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An Analysis of Important Issues Associated with Cloud Computing

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Abstract: **Cloud computing is a service based technology on internet which provides many facilities to the users to access plenty of resources on demand from anywhere and anytime in the world. Cloud computing mainly aims to give proficient access to the remote and geographically distributed resources. As cloud technology is evolving day by day it confronts many numerous challenges. This paper gives an overview of cloud computing and provides a concise but all-round analysis of important issues like scheduling issues, security issues, access control issues, multi tenancy issues, trust management , privacy issues etc.**

Keywords: **Access control, multi tenancy, power consumption, privacy, scheduling, trust management.**

I. INTRODUCTION

Over the past few years, cloud computing has become a trending research topic for scientific research. Cloud Computing ensures reliable, scalable, pay-per-use, customized and dynamic computing environments for end-users. Cloud computing offers high capacity storage and high performance computing from any location with internet access, while not requiring users to invest in new hardware or upgrade their software. Cloud computing is based on three computing concepts -Grid computing, Utility computing and autonomic computing [1]. Grid computing is a service provisioning heterogeneous distributed system that is used for executing the highly complex applications requiring huge processing power and massive amount of data. The renting of computing resources like network bandwidth, hardware and software on demand as per the requirement is known as utility computing. Autonomic computing means capability of self-management. Cloud computing is the combination of loosely coupled heterogeneous devices which are connected via internet providing the wide range of services according to the specifications mentioned in the service level agreement. Cloud has become a commercial commodity hence it is very important to consider the various quality of service parameters like cost, time, reliability and security while offering the services to clients to satisfy the customers. It has the efficiency to handle large loads with less cost investment. It is prominent technology which provides both hardware and software services along with storage facility as per user‟s request dynamically over the internet using the pay per usage model. Cloud computing is based on virtualization paradigm. It gives the illusion that the available resources are unlimited. This feature of "illusion of infinite resources" allows client to access the resources required for their needs anytime without thinking of reserving the resources for future [2].

Cloud computing has many benefits like scalability, elasticity, cost effectiveness, easy access reducing business risks and maintenance cost, due to which it has become a buzzword in many enterprise software such as banking, e-commerce etc.

Some of the most common cloud Service providers are Amazon, Google, IBM and Microsoft.

Cloud Computing Characteristics: According to NIST, the five essential characteristics of cloud are [3]:

On-demand self-service:

The clients can make use of the services provided by the cloud providers automatically whenever and anywhere they want without any delay, with no human interference with the cloud service provider.

Broad network access:

Cloud computing services like SaaS, PaaS and IaaS can be accessed by the client with the help of the many devices like smart phones, tablets, workstations, laptops having the internet facility.

Resources pooling:

The computing resources are shared using virtualization or multi-tenant model by creating unlimited resources via VMs in which a single physical resource is mapped into multiple logical representations (VMs). These VMs can be dynamically accessed by the multiple clients to fulfill their needs. It increases the resource utilization and saves the cost.

Rapid elasticity:

The computing resources can be scaled up and scaled down
according to business need in any quantity at any time. This gives an illusion to the clients that the resources are unlimited.

Measured service:
Cloud services are measured by cloud providers in order to charge the fee from the customers for amount of the services used. The computer services are monitored and controlled for the effective utilization of the resources.
Service Model: The cloud computing offers services in three ways namely Software as a service (SaaS), Platform as a service (PaaS), and Infrastructure as a service (IaaS) [3].
SaaS (Software as a Service): Applications are deployed over the internet for the clients in a single instance multi-tenant model and are accessed by various devices having internet capability through web browser or program interface. The client doesn‟t need to manage the underlying cloud infrastructure. It is one of the fastest growing services in cloud. Examples of SaaS providers include salesforce.com, Google Apps, Gmail, yahoo mail.
PaaS (Platform as a service): PaaS is a development tool which provides a collaborative platform that consists of database system, operating system, programming stacks and hardware for creating business applications easily and quickly without much cost. It is based on multi-tenant model. The client doesn‟t need to buy and maintain the underlying cloud infrastructure where as they have to work within the given platform constraints. Examples are Google App Engine, Force.com, Windows Azure, and Microsoft .Net Services. IaaS (Infrastructure as a service): IaaS is a way to provide computing infrastructural resources (VMs) rather than buying them online in multi-tenant fashion on pay per usage basis. It is used where high performance and high scalability is required. Examples are Amazon EC2, GoGrid, Rackspace and Flexiscale .

