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A Technical and Analytical Study Report of Business Usage Perspectives on Cloud Computing

J. Gnana Jayanthi* and M. Nithya**

ABSTRACT

Cloud Computing Technology is the one of the promising and recently blooming technology providing various kinds of services as per the requirements of the customers, especially more beneficial to business owners over the Internet. Cloud services are offered at different pricing schemes and techniques depending upon the usage of the types of clouds through the cloud service providers. Besides, this paper is intended to present cloud architecture and survey of cloud computing implementation and adoption by some of the major IT companies. The highlight of this paper is to give precise and concise outcomes of their analytical study reports. Further this paper paves a way to the young researchers to march towards further research on Cloud Computing for the better utilization.

Keywords: Cloud Computing, Cloud Storage, Cloud Architecture, Cloud Services, Virtualization

1. INTRODUCTION

Cloud Computing is a new utilization and delivery model for Information and Communication Technologies (ICT) services. In Cloud Computing the users' services are fully managed by the Cloud Computing providers. At any point of time, the users can consume their required services at a rate, on-demand that is set by their particular needs.

The concepts of Cloud Computing dates back to the envision of John McCarthy in the year 1960. In his seminal, he pointed out that, computing may be organized as a public utility in future just as the telephone system is a public utility. The computer utility could become the basis of a new and important industry [1].

In 2008, Gartner, in his Special Report on the Realities and Risks of Cloud Computing, defines cloud computing as a style of computing where massively scalable IT-related capabilities are provided as a service using Internet technologies to multiple external customers [2].

In 2009, the National Institute of Standards and Technology (NIST) defines "Cloud computing is 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[3].

Therefore Cloud Computing may be defined as *Cloud Computing otherwise referred to as On-Demand Computing is a kind of Internet-based computing, where shared resources, data and information are provided to computers and other devices on-demand.*

Cloud computing removes much of the need for users to plan ahead for provisioning. Typically the service is set-up to deliver what the organization needs at enrolment, with the capability to add more services dynamically as needs expand. When is needed is that more resources these can be deployed painlessly and rapidly in a highly

* Assistant Professor, *Email: jgnanamtcy@gmail.com*

** MPhil Research Scholar, Department of Computer Science, Rajah Serfoji Govt. College (Autonomous),Thanjavur, Tamilnadu, *Email: nithyamuthuraman92826@gmail.com*

cost-effective manner. There are typically no upfront costs, one has to pay for what he/she uses on a demand basis – his/her IT spends becomes highly optimized.

The remainder of this paper is organized as follows. Section 2 is presented with the evolution of Cloud Computing. Section 3 overviews the technology with the perspectives on Significant Business Benefits and Architecture. The various supporting and enabling technologies of cloud computing are summarized in section 4. Section 5 summarizes Corporate Analysis Study and their key findings are highlighted. In Section 6, we summarize our observations and discussions from the study on cloud computing and its implementation. Finally, the paper concludes in Section 7.

2. EVOLUTION

Cloud Computing technology raise up with the ideas and there are a few milestones to mention:

In 1999 Salesforce.com started delivering applications to users using a simple website. The applications were delivered to enterprises over the Internet, and the dream of computing sold as utility started being reality. Although the service was successful, some more time would pass until it would become widespread. In 2002 Amazon started Amazon Web Services, providing services like storage, computation and even human intelligence. In 2006, Amazon announced its launch of the Elastic Compute Cloud, which is truly a commercial service open to everyone. In 2006, following Amazon, Sun Microsystems, whose longtime logo "The Network is the Computer" embodied cloud-like thinking, opened its public utility compute resource, it was called the Sun Grid. The Sun service allowed users to order up compute capacity over the Internet and pay for it via PayPal. In 2009 Microsoft launched Windows Azure, and companies like Oracle and HP have all joined then [4].

