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# Cloud Computing Implementation: Key Issues and Solutions

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***Abstract – To meet ever-changing business needs, organizations are required to invest time and budget to scale up IT infrastructure such as hardware, software and services. However with own premises and investment in IT infrastructure scaling process can be slow and costly. Moreover, even if organizations scale up their IT infrastructure, these are hardly able to achieve the optimal utilization of the same. This has been a major hurdle in organizations decision to invest huge capital and resources for scaling up its operations. All this has forced companies to continuously look for innovative solutions in the form of new technological solutions that are easy as well as cost effective. One such technology that has come as a boon today is cloud computing. “Cloud computing” is a paradigm shift to provide computing over the internet. It implements Service Oriented Architecture (SOA) resulting in less investment on IT infrastructure, rapid elasticity and finally reduced total cost of ownership. However, implementing Cloud Computing is not so easy and there are lot of issues that may need to be taken care of before it can deliver intended benefits. Unfortunately, there is not enough of research available which has researched various implementations issues in a structured way.***

***In this paper, we have made an attempt to understand the concept of cloud computing in detail and tried to structure major issues that may arise while implementing cloud computing after reviewing the literature thoroughly. Further, apart from identifications of these key issues, possible solutions as suggested by the practitioners have been also been discussed.***

***Keywords – Cloud computing, Implementation issues, rapid elasticity, scaling process.***

## I. INTRODUCTION

To meet ever-changing business needs organizations are required to invest time and budget to scale up IT infrastructure such as hardware, software and services. However with own premises and investment IT infrastructure scaling process can be slow and costly. Moreover, even if organizations scale up their IT infrastructure, these hardly are able to achieve the optimal utilization of the same. This has been a major hurdle in

organizations decision to invest huge capital and resources for scaling up its operations. All this has forced companies to continuously look for innovative solutions in the form of new technological solutions that are easy as well as cost effective. One such technology that has come as a boon today is cloud computing.

Cloud computing is a paradigm shift to provide computing over the internet. The cloud computing has various technologies as its antecedents like client/server computing, peer to peer computing, distributed computing, cluster and grid computing. All efforts in the antecedent's technologies were made towards high performance computing with the aim of optimal utilization of resources.

Cloud computing is a recent trend in IT that moves computing and data away from personal computer and desktops to large data storages called data centers. Deliver applications as a service. [2]. It is the next step after Grid computing in the evolution of on-demand and pay-as-per-use model. [1]

Cloud concept assures a cost-effective realization of utility computing, allows availing services in a pay-as-you-go fashion, thus decreasing cost and improving resource utilization. The cloud has made a major impact on the IT ecosystem, giving rise to new markets and new user's communities. [3]

This has been divided into two parts. The first part brings out in-depth understanding of cloud computing by defining it, enlisting its essential characteristics, discussing NIST model. The second part of the paper deals with clear identification of issues that may arise while implementing it in an organization. Further, the current practices to address these issues have been discussed. In nut shell, the major contributions of this paper are –

- Developing in-depth understanding of cloud computing and NIST Model.
- Exploring major issues in the implementation of cloud computing and solutions till now in the practice.

## II. UNDERSTANDING CLOUD COMPUTING AND NIST MODEL

The most popular and suitable definition of cloud computing is provided by the National Institute of Standards and Technology (NIST) in 2009 and updated the same in 2011. According to this definition -

“CLOUD computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This CLOUD model is composed of five essential characteristics, three service models (Software / Platform / Infrastructure as a Service), and four deployment models, where the five characteristics are: on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service. The deployment models include private, community, public and hybrid CLOUD”. [4]

“A 'CLOUD' is an elastic execution environment of resources involving multiple stakeholders and providing a metered service at multiple granularities for a specified level of quality (of service)” [5]

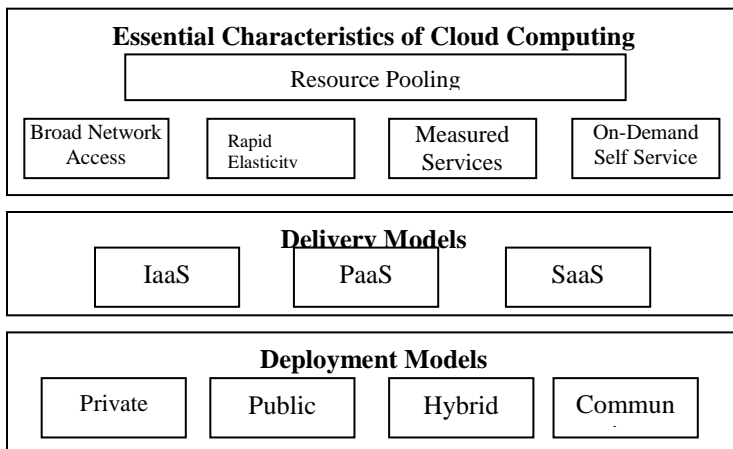


Fig. 1. NIST Cloud Model [6]

The one of the major users of Cloud Computing networks in U.S., National Institute of Standards and Technology (NIST) has introduced some set of working definitions.

