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Cloud Computing –Its Prospects and Challenges

[1]Mrs.Papri Das, [2]Dr. Pravin Bhatawala
[1,2]*School of IT, AURO University of Hospitality and Management, Surat, India*

Abstract: *The extensive use of information and communication technology has transformed manufacturing organizations and economies into information centric and customer focused organizations. In present times, the information about a product or customer has become as valuable to the company as the product or service. However gaining information is an evolutionary process which begins with collection and storage of data to analysis and processing which is transformed into knowledge. It is this knowledge that is mission critical for organizations and their success.*

It is extremely vital for an organization to ensure that at no point of operation, the data which enables it with this knowledge is compromised. To ensure this the organizations invest a significant volume of their capital to set up an IT infrastructure to Preserve, Process and Protect this most valuable asset to an organization in present paradigm, its data. However for a small and medium sized company it is extremely demanding to implement the fundamentals of this new information based economy as it requires a significant investment upfront. For such organizations choosing cloud computing is a cost effective alternative but with obvious concerns.

Cloud Computing offers the opportunity to access IT resources and services with appreciable convenience and speed. Whilst cloud computing is gaining growing popularity in the IT industry, it also meets with some challenges like data security, integrity, availability. This paper discusses the concept of "cloud" computing and its prospects and challenges. The benefits of cloud computing has led increasingly many enterprises to outsource their IT resources tothe cloud, despite some challenges. The main contribution of this paper is that we discuss challenges that organizations which want to migrate to cloud faces.

Key words: *cloud computing, cloud technologies, service.*

I. Introduction

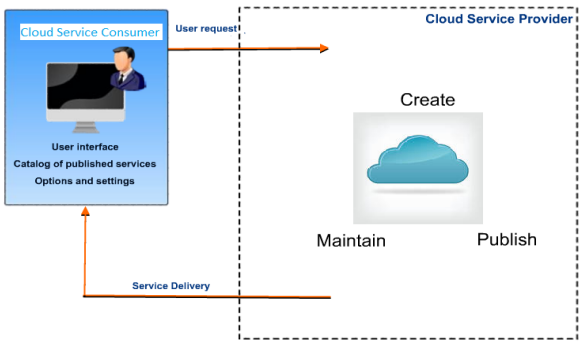

Figure 1 cloud computing infrastructure

Cloud computing is the next generation in computation. A cloud is referred to computing infrastructure for a representation of network. From the perspective of providers, the main characteristics of cloud computing is being dynamic, high power in computing and storage.Maybe Clouds can save the world; possibly people can have everything they need on the cloud. Cloud computing is the next natural step in the evolution of on-demand information technology services and products. The Cloud is a metaphor for the Internet, based on how it is depicted in computer network diagrams, and is an abstraction for the complex infrastructure it conceals. It is a style of computing in which IT-related capabilities are provided "as a service", allowing users to access technology-enabled services from the Internet (i.e., the Cloud) without knowledge of, expertise with, or control over the technology infrastructure that supports them.

II. Definition

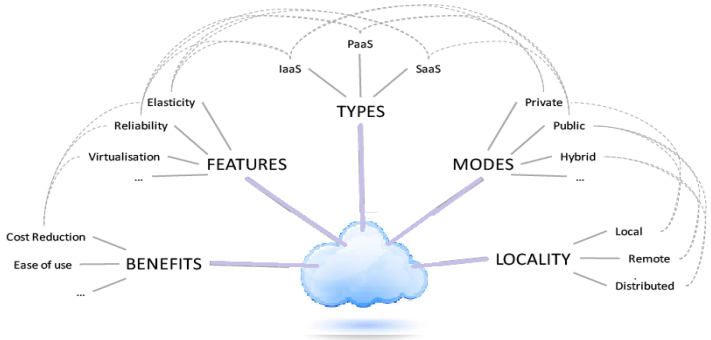

Figure 2 classification of cloud computing

Though there are myriad ways of defining the phenomenon of cloud computing, we put forth the one coined by NIST [1]. According to them, cloud computing is defined as "A model for enabling convenient, on-demand network access to a shared pool of configurable computing re- sources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [2]. Loosely speaking, cloud computing represents a new way to deploycomputing technology to give users the ability to access, work on, share, and store information using the internet [3]. The cloud itself is a network of data center, each composed of many thousands of computers working together that can perform the functions of software on a personal or business computer by providing users access to powerful application, platforms, and services delivered over the internet. It is in essence a set of network enabled services that is capable of providing scalable, customized and inexpensive computing infrastructures on demand, which could be accessed in a simple and pervasive way by a wide range of geographically dispersed users.

