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A Review on Cloud Computing, It's Overview and Current Research Challenges

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Abstract- Cloud computing is an emerging computing technology and trend in research field today. It is an internet based computing model that shares pool of computing resources such as servers, storage, computer networks, applications and services to other devices on demand over a network on a leased basis. Many industries such as banking, healthcare and education are moving towards cloud due to efficiency of services provided by the pay per use pattern based on resources such as processing power used, transactions carried out, bandwidth consumed, data transferred or storage space occupied. Cloud computing is aimed at providing IT as a service to the cloud users on demand basis with greater flexibility, availability, reliability and scalability. There are various issues such as load balancing, management of energy, privacy and security which hinders their growth. Serverless architecture, Security and load balancing are critical issues in cloud computing in present era. This paper presents review on use of cloud computing, its various models, cloud computing architecture and various research challenges in cloud computing.

***Keywords*:** Cloud computing, Software as a service (SaaS), Platform as a service (PaaS), Infrastructure as a service (Iaas), NIST(National Institute of standards and technology).

I. INTRODUCTION

The term cloud computing is a recent buzzword in the IT world [1]. Cloud computing is where apps or data are stored and accessible on the internet instead of on a single computer or networks. Online payment, customer self scheduling, data storage and accounting software are some examples of cloud services. It is an amazing technology that uses internet and central remote servers to maintain data and different applications. The cloud computing is computing paradigm in which there are two types of players such as cloud users and cloud service providers[2]. The party which uses cloud based IT resources is called cloud users and the party which provides cloud based IT resources is called cloud service providers. Cloud has three components: client's computer, data centres and distributed servers.

End users interact with the clients to manage information related to the cloud. Clients generally fall into three categories as: Mobile, thin clients and thick clients. Mobile is Windows Mobile Smartphone, smart phones, like a Blackberry, or an iphone. Thin clients don't do any computation work. They only display the information. Servers do all the works for them. Thin clients do not have any internal memory. Thick clients use different browsers like IE or Mozilla Firefox or Google Chrome to connect to the Internet cloud. Now-a-days thin clients are more popular as compared to other clients because of their low price, security, low consumption of power, less noise, easily replaceable and repairable. Data centre is nothing but a collection of servers hosting different applications. An end user connects to the data centre to subscribe different applications. A data centre may exist at a large distance from the clients. Now-a-days a concept called virtualisation is used to install software that allows multiple instances of virtual server applications. Distributed servers are the parts of a cloud which are present throughout the Internet hosting different applications. But while using the application from the cloud, the user will feel that he is using this application from its own machine. It allows customers and businesses to use applications without installation and access their personal files at any computer with internet access. It is an emerging trend to deploy and maintain software is being adopted by industry such as Google, IBM, Microsoft and Amazon. Cloud computing may be applied to solve problems in many domains of information technology like GIS(Geographic information system), Scientific research[4], e-governance system[5], decision support system[6], ERP[7], web application development[8], and mobile technology[9]. The following section describe as: section 2 describe overview of cloud computing, section 3 describe cloud computing architecture, section 4 deals with

cloud computing models and future of service model, section 5 describes cloud computing benefits, section 6 describe current research challenges in cloud computing, section 7 describes conclusions and future work and section 8 shows references.

II. CLOUD COMPUTING: OVERVIEW

Cloud computing is a process that entails accessing of services, including, storage, applications and servers through the Internet, making use of another company's remote services for a fee. This enables a company to store and access data or programs virtually, i.e. in a cloud, rather than on local hard drives or servers.

Cloud Computing also supports multi tenancy, providing systems configured in such a way that they can be pooled to be shared by many organizations or individuals [12]. The idea of cloud computing is based on very fundamental principal of reusability of IT capabilities. Forrester defines cloud computing as, "A pool of abstracted, highly scalable and managed compute infrastructure capable of hosting end customer applications and billed by consumption".

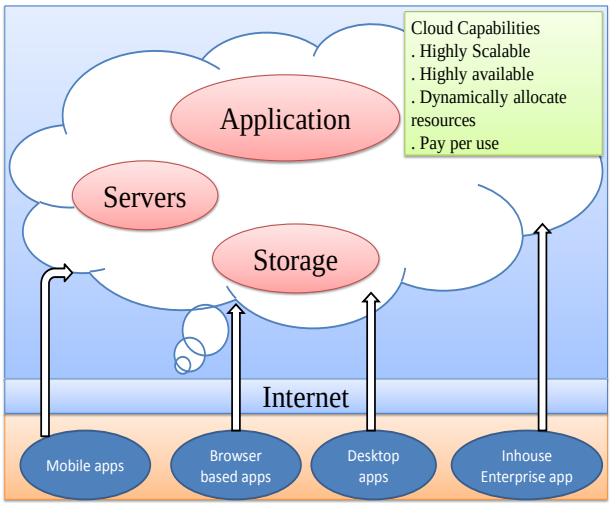

Figure1 Conceptual view of cloud computing

III. CLOUD COMPUTING ARCHITECTURE

In 2009, NIST[18] defines cloud computing as " It is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction". The cloud providers actually have the physical data centres to provide virtualized services to their users through Internet. The cloud providers often provide separation between application and data. This scenario is shown in the Figure 2. The underlying physical machines are generally organized in grids and they are usually geographically distributed. Virtualization plays an important role in the cloud scenario. The data centre hosts provide the physical hardware on which virtual machines resides. User potentially can use any OS supported by the virtual machines used.