Deployment Models: A cloud system can be deployed using four types of models on the basis of size, ownership and access [3].
Public cloud: The cloud is hosted by a vendor organization that provides services to other organizations on demand. It is a true cloud. The customers don‟t know where the server is hosted geographically and don‟t have control on it. It is less secure but cost effective and scalable than private clouds. An example of public cloud is Google which provide free services.
Private cloud: The private cloud is dedicated to a single organization and is managed by the same organization or some third party. It is not cost effective but very secure. Hybrid cloud: Hybrid cloud is a combination of public and private enjoying the security advantage of private cloud and cost advantage of public cloud. It is also used for handling less sensitive, high load applications which may not be controlled by private cloud.
Community cloud: Community cloud is a cloud that is shared by various groups and organization which are having similar concerns. It has the features of public cloud like multi-tenant model, pay per usage model along with added security benefit.

Features of Cloud Computing:
Resource Pooling: In cloud computing resources are pooled to serve large number of customers. Cloud computing uses multi tenancy where different resources are dynamically allocated and de-allocated according to demand.
Self service and on demand service Cloud computing is based on self-service and on demand service model. It should allow the user to interact with the cloud to perform tasks like building, deploying, managing and scheduling.
Scalability: It is an ability of a computer application or product to continue to function well when it is changed in size or volume in order to meet a user need.
Virtualization: Virtualization is the creation of a virtual version of something, such as a server, a desktop, a storage device, an operating system or network resources. Virtualization is a technique which allows sharing a single physical instance of a resource or an application among multiple customers and organizations. It does by assigning a logical name to a physical storage and providing a pointer to that physical resource when demanded.
Quality of Service: Every user wants best QoS for its application. QoS is the ability to provide different priority to different jobs or to users onto guarantee a certain level of performance to a job.
Performance: Performance of Virtual machines in cloud depends on various kinds of scheduling techniques used for scheduling the tasks.

II. ISSUES RELATED TO CLOUD COMPUTING

A. Access Control Related Issues*:*
Access control service allows or denies access to the system. Access control plays important role in monitoring the events occurring to access the system. It provides system security. Since system is vulnerable hence access control becomes one of the serious issues in cloud computing.

I. An Integrated Privacy Preserving Attributes Based Access Control Framework:
This paper [12] proposed an approach which includes privacy preserving revocable cipher text policy attribute based encryption (PR-CP-ABE) scheme. This scheme has new features like user centric data and policy management, immediate privilege revocation and privacy protection etc. The proposed framework satisfies security and privacy requirements. This paper also proposed a protocol called extended PATH-ORAM protocol which addresses access pattern privacy as user access the protected data on cloud.

II. Access Control in Cloud Computing:
This paper [13] represents many access control methods such as Mandatory Access Control (MAC), Discretionary Access Control (DAC), Role Based Access Control (RBAC), Attribute Based Access Control (ABAC), and Identification Based Access Control (IBAC).

Sr. No.	Method	Year	Pros	Cons
1	An integrated privacy preserving attributes based access control framework	2016	Satisfies security and privacy requirements and shows good performance in terms of communication cost	Still not implemented in real life environment, not applicable in mobile applications
2.	Access control in cloud computing	2012	Provides a brief survey of some access control mechanisms	No new issues highlighted

B. Multi Tenancy Related Issues:
Whether an IT organization is going with public or private clouds, it's important to understand the nuances of multi-tenant architecture. For public clouds, IT managers need to understand the degree of multi-tenancy supported by whichever vendor they are looking at. For private clouds, the entire responsibility of designing a multi-tenant architecture rests with the IT managers. Multi tenancy issues refer to resource sharing, security isolation and lack of flexibility for user interface.

