnecessary overheads in terms of stability. In compared to cluster and grid computing, clouds are highly scalable, capable of both centralized & distributed resource handling, loosely coupled and provide on-demand computation & application service. Cloud computing is basically known as computing over internet. Cloud computing is an enhancement of distributed and parallel computing, Cluster Computing and Grid computing. In this advanced era, not only user able to use a particular web based application but also that may be in active participation in its computational procedure by either adopting ,demanding or pay per use basis [9][10].

1.2 Challenges of Cloud Computing

Cloud computing is presenting itself as a good servant to the end user, but it has some challenges and issues. Security issues are the most vital issues of the cloud computing. Its very risk to put all the data, information of an organization to a cloud provider and running an application at another's place is also at stake. Because data loss, phishing the data, threat is the common problem. Privacy and reliability are to be maintained during transportation and storage of the data. Cloud is made for sharing the workload into the common infrastructure and users have to rely on the cloud provider about their identity information, operation histories and perceptive data. Cloud is not responsible for unauthorized usage and its retrieval, lack of user administration and third party access. In piracy aspect, there is a pool of resources and millions of software, applications and services are running publicly. So it's very easy to pirate all those things from floating data and use it in an unauthorized way without any identification & authentication. Over-utilization of capacity makes a customer irritated when CSP have promised to deliver a service but could not able to meet the needs of the customer. Internet latency is also a hindrance of clod computing, which hampers the CSPs to deliver the services on time. In the view of auditing, in a particular service or application, cloud service provider (CSP) and the end user has the authoritative control over the data. CSP has the authority to replicate, shift and alter the data. That's why the clients need to keep a watch over all those activities so that CSP can't do those behaviors beyond its domain. But this is not practical to audit all the data and also complicated to decide which data need to be audit [18]. Moreover multi-tenancy is also a considerable issue if the numbers of applications, which are running on a particular node, are going to increase, then the bandwidth allocated to each application decreases that mean number of applications and allocated bandwidth is inversely proportional. It reduces the performance of the system.

The paper organized as follows: In the section 2, we have discussed the virtualization Vs traditional approach. Section 3 describes the deployment models. Section 4 has given the idea of conventional cloud service models. And in the section 5, we have given a proposed architectural framework & its constraints. Lastly, section 6 concludes the work.

2. VIRTUALIZATION VERSUS TRADITIONAL APPROACH

Virtualization is used computer resources to imitate other computer resources or whole computers. A virtualization environment that enables the configuration of systems (i.e. compute power, bandwidth and storage) as well as helps the creation of individual virtual machine, has become the essential technology of cloud computing environments. Virtualization provides a platform for optimizing complex IT resources in a scalable manner (efficiently growing), which is ideal for delivering services. At a fundamental level, virtualization technology enables the abstraction or decoupling of the application payload from the underlying physical resource [3] that means Physical resources can be changed or transformed into virtual or logical resources on-demand which is called Provisioning.

In traditional approach, there are mixed hardware environment, multiple management tools, frequent application patching and updating, complex workloads and multiple software architecture. But comparatively in cloud data center far better approach like homogeneous environment, standardize management tools, minimal application patching and updating, simple workloads and single standard software architecture [5].

3. DEPLOYMENT MODELS

Depending on the requirement of services and the applications, cloud models are categorized into four types:

- ***Public Cloud***: In this cloud model, the computer resources and same infrastructure used by multiple users. Usable standardized workload for applications, high scalability, testing and developing applications, security strategy are the basic criterion of public cloud. Email-system is a good example of public cloud. For example, when end-users use mail services say Yahoo or Gmail account, they need to have only a computer and internet connection. User need not to know about the underlying process. They are just using the cloud. All the maintaining, testing and developing task are done by Yahoo or Google itself.
- ***Private Cloud***: In this cloud model, the computer resources and infrastructure are handled by an organization and highly virtualized data-center is located inside the client's firewall. It has specific workloads and provides well-managed environment, optimized usage of computing resources, security and compliance. Quality of Service (QoS) is managed and controlled by the organization itself. For example, Amazon Virtual Private Cloud (VPC) is a private cloud, which offers clients isolated AWS (Amazon Work Space) and protection by Virtual Private Network (VPN) connections.
- ***Hybrid Cloud***: Combination of private cloud and public cloud makes hybrid cloud. The vendors use the physical resources from public cloud on-demand basis and return it when it is of no use [8]. Let us consider a scenario: Suppose a company want to use a SaaS Application, which would meet the considerations of the company, i.e. Security and standardize usage throughout the company. The SaaS provider creates a private cloud for the particular company inside their firewall so that the entire company can use the cloud as a standard. Now they provide the company with a Virtual Private Network (VPN) for getting more security [4]. Hence, we can see that. Combining the advantages of private and public cloud, we can create a hybrid cloud.
- ***Community cloud***: In case of joint venture application, a same cloud infrastructure needs to be constructed and shared by several organizations jointly, so that they can use the same framework as well as policies, services, requirements, applications, and concerns [7]. Hybrid cloud is highly scalable and reduces cost complexity. The third-party vendor or any one of the vendors within the community may host and maintain the community cloud infrastructure.

4. CLOUD SERVICE

End-users or clients use the cloud services according to their needs. While discussing the cloud service, we are first going to confer about conventional cloud service. In traditional cloud concept, as shown as figure [1], Cloud Providers provides three types of Services which include Software as a Service (SaaS) which is the top most layer of the cloud stack. End users can use the services or software provided by SaaS without purchasing and maintaining overhead, Platform as a Service (PaaS) where end users can run & deploy their applications which are able to run concurrently on the same cloud platform and Infrastructure as a Service (IaaS) that provides mainly infrastructure-based services. It also provides pool of physical resources (i.e. Servers, networks, bandwidth, storage, and data center space), virtualization technology and virtual machines (VMs). IaaS maintains and manages those entire things alone and it's a really huge task for IaaS. There is no separate resource pool and also management layer which separately controls the accesses of VMs.

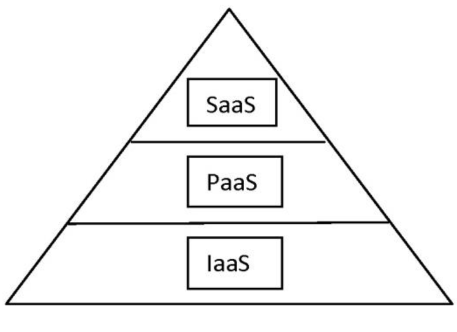

Figure 1. Traditional Cloud Service Architecture

5. PROPOSED MODEL

We proposed a enhanced service model shown in figure [2] which separates IaaS into three sub-modules namely IaaS itself, Hypervisor Monitoring Environment (HME), Resources as a Service (RaaS). (1) ***Software as a Service***: **SaaS** delivers the end-user applications. User-clients just use this service without the headache of running, maintaining, updating the software. It will help to get rid of cost complexity because end users need not to worry about all those things. Salesforce.com is example of SaaS. (2) ***Platform as a Service***: PaaS provides independent platform which has deployment capabilities and multi-tenancy (capable of running many application on single platform concurrently) architecture. The client has the freedom to create his own applications, which run on the provider's infrastructure. PaaS providers offer a predefined arrangement of OS and application servers [6]. Google Apps Engine is a common example of PaaS. (3) ***Infrastructure as a Service*: IaaS** acts as a service-provider of infrastructure on which RaaS may expand itself on-demand basis. It delivers operating systems and virtualization technology to manage the resources. It monitors how the physical resources are distributed for virtualization and how VMs should be placed so that the cloud service providers (CSP) and end users can retrieve the data & compute resources from the resource pool via Hypervisor Monitoring Environment (HME) in a efficient way. It's smarter to rent than to buy IaaS service because of price, aggregation of resources, speed to deployment, security. Amazon EC2, Rackspace are the common example of IaaS.

