Emerging Trends in Cloud Computing

* Deepti Tara
** Pooja Thakur

Abstract

As we are adopting internet technology in most of our day to day processes and it is considered to be somewhat more than a mere medium of communication, new technologies of distributed computing are emerging to take businesses to a new platform. Cloud computing has become the hottest pick for practitioners and researchers. Everyone today is talking about cloud. A considerable amount of research has been done in this direction to identify the applications of cloud in businesses. Cloud computing is an umbrella term to define the services that are remotely hosted, always available from anywhere and are co-modified. Every IT industry is migrating to cloud to meet high computational requirement and that too at very low cost. This paper gives an idea of the services offered by cloud. A brief summary of the emerging services expected to be provided by cloud is also presented.

Index Terms : cloud computing, cloud models, emerging services.

I. INTRODUCTION

With a blend of recent technologies like virtualization, utility computing, and grid computing, cloud computing is emerging as a promising technology that affects businesses positively. It is turning the table in internetworking technologies and is reshaping the day to day processes of IT. The technological boon has left the world to be a global village. It is not merely a technology concept but also a new approach of implementing electronic commerce [1].

Today's businesses and business processes are providing novel perspectives of adoption of cloud computing. According to McKinsey, approximately 80% companies of US have either adopted cloud's innovative business processes or have set their vision for implementation of cloud computing for their day to day business operations [2].

From the technological view point, unlike utility computing, cloud computing strives to provide services to clients with integrated and networked resources be it hardware or software or internet and that too via encapsulating the complexity and underlying hardware description. The client has to pay for the services that are used and needed anywhere, anytime and at any place [3]. It is an umbrella term that refers to services that are remotely hosted, always available from anywhere and are co-modified.

Cloud computing provides services either according to the structure of the organization or depending upon what kind of services are required. NIST categorizes the services of cloud according to two popular models namely deployment models and service models. The present paper dwells upon the service models of cloud computing. NIST recognizes three service models of cloud computing: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). Apart from these known models, cloud computing can now be applied to other areas also [4, 5].

II. TRADITIONAL SERVICES

National Institute of Standards and Technology (NIST) has defined three models of clouds depending for their service portfolio. These models are called as service models of cloud computing. There are many different service models defined in literature but the universally accepted models are only three.

A. Software as a Service (SaaS)

Software as a Service explores cloud service where

* Assistant Professor, University Institute of Computing, Chandigarh University, Chandigarh Ludhiana Road, Gharuan Punjab, MCA, Pursuing Ph.D. E-mail : Uic.deeptintara@gmail.com
** Assistant Professor, University Institute of Computing, Chandigarh University, Chandigarh Ludiana Road, Gharuan Punjab, MCA.

software applications are deployed over the internet. The applications are licensed to the clients either as on demand service or through subscription in pay-as-you-go model [6]. Many times the services are deployed for no charge as there are other opportunities to generate revenue such as advertisements. Software management is centralized but can be delivered over diversified models. The clients purchase applications purely on subscription basis, use the application data and save it in cloud storage instead of their own computer systems. Issues related to software upgrades and patches are taken care of by Application Programming Interface (API).

The initial movers to the SaaS cloud are the organizations facilitating "Vanilla" offerings. In such organizations, the solution is largely undifferentiated as many competitors use the same software. In addition to this, applications where the interaction between the organization and the outside world is significant, the applications where demand spikes significantly, software whose life span is very short or the applications that need web and mobile access are used. Google Docs, IBM's Big Blue, Gmail for mobile devices, MS Office Live Small Business, Intuit-QuickBooks all are the examples of Software as a Service cloud.

There are numerous reasons are why SaaS is beneficial to organizations and personal users alike:

❖ **No initial setup costs:** applications can be readily used once the user subscribes.

❖ **No additional Investment for hardware:** the pre-requisites to run the applications are supplied by the cloud provider.

❖**Pay for what you use:** Payment is made on subscription basis. Subscriptions can be renewed as and when required.

❖ **Scalable Usage:** if more storage or additional services are required, these can be accessed on demand without the need to install new software or hardware.

❖ **Automated Updates:** If any aspect of application is updated, it is made available to the consumer free of cost. No new software is required and the updates are deployed automatically by the cloud provider [3].

❖ **Platform Independence:** SaaS applications can be accessed via any internet enabled phones and tablets which makes it ideal for those who use a number of different devices [3].

B. Platform as a Service (PaaS)

Platform as a Service, cloud computing provide a platform and environment for which development tool itself is deployed over the cloud. This enables developers to build web applications without installing necessary software and tools on their computer systems [7]. Such applications can be made available without any specific systems administrative skills. The application is simply coded by the developer and the PaaS cloud provider uploads and presents the code over internet [8].