I. Multi Tenancy Issues in Cloud Computing For SaaS Environment:
The characteristics of multi tenancy are used in cloud computing systems for business purpose. This survey paper [14] tells that in multi tenancy there are other issues also which are related such as security isolation, resource sharing and lack of flexibility for user interface issues.

II. A Data Center Virtualization Framework towards Load Balancing and Multi-Tenancy:
This paper [15] proposed a virtualization framework that considers two problems multi tenancy and load balancing simultaneously. This framework achieves load balancing using an elaborately designed link establishment algorithm. This framework generates multi-tenancy oriented private clouds, which offers great flexibility to cloud users.

Sr. No.	Method	Year	Pros	Cons
1.	Multi-tenancy issues in cloud computing for SaaS environment	2016	Supports multi tenancy	Not useful of typical cloud which have inactive users
2.	A data center virtualization framework towards load balancing and multi-tenancy	2016	Provides load balancing and multi tenancy	Needs complex network

C. Power Consumption Related Issues:
In general researchers don"t give much attention to energy consumption in data centers since cloud computing is more often praised for its other features. Some researchers found that transporting data between data centers and home computers can consume even larger amounts of energy than storing it.

I. A Comparative Study on Performance of Energy Efficient Load Balancing Techniques in Cloud:
This paper [18] presents a comparative analysis in terms of performance among various load balancing techniques like WFCFS weighted first come first serve, Round Robin. It considers metrics like energy consumption, processing cost and execution and response time and processing cost. It finds the most optimal load balancing solution. In this paper load balancing techniques applied at cloud data centers which minimize massive energy consumption by high speed servers and storage devices by uniformly distributing the workload amidst all servers and unevenness in resource distribution. The performance of data centers having load balancer has improved and saves

energy consumption. As future work this framework can be used to model the green cloud data center with live migration of virtual machines and thereby avoid overload.
II. Prediction Method about Power Consumption by Using Utilization Rate of Resource in Cloud Computing Environment: Since prediction is not sufficient in real cloud computing environment but this paper [19] proposed a prediction method about power consumption by using utilization rate of CPU, Memory, and Hard Disk. Prediction is based on some parameters given in this paper. It improves accuracy of our prediction method. In this paper a CPU test is performed to compare and analyze predictive power consumption and actual power consumption.

III. BEE-MMT: A Load Balancing Method For Power Consumption Management In Cloud Computing: This paper [20] proposed a new load balancing method "artificial bee colony algorithm-minimal migration time". It declines the power consumption because of this reason 2 production and operational cost gets decreased. This algorithm utilized hosts and then migrate one virtual machine from them to reduce hardware utilization. This paper gave better results than other existing methods like NON-POWER AWARE, LR-MMT and MAD-MMT.

Sr. No.	Method	Year	Pros	Cons
1.	A comparative study on performance of energy efficient load balancing techniques in cloud	2016	Minimizes energy consumption processing cost, execution and response time,better resource utilization	Needs an Energy efficient resource provisionig framework to model the green cloud data center.
2.	Prediction Method about power consumption by using utilization rate of resource incloud computing environment	2016	Error rate Between predictie And actual power consumption is 4.22% in CPU test	Still some Studies are needed to reduce time error.
3.	BEE-MMT: A load balancing method for power consumption management in cloud computing	2013	Reducing energy consumption in cloud computing, SLA violation less than other methods, less CO2 production, requires less no. of VM migrations	Needs to study trade-off between energy consumption and SLA violation