#### A. Essential Characteristics

There are five most important characteristics of cloud computing-

- Resource pooling* – The provider’s computing resources are pooled together to serve multiple consumers using multi-tenant model.
- Broad Network Access* – Cloud capabilities are available over the network and accessed through any client.
- Rapid Elasticity*- Cloud services can be easily scaled out or in according to the requirements.

- Measured Services*- Cloud computing services use metering capabilities which enables to control and optimize resource utilization. [6]
- On-Demand Self Service* – All the services such as email, storage are provided without requiring any human interaction.

#### B. Delivery Models

- Software as a Service (SaaS)* - It refers to a software that is deployed on a hosted service and is accessible via internet. The major advantage of this is that consumers can customize their applications without affecting the core functionality [7,8].
- Platform as a Service (PaaS)*- provides organization with platform or runtime environment to create and deploy runtime applications. Here the organization is only responsible for development, maintenance and management of the applications.
- Infrastructure as a Service (IaaS)* – Provides access to fundamental resources such as physical machines, virtual machines, virtual storage etc.[6]

#### C. Deployment Models

- Private cloud* –This infrastructure is operated solely for a single organization.
- Public cloud*- This infrastructure is available for public use. It is generally owned by a 3<sup>rd</sup> party Cloud Service Provider (CSP).
- Hybrid cloud*- A “Hybrid” combines 2 or more clouds of public or private or community, where those clouds retain their unique identities.
- Community cloud*- The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations).

### III. RESEACH CHALLENGES

Whenever any technology comes in, it brings in some benefits as well as some challenges with it. This is true in case of Cloud Technology also. Given the potential benefits that Cloud Computing brings, Organizations have been more than willing to embrace Cloud Computing. But in today’s rat race, everyone has looked at the benefits only and has largely ignored potentials pitfalls. Like issues of standards availability, bandwidth bottleneck, security etc. These challenges are coming in front now and organizations have started taking note of them.

However, these challenges are mentioned in tits n bits spreading across diverse literature. The journals on which literature on cloud is available, largely pertains to journals in different computer science fields. The research done so far provides some idea about issues in various areas. Some

researchers have done the work on issues about security; some have done about SLA (Service Level Agreement) etc. In short lots of literature is available regarding cloud computing issues but no literature is available that will give a holistic view of the major issues while implementing cloud computing. If a company today, implements Cloud, it won't be able to find a structured listing of these potential challenges it may face, leave alone finding solutions to these problems.

### IV. KEY ISSUES AND CORRESPONDING SOLUTIONS

In this section we have listed all the major issues generally faced while implementation and working with cloud. We have also tried to search out and discuss best solution, which may be used to resolve them

#### A. License Management

License Management in Cloud Computing focuses on ability to move applications from one virtual environment to another. It also includes license mobility for applications and Operating Systems from one virtual environment to another. In cloud environment some licensing structures are un-user friendly due to major differences in technologies. One of the major problem that is observed is lack of standards based practices which describe license management [21].

There are some popular approaches to license management in cloud now days in practice –

- Sourcing Management – this approach attempts to minimize the need for license management by choosing generally free and open source software.
- Contractual approach – this approach minimizes the need for license management by assigning such responsibilities to another party, which is generally outsourcer.
- Mash up approach – it is a mix of tools and approaches. Generally this approach is used in corporate, but has inefficiencies that is why not very successful.

#### B. Load Balancing

As we know that cloud are a large number of resources on internet and we can use these resources by paying something called as Pay-as-you-go model [5]. We pay amount according to the services we require either it is a computational service or storage service. The issue that comes in the site is of load balancing and scheduling of machines and resources. In cloud there are number of resources and number of machines to serve the request. Whenever any request comes to the provider it is assigned to the machines by a scheduler. Sometime it happens that

due to large number of request or in peak hours some nodes gets overloaded in comparison to other, which further affect the overall performance of the cloud. Traditional techniques of scheduling will not work because the numbers of users are large and heterogeneous [9].

To solve this issue, various algorithms have been developed by researchers. Few most commonly used and discussed algorithms are – Min-Min, Max-Min, Min-Max, RASA, heuristic algorithms for dependent task etc.

#### C. Automated Service Management

Because cloud provides Pay-as-you-go model, i.e. user may vary demand of service and resources according to the requirement. These requirements can be increased or decreased sometimes. Therefore, cloud model should be able to deal with these elastic flexibilities [10].

