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Cloud Computing: A Survey

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Abstract - Cloud computing provides huge computing services to the business for improving the organizational growth. Basic requirement needed for this technology is Internet but provides higher capability when compared to the Internet. Cloud computing is a combination of computation, software, data access and also provides storage services. In Cloud, storage of data and the location of stored data are not known to the user. Cloud computing adopts the concept of virtualization, service oriented architecture, autonomic, and utility computing. The cloud has more advantages and easy to implement with any business logics. Cloud delivers services from different data sources and servers located on different geographical location but the user gets single point of view from the cloud service.

This paper presents the survey on cloud computing, it includes cloud architecture, different models of deployment, and characteristics of Clouds. Cloud computing saves time, money and effort. The nature of cloud computing and their dependence on broad band internet might pose some serious issues for cloud provider and cloud users. This paper also describes some of the issues and challenges related to the cloud computing. Finally, the paper presents an observation study and suggests where to apply the cloud and where not to.

Keywords - *Cloud computing; Security Issue; Search Trend.*

I. INTRODUCTION

Cloud computing is a developing computing technology that uses the internet and multiple remote servers to maintain data and software applications [1]. Cloud computing allows users to use robust software applications without installing them on a local computer. Twenty definitions of cloud computing were described in [2] to focus on certain aspects of cloud technology. In the year of 2007, IBM and Google [3] have announced collaboration in cloud computing [4]. The term "cloud computing" become popular after the announcement. Cloud service acknowledged by the following test:*"If you can walk into any library or internet café and sit down at any computer without preference for operating system or browser and access a service, that service is cloud-based".*

End-user pays a subscription fee for using Cloud software service. The software is hosted directly from the software providers' servers and is accessed by the end user over the internet. This technology increases computing efficiency by multiple storage, memory, processing and bandwidth. Cloud computing is developed by technologies and business approaches that emerged over a number of years. Fig.1 illustrates the origin of the cloud computing.

A. Properties of Cloud

Kai-Fu Lee denotes six properties of cloud computing from Google's perspective, stated in [5] as follows

- *Cloud computing is user-centric.* The data stored in the cloud is owned by a specific user. In addition user can also share data with others.

- *Cloud computing is task-centric.* The user should focus on how a task could be completed by the cloud application.

- *Cloud computing is powerful.* Multiple computational resources are connected together in the cloud to create a high computing power, scalability and reliability.

- *Cloud computing is accessible.* Cloud provides instant response to user from multiple repositories. No need to depend on a single source of data.

- *Cloud computing is intelligent.* Cloud should use intelligent data mining technique to retrieve information from huge amount of data.

- *Cloud computing is programmable.* The process of cloud is automated for handling some unexpected

situations. To improve the integrity of data stored in the cloud, the data must be replicated. If any computer in the cloud is crashed, programs redistribute crashed computer data to new computer in the cloud. Thus the replication of data in the cloud is more useful in some critical situation.
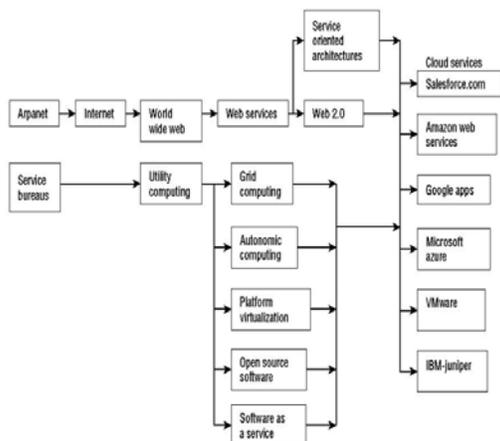

Fig.1: Origin of Cloud computing [22]

B. Cloud Services:

In [6], describes that, there are 11 major categories or patterns of cloud computing technology. This section describes three main business models: Infrastructure as a Service (IaaS), Software as a Service (SaaS) and Platform as a Service (PaaS) [7].

✓ *Infrastructure as a Service (IaaS) :*

The cloud provides capability to users to use computing resources like storage, computing hardware and so on. Instead of buying resources, users have to pay for their usage. The users have rights to control the storage, operating systems, deployed applications and limited control of selected networking components.

✓ *Software as a Service (SaaS):*

The cloud provides software to the users. Users need not to install any application on their PCs to access the software services provided by the cloud. The minimum requirement for access all the cloud services are internet connection with a PC. The user can use the software utility but don't have rights to control or manage infrastructure of the cloud. For example, Google Calendar.