Thus, Cloud Computing provides the users with large pools of resources in a transparent way along with a mechanism for managing unnecessary performance overhead. The ideal way describe cloud computing then would be to term it as "Everything as a Service" abbreviated as XaaS[4]. Below, we sum up the key feature of cloud computing:

- Agility-helps in rapid and inexpensive provision of resources.
- Location Independence-resources can be accessed from anywhere and everywhere.
- Multi-Tenancy-resources are shared amongst a large pool of users.
- Reliability-dependable accessibility of resources and computation.
- Scalability-dynamic provisioning of data helps in avoiding various bottleneck scenarios.
- Maintenance-users (companies/organization) have less work in terms of resource upgrades and management, which in the new paradigm will be handled by service providers of cloud computing.

However, cloud computing doesn't imply that it consists of only one cloud. The term "cloud" symbolizes the Internet, which in itself is a network of networks. Also, not all forms of remote computing is cloud computing. On the contrary, cloud computing is nothing but services offered by provides who might have their own systems in place [5].

III. Review of literature

The literature has a range of diverging definitions for cloud computing. The US National Institute of Standards and Technology (NIST) [1]has developed a working definition that covers the commonly agreed aspects of cloud computing. The NIST working definition summarizes cloud computing as:

A model for enabling 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 [1]

This definition describes cloud computing as having five essential characteristics. The essential characteristics are:

- On-demand self-service: Computing resources can be acquired and used at any time without the need for human interaction with cloud service providers. Computing resources include processing power, storage, virtual machines etc.

- Broad network access: The previously mentioned resources can be accessed over a network using heterogeneous devices such as laptops or mobiles phones.
- Resource pooling: Cloud service providers pool their resources that are then shared by multiple users. This is known as multi-tenancy where for example a physical server may host several virtual machines belonging to different users.
- Rapid elasticity: A user can quickly acquire more resources from the cloud by scaling out. They can scale back in by releasing those resources once they are no longer required.
- Measured service: Resource usage is metered using appropriate metrics such monitoring storage usage, CPU hours, bandwidth usage etc. The literature identifies three different broad service models for cloud computing:
- Software as a Service (SaaS), where applications are hosted and delivered online via a Web browser offering traditional desktop functionality, for example Google Docs, Gmail.
- Platform as a Service (PaaS), where the cloud provides the software platform for systems (as opposed to just software), the best current example being the Google App Engine.
- Infrastructure as a Service (IaaS), where a set of virtualized computing resources, such as storage and computing capacity are hosted in the cloud.Customers deploy and run their own software stacks to obtain services. Current examples are Amazon Elastic Compute Cloud (EC2), Simple Storage Service (S3) and Simple DB. The literature also differentiates cloud computing offerings by scope.
- In private clouds; services are provided exclusively to trusted users via a single-tenant operating environment. Essentially, an organization's data Centre delivers cloud computing services to clients who may or may not be in the premises [6].
- Public clouds are the opposite: Services are offered to individuals and organizations who want to retain elasticity and accountability without absorbing the full costs of in-house infrastructures [6]. Public cloud users are by default treated as untrustworthy.
- Hybrid clouds: There are also hybrid clouds combining both private and public cloud service offerings [7].

IV. Benefits of Cloud Computing

Cloud computing offers numerous advantages both to end users and businesses. One obvious advantage is that you no more have to support the infrastructure or have the knowledge necessary to develop and maintain the infrastructure, development environment or application, as were things up until recently. The burden has been lifted and someone else is taking care of all that. Businesses are now able to focus on their core business by outsourcing all the hassle of IT infrastructure.

