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CLOUD COMPUTING AS A TOOL FOR INFRASTRUCTURE MANAGEMENT

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ABSTRACT: In last few years, cloud computing concept has emerged a lot which result that it has become the fastest growing business for the IT industry. Because it has became a promising business concept with win-win situation for the clients to shift. Cloud computing is a latest emerging business concept [1]. Now, recession-hit companies have acknowledged that simply by shifting into the cloud they will gain the fast access to best breed of business applications or appreciably enhance their productivity, all at negligible cost.

As more and more data and information of individuals and companies is placed in the cloud, their concern about data and environment safety, security issues, requirements and challenges has also grown. In today's scenario, each and every organization is totally dependent on the latest technologies those are updating and growing on daily basis. So that now it is becoming more challenging to secure the digital assets of a company in accordance with the changing demand & growing technologies which were almost fixed earlier [2].

Keywords: Cloud Computing, Cloud computing evolution, Cloud models, Cloud Security

1. INTRODUCTION

Cloud Computing is an Internet based computing, where the shared resources, software, and information are provided to computers (users) and other devices on demand, like the electricity grid. "Cloud computing" is the next natural step in the evolution of on-demand information technology services and products.

"Cloud computing" simply provides latest technologies, IT services and software products as on demand utility to the organizations connected on the Clouds. This provides the power of on-demand computing to the organizations as the other on demand utilities such as electricity, water etc. Cloud computing gain popularity around October 2007, when IBM announced collaboration with the Google in this sphere. Thereafter IBM's announced the "Blue Cloud" concept. Since then, the term "Cloud Computing" starts gaining the popularity.

Cloud computing acceptance is growing very quickly. Mostly IT departments are forced to spend a lot of time, money and energy on its IT infrastructure implementation, maintenance, and up gradation. So that now gradually more IT giants as well as middle size organizations are moving to cloud computing technology which minimizes their set up cost & time required to install all digital infrastructure. Now just by adopting cloud computing IT professional are required only to focus on strategies not on technologies which will boost up their revenues.

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As the mobility has increased, now it is a challenge to secure the increasing boundaries. Now the security focus has began to shift from securing the data centres to protecting the ad hoc endpoints. This was done mainly through many mechanisms including firewalls, confining the end point services, routine changing configurations to restrict access and by other related techniques.

2. THE BACK GROUND OF CLOUD COMPUTING

The best thing about the cloud computing is that now computing resources will be accessed and charged according to its usage which will fulfil the organization need at relatively low cost. So, the users would not need to know about clouds functioning and on demand technical services delivery to the organizations. This technology replaces the actual physical infrastructure through virtual infrastructure which will be delivered through internet. So that it allocate resources according to the demand with ease of scalability. In cloud computing, each and every organization is allotted with a different physical node so that while maintaining the security and reliability of the resources, during controlling of the resource pool each different physical node can be allotted with a different resource pool.

Cloud computing is primarily enhancement of distributed computing, utility computing and grid computing. The features of all above concepts are merged to provide the new business term. Basically in cloud computing the computing tasks are distributed to many distributed computers, those may be local or remote servers. So, the enterprises are need to pay attention only to the computing applications and can access

the computer resources, software's and storage system according to its requirement.

Before we start with cloud computing, three concepts must be clearly understood those are: cluster computing, grid computing and utility computing. In cluster computing, cluster stands for a group of inter linked local computers, those works together towards a single goal. Instead of grid computing links a lot of different geographically distributed individual computers to build a single large super infrastructure. Utility computing works on pay per use model i.e. paying for what you accessed and used from a shared pool of resources e.g. storage system, software and servers like public utilities e.g. water, electricity and gas etc.

3. CLOUD COMPUTING EVOLUTION

The History begins from the following technologies:

3.1 Cluster Computing

This is basically clustering of the coupled computers, to work in a group to accomplish a single computing task by working closely equivalent of forming a single computer. The cluster components are not necessarily, connected to each other through fast local area networks. This grouping of computers improves the performance, speed and availability as well as reduces the overall cost, instead of working over a single computer.