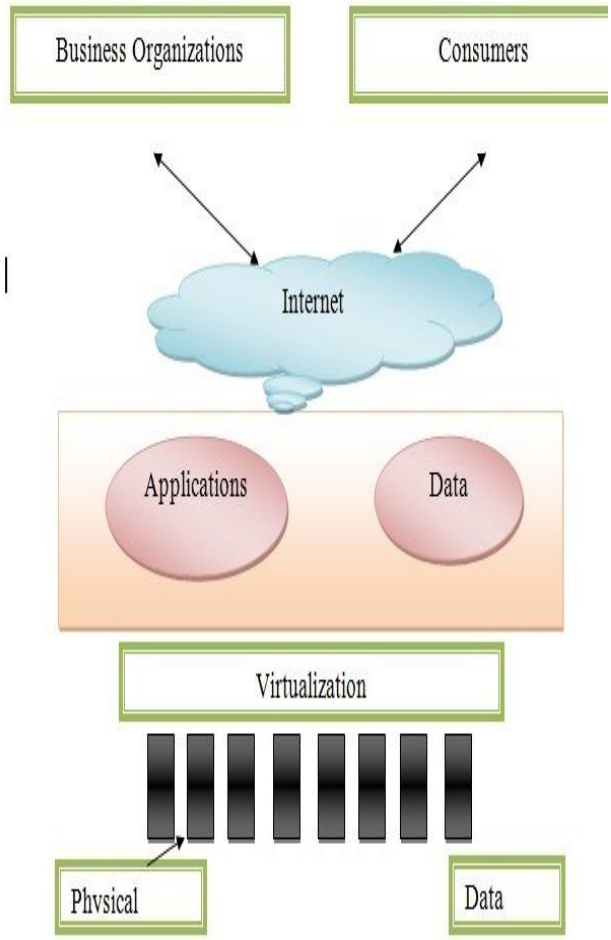

Figure 2 Basic cloud computing architecture

IV. CLOUD COMPUTING MODELS

Basically there are three model in cloud computing. These are shown in figure given below:

- Five essential characteristics of cloud computing
- Deployment model
- Service model

Five essential characteristics of cloud computing [2]:
(a) On demand Self Services: Computing capabilities can be provided to customer according to requirement of user. Capabilities like storage and server time allocated without human interaction.
(b) Broad Network Access: Cloud can be accessed through network using thick or thin clients. Examples of clients are tablets, laptops, mobile phones and workstations.
(c) Resource Pooling: Computing resources are pooled to provide multiple consumers.

(d) Rapid Elasticity: Depending on user's requirement, capabilities and resources in the cloud can be released and provided automatically.
(e) Measure Service: Services provided to user are measured by cloud system and are reported to user and provider.

Deployment model:
The three deployment models in cloud computing are public cloud, private cloud and hybrid cloud [3].
(a) Private Cloud: Deploying resources on-premises, using virtualization and resource management tools, is sometimes called "private cloud". On-premises deployment does not provide many of the benefits of cloud computing but is sometimes sought for its ability to provide dedicated resources. In most cases this deployment model is the same as legacy IT infrastructure while using application management and virtualization technologies to try and increase resource utilization. Eucalyptus System [13] is one of the examples of private cloud.

(b) Public Cloud: This cloud available to the general public over the Internet. Applications in the cloud have either been created in the cloud or have been migrated from an existing infrastructure to take advantage of the benefits of cloud computing. Cloud-based applications can be built on low-level infrastructure pieces or can use higher level services that provide abstraction from the management, architecting, and scaling requirements of core infrastructure. Examples of a public cloud include Microsoft Azure, Google App Engine.

(c) Hybrid Cloud: Hybrid Clouds combine both public and private cloud models. The Hybrid cloud environment is capable of providing on-demand, externally provisioned scale. The ability to augment a private cloud with the resources of a public cloud can be used to manage any unexpected surges in workload. An example of a Hybrid Cloud includes Amazon Web Services (AWS).

Service model:
Cloud Providers offer services that can be grouped into three categories [14].
(a) Software as a Service (SaaS): In this model, a complete application is offered to the customer, as a service on demand. A single instance of the service runs on the cloud & multiple end users are serviced. Today SaaS is offered by companies such as Google, Salesforce, Microsoft, Zoho, etc.