Figure 3 advantages of cloud computing

These advantages include both a company's and an end-user's perspective.

- **Cost Efficiency**

This is the biggest advantage of cloud computing, achieved by the elimination of the investment in stand-alone software or servers. By leveraging cloud's capabilities, companies can save on licensing fees and at the same time eliminate overhead charges such as the cost of data storage, software updates, management etc. The cloud is in general available at much cheaper rates than traditional approaches and can significantly lower the overall IT expenses. At the same time, convenient and scalable charging models have emerged (such as one-time-payment and pay-as-you-go), making the cloud even more attractive.

If you want to get more technical and analytical, cloud computing delivers a better cash flow by eliminating the capital expense (CAPEX) associated with developing and maintaining the server infrastructure.

- **Convenience and continuous availability**

Public clouds offer services that are available wherever the end user might be located. This approach enables easy access to information and accommodates the needs of users in different time zones and geographic locations. As a side benefit, collaboration booms since it is now easier than ever to access, view and modify shared documents and files.

Moreover, service uptime is in most cases guaranteed, providing in that way continuous availability of resources. The various cloud vendors typically use multiple servers for maximum redundancy. In case of system failure, alternative instances are automatically spawned on other machines.

- **Backup and Recovery**

The process of backing up and recovering data is simplified since those now reside on the cloud and not on a physical device. The various cloud providers offer reliable and flexible backup/recovery solutions. In some cases, the cloud itself is used solely as a backup repository of the data located in local computers.

- **Cloud is environmentally friendly**

The cloud is in general more efficient than the typical IT infrastructure and It takes fewer resources to compute, thus saving energy. For example, when servers are not used, the infrastructure normally scales down, freeing up resources and consuming less power. At any moment, only the resources that are truly needed are consumed by the system.

- **Resiliency and Redundancy**

A cloud deployment is usually built on a robust architecture thus providing resiliency and redundancy to its users. The cloud offers automatic failover between hardware platforms out of the box, while disaster recovery services are also often included.

- **Scalability and Performance**

Scalability is a built-in feature for cloud deployments. Cloud instances are deployed automatically only when needed and as a result, you pay only for the applications and data storage you need. Hand in hand, also comes elasticity, since clouds can be scaled to meet your changing IT system demands.
Regarding performance, the systems utilize distributed architectures which offer excellent speed of computations. Again, it is the provider's responsibility to ensure that your services run on cutting edge machinery. Instances can be added instantly for improved performance and customers have access to the total resources of the cloud's core hardware via their dashboards.

- **Quick deployment and ease of integration**

A cloud system can be up and running in a very short period, making quick deployment a key benefit. On the same aspect, the introduction of a new user in the system happens instantaneously, eliminating waiting periods.

Furthermore, software integration occurs automatically and organically in cloud installations. A business is allowed to choose the services and applications that best suit their preferences, while there is minimum effort in customizing and integrating those applications.

- **Increased Storage Capacity**

The cloud can accommodate and store much more data compared to a personal computer and in a way offers almost unlimited storage capacity. It eliminates worries about running out of storage space and at the same time It spares businesses the need to upgrade their computer hardware, further reducing the overall IT cost.

- **Device Diversity and Location Independence**

Cloud computing services can be accessed via a plethora of electronic devices that are able to have access to the internet. These devices include not only the traditional PCs, but also smartphones, tablets etc. With the cloud, the "Bring your own device" (BYOD) policy can be easily adopted; permitting employees to bring personally owned mobile devices to their workplace.

An end-user might decide not only which device to use, but also where to access the service from. There is no limitation of place and medium. We can access our applications and data anywhere in the world, making this method very attractive to people. Cloud computing is in that way especially appealing to international companies as it offers the flexibility for its employees to access company files wherever they are.