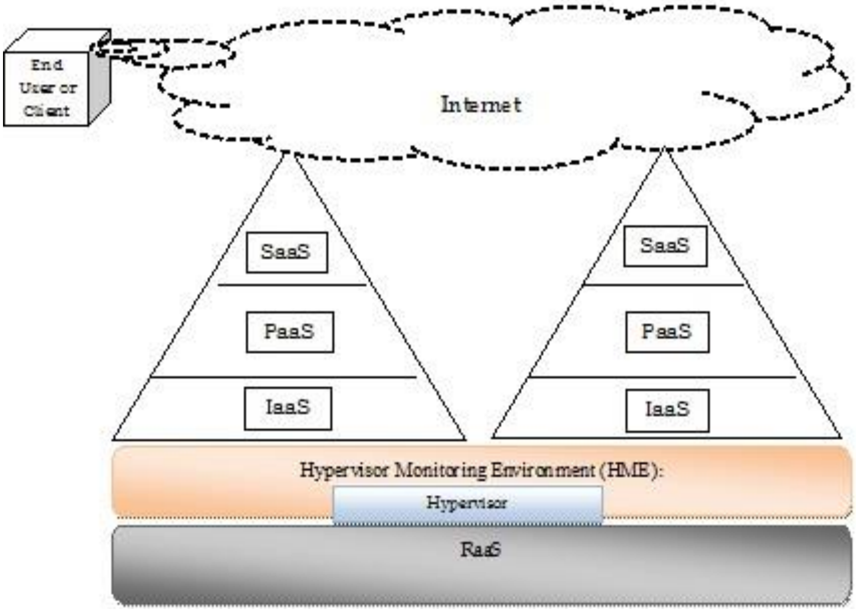

Figure 2. Enhanced Cloud Service

Meanwhile, (4) ***Hypervisor Monitoring Environment***: HME is like a middleware, which persists in between IaaS and physical resources. It consists of hypervisor and monitoring system. Hypervisor is a mainframe operating system, which allows other operating systems to run on the same system concurrently. And its monitoring system monitors the accesses of Virtual Machines. Let us consider a service scenario so that we can understand the usability of HME. Suppose an organization is in need of Infrastructure-based service. While requesting for data and resources, hypervisor is accessible in the booting time of the system to regulate the allocation of computer resources and hardware resources from the bottom-most layer i.e. RaaS across multiple VMs, which are lying in the IaaS layer. Hypervisors may be subcategorized in three types [4]:

- *Native Hypervisor*: This type of hypervisor resides directly on the hardware platform for getting better performance.
- *Embedded Hypervisor*: Those are integrated with processors on a separate chip for getting performance development.
- *Host Hypervisor*: those act as a separate software layer above both hardware & OS to gain performance improvement.

Furthermore, (5) ***Resources as a Service (RaaS)*****:** At the lowest level of the cloud stack, there would be a pool of physical Resources i.e. Servers, networks, bandwidth, storage, and data center space, which may be shared by multiple cloud providers. In this era of rapid growth of resources virtualization, from this pool of physical resources multiple vendors or the service providers may use the RaaS service on-demand basis.