3. TECHNOLOGY PERSPECTIVES

3.1. Significant Business Benefits

Cloud services have grown in popularity over the past couple of years. Cloud computing is the number one strategic trend in the recently released top ten strategic technologies from Gartner. Cloud-based services can be exploited in a variety of ways to deploy an application or a solution. Some of the several significant business features in Cloud Computing technology are (1) Flexibility, (2) Disaster Recovery, (3) Automatic Software Updates, (4) Capital-expenditure free, (5) Increased Collaboration, (6) Work from anywhere, (7) Document Control, (8) Security, (9) Competitiveness (10) Environmentally friendly etc.

Using Cloud Computing Technology, resources does not eliminate the costs associated with IT solutions, but does re-arrange some costs and reduce others. Further, enterprises consuming cloud services may increasingly act as cloud providers and deliver application, information or business process services to customers and business partners. The report indicates that cloud-based, "on-demand" enterprise solutions, which include cloud-based workforce management solutions, are in growing demand. The Service delivery model allows organizations to deploy workforce management products quickly and easily, with minimal upfront investment. Because the vendor is responsible for maintaining all hardware and network infrastructure, as well as application performance and availability, this model reduces the strain on company IT departments. In addition, organizations automatically get the latest and most advanced workforce management applications without having to perform expensive upgrades or purchase new software licenses. These applications can take advantage of cost efficiencies and may also embrace the on-demand infrastructure of a cloud to provide additional services when needed [5].

3.2. Architecture

Cloud Computing architecture design comprises of (i) Front-End Platforms, (ii) Back-End Platforms, (iii) Infrastructure, as depicted in figure Fig.1.

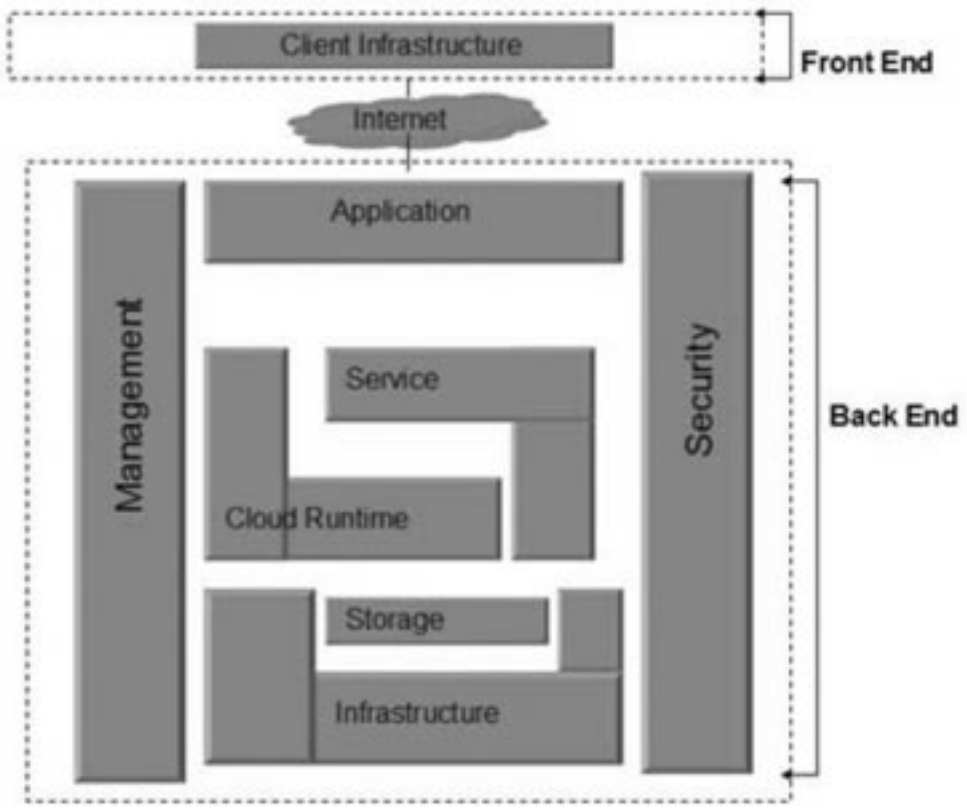

Figure 1: Cloud Computing Technology – Architecture

3.2.1. Front-End Platforms

"Front-End Platforms" are the clients or Cloud clients. These clients comprise servers, fat (or thick) clients, thin clients, zero clients, tablets and mobile devices. These client platforms interact with the cloud data storage via an application (middleware), via a web browser, or through a virtual session which plays a role of access point to the cloud.