- **Smaller learning curve**

Cloud applications usually entail smaller learning curves since people are quietly used to them. Users find it easier to adopt them and come up to speed much faster. Main examples of this are applications like GMail and Google Docs

V. Challenges in Cloud Computing

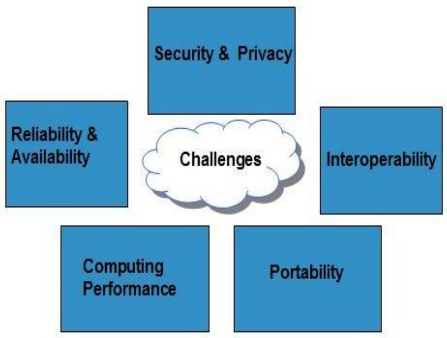

Figure 4 challenges of cloud computing

- **Security and privacy in the Cloud**

Security is the biggest concern when it comes to cloud computing. By using a remote cloud based infrastructure, a company essentially gives away sensitive and confidential private data and information. The cloud service providers reliability is very critical because it is up to the cloud service provider to manage, protect and retain them. A company's existence might be put in risk, so all possible alternatives should be explored before a decision. On the same note, even end users might feel uncomfortable surrendering their data to a third party.

Similarly, privacy in the cloud is another huge issue. Organizations and different users have to trust their cloud service vendors that they will protect their data from unauthorized users. The various stories of data loss and password leakage in the media do not help to reassure some of the most concerned users.

- **Dependency and vendor lock-in**

One of the major disadvantages of cloud computing is the implicit dependency on the provider. This is what the industry calls "vendor lock-in" since it is difficult, and sometimes impossible, to migrate from a provider once you have rolled with him. If a user wishes to switch to some other provider, then it can be really painful and cumbersome to transfer huge data from the old provider to the new one. This is another reason why you should carefully and thoroughly contemplate all options when picking a vendor.

- **Technical Difficulties and Downtime**

Certainly the smaller business will enjoy not having to deal with the daily technical issues and will prefer handing those to an established IT company, however you should keep in mind that all systems might face dysfunctions from time to time. Outage and downtime is possible even to the best cloud service providers, as the past has shown.

Additionally, you should remember that the whole setup is dependent on internet access, thus any network or connectivity problems will render the setup useless. As a minor detail, also keep in mind that it might take several minutes for the cloud to detect a server fault and launch a new instance from an image snapshot.

- **Limited control and flexibility**

Since the applications and services run on remote, third party virtual environments, companies and users have limited control over the function and execution of the hardware and software. Moreover, since remote software is being used, it usually lacks the features of an application running locally.

- **Increased Vulnerability**

Related to the security and privacy mentioned before, note that cloud based solutions are exposed on the public internet and are thus a more vulnerable target for malicious users and hackers. Nothing on the Internet is completely secured and even the biggest players suffer from serious attacks and security breaches. Due to the

interdependency of the system, if there is a compromise one of the machines that data is stored, there might be a leakage of personal information to the world.

VI. Possible Solutions

A group of researchers from MIT and Microsof t[9] have suggested a way to prevent users of one virtual machine on a server from gathering information by monitoring the use of shared cache memory by another virtual machine on the same server.

A group of researchers from IBM have proposed a security mechanism that would, in essence frisk new virtual machines as they entered the cloud.

The field of cryptography is the tool that can also ensure the security of cloud computing. Cloud users can already encrypt data to protect it from being leaked, stolen, or released by a cloud provider. This approach can be problematic.Encrypted documents stored in a cloud can't easily be searched or retrieved, and it's hard to perform calculations on encrypted data. Emerging encrypted technologies, can protect data in clouds even though users will search,retrieve, and perform calculations on the data.

VII. Conclusion and Future Scope

Cloud computing is a revolutionary computing paradigm that allows organizations to build systems that scale automatically without big upfront investments or long-time contracts. The cloud computing is at the beginning and knocking doors to gain attention. Cloud computing is an attractive operating environment for organizations. Organizations can scale their IT infrastructure without actually operating and maintaining data centers with less staff and at lower cost and less worry. Just as every coin has two sides, cloud computing also had pros and cons. The challenges have to be sorted out for making cloud computing attractive for the small and large enterprises and individuals.

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