The lot of research has been already done in this regard for dynamic resource provisioning. The typical approaches used are – construct the application by predicting the demand at each level, periodically predict future demand etc. [11, 12].

#### D. Security of Data

Since data is stored on the cloud, therefore, security i.e. whether on 3<sup>rd</sup> party data is secure or not, is one the most important concern. Service providers do not have access to the physical data centers. They must rely on infrastructure provider to provide full data security. For this generally layered security is provided at every architectural layer of the cloud. Like 1<sup>st</sup> the hardware layer must be trusted using hardware Trusted Platform Module. Then virtualization platform must be trusted using secure virtual machine monitors.[13]

#### E. Data Lock-In and API Design

API is called as Application Programme Interface through which a user can interact with the service provider. These are usually in the form of web pages. Every service provider has different kind of APIs and their formats. There are lots of users so we have keep in mind that all the APIs that are visible to the users should be user compatible. The cloud client can be window based, Linux based or from any other environment.

The solution to the mentioned issue could be standardizing the APIs so that SaaS developers could deploy services and data across multiple cloud computing providers and can be accessed by any type of client.

#### F. Cloud to Cloud federation and Interoperability

The cloud federation implies the creation of group of aggregated providers that are mutually collaborating to share their resources in order to improve their services [14]. As in our day to day life utilities like electricity, water, telephony are interconnected in the similar way cloud interoperability is also important not only for the protection of the user investments but also for realization of computing as a utility.

There are two approaches to obtain interoperability in practice [15]–

1. Developing broker of services, which translates message between different cloud interfaces.
2. Standard interfaces

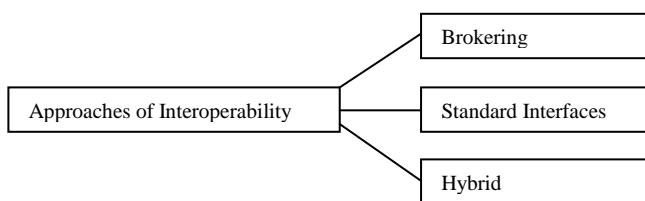


Fig. 2. Cloud Interoperatable approaches [16]

#### G. Bandwidth Requirement

Although the cloud computing is the technology which revolutionize the IT on demand basis, but the most evident bottleneck of this technology is Bandwidth. When you have dozens of users and all are trying to use cloud resources, when some high transaction process wants to contact to the data center the network speed gets down or halts. There are various solutions provided by various companies and researchers. Some are [17, 18]–

- When the traffic is increased, some cloud provider directs the traffic to the nearest servers.
- High performance edge routers can be used through which operators can efficiently manage the traffic. The edge routers are capable of processing large number of cloud packets.
- In the particular area the WAN traffic can be diverted using Optical fibers. But it will also increase the cost.

#### H. Mobile cloud

It is concerned with applications and data accessibility and usage through mobiles. So how to use cloud concept for mobile devices is another major issue? When we merge cloud computing with mobile then we can call it Mobile Cloud Computing. It is a mobile computing technology that uses unified elastic resources of different clouds and network technologies to provide mobile user with high computing power and storage capacity with limited

resources in hand, and is based on the “pay-as-you-use” principle [19]. The major challenge that occurs due to the structural limitations of mobile devices from the user’s point of view is that whether the technology can provide the service that has been requested by a customer/user or not? without compromising the service quality and optimal resource utilization. The solution for this Elastic Mobile Apps [20], which are used to deal with this condition as these applications and can be launched on the device.

#### I. Availability of Service

Whether a particular service or resource demanded by a user is available on the cloud or not is also an issue. For example if user wants to access Google for search and it is not available, they can think that internet is down or not working. Despite the company has number of data centers and server, even then it may go out of business due to unavailability of services [18]. The only and plausible solution to this can be multiple cloud computing providers i.e. no single source of failure is allowed.

### IV. CONCLUSION

With the advancement of technology, every person demands for optimum service yet with minimum usage of resources. Cloud computing has recently emerged as a compelling paradigm for managing and delivering services over the Internet. Organization can simply connect to the cloud and use the available resources on the paper use bases. This avoids company a capital expenditure for additional on premises infrastructure and resources. However, implementing Cloud Computing is difficult and involves lot of challenges. Unfortunately, there is not enough of research available which has researched various implementations issues in a structured way.

In this paper we have made an attempt to bring a more detailed understanding about cloud computing through discussing essential characteristics of cloud computing, deployment models and delivery models. Apart from this, one of the major contribution of this paper is to structure and present key issues and challenges faced in the implementation of cloud computing and given some practices used as a solution to resolve the same. We hope that our work will provide better understanding about the issues while implementing cloud computing.

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