PaaS is by and large similar to SaaS except that rather than delivering software over the internet, it permits the creation of web applications quickly and easily and without the complexity of buying and maintaining the software and infrastructure underneath it . PaaS provides facilities that help in completing the life cycle of applications and services through internet [9, 10]. The characteristics of PaaS include the services required to fulfill the application development process, multi-tenant architecture, web based user interface creation tools, built in scalability of deployed software including load balancing and failover, integration with web services and databases, support for development team collaboration, and tools to handle billing and subscription management [9]. PaaS makes sense in organizations where one project is worked upon by multiple developers and where intervention of external parties is needed during the development process. The organizations which have an existing data source and have automated testing and deployment service can also make use of PaaS. Google App Engine, Microsoft Azure Services, IBM Blue Mix, Force.com are few of the products built on PaaS model.

Some of the features of PaaS for application developers are:

❖ **Simplified deployment:** the ability to 'rent' virtual infrastructure has both cost benefits and practical benefits. The developers don't have to own hardware themselves or have experts in their workforce to manage the underlying hardware [11]. So they can focus on the development of applications. Moreover, the clients only need to rent the resources they need rather than investing in fixed, unused, and therefore, wasted capacity.

❖ **Prebuilt business functionality:** Due to some PaaS services anyone can develop an application. Some PaaS vendors also provide reusable business functionality so that users can avoid building everything from scratch,

hence, helping jump-start projects [7].

❖ **Flexibility:** customers can be provided tools that are installed within their platforms and create platform according to their specific requirements.

❖ **Scalability:** Applications deployed can be utilized by one to tens of thousands of users without any changes to the application [7].

❖ **Instant community:** since only an internet connection and web browser is required, multiple developers can work together on one application regardless of their location.

❖ **Security:** security is provided, including data security, backup and recovery.

C. Infrastructure as a Service (IaaS)

IaaS is the delivery of technology infrastructure resources (computer, servers, networking, operating systems, memory, load balancers, bandwidth) as an on demand scalable service. The clients are usually provided with a multitenant virtualized environment and billing is done based on the usage. The IaaS services can be coupled with managed services of the operating system and application support services [12].

Majority of IaaS providers tend to provide scalability at customers' end through client operated interface where customer can manage, control, and scale the computing resources up or down as per their need. Dynamic infrastructure scaling, guaranteed uptime, automation of administrative tasks, policy based service, elastic load balancing, customized machine images, access to latest technology and stringent security controls are the key features of IaaS. IaaS is a great option for organizations in which demand is volatile. The organizations which don't want to invest in hardware initially can go for IaaS cloud. Related to this, the rapidly growing organizations where hardware upgradation may be problematic, can also opt for IaaS. opSource, GoGrid, AT&T, Blizzards are few of the IaaS providers.

III. EMERGING SERVICES OF CLOUD

The major cloud service providers are exploring new areas of services of cloud by offering services apart from the ones standardized by NIST. These services allow more functionality and flexibility to immature entrepreneurs. The new service offerings by cloud providers are discussed as below.

A. Database as a Service (DBaaS)

Over a network, the formats and sources of data are diversified and a wide variety of users can be given access to this data. The web service interface provided by cloud environment allows storage and retrieval of data anywhere, anytime. The database as a service cloud (DBaaS) is also known as **relational cloud**. All the SQL tasks such as allocation of resources, software configuration, achieving desired security, access control, data privacy, and efficient performance is taken care of by DBaaS. The desired cloud databases are available in the market but they all share similar concepts and features [13]. The already existing DBaaS is adaptive for being cost effective and incurs low costs for businesses, but these cloud players are not sufficiently providing the efficiency of multi tenant environment, scale up and down services, and last but not the least, privacy of data. Consolidated database, reduced high costs, dedicated servers, multiple DBAs all make Database as a Service cloud the choicest option for the majority of cloud clients. However, the key enabler in building consolidated hardware services is Virtualization [14]. The SQL databases for example SQL Server, Oracle, NuoDB, MySQL etc. can run in the cloud efficiently. The environment can be facilitated using a virtual machine. The only challenge with SQL databases is the difficult in scalability.

Apart from SQL DB, some cloud vendors also support NoSQL DB. Let us take an example, the cloud provider Rackspace through its MongoDB provides managed hosting for MySQL on dedicated as well as cloud architectures and NoSQL databases. Similarly, on Azure and on Amazon Web Services, MongoLab provides MongoDB-as-a-Service [15]. NoSQL databases such as CouchDB, Apache Cassandra are other types of databases which can run on the cloud [16]. The NoSQL databases can serve heavy read/write loads and have flexibility in scalability. Most of the times, the data model is used to develop applications is SQL. So if one needs to work with NoSQL database, one needs to rewrite the entire application code if application development requires another database language.