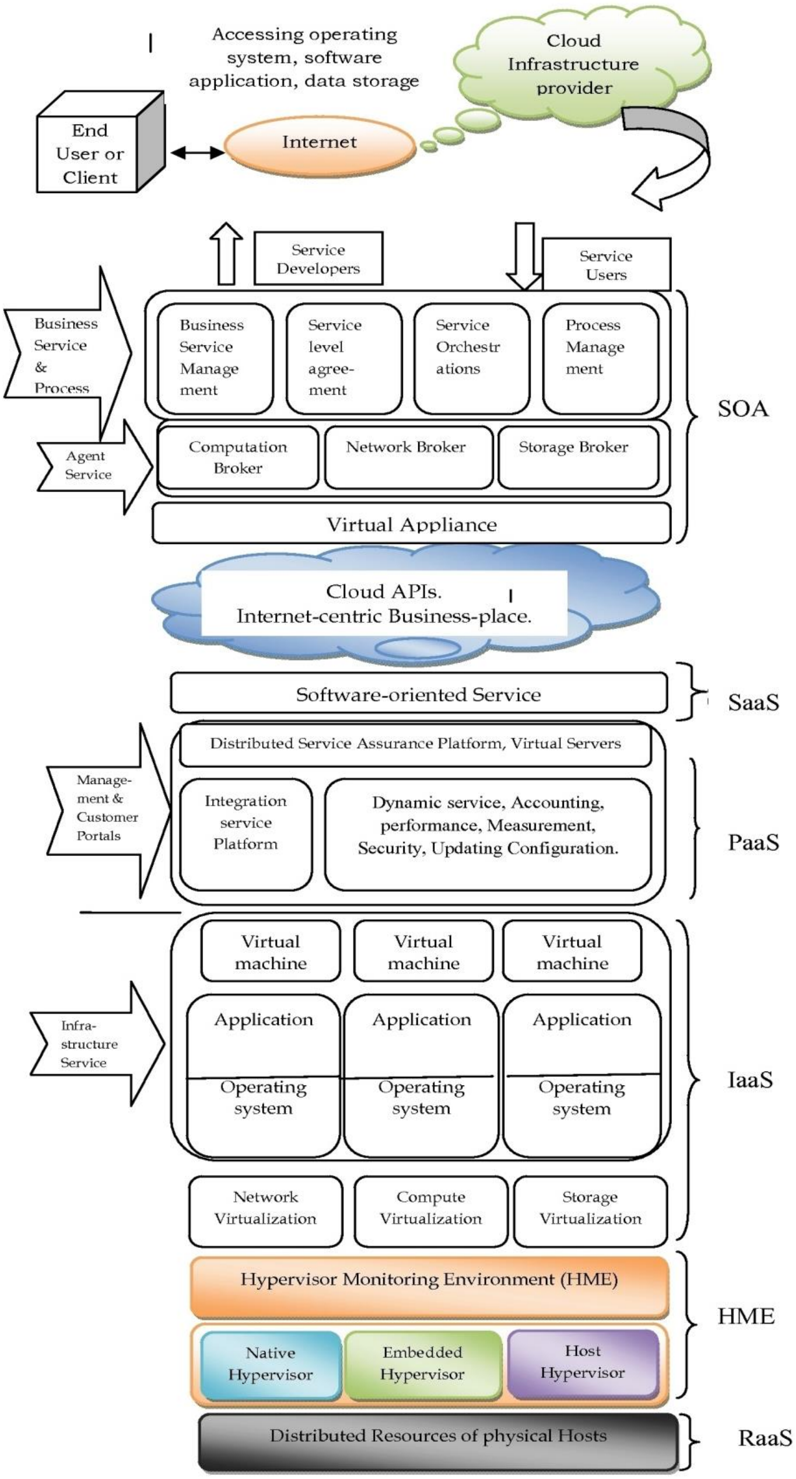

Figure 3. Cloud Hybrid Framework

5.1. Cloud Architecture

This section, deals with hybrid architecture issues of the cloud. Each cloud-client or end user or employee of an organization is accessing operating system, software application, network, bandwidth, storage via internet as shown in the figure [3]. The entire hybrid framework may be subdivided into two important layers [5] as Cloud Platform Architecture (CPA) and Cloud Application Architecture (CAA). In between CPA & CAA layer, there is a connecting layer which is cloud provider, associated with Cloud APIs and which is available in the Internet-oriented Business-place of IT industry. The significance of two layers is discussed below. (a) **Cloud Platform Architecture**: Cloud Platform Architecture is the base architecture of cloud, which includes the cloud-service oriented architecture. In CPA Reference model, we classified CPA model into following sub layers.