✓ *Platform as a Service (PaaS) :*

The cloud provides platform to deploy users application and software. Deployed application are accessed from anywhere by the cloud user. The space for users application is increased and decreased based on the usage. The users have rights to control their

deployed application and several application hosting environment configurations. Before deploying an application or software on the cloud, user must get a confirmation about whether the user application or software tool is supported by the cloud provider.

The Fig.2 illustrates the security control responsibilities between the cloud service provider and the cloud user in different cloud service models.
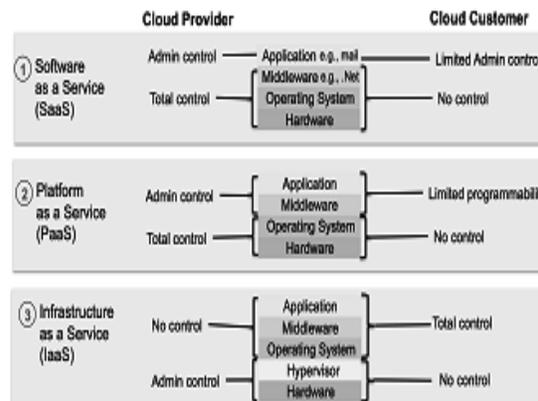

Fig. 2 : NIST Cloud Service Model [8]

II. CHARACTERISTICS OF CLOUD

Cloud computing is based on different characteristics that demonstrates their relation to, and differences from traditional computing approaches [9], [10].

A. Essential characteristics:

- *On-demand self-service:*

Consumers have some provision in computing capabilities, such as server time and network storage.

- *Broad network access.*

As the capabilities are available over the network and accessed through standard mechanisms, it means that access to user is available through the internet from a broad range of devices such as PCs, laptops, and mobile devices.

- *Resource pooling or shared Infrastructure:*

The technological resources of cloud service providers are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. The customer has no control or knowledge about the exact location of the provided resources but may be able to specify location at a higher level of abstraction. Examples of resources include storage, processing, memory, network bandwidth, and virtual machines.

- *Rapid elasticity:*

Capabilities can be rapidly and elastically provisioned, cloud provides unlimited provisioning of capabilities to user at any time.

- *Measured Service:*

Cloud systems automatically controls and optimizes resource used by leveraging a measuring/metering capability appropriate to the type of service. Resource usage can be monitored, controlled, and reported providing transparency for both the provider and consumer of the utilized service.

B. Key characteristics

Key characteristics of cloud computing are described in [4] as follows

- *Agility-* Technological infrastructure resources could be re-provisioned easily and inexpensively by the user.

- *Cost-* Cost can be considerably minimized and expenses incurred in capital are converted to operational expenses. Instead of purchase the resources, users can use resources provided by a third-party and pay as per usage.

- *Device and location independence- e*nable users to access systems using a web browser regardless of their location or what device they are using (e.g., PC, mobile).

- *Reliability-* data can be stored in multiple servers, which makes cloud suitable for business continuity and disaster recovery.

- *Sustainability-* comes about through improved resource utilization, more efficient systems, and carbon neutrality. Nonetheless, computers and associated infrastructure are major consumers of energy.+

- *Maintenance-* Application maintenance of cloud is not so difficult; cloud does not require any application to be installed in the client machine. If any changes occurred, it would reach the user instantly.

- *Metering-* Usage of cloud resources must be measured and metered per client, based on an application on a daily, weekly, monthly, and yearly basis.

III. CLOUD ARCHITECTURE

Fig.3. illustrates the typical structure of general cloud architecture. This architecture contains massive collection of servers. This architecture represents the culture of cloud and access procedure of the cloud server. Virtualization is the key mechanism, it could be used to increase the server utilization as much the computing power available to the server, e.g. to better match the overall workload. The architecture provides a front end interface such as a Portal that allows a user to select a service from a catalogue.
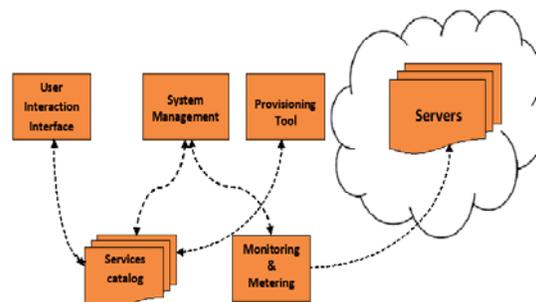

Fig. 3 : General cloud computing architecture

The user request is passed to the system management, finds the correct resources and then calls the provisioning services which allocate resources in the Cloud. The provisioning service may deploy the requested software stack or application as well, e.g. via licensing on-demand [11].