3.2 Grid Computing

Grid computing links various geographically distributed individual computers to build a single large infrastructure. It combines the various computer assets from multiple administrative domains to accomplish a single computing task. The main differences between the grids computing from cluster computing are

(*a*) More loosely coupled

(*b*) Heterogeneous

(*c*) Geographically distributed.

The separate grids can be dedicated to single application; but a single grid can also be accessed for a variety of different applications.

3.3 Utility Computing

Utility computing works on pay per use basis i.e. paying for what you accessed and used from a shared pool of resources e.g. storage system, software and servers like public utilities e.g. water, electricity and gas etc. So utility computing is the wrapping up of computing resources as a metered service. This concept has the benefit of having negligible or no initial investment to access the various computing resources. Basically in this concept the computational resources are mainly rented as compared to the earlier scenario in which we required to purchase the products to avail the services.

This facility of being served as a utility became the basis of the "On Demand" computing. Cloud computing model further proposed the concept of delivering computing, application and network components as a service. IBM, HP and Microsoft were early giant leaders in the field of utility computing and they have invested a lot on the research work on working of the cloud architecture, payment system and development challenges. Google, Amazon and others started to take the lead in 2008, as they established their own utility services for computing, storage and applications.

3.4 Cloud Computing

Cloud computing permits users and organizations to access their applications without any investment and installation and give them the power to access their personal data at any computer by just having internet connection. This technology ensures additional computing power to the user by centralizing storage devices and server which gives them much more processing speed. This technology just uses the internet connection and centralized remote servers.

Yahoo mail, Gmail and other social networks the simplest and widely accepted example of cloud computing. We generally do not to care about the implementation of any server to access them. The consumers just need an internet connection and you can start accessing the email inbox. All the management including of servers and emails are done under the supervision of cloud service providers Yahoo, Microsoft, Google etc. The consumer gets only to use the software interface and all remaining management will be accomplished by the cloud service provider itself. The users simply enjoy the benefits.

4. BENEFITS OF CLOUD COMPUTING

Cloud computing strategy has a many benefits over traditional computing strategies. It reduce run time, investment cost, increase the speed of deploying, minimizing the risk factor, ease of maintenance and increased security measure etc. Some more benefits are described as following:

- Reduced Investment and operational Cost

  For using Cloud services user need only to pay for what he used. So that initial set up and running Cost is greatly reduced and now the expenditure will be only operational expenditure. All the services will be provided by a third-party Cloud service provider and user does not need to be maintaining all the services. Cloud computing resources are mainly metered per client and application on a daily, weekly, monthly, and yearly basis.

- Enhanced Scalability

  Cloud users can easily acquire and release the Cloud resources on demand in the minimal time. This enhances the scalability of cloud services.

- Efficient & better resource utilization

  Cloud services are accessed through a pool of cloud resources purely maintained by the team of professionals and experts. This ensures efficient and better cloud resources utilization and efficiency for systems that are often only 10-20% utilized.

- Location and Device independence

  Cloud service providers enable the Cloud users to access cloud resources through a web browser regardless of their location or the type of the devices they are having (e.g., PC, mobile, PDA etc.). Since the Cloud infrastructure are mainly off-site which is maintained by a third-party. So that it can be accessed through the Internet, users can connect from anywhere which gives them the capability of location and device independence.

- Fast Application Deployment

  By adopting Cloud computing, the users can easily acquire and release the Cloud resources on demand in the minimal time. Cloud services are accessed through a pool of cloud resources purely maintained by the team of professionals and experts. This gives the power of fast application deployment and realising.

- Hassle Free Maintenance

  Cloud services are maintained by the team of professionals and experts; which makes cloud computing maintenance easier and hassle free. They are easier to use, support, maintain and improve since the changes reach the clients instantly. This provides the cloud users an excellent service quality.

- Multi-tenancy

  Same pool of cloud resources is accessed across a large pool of users thus allowing each user to work on its own separate copy of resources in his own way. This is enabled by centralization of infrastructure. Now Peak-load capacity is also increased, utilization and efficiency improvements will also be there that are often only 10-20%.