B. Monitoring as a Service

Presently, Monitoring as a Service (MaaS) is an emerging part of the cloud frazzle [9]. Businesses realized that to ensure the proactive elimination of

downtime risks, their infrastructure and key applications should be equipped with monitoring tools. MaaS allows shifting auditing costs because monitoring is performed as a service. Instead of owning the monitoring tool, one uses and pays for the service only, thereby, cutting down the cost of investing in the in-house tool [4]. The consumer can keep an eye on their applications and their behavior by simply logging onto the clients machine or web without knowing their location. Easy setup and purchasing process makes MaaS key pay as you go model for the early migrants of cloud as well as beginners in many businesses.

MaaS combines the benefits of cloud computing technology as well as the traditional monitoring services that include an organization's on–premise hardware. It is a delivery model for organizations that adopt a monitoring framework with minimal investment. MaaS provides the services of monitoring internal IT infrastructure in the cloud environment. Be it hardware, monitoring software or specialized IT experts etc., all the monitoring framework is facilitated by the MaaS vendor. The customer gets the paid subscription of the services that he wishes to use. The MaaS services can be available 24x7x365 [11]. In MaaS, the customer gets access to a monitoring tool through an interface provided by MaaS provider which is accessible through a browser. MaaS can monitor any private cloud and is compatible with PaaS and SaaS. The customer needs to indulge in zero maintenance overheads. MaaS provides cost effective pay as you go model. MaaS can come with PaaS and SaaS as additional services. MaaS can be utilized as a sufficiently good option for hybrid cloud computing environment. MaaS is capable of monitoring servers, systems, databases, networks, storage, applications, and the cloud itself.

C. Communication as a Service (CaaS)

CaaS is the enterprise communication solution that is handled by an external party. CaaS vendor is the entity that facilitates cloud based solution for communication services. CaaS vendor is responsible for facilitating necessary infrastructure for telecommunication services such as video conferencing, VoIP, messaging etc. The application of this cloud model is limited to telecommunication industry only. CaaS offers the guarantee of quality of service as well as a clearly defined service level agreement. Depending upon the functionality requirements of the customer, the network

capacity can be enhanced. This scalability and flexibility of CaaS offering makes it convenient to be used in small and medium sized businesses. The customer has nothing to do with the resource (hardware and software) upgrades and replacements as these issues are addressed by the cloud vendor [6].

D. Workplace as a Service

This model of cloud computing allows organizations to manage the jobs of their employees. The organizations set up and install the necessary software to operate their personnel. Around the globe the practice of Workspace as a Service model grew from $4.76 billion in the year 2014 to $9.41 billion in 2019 [17, 18]. Enterprises and small and medium businesses are widely adopting WaaS because these solutions are easy to manage and incur lower setup cost. Employees are increasingly demanding to work from anywhere, anytime and that too using their own devices. So, companies are expected to make huge investment in WaaS solutions and services in the years to come. The increasing trend of BYOD (Bring Your Own Device) technology has given a positive push to new remote workspace technologies. All these factors have affected the demand of WaaS solutions so that device independent access may be experienced by employees and customers in business applications and corporate IT.

E. XaaS

This is an acronym for Anything as a Service. It is a cutting-edge technology through which the deliverables of public as well as private cloud are served to the organizations so that they may control their day to day business processes and operations. All that is required for availing the said services is the access to Internet. XaaS offers deliverables ranging from softwares to servers, physical handset to a physical telephone handset, and from backup to restore as a service. The diverse offerings of XaaS affect the design and negotiations related to the service level agreement. The early migrants of cloud can also be benefitted from XaaS offerings. It is forecasted that in future, this technological shift may be the best option for relevant organizations since organizations may own their organization wide cloud for their internal processes and systems [2, 19].

IV. CONCLUSION

Cloud computing and its services are set to rule the next decade by overcoming existing limitations. In this paper we have given a brief idea of the cloud offerings in terms of services that are already existing, as well as the upcoming services and future applications for which cloud can be looked upon. Recommendations related to who should adapt cloud, and the subsequent advantages to the beneficiaries have been quoted.

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About the Authors

Deepti Tara (M'11) became the Member of IEEE in 2011. She completed her Computer Engineering in the year 2002. Later she did her Bachelors and Masters in the field of Computer Applications.

She is presently working as Assistant Professor in University Institute of Computing, Chandigarh University, Gharuan, Mohali. She also has exposure to industrial work environment. She has served few other educational organizations also and has a vast experience of thirteen years. She has attended many conferences and published papers in various National and International Journals. She has also attended 16 workshops till now organized by various institutes including NITTTR, Chandigarh.

Pooja Thakur completed her Masters in Computer Applications in 2011. She is presently working as Assistant Professor in University Institute of Computing, Chandigarh University, Gharuan, Mohali. She started her career as a web developer and later on chose teaching as her profession.