D. Scheduling Related Issues:
Scheduling is a procedure to assign the tasks to the best possible resources in order to give the quality of service (QoS) as demanded by the customers. Efficient scheduling is very important as it can enhance the overall performance and throughput of the system considerably. Classification of task scheduling is done on the basis of dependency and on the basis of time at which scheduling decision is made. It is broadly classified into two categories: Independent (job based) and dependent (workflows). In independent scheduling, tasks can run independently whereas workflow scheduling, tasks are dependent on each other. Dependency means that there exists precedence order between the tasks, which means that a task cannot be started until all its parent tasks are done. Scheduling is of two kinds: static scheduling and dynamic scheduling. In static scheduling, at compilation time information such as dependencies between tasks, their execution time and data size is known beforehand. Dynamic scheduling is considered to be more systematic as the allocation of the task is done at the run time because the information related to the communication costs, execution details and the task dependencies are known at run time. In cloud computing environment scheduling of tasks is very important. If not handled properly it may increase execution cost and the execution time of tasks. Also it may decrease the performance of virtual machines in cloud server which may not be acceptable from business point of view. Many researchers

have proposed no. of scheduling algorithms. Some of them are given below:

I. A Constraint Programming Scheduler for Heterogeneous High-Performance Computing Machine:

This paper presents a constraint programming technique used scheduler [4] which improves the results obtained from commercial schedulers. It was implemented to make it usable on real life high performance computing setting. The scheduler works well in both simulated and real HPC environment. This scheduling algorithm ensures robustness, flexibility and scalability.

II. Cost Effective Genetic Algorithm for Workflow Scheduling in Cloud under Deadline Constraints:

Most of the research papers mainly focused on minimizing finishing time (make-span) or minimization of cost considering quality of services. But they don‟t consider virtual machine performance and acquisition delay. This paper proposed a meta –heuristic cost effective genetic algorithm (CEGA)[9] that minimizes the execution cost of the workflow while meeting the deadline in cloud computing. It considers many characteristic of the cloud such as heterogeneity, on demand resource provisioning etc. Also it handles some major issues such as VMs performance variation and booting time. The simulation experiments conducted on four scientific workflows (Montage, LIGO, CyberShake, Epigenomics) and exhibited better performance than current state of art algorithms. The proposed CEGA exhibits the highest hit rate for deadline constraint.

III. Cost Minimized PSO Based Workflow Scheduling Plan For Cloud Computing:

This paper uses Bi-criteria Priority based Particle Swarm Optimization (BPSO) [7]. It schedules workflow tasks over the cloud processors under deadline and budget constraints. Priority is assigned to each workflow‟s task using bottom level. It decreases the execution cost of schedule as compared to state of art algorithm [8] under the same deadline and budget constraint while considering the load on resources too.

IV. List Scheduling Algorithm for Heterogeneous Systems by an Optimistic Cost Table:

This paper introduced a new list scheduling algorithm [6] with less time complexity than HEFT algorithm. It can be assumed as improved version of HEFT algorithm. This algorithm is based on a matrix called Optimistic Cost Table (OCT) which is computed before scheduling. This cost table represents for each pair of (task, processor) the minimum processing time of the longest path from the current task to the exit node by assigning the best processors to each of those tasks. The term „optimistic‟ means it does not consider the availability of processor (virtual machine). Cost table values are used for processor selection whereas in case of HEFT we consider only EFT of scheduled task.

V. Performance Effective And Low Complexity Task Scheduling For Heterogeneous Computing:

This paper presented an algorithm [5] called HEFT which is a viable solution for the DAG scheduling problem on heterogeneous systems. HEFT algorithm works in two phases: task prioritizing phase and processor selection phase. Processor selection phase tries to minimize the earliest finish time of the critical child task of each selected task.