(b) Platform as a Service (Paas): This service provides a layer of software, or development environment is encapsulated & offered as a service, upon which other higher levels of service can be built. LAMP platform (Linux, Apache, MySql and PHP), restricted J2EE, Ruby etc. Google¨s App Engine, Force.com, etc are some of the popular PaaS examples.

(c) Infrastructure as a Service (Iaas): Servers, storage systems, networking equipment, data centre space etc. are pooled and made available to handle workloads. The customer would typically deploy his own software on the infrastructure. Some common examples are Amazon, GoGrid, 3 Tera, etc.

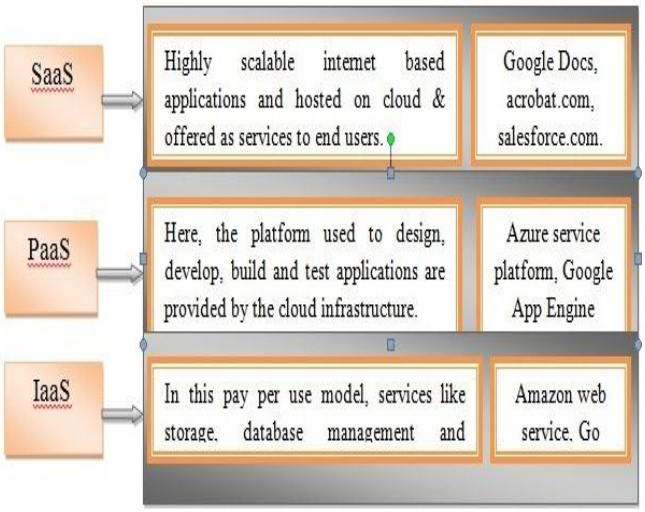

Figure 3 Future of service model[23]

1)Best Practices under development: SaaS : There are several trade associations, promoting SaaS. There are many SaaS companies' e.g. Salesforce.com and NetSuite using Cloud infrastructure to increase scalability.Google Apps and Zoho are SaaS competitors with MS Office.Microsoft SaaS implementations (e.g. Exchange) available. Traditional enterprise software dealers are moving to the Cloud (e.g. Oracle). Interoperability between SaaS is possible using Web standards (possibly hosted in Cloud). U.S. Government has created a SaaS Apps.gov Web site. PaaS tools make it easier to create scalable, customized SaaS. There will be an explosive growth in SaaS applications due to low cost of entry for vendors and users, ability to rapidly deploy and update capabilities, elasticity and scalability of billing.

2) Technology under development: Google App Engine and Microsoft Azure are PaaS products integrating development and deployment. Many smaller as well as major Cloud vendors e.g. Amazon, Salesforce.com are moving towards PaaS. PaaS will become the battleground for determining the future of Cloud Computing. All the major players will provide Cloud platform capabilities to attract a critical mass of applications. Several dominant Cloud ecosystems will emerge.

3) Standards under developments: Multiple companies are offering IaaS services for storage and computing e.g. Amazon, GoGrid, and Rackspace. Virtualization management tools (e.g from Citrix and VMware) are

offering IaaS. U.S. Government has created an IaaS Cloud Storefront. Without PaaS tools and utilities, IaaS can be considered a different business model for hosting. Core IaaS will become increasingly standardized and commoditized for horizontally scalable applications. There will still be diversity across multiple Cloud implementations (e.g. AWS and vCloud-based).Cross-Cloud tools and middleware will be available to enable interoperability and portability across core IaaS.

V. CLOUD COMPUTING BENEFITS

Enterprises would need to align their applications, so as to exploit the architecture models that Cloud Computing offers. Some of the typical benefits [25] are listed below:

Reduced Cost: One of the best properties of cloud technology is lower costs. The billing model is pay as per usage; the infrastructure is not purchased thus lowering maintenance. Initial expense and recurring expenses are much lower than traditional computing.

Increased Storage: With the massive Infrastructure that is offered by Cloud providers today, storage & maintenance of large volumes of data is a reality. Sudden workload spikes are also managed effectively & efficiently, since the cloud can scale dynamically.

Flexibility: This is an extremely important characteristic. With enterprises having to adapt, even more rapidly, to changing business conditions, speed to deliver is critical. Cloud computing stresses on getting applications to market very quickly, by using the most appropriate building blocks necessary for deployment.

Trade capital expense for variable expense: Instead of having to invest heavily in data centres and servers before you know how you're going to use them, you can only pay when you consume computing resources, and only pay for how much you consume.

Benefit from massive economies of scale: By using cloud computing, you can achieve a lower variable cost than you can get on your own. Because usage from hundreds of thousands of customers are aggregated in the cloud, providers such as Amazon Web Services can achieve higher economies of scale which translates into lower pay as you go prices.