- User interface (Portal or desktop) - this entity allows the users to interact with the cloud interface to request services from the cloud server;

- Services catalogue - this entity provide the list of services available in the server, user can request the services from the list;

- System management - to manages the computer resources available in the cloud architecture;

- Provisioning tool - this tool allocates the systems from the Grid to deliver on the requested service by the user. It may also deploy the required software;

- Monitoring and metering - an optional part to tracks the usage of the services, so the resources used can be credited to a user on specific time;

- Servers – the system management tool is used to manage the servers. They can be either real or virtual.

A. Deployment models of Cloud Computing:

Cloud Computing has four main deployment models from the architecture, each with specific characteristics that supports the needs of the services and users of the clouds in particular ways [12].

- *Private Cloud:*

Private clouds are owned and operated by a user or a cloud computing provider, this type of cloud is built for the sole use of a single user. Private clouds utilize

the same technology as public clouds and it's mainly built to enable an individual company to maximize the use of its computing resources and be more responsive to company needs.

- *Public Cloud:*

Public clouds are owned and operated by third parties and located in data centers that operate outside of the user location. Multiple companies share these resources; each cloud user is assigned own virtual computing capabilities based on a common set of physical resources. Public clouds are provided by companies like Amazon, Hewlett-Packard, IBM, Google, Microsoft, Rackspace, and Salesforce.com.
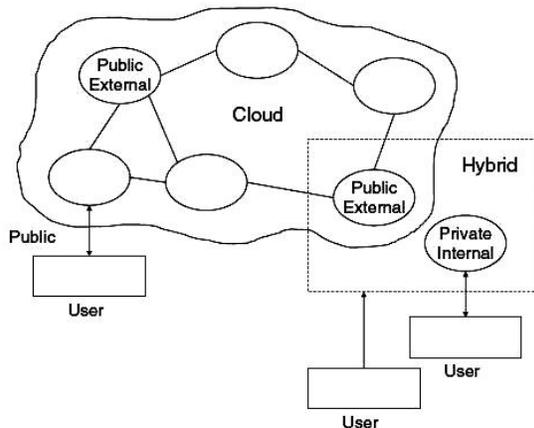

Fig. 4: Deployment Models [24]

- *Hybrid Cloud :*

Hybrid clouds are combinations of multiple clouds that are both public and private. These clouds are created by individual customers to meet their precise needs. For example, a company may decide to create a hybrid cloud to combine a CRM system provided on a public cloud operated by Sales-Force.com with an ERP system running on their private cloud.

- *Community Cloud:*

Community cloud infrastructure is shared by some organizations and supports a specific community that shares concerns (e.g., mission, security requirements, govt, education and compliance considerations). It may either be managed by the organizations or a third party and may exist on premise or off premise.

IV. IMPORTANTANCE OF CLOUD

Cloud is the delivery of IT services through the internet. The big idea is that users will no longer need to purchase or install software and companies won't run their own application and data servers. Cloud service providers host applications and provide computing power from its data centers, benefiting from massive economies of scale and dramatically lowering the costs of IT.

Virtualization is a key feature of cloud. Virtualization further enhances flexibility because it abstracts the hardware to the point where software stacks can be deployed and redeployed without being tied to a specific physical server. Virtualization enables a dynamic datacenter where servers provide a pool of resources that are harnessed as needed, and where the relationship of applications to compute, storage, and network resources changes dynamically in order to meet both workload and business demands. IT organizations have understood for years that virtualization allows them to quickly and easily create copies of existing environments, sometimes involving multiple virtual machines to support test, development, and staging activities [14].

Cloud computing saves time and money during upgradation; cloud services are updated by the provider, so everyone is always working on the latest platform. In addition to minimizing wasted computing resources, cloud computing can also reduce energy consumption significantly.

Once an enterprise starts using the cloud computing services, they no need to worry about the technology deficiency related to IT installations. They can replace their complex installations of servers, workstations, networking and numerous applications with simple workstation computers and fast Internet connectivity. The cloud service providers will provide the infrastructure, platforms and even applications needed by the enterprises.

V. CLOUD ISSUES AND CHALLENGES

Cloud computing saves time, money and effort. But the nature of cloud computing applications, as well as their dependence on broadband internet poses some serious issues, that are as follows,

- *Privacy-* Cloud computing lies in its high level of scalability. Information stored in the cloud is looked after by the provider, meaning that consumers share control over their information with the provider. This creates a range of privacy and security issues, as well as legal concerns as to who owns and has access to the information [16].