3.2.2. Back-End Platforms

The back-end platforms consist of (i) Storage, (ii) Service, (iii) Management, (iv) Security and (v) Application, which concisely are called the actual cloud. In the Cloud Computing environment, data are held and managed centrally by a Service Provider, with applications provided over the web, paid for on a rental or demand basis.

3.3. Storage

Cloud Storage Resources are generally deployed with the following types of clouds configurations as (i) Private Cloud, (ii) Public Cloud, (iii) Hybrid Cloud, (iv) Virtual Private Cloud and (v) Community Cloud [3,6].

Private Cloud is implemented using a dedicated data center infrastructure of hardware and software that is used privately by an organization. The data center can be on-premises or off-premises. It is not shared with another organization.

A Public Cloud is implemented using a shared data center infrastructure of hardware and software that is shared by multiple organizations. The data center is off-premises. The Cloud Computing Stack in a Public Cloud is also shared with other organizations. The data, however, for each organization is kept separate. *A Hybrid Cloud* is any combination of Clouds. It could be a Private Cloud and one or more Public Clouds.

A Virtual Private Cloud is implemented using a shared data center infrastructure of hardware and software. The data center is most likely off-premises. It is shared with multiple organizations. If the data center is not shared, that is a Private Cloud.

A Community Cloud can be a Private Cloud, Virtual Private Cloud, Public Cloud, or Hybrid Cloud. A Community Cloud is designed to meet the needs of a community. Such communities involve people or organization that has shared interests.

3.4. Service

The primary service models being deployed are being deployed under three major categories and they are (i) Software as a Service (SaaS), (ii) Platform as a Service (PaaS) and (iii) Infrastructure as a Service (IaaS).

Software as a Service (SaaS) Consumers purchase the ability to access and use an application or service that is hosted in the cloud. SaaS service-model involves the cloud provider installing and maintaining software in the cloud and users running the software from their cloud clients over the Internet (or Intranet).

Platform as a Service (PaaS) Consumers purchase access to the platforms, enabling them to deploy their own software and applications in the cloud. The operating systems and network access are not managed by the consumer, and there might be constraints as to which applications can be deployed.

Infrastructure as a Service (IaaS) Consumers control and manage the systems in terms of the operating systems, applications, storage, and network connectivity, but do not themselves control the cloud infrastructure.

Apart from IaaS, PaaS, SaaS, the other deployment model that is recently researched is the Anything-as-a-Service (XaaS).

Anything-as-a-Service (XaaS) includes (a) Network-as-a-Service (NaaS), (b) Business-as-a-Service, (c) Identity-as-a-Service, (c) Database-as-a-Service or Strategy-as-a-Service.

Network as a Service (NaaS) is sometimes listed as a separate Cloud provider along with IaaS, PaaS, SaaS. NaaS can include flexible and extended Virtual Private Network (VPN), bandwidth on demand, custom routing, multicast protocols, security firewall, intrustions detection and prevention, Wide Area Network (WAN), content monitoring and filtering, and antivirus. Using NaaS, tenants can easily deploy custom routing and multicast protocols.

Business-as-a-Service (BaaS) is the service that will be provided to the consumer in the form of an integrated set of transactional and collaborative activities to accomplish a specific organizational goal. Comprehensive business services (offered as SaaS) will be orchestrated (as BPaaS), managed and monitored (as MaaS), run (as PaaS) and hosted (as IaaS) – all in cloud.

Identity-as-a-Service (IDaaS) is to identity and access management services that are offered through the cloud or SaaS (software-as-a-service) on a subscription basis. These systems also tend to rely heavily on Active Directory (AD) and the Lightweight Directory Access Protocol (LDAP) for their IAM services.