Sr. No.	Method	Year	Pros	Cons
1.	A Constraint Programming Scheduler for Heterogeneous High-Performance Computing Machines	2016	Implements all the features to make it usable in real life high performance computing	Some improvements are still pending like uncertainty on execution
2.	Cost Effective Genetic Algorithm for Workflow Scheduling In Cloud under Deadline Constraints:	2016	Minimizes execution cost while meeting deadlines	Still termination delay of virtual machinesis uncovered
3.	Cost Minimized PSO based Workflow scheduling plan for cloud computing	2015	Minimizes execution cost & meets deadlines	Canbe improved by merging BPSOwith dynamic heuristics
4.	List Scheduling Algorithm for Heterogeneous Systems by an Optimistic Cost Table	201 4	Gives improved results than HEFT, less time complexity than HEFT	Exhibitsthe best performance only for the static scheduling of DAGs,not performs better in

5.	Performance Effective And Low Complexity Task Scheduling For Heterogeneous Computing	2002	Minimizes earliest finish time, CPOP makes task prioritizing easy	Applicable onlyin connected network, some bounds on degradation of

E. Security and Privacy Related Issues:

Security and privacy are key issues in cloud computing. While the cloud may be flexible and cost-efficient, a lack of data safe guards and compliance standards makes security the largest hurdle to leap. Cloud computing services are relatively new, yet data breaches in all forms have existed for years. The question remains: "with sensitive data being stored online rather than on-premise, is the cloud inherently less safe? ". The growth and implementation of the cloud in many organizations has opened a whole new set of issues in account hijacking. Attackers now have the ability to use your login information to remotely access sensitive data stored on the cloud. An attack from inside your organization may seem unlikely, but the insider threat does exist. Employees can use their authorization to an organization‟s cloud based service to misuse or access information such as customer accounts, financial forms, and other sensitive information. The malicious code can be injected into cloud service and viewed as part of the software or service that is running within the cloud servers themselves.

I. Security and Privacy Issues In Cloud Computing:

This paper [10] presents a survey about major issues related to security and the privacy of data stored in cloud. It includes data confidentiality issue in which user has to ensure that his information including physical memory, CPU, platform, data and applications are not compromised access by any other users. Mostly data integrity and privacy are key concern for security issues. It also explains some situations in which confidential data of users is disclosed to cloud provider. This paper also summarized data availability issues, data integrity issue, data locality issue and many security threats like traffic hijacking, insecure interface and APIs, Denial of service etc. this paper also gives solution for various security issues. Hence we concluded that there are many vulnerabilities for cloud security.

II. Cloud Computing Features, Issues And Challenges, a Big Picture:

This paper [11] demonstrate the architecture of cloud computing, various deployment models, service models and features of cloud computing such as scalability and virtualization etc. it mainly focused on security issues in cloud.

Sr. No.	Method	Year	Pros	Cons
1.	Security and privacy issues in cloud computing	2016	Covers most of the issues related to data integrity and privacy	Risk of being accessed by multiple unauthorized users.
2.	Cloud Computing Features, Issues And Challenges, a Big Picture	2016	Covers various issues in SaaS, PaaS, IaaS.	Handling uncertainties is still a big challenge.

F. Trust Management Related Issues:

Trust management means the level to which an organization can trust the cloud service provider for handling their company‟s data. As we know that preserving consumers‟ privacy is very important task because of sensitive information. There are many challenges in building trust between cloud consumer and service providers.

I. Survey Paper on Trust Management and Security Issues In Cloud Computing:

This survey paper [16] includes the various situations creating while going for cloud service. It tells that while using cloud service trust and data security is very much necessary.

II. Supporting Reputation-Based Trust Management For Cloud Services:

This paper [17] introduced a framework called reputation based trust management framework which provides a set of functionalities to deliver trust as a service which includes the feedbacks from the consumers.

Sr. No.	Method	Year	Pros	Cons
1.	Survey Paper on Trust Management and Security Issues In Cloud Computing	2016	Summarizes the theoretical	Lacks of new ideas
2.	Supporting Reputation-Based Trust Management For Cloud Services	2016	Applicable in real world detects malicious attacks	Performance optimization is still pending , reputation & recommendation techniques can be combined to increase trust result

CONCLUSION

This paper highlights that along with plenty of advantages that are inherent in cloud computing there are many important issues which must be handled carefully. We presented an overview of cloud computing, its benefits and classifications. This work provides an analysis of the work done so far on various important issues associated with cloud computing.

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