- Reliability

  Reliability has improved with the shifting to Clouds. It has more reliable data centres, high safety measures and better disaster recovery.

- Security

  Cloud security is much improved due to centralization of data, increased security-focused resources, and strategies etc.

5. CLOUD COMPUTING MODELS

Cloud service providers offer all types of services through cloud computing, which includes delivery of various software and hardware through internet. The various cloud services are shown in the figure 1. All the cloud services are mainly categorized into three categories [3]:

(*i*) Software as a Service (SaaS)

(*ii*) Platform as a Service (PaaS)

(*iii*) Infrastructure as a Service (IaaS)

5.1 Software as a Service (SaaS)

In Software as a Service, cloud computing delivers the software's as a service to its end user [4]. All the software are delivered trough an appropriate web browser to the cloud user as a service which was demanded by him to the cloud vendor. This gives the advantages of paying only for what the user used. SaaS facilitate the users just to request the required software's to its cloud vendor on internet and then vendor will provide the required software services to its end users in minimal amount of time. It is the vendor's responsibility to ensure about the genuineness and the licensing of the delivered software, now the user need not to worry about all these licensing and genuineness of the software that he has delivered.

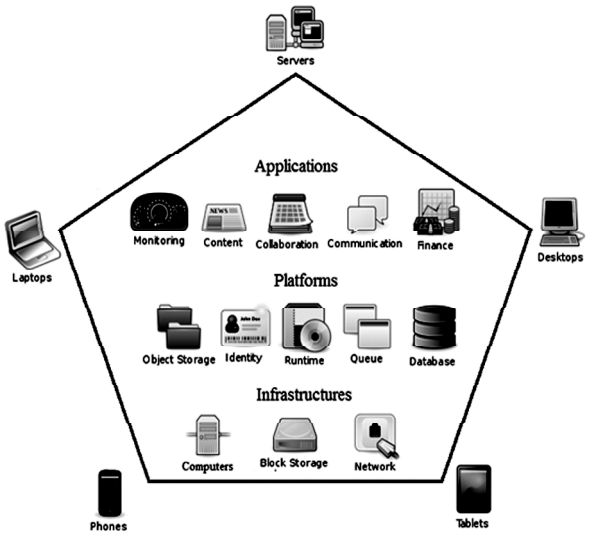

Figure 1: The Various Cloud Services

3.2 Platform as a Service (PaaS)

PaaS is similar to SaaS delivery model. This model delivers the computing platforms as a service to the end users over the internet. Now the circumstances of development of software, their deployment and finally the execution the software product has totally changed. It is the core service provided by the cloud computing, it eliminates the investment costs and the difficulty of buying, evaluating, configuring, and managing the hardware and software required by an organization. PaaS provides all the required set up to support the complete life cycle of building, deploying and delivering any web applications exclusively on the web.

5.3 Infrastructure as a Service (IaaS)

Infrastructure as a Service is a delivery model in which an enterprise outsources the Infrastructure required to support all the operations of the enterprise which includes storage, hardware, servers and networking equipments. The cloud vendor will owns all the equipment and is responsible for safe boarding, smooth running and even maintaining it. This provides the power of paying on per-use basis to the client organisation even for the costliest infrastructure or equipments. This reduces the set up investment and operational cost of the organizations. Now even the client organization need not to worry about the safe boarding, smooth running and maintenance of the entire hired infrastructure. Infrastructure as a Service is sometimes also referred as Hardware as a Service (HaaS).

6. TYPES OF CLOUDS

The cloud infrastructure can be accessed and required for general public, for a large industry organization and for both. On the basis of demand the various types of clouds are [5]:

6.1 Public Cloud

In this cloud infrastructure, the cloud services are accessible to the general public and the large scale organization. The cloud vendors manage all the cloud services. It is not the responsibility of the end user or the organizations accessing public cloud, to control, operate and secure the cloud services. The main characteristics of the public clouds are:

- Owned and managed by service provider
- Delivers limited and selected options for software's, application or infrastructure services.
- Accessed from "outside" the firewall

The Public/ External clouds make the things easier for implementation and usage. All the services are mainly metered and are typically billed according to usage. This reduces the set up investment as well as the operational expenditure by providing the feature of scaling according to the organization's needs.