Database as a Service (DBaaS) is a cloud-based approach to the storage and management of structured data. DBaaS delivers database functionality similar to what is found in relational database management systems (RDBMSes) such as SQL Server, MySQL and Oracle.

3.4.1 Management

Cloud provider is responsible to manage resources and their performance. Management of resources includes several aspects of cloud computing such as load balancing, performance, storage, backups, capacity, deployment, etc. The cloud provider performs a number of tasks to ensure efficient use of cloud resources and they are:

- ✓ Audit the backups timely to ensure restoring of randomly selected files of different users

- ✓ Monitor the Data Flow of the System for the movement of data belonging to an organization
- ✓ Beware of Vendor Lock-In Awareness and Solutions
- ✓ Knowing Provider's Security Procedures
- ✓ Monitoring Capacity Planning and Scaling Capabilities
- ✓ Monitor Audit Log Use

In order to identify errors in the system, managers must audit the logs on a regular basis.

3.4.2. Security

Security in cloud computing is a major concern. Data in cloud should be stored in encrypted form. To restrict client from accessing the shared data directly, proxy and brokerage services should be employed. It is necessary to analyze several aspects of the resource before deploying a particular resource to cloud.

Cloud Service Models such as IaaS, PaaS, and SaaS, require customer to be responsible for security at different levels of service. Hence a customer needs to select which of the service models and cloud types he is required. A particular service model defines the boundary between the responsibilities of service provider and customer. Cloud Security Alliance (CSA) stack model defines the boundaries between each service model and shows how different functional units relate to each other. Although each service model has security mechanism, the security needs also depend upon where these services are located, in private, public, hybrid or community cloud. Since all the data is transferred using Internet, data security is of major concern in the cloud. The key mechanisms for protecting data are (i) Access Control, (ii) Auditing, (iii) Authentication and Authorization. Since data stored in cloud can be accessed from anywhere, we must have a mechanism to isolate data and protect it from client's direct access. Brokered Cloud Storage Access is an approach for isolating storage in the cloud. The procedure when the client issues request to access data are:

- ✓ The client data request goes to the external service interface of proxy.
- ✓ The proxy forwards the request to the broker.
- ✓ The broker requests the data from cloud storage system.
- ✓ The cloud storage system returns the data to the broker.
- ✓ The broker returns the data to proxy.
- ✓ Finally the proxy sends the data to the client.

3.4.3. Application

Cloud Computing has its applications in almost all the fields such as business, entertainment, data storage, social networking, management, entertainment, education, art and global positioning system, etc. Some of the widely famous cloud computing applications are (i) Business Applications, (ii) Data Storage and Backup, (iii) Management Applications, (iv) Social Applications, (v) Entertainment Applications, and (vi) Art Applications. Some of the very popular applications in each category are listed below in the table Table [1].

3.4.4. Infrastructure

Cloud infrastructure consists of (i) Servers, (ii) Storage Devices, (iii) Network, (iv) Management Software, (v) Deployment Software, and (vi) Platform Virtualization.

The Servers are to (i) provide Service Delivery to the Cloud Clients, (ii) compute the resource sharing and (iii) offer other services such as resource allocation and de-allocation, monitoring the resources, providing security etc.

Table [1]
Popular Cloud Applications

S. No.	Application	Description
		Business Applications
1	Google Apps for Business	Offers creating text documents, spreadsheets, presentations, etc., on Google Docs which allows the business users to share them in collaborating manner
		Data Storage and Backup
2	Box.com	Offers drag and drop service for files. The users need to drop the files into box and access from anywhere
		Management Applications
3	Toggl	Helps in tracking time period assigned to a particular project.
		Social Applications
4	Facebook	Offers social networking service. One can share photos, videos, files, status and much more.
		Entertainment Applications
6	Audiobox.fm	Offers streaming service. The music files are stored online and can be played from cloud using the own media player of the service.
		Art Applications
7	Moo	Offers art services such as designing and printing business cards, postcards and mini cards.

These Cloud Computing services are deployed in terms of business models and can differ depending on the requirements.