- *How users' information may be used* – Data might be sent by service providers or third parties. Because cloud computing services offer effectively unlimited storage space, it becomes unnecessary to delete information or content that the consumer added. This is in turn creates enormous amounts of lucrative data that

can be sold depending on the ownership of the information, which poses another issue to consumers. Even when information, such as email, is deleted, its still exists somewhere, with many organizations retaining content.

- *Accountability* - If the cloud fails, can the user access their information from somewhere else? Or if they decide to move clouds. For example, migrate from Google to Yahoo, can their data be transferred? By relying on cloud computing, the user is entrusting all of their information to a service provider. If the cloud fails, who is responsible for recovering that lost information, and for any costs or damages incurred by that loss? [17].

- *Connectivity* - Clouds function in ways that recall in some respects the closed, proprietary networks of the 1980s and 90s, such as Compuserve or AOL. The tremendous benefit of the Internet as it emerged in the 1990s was the capacity for users to communicate across networks, but users may now be losing some of the freedom. Some experts suggested that the next major challenge for Internet architects will be ensuring that clouds communicate with each other.

A. Security in cloud:

The cloud is a place to keep the users data; normally the users are very sensitive to store their private data in cloud. Similarly the business logic and other business related transactions are to be stored in the place of cloud, so the cloud users want high security to keep their own private data in the cloud. The cloud computing should set out the IT security arrangements that the customer requires. The encryption of data prior to transmission between the customer's premises and the service provider's premises is particularly important, for example, where the internet is used for transmission. Customers may also require that their applications are hosted on hardware that is specific to them, rather than on shared hardware. There should be an access privileges between cloud providers and cloud customers. This will protect the unauthorized access, authentication procedure are followed for allowing user to access their data in cloud.

Gartner identifies some specific security issues that customers should raise with vendors before selecting a cloud vendor in [18] as follows:

- ∗ *Privileged user access* - information transmitted from the client through the Internet poses a certain degree of risk, because of issues of data ownership; enterprises should spend time getting to know their providers and their regulations as much as possible before assigning some trivial applications first to test the water

- ∗ *Regulatory compliance* - clients are accountable for the security of their solution, as they can choose between providers that allow to be audited by 3rd party organizations that check levels of security and providers that don't

- ∗ *Data location* - depending on contracts, some clients might never know what country or what jurisdiction their data is located

- ∗ *Data segregation* - encrypted information from multiple companies may be stored on the same hard disk, so a mechanism to separate data should be deployed by the provider.

- ∗ *Recovery* - every provider should have a disaster recovery protocol to protect user data

- ∗ *Investigative support* - if a client suspects faulty activity from the provider, it may not have many legal ways pursue an investigation

- ∗ *Long-term viability* - refers to the ability to retract a contract and all data if the current provider is bought out by another firm.

VI. OBSERVATION

More than twenty papers were surveyed on Cloud computing. Cloud computing was focused by the researchers from 2007 [21]. More researches are undertaken on cloud technology. Users are aware of cloud computing and ready to adopt this genius application. Fig 5 shows that the Google search trends on cloud computing. According to Google Trends, the term cloud computing became popular in 2007. The Fig 5 shows the growth of the Cloud computing around the world from 2007 to July 2011. Trends of searching information concerning cloud computing is increased exponentially over the last four years.

Fig.5 : Searches for cloud computing from worldwide on google.com, taken from Google Trends [28]

Progress of Cloud Computing in India is faster than other countries. According to a survey, a list of top 10 countries ranked in surfing cloud computing, this is shown in the Fig 6. Cloud computing services have huge opportunity in Indian market due to the large number of small and medium businesses (SMBs) [22] which are at around 35 million and desiring easy to use, reliable and

scalable application and helps to develop and expand their business. IBM India collaborated with IIT Kanpur has come up with some new developments in cloud computing which will be helpful in academic advancement.
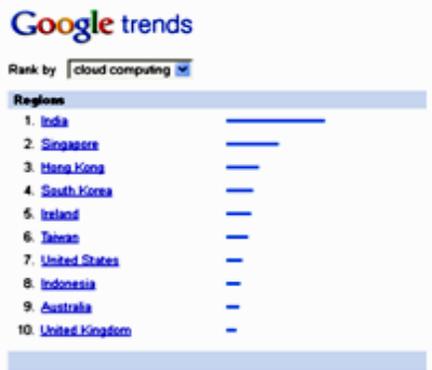

Fig. 6 : Searching Trends of Cloud Computing by different countries, taken from Google Trends [28]