It has also a disadvantage of housing your private data in an offsite organization which may be outside the legal and regulatory circumference of your organization. It is also difficult to identify and document the physical location of data at any particular moment because the user's data can reside in more than one data centres at a time.

6.2 Private Cloud

This cloud infrastructure is operated separately & solely for a single organization. It may be managed by the organization or a third party and may exist on or off-premises. While the organization does not need to physically own or operate all the assets, the key is that a shared pool of computing resources can be rapidly provisioned, dynamically allocated and operated for the benefit of a single organization. The key features of the private clouds are:

- Owned and managed by the enterprise
- Limits access to enterprise and partner network
- Retains high degree of control, privacy and security
- Accessed from "inside" the firewall

Mainly in the private/ internal cloud, the cloud infrastructure is completely organized and maintained by the enterprise itself. Mainly, the private clouds are implemented in the enterprise's own data centre and controlled by their own internal resources and professional teams.

Private clouds have one main disadvantage that it requires a big set up investment and operational expenditure as well as highly skilled technicians which increases the expenditure of the organization.

6.3 Hybrid Cloud

This cloud infrastructure is a combination of two or more clouds (private or public). To combine the benefits of both approaches private and public cloud, newer implementation models have been developed to merge both models into an integrated solution.

In Hybrid clouds the sensitive data is maintained in the Private cloud and the non sensitive data in the public cloud. This increases the security of the data in the Hybrid clouds. Implementation of a hybrid cloud requires additional synchronization between the private and public service management system. Thus Hybrid clouds combine the best parts of both public and private clouds.

7. SECURITY ISSUES AND CHALLENGES OF CLOUD COMPUTING

Some security concerns are listed and discussed below [6]:

1. With this model the physical security has become a major because all the resources are shared among the various companies. So that any other company can easily violate the laws that may result into the loss of data.
2. Transition between the clouds platforms may result in loss of data due to incompatibility of one vendor's storage services with another vendor's services is a major issue in cloud computing e.g. Microsoft cloud storage services are incompatible with Google cloud storage services. [7]
3. The controlling of the encryption/decryption keys by unprofessional persons may result into failure of cloud set up.
4. Maintaining of consistency of the data is another main concern of the clients as well as of vendors. The data should be updated in all data copies in response to authorized user transactions.
5. The updated information about the cloud platform status usually not shared with the users.
6. Due to government regulations, they may apply strict limits on where data about its citizens can be stored and for how much time.
7. The changing nature of virtual machines will make it difficult to maintain so consistency will be difficult.

To deal with the security concerns listed above, the vendors will need to enhance and update the commonly used security practices. Some more challenges in implementing the cloud computing is listed below [6]:

7.1 Security Management

One of the most crucial jobs for an organization is to build up a formal team for the security management of organization assets. The team should be occupied with the strategic plans of the organization. The individual's role, their responsibility and organization expectations should be clearly stated among security team members. The confusion in above stated issues among the security team may lead to major loss to the organization.

B. Risk Estimation

Risk estimation is always important in every stage of business. It helps a lot to make better decisions which makes balance between both business motive and cloud assets of the vendors [9] [8]. Security risk's estimation should be planned and managed on periodic or as need basis. So the standard strategies should be followed for risk estimation.

7.3 Security Awareness among People

The cloud users are the weakest link for data security. Lacking of proper security awareness and training to the people will lead the company to a variety of security risks, rather than due to system or application shortcomings. So a lot of security risks will arise due to lack of managed and effective security awareness program for the people.

7.4 Physical Security

The cloud data is actually stored at geographically distributed physical locations. The bulk investment and skilled team of professionals are required to protect these physical data centres. That's way to skip out this investment and tension; the companies prefer to move to cloud service.