Cloud keeps multiple replicas of storage. If one of the storage resources fails, then it can be extracted from another one, which makes cloud computing more reliable.

Storage devices can be broadly classified into two categories as (i) Block Storage Devices and (ii) File Storage Devices. The Block Storage Devices offer raw storage to the clients. These raw storage are partitioned to create volumes. The File Storage Devices offer storage to clients in the form of files, maintaining its own file system. This storage is in the form of Network Attached Storage (NAS).

The *Cloud Storage System* stores multiple copies of data on multiple servers, at multiple locations. If one system fails, then it is required only to change the pointer to the location, where the object is stored.

The Virtual Storage Containers offer high performance cloud storage systems. Logical Unit Number (LUN) of device, files and other objects are created in virtual storage containers.

Hypervisor is a firmware or low-level program that acts as a Virtual Machine Manager. It allows in sharing the single physical instance of cloud resources between several tenants.

Management Software helps to maintain and configure the infrastructure.

Deployment Software helps to deploy and integrate the application on the cloud.

Network is the key component of cloud infrastructure. It allows to connect cloud services over the Internet. It is also possible to deliver network as a utility over the Internet, which means, the customer can customize the network route and protocol.

Virtualization is the key to share resources in cloud environment. But it is not possible to satisfy the demand with single resource or server. Therefore, there must be transparency in resources, load balancing and application, to scale them on demand.

4. SUPPORTING AND ENABLING TECHNOLOGIES

There are certain technologies working behind the cloud computing platforms making cloud computing flexible, reliable, and usable. These supporting technologies are (i) Virtualization, (ii) Service-Oriented Architecture (SOA), (iii) Grid Computing, (iv) Utility Computing, (v) Wireless Sensor Networks (WSNs), (vi) Database Management Systems, (vii) World Wide Web Services.

4.1. Virtualization

Virtualization allows sharing single physical instance of an application or resource among multiple organizations or customers. It does this by assigning a logical name to a physical resource and providing a pointer to that physical resource when demanded. The Multitenant architecture offers virtual isolation among the multiple tenants. Hence, the organizations can use and customize their application as though they each have their instances running [7].

4.2. Service-Oriented Architecture (SOA)

Service-Oriented Architecture helps to use applications as a service for other applications regardless the type of vendor, product or technology. Therefore, it is possible to exchange the data between applications of different vendors without additional programming or making changes to services [8].

4.3. Grid Computing

Grid Computing refers to distributed computing, in which a group of computers from multiple locations are connected with each other to achieve a common objective. These computer resources are heterogeneous and geographically dispersed. Grid Computing breaks complex task into smaller pieces, which are distributed to CPUs that reside within the grid [9].

4.4. Utility Computing

Utility computing is based on Pay-per-Use model. It offers computational resources on demand as a metered service. Cloud computing, grid computing, and managed IT services are based on the concept of utility computing [10].

4.5. Wireless Sensor Networks (WSNs)

Wireless Sensor Networks (WSNs) Technology plays a role in Cloud Computing to share and analyze real time sensor data on-the-fly by providing sensor data or sensor event as a service over the internet [11]. The terms Sensing as a Service (SeaaS) and Sensor Event as a Service (SEaaS) are processing the sensor data and event of interests available to the cloud clients respectively over the cloud infrastructure. Merging WSNs with Cloud Computing puts forth a large number of applications such as weather forecasting, transport monitoring, healthcare etc. [12]

4.6. Database Management Systems

Database management systems have adapted to run in cloud environments by horizontally scaling database servers and partitioning tables across them. This technique, known as sharding, allows multiple instances of database software, MySQL to scale performance in a cloud environment. Rather than accessing a single, central database, applications now access one of many database instances depending on which shard contains the desired data [13].

4.7. World Wide Web Services

World Wide Web, referred to as 'WWW', was first launched in 1991. Due to the technological advancements, newer versions in the form of Web 2.0, Web 3.0 and Web 4.0 have emerged into existence and are noticeably

considered more advanced and easy to use. Of these, Web 4.0 offers as a read-write-execution-concurrency web with intelligent interactions between human mind and machines. Web 4.0 or webOS will be such as a middleware in which will start functioning similar to an operating system [14,15].