- Distributed Resources of physical hosts: Resources of physical hosts are distributed over the lowest level of the framework. These resources are logically represented as a multiple numbers of virtual machines (VMs) through resource-virtualization.
- Cloud Hypervisor: Cloud hypervisor is designed like a mainframe Operating System that allows other operating systems to run on the same machine concurrently. It monitors the accesses of guest Operating systems. Hypervisor monitoring Environment (HME) administrates the system by letting the guest node entering in the system and handling the memory management of the VMs. Ex.: VMware, Hyper-V, KMV, Xen.
- Resources Virtualization: The concept of virtualization is the most basic important Sub-block of the cloud framework. Virtualization is the process by which we can hide the underlying infrastructure by inserting a logical layer. The three basic resources i.e. computation, network and storage are virtualized and represented logically in this layer.
- Virtual Machines (VMs): multiple numbers of virtual machines are there to support multiple operating system and application instances. These VMs provides greater scalability, flexibility, better performance. Virtualization facilitate the providing and management of the dynamic data center's infrastructure. Virtualization provides the abstraction of the four computing resources (storage, processing power, memory, and network or I/O). Instead of dealing with a single computer, it aggregates resources from multiple computers and it presents a uniform view to the users and applications.
- Distributed Service Assurance Platform: This platform helps to create FCAPS-Oriented (Fault, Configuration, Account, Performance, Security) virtual servers [1] that allow hosting the operating systems and executing the applications. It provides dynamic service, Accounting, Performance optimization, enabling security, updating configuration.
- Software-oriented Service: This module provides ready-to-use software service. The end users have not to take any overhead for purchasing and maintaining the software. They just use the software services through this module**.**

Meanwhile, (b) ***Cloud Application Architecture*****:** Cloud Application Architecture is basically Service-Oriented-architecture (SOA), which helps user-clients to get their on-demand service. This reference model will help the service providers and end-users maintaining controlled access and dynamism in real-time applications. This architecture includes three sub-layers namely virtual appliances, agent-based layer and business service provider. Each of this sub layer as follows:

- ***Virtual Appliances*****:** Virtual Appliances run with the APIs of various Customer Service Providers (CSPs) or Platforms. It is an instance of Virtual Environment Extension (VEE). Cloud Applications are deployed as virtual appliances to make management better. Virtual Appliance configuration should be in such a way that the application and services are growing but management overheads would not be growing proportionally.
- ***Agent-based Layer*****:** In this layer, cloud agents are like brokers between virtual appliances layer and Business Service and Provider (BSP) layer. The main aim of the cloud agents is the optimal arrangement of VEEs into CSPs configured and managed by the service manager. They have the authority to move throughout the VEEs and also remote sites until arrangement is satisfied.
- ***Business Service Provider (BSP):*** BSP layer consists of Business Service Management (BSM), Service Level Agreement (SLA), Service orchestration, Process Management. BSP layer provides common infrastructure elements for service level management, metered usage, policy management, license management, and disaster recovery [3]. SLA is concerned about business-oriented agreement (SLA) and laws. Process management schedules and manage the processes.

5.2. Framework Constraint

Though cloud hybrid model provides good-quality service to the customers, in spite of that it has some constraints. (a) ***Dependability on hypervisor*****:** As hypervisor controls all the accesses of VMs and monitors the environment, so failure of the hypervisor or crashing of hypervisor or attack on it by the hackers may lead to performance degradation. (b) ***Standardize platform*****:** Each organization has their own APIs, services, policies. So in a cloud platform, it's quite difficult to maintain the combination of all those things from various organizations and also interoperability of all the applications is a mammoth task. (c) ***Energy-efficiency*****:** May cloud computing provide various types of on-demand services and running applications, but requires a lot of power. And hypervisor monitoring system also requires huge amount of electricity to monitor the accesses of VMs. So energy-efficiency is also a concern in cloud computing.

6. CONCLUSION

In surge of demand of Internet and its immense response all over the globe, the cloud concept came up. Our frame work for cloud computing incorporated some new phases to enhances its capabilities. The appropriate solutions for our framework constraints are the future scope of work.