7.5 Policies and Standards

Fair business policies should be developed. They must be documented and implemented with detailed documentation. To prevent the policies from becoming obsolete they should be reviewed at periodic time intervals or when considerable changes arise in the business or IT environment.

7.6 Data Safety

The main concerned of the organizations in shifting to clouds is their data security. The vendors must apply the proper security mechanism, user authentication and the latest encryption techniques to make client data protected. The vendor can also restrict the locality of the data centres to secure data.

7.7 Data Privacy

A security committee should also be settled to make decisions related to data privacy. The security compliance team should be given a formalized training on data privacy.

7.8 User Identity Management

Every organization does care about managing of level of user's accessibility to the cloud resources. Usually the concept of minimum privileged is adopted by the organizations. This means, while using the cloud applications, each and every user must be granted permission only for least span of time as well as the privilege should be given only for the least resources just enough to accomplish the operation.

8. RESEARCHES ON CLOUD COMPUTING

- IBM/Google has started an academic Cloud Computing initiative.
- HP, Intel Corporation and Yahoo announced the creation of a global, multi-data center, open source test bed, called Open Cirrus.
- Institutes researching on Cloud Computing

  The Electronics and Telecommunications Research Institute (ETRI) in Korea, Karlsruhe Institute of Technology, the Malaysian Institute for Microelectronic Systems (MIMOS), the Info comm. Development Authority (IDA) of Singapore, and the Institute for System Programming at the Russian Academy of Sciences.
- Universities researching on Cloud Computing

  Boston University, Carnegie Mellon, MIT, Indiana University, North Carolina State, Purdue, University of California, University of Melbourne (Australia), Georgia Tech, University of Massachusetts, Yale, Wayne State, University of Utah, University of Minnesota Virginia Tech, University of Wisconsin Madison, University of Maryland, University of Washington, University of Virginia.

8.1 Main Cloud Computing Service Providers

- Amazon
- Microsoft windows Azure
- Google AppEngine
- Vmware cloud
- Go grid
- Savvis
- Rack space
- Verizon
- AppNexus

8.2 Services offered in Cloud Computing

- Amazon:

  Amazon Elastic Compute Cloud (EC2), Amazon SimpleDB, Amazon Relational Database Service (RDS), Amazon Elastic MapReduce, Amazon Virtual Private Cloud (VPC), Auto Scaling, Amazon CloudFront, Amazon Fulfillment Web Service (FWS), Amazon Simple Queue Service (SQS), Amazon Simple Storage Service (S3).
- Google:

  Google invests more than $2 billion a year in data centers for cloud computing.

  Google App Engine

  AdWords, Maps, Google Places, Base, Google Site Search, AdSense, Analytics, Checkout, Ad Manager, Web Optimizer, Google Apps, Google Friend Connect, Postini services, Webmaster Central, Grow viral traffic to your site, Search company information, Secure your email
- Microsoft "Azure" :
- Internet-scale cloud computing and services platform hosted in Microsoft data centers.
- Provides a range of functionality to build applications that span from consumer web to enterprise scenarios.
- Designed to help developers quickly and easily create, deploy, manage, and distribute web services and applications on the internet.

8.3 Widely Used Cloud Services

FaceBook, Yahoo, Gmail, Rediff mail, Other email Service providers, Bit Torrent, Skype, LinkedIn, YouTube, Google, Microsoft, Blog-space, Forums, Website Hosting, VPS, WebEx, Groove, Qualys, SecondLife.

9. CONCLUSION

Computing clouds is changing the whole IT industry, businesses and global economy. Clearly, cloud computing demands effectiveness, security, and trustworthiness. Cloud computing has now become a common in business [10], government, education, and entertainment which is maintained by the 50 millions of servers globally installed at thousands of data centres today. Private clouds will also become usual in addition to using a few public clouds that are under heavy competition among Google, MS, Amazon, Intel, EMC, IBM, SGI, VMware, Saleforce.com etc.

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