5. CORPORATES ANALYSIS STUDY

An analysis study and report of the big IT corporates such as RightScale® Inc, Avanade's research, accountingWEB, ORACLE, REDHAT, IBM etc., have been studied to analyse the impact of the implementation usage of the cloud computing technology. In this section some of the analysis study reports are presented.

5.1. RightScale® Inc

In January 2016, RightScale® Inc., a demonstrated leader in enterprise universal cloud management, conducted its annual State of the Cloud Survey of corporate cloud users, including 1,060 technology professionals responded at large and small enterprises across a broad cross-section of industries about their adoption of cloud computing. The highlights of the RightScale 2016 State of the Cloud Report include [16]:

- ✓ Hybrid Cloud Adoption Grew Significantly: Private cloud adoption increased from 63 percent to 77 percent, driving hybrid cloud adoption up from 58 percent to 71 percent year-over-year as in figure Fig.
- ✓ Cloud Users Leverage 6 Clouds on Average: Cloud users are running applications in an average of 1.5 public clouds and 1.7 private clouds. They are experimenting with an additional 1.5 public clouds and 1.3 private clouds as in figure Fig.
- ✓ Amazon Web Services (AWS) Continues to Lead in Public Cloud Adoption, but Azure (Iaas and PaaS) Gain Ground: Overall, AWS is used by 57 percent of respondents, flat from last year.

5.2. Avanade's research

In March 2011, Avanade commissioned a survey of 573 C-level executives, business unit leaders and IT decision makers in 18 countries to learn how technology, particularly cloud computing, is being used in the enterprises [17]. Key findings show the following facts.

- ✓ 74 percent of enterprises are using some form of cloud services.
- ✓ Respondents view private clouds as more secure, public cloud services are becoming faster, easier and cheaper to provision. Some are so easy to use and purchase, they are outpacing IT's ability to manage and control them.

5.3. ORACLE

ORACLE (expansion) sponsored the study "Cloud Computing Comes of Age" conducted by Harvard Business Review Analytic Services. The global survey of 376 business and technology leaders reveals a shift from pockets of cloud at the edges to the permeation of cloud throughout the enterprise. Nearly 47% of respondents are from North America, 25% are from Asia, with just 17% from Europe. The remaining 11% are from ROW [18]. Some of the noteworthy findings are presented below,

- ✓ There is a correlation between a more mature use of cloud and a variety of new business activities.
- ✓ Cloud leaders—companies that take a more managed, enterprise approach—are significantly more likely to have launched new products and expanded into new markets than companies that take a more ad hoc approach.
- ✓ Business agility has been the main driver for and the main benefit of the move to cloud, with 64 percent of respondents saying the use of cloud has increased their organization's agility.

- ✓ Cloud leaders are not only more likely to use cloud across the top five functions where cloud ser-vices are in use, but they're also much more likely to be pushing cloud into more core business functions like procurement, supply chain, and accounting.
- ✓ Cloud growth will continue; 85 percent of respondents expect the number of cloud services they personally use at work to increase over the next few years. However, concerns over security could limit that growth; 62 percent say security concerns are the biggest barrier to their organization's more fully embracing cloud. That's almost twice as many as named the next biggest barriers— integration challenges and the cost of changing over from current systems.

5.4. Red Hat

Red Hat Corporate conducted a survey on "Customers reporting interest in cloud, containers, Linux, and OpenStack for 2015" in 2014, to a group of 115 Red Hat customers – ranging from FORTUNE 500 companies to small businesses – about their priorities for 2015 [19] and reported as listed below;

- ✓ 84% of survey respondents were optimistic about their 2015 budgets, with 40% of respondents planning for a budget increase
- ✓ 44% expecting their budgets to stay the same. According to the survey results, respondents are planning for several key IT initiatives in 2015
- ✓ Respondents identified their organization's cloud deployment strategy with Private cloud (27%), Hybrid cloud (26%) and Public cloud (15%)
- ✓ Respondents identified the top benefits of cloud computing, respondents cited cost savings (59%), followed by scalability (55%); accessibility (including mobility and business continuity) (53%); speed of deployment (50%); and the ability to replace on-premise legacy technology (48%). The survey revealed some potential challenges for cloud in 2015, including security (57%); cloud interoperability (31%); compliance (30%); ability to measure ROI (29%); cloud portability (27%); and governance / loss of IT control (27%).