REFERENCES

[1] V. Sarathy et al, "Next generation cloud computing architecture -enabling real-time dynamism for shared distributed physical infrastructure", 19th IEEE International Workshops on Enabling Technologies: Infrastructures for Collaborative Enterprises (WETICE'10), Larissa, Greece, 28-30 June 2010, pp. 48-53.
[2] P. Mell et al, "NIST definition of cloud computing", vol. 15, October 2009.
[3] Rajkumar Buyyaa, Chee Shin Yeoa, , Srikumar Venugopala, James Broberga, and Ivona Brandicc, "Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility", Future Generation Computer Systems, Volume 25, Issue 6, June 2009, Pages 599-616.
[4] Cloud computing for dummies-Wiley Publications, by Judith Hurwitz, Robin Bloor, Marcia Kaufman, Fern Halper.
[5] "Cloud Computing Architectures" by Huaglory Tianfield, 978-1-4577-0653-0/11/$26.00 ©2011 IEEE
[6] Sanjit Kumar Dash et al, "A Survey on Application of Wireless Sensor Network Using Cloud Computing", International Journal of Computer science & Engineering Technologies (E-ISSN:2044-6004), Volume 1, Issue 4, December 2010, pages 50-55.
[7] Jianfeng Yang et al, Cloud Computing Research and Security Issues, 978-1-4244-5392-4/10/$26.00 ©2010 IEEE
[8] June13, 2009, http://server.zol.com.cn/183/1830464.html.
[9] L. Silva and R. Buyya, Parallel Programming Models and Paradigms, High Performance Cluster Computing: Programming and Applications, Rajkumar Buyya (editor), ISBN 0-13-013785-5, Prentice Hall PTR, NJ, USA, 1999 .
[10] O'Reilly, T. What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software.
[11] Ghemawat, S., Gobioff, H., Leung, S.T.: The Google file system. ACM SIGOPS Operating System, Rev. 37(5), 43 (2003).
[12] Rajkumar Buyya, Chee Shin Yeo, Srikumar Venugopal. Market-Oriented Cloud Computing: Vision, Hype, and Reality for Delivering IT Services as Computing Utilities. In 10th IEEE International Conference on High Performance Computing and Communications, , September 2008.pp 5–13.
[13] Scott Hazelhurst. Scientific computing using virtual high-performance computing: a case study using the amazon elastic computing cloud. In SAICSIT '08: Proceedings of the 2008 annual research conference of the South African Institute of Computer Scientists and Information Technologists on IT research in developing countries, New York, NY, USA, 2008.ACM,pp 94–103.
[14] Naidila Sadashiv , S. M Dilip Kumar "Cluster, Grid and Cloud Computing: A Detailed Comparison", The 6th International Conference on Computer Science & Education (ICCSE 2011) August 3-5, 2011. SuperStar Virgo, Singapore, pages 477-482.
[15] K. Krauter, R. Buyya, and M. Maheswaran, "A Taxonomy and Survey of Grid Resource Management Systems for Distributed Computing", *Jr. of Software Practice and Experience*, 32,(2), pp. 135-164, 2002.
[16] M.Chetty and R. Buyya, "Weaving Computational Grids: How Analogous Are They with Electrical Grids?" , Computing in Science and Engineering (CiSE),4, pp. 61-71, 2002.
[17] Shuai Zhang et al "The Comparison Between Cloud Computing and Grid Computing" , 2010 International Conference on Computer Application and System Modeling (ICCASM 2010), V11-72 to V11-75.
[18] Hall, J.A.& Liedtka, L.L. "The Sarbanes-Oxley Act: implications for Large-scale IT outsourcing", Communications of the ACM, 2007, pp. 95-100

BIOGRAPHY OF AUTHORS

Souvik Pal
M.Tech Research Scholar, KIIT University, India.
Research Area : Cloud Computing and Virtualization.

Email id: souvikpal22@gmail.com

Dr. Prasant Kumar Pattnaik
Associate Professor, KIIT University, India
Senior member of IACSIT.
Research Area : MANET, Wireless Sensor Network, Cloud Computing.

Email id: patnaikprasant@gmail.com