Fig 7 shows how the enhancement of searching trend on cloud computing in India? Cloud services have been started in India since September 2005. Nowadays searching of cloud has increased exponentially in India. Different Business organization has started the cloud services. Bharti Airtel launched the cloud computing services with their NetPc model and other giant companies like Reliance Communications, TCS, HCL technologies, Wipro, Netmagic, Verizon, Novatium etc., also launched cloud computing services in India. Table 1 provides the list cloud service providers in India.
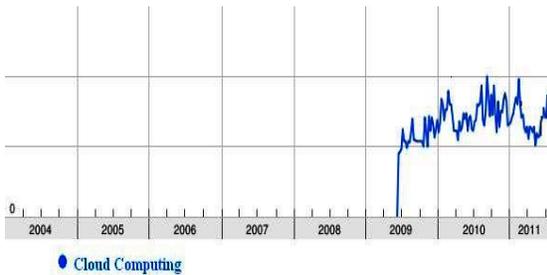

Fig.7 : Searches for Cloud Computing from India on google.com, taken from Google Trends [29]

The popularity of different paradigms varies with time. The web search popularity, is measured by the Google search trends, for terms "Cloud Computing", "Service Oriented Architecture (SOA)", "Virtualization" and ``Grid computing" is shown in Fig 8. From the Google trends, it is observed that Virtualization and SOA was a popular term during 2000s, from early 2000 Grid computing become popular, and recently Cloud computing started gaining popularity from 2007.
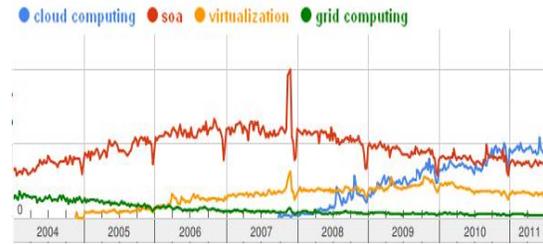

Fig. 8 : Searches for cloud computing, soa, virtualization, grid computing from worldwide on google.com, taken from Google Trends [30]

TABLE 1: LIST OF INDIA BASED CLOUD COMPUTING SERVICE PROVIDERS

S. No	Company	Location	Service	Cloud Type
	Zenith InfoTech	Mumbai, India	PROUD	IaaS
	Wolf Frameworks	Bangaluru, India	Wolf PaaS	PaaS
	OrangeScape	Chennai, India	OrangeScape Cloud	PaaS
	TCS	India	ITaaS	IaaS+ SaaS
	Cynapse India	Mumbai, India	Cyn.in	IaaS, on Demand SaaS
	Wipro Technologies	India	Wipro w-SaaS	SaaS
	Netmagic Solutions	Mumbai, India	CloudNet, CloudServe, PrivateCloud	IaaS
	Reliance Data Center	India	Reliance Cloud Computing Services	IaaS+ SaaS+ PaaS
	Infosys Technologies	Bangalore, India	Cloud based Solution for Auto Sector	SaaS
	Synage	Mumbai, India	DeskAway	SaaS

Cloud Computing is also implemented in educational institution to satisfy educational business needs. It is one of the new technology would likely to have a significant impact on teaching and learning environment. Many educational institutions began to move on to cloud computing by outsourcing students email provision. Email is a basic, fairly standardized service, provided easily by third parties, and is arguably not core to the educational mission.

Top ten cloud service providers in world are Amazon, Google, VMware, Rackspace, Salesforce.com, Microsoft, Joyent, IBM, Netsuite and 3Tera.

VII.CONCLUSION

Cloud computing is an emerging technology supporting business and satisfies customer needs. Users run applications in shared environment. When a user uses any application on the Cloud, just logs in, customizes it, and starts using it. That's the power of Cloud computing. This paper gives an idea about Cloud Computing, its architecture and Characteristics, along with the issues related to cloud. According to the issue noted above, storage of data in cloud may have some risks. Moreover, cloud computing is not risky for every system. Potential users need to evaluate security measures such as firewalls, and encryption technique and make sure that they will have access to data and software or source code if the service provider goes out business. Our suggestion is, cloud computing is a wonderful and intelligent technology for all kind of on-line businesses. Cloud computing is not suggested for some sensitive applications like E-banking due to security issues. Concerning of security, the cloud would refine more to provide the secured data usage in the cloud environment. Nowadays most organizations are trying to adopt the cloud. Based on the searching trend the growth of cloud is improved very well over last four years and in near future it will be focused by all kinds of business people in the world.

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