5.5. IBM

IBM study reported from its survey on "*Growing up Hybrid: Accelerating digital transformation*" among 500 hybrid cloud implementers from 13 countries and 23 industries and identified a leading group of organizations [20, 21].

- ✓ 26 percent of the respondents – that are gaining competitive advantage through hybrid cloud and managing their environment in an integrated, comprehensive fashion for high visibility and control.
- ✓ Leaders are using hybrid cloud to jumpstart "next-generation" initiatives. Leaders are almost three times more likely than other implementers to use hybrid cloud for commercializing insights (e.g., assembling data assets or monetizing data).

With a hybrid cloud approach, organizations can be selective about when to use cloud and when to use traditional IT infrastructure—delivering the best functionality while meeting speed and flexibility needs, as well as resiliency, security and regulatory requirements.

6. OBSERVATIONS AND DISCUSSIONS

From the technical study, the facts observed are *(i) It is difficult to find out any reference to cloud computing prior to 2006; (ii) The year 2009 marked a key turning point in the evolution of cloud computing, with the arrival of browser based cloud enterprise applications, with the best known being Google Apps; and (iii) Many of the big IT Companies are present in the Cloud Computing evolution.* These factors prove that today, cloud computing has become mainstream and might have evolved from the year 2006.

Further, with the rapid development of processing and storage technologies and the success of the Internet, cloud computing resources have become cheaper, more powerful and more ubiquitously available. The emergence of cloud computing technology has a marvellous impact on the IT industry such as Google, Amazon.

A Private Cloud may participate in a Hybrid Cloud. A Public Cloud may participate in a Hybrid Cloud. A Virtual Private Cloud may participate in a Hybrid Cloud.

In the twelve months since the last State of the Cloud Survey, there has been strong growth in hybrid cloud adoption as public cloud users added private cloud resource pools.

77 percent of respondents are now adopting private cloud from 63 percent last year. As a result, use of hybrid cloud environments has grown to 71 percent. In total, 95 percent of respondents are now using cloud up from 93 percent in 2015.

The 2016 State of the Cloud Survey shows that cloud adoption is growing and hybrid cloud adoption has now hit its stride. The strong growth in the use of private cloud, combined with the ubiquity of public cloud means that a super-majority of organizations are now operating in a hybrid environment.

With increasing maturity of both cloud users and cloud providers, we are seeing a reduction in concerns about cloud security, but IT organizations are challenged by a shortage of trained resources that they will need to fuel this growth.

As adoption grows, cloud bills and cost concerns are also growing, but most organizations are doing little to implement cost management and optimization strategies. This represents an opportunity to reduce costs and further improve cloud ROI.

Among public cloud providers, AWS maintains its lead, but Azure continues to make inroads in the percentage of respondents running applications as well as those who have plans to use it.

All private cloud technologies saw growth in the 2016 survey, with VMware vSphere maintaining its lead and OpenStack and Microsoft generating strong interest. Bare-metal cloud is coming onto the scene as well.

7. CONCLUSION

Cloud computing solutions present new opportunities including cutting costs, underpinning growth, driving innovation and making business truly agile. Presently, a lot of research activities in Cloud Computing implementation is being carried out in several developed countries and has been successfully promoted in the fields of medicine, manufacturing, energy, financial services. Cloud Computing would play a very critical role in the field of Agriculture and in many more fields of day-today life which cannot be restricted with limitations. However there are several challenges and issues in the implementation of cloud computing that should be studied in detail before its implementation in a particular area in real life.

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