Stop guessing capacity: Eliminate guessing on your infrastructure capacity needs. When you make a capacity decision prior to deploying an application, you often either ends up sitting on expensive idle resources or dealing with limited capacity. With cloud computing, these problems go away. You can access as much or as little as you need, and scale up and down as required with only a few minutes' notice.

Increase speed and agility: In a cloud computing environment, new IT resources are only ever a click away, which means you reduce the time it takes to make those resources available to your developers from weeks to just minutes. This result in a dramatic increase in agility for the organization, since the cost and time it takes to experiment and develop is significantly lower.

Stop spending money on running and maintaining data centres: Focus on projects that differentiate your business, not the infrastructure. Cloud computing lets you focus on your own customers, rather than on the heavy lifting of racking, stacking and powering servers.

Go global in minutes: Easily deploy your application in multiple regions around the world with just a few clicks. This means you can provide a lower latency and better experience for your customers simply and at minimal cost.

VI. CURRENT RESEARCH CHALLENGES IN CLOUD COMPUTING

Cloud Computing research addresses the challenges of meeting the requirements of next generation private, public and hybrid cloud computing architectures, also the challenges of allowing applications and development platforms to take advantage of the benefits of cloud computing. The research on cloud computing is still at an early stage. Cloud computing has been used drastically in business world however there are number of issues like load balancing, privacy, energy management, security and migration of virtual machine[21]. Many existing issues have not been fully addressed, while new challenges keep emerging from industry applications.

Some of the challenging research issues in cloud computing are given below [9], [10].

Service Level Agreements (SLA's): Cloud is administrated by service level agreements that allow several instances of one application to be replicated on multiple servers dependent on a priority scheme; the cloud may minimize or shut down a lower level application. A big challenge for the Cloud customers is to evaluate SLAs of Cloud vendors. Most vendors create SLAs to make a defensive shield against legal action, while offering minimal assurances to customers. So, there are some important issues, e.g., data protection, outages, and price structures that need to be taken into account by the customers before signing a contract with a provider [11].

Cloud Data Management: One of the most important feature of cloud computing is elasticity [17]. The resources

are available to users as per their requirements when it is not need it is stored in cloud storage just like behaviour of elastic. Cloud data can be very large (e.g. text-based or scientific applications), unstructured or semi-structured, and typically append-only with rare updates Cloud data management an important research topic in cloud computing.

Data Encryption: Encryption is a key technology for data security. Understand data in motion and data at rest encryption. Remember, security can range from simple (easy to manage, low cost and quite frankly, not very secure) all the way to highly secure (very complex, expensive to manage, and quite limiting in terms of access).[27]

Migration of Virtual Machines: Applications are not hardware specific; various programs may run on one machine using virtualization or many machines may run one program. Virtualization can provide significant benefits in cloud computing by enabling virtual machine migration to balance load across the data centre. In addition, virtual machine migration enables robust and highly responsive provisioning in data centres. Virtual machine migration has evolved from process migration techniques. Currently, detecting workload hotspots and initiating a migration lacks the agility to respond to sudden workload changes.

Interoperability: This is the ability of two or more systems work together in order to exchange information and use that exchanged information. Many public cloud networks are configured as closed systems and are not designed to interact with each other. The lack of integration between these networks makes it difficult for organizations to combine their IT systems in the cloud and realize productivity gains and cost savings.

Access Controls: Authentication and identity management is more important than ever. And, it is not really all that different. If you use strong passwords, changed frequently, with typical IT security processes, you will protect that element of access.

Energy Resource Management: Significant saving in the energy of a cloud data centre without sacrificing SLA are an excellent economic incentive for data centre operators and would also make a significant contribution to greater environmental sustainability. It has been estimated that the cost of powering and cooling accounts for 53% of the total operational expenditure of data centres. The goal is not only to cut down energy cost in data centres, but also to meet government regulations and environmental standards. Designing energy-efficient data centres has recently received considerable attention.

Multi-tenancy: There are multiple types of cloud applications that users can access through the internet, from small Internet-based widgets to large enterprise software applications. This application requests require multi-tenancy for many reasons, the most important is cost. Multiple customers accessing the same hardware, application servers, and databases may affect response times and performance for other customers. For application-layer multi-tenancy specifically, resources are shared at each infrastructure layer and have valid security and performance concerns. For example, multiple service requests accessing resources at the same time increase wait times but not necessarily CPU time, or the number of connections to an HTTP server has been exhausted, and the service must wait until it can use an available connection or in a worst-case scenario drops the service request.

Server Consolidation: The increased resource utilization and reduction in power and cooling requirements achieved by server consolidation are now being expanded into the cloud. Server consolidation is an effective approach to maximize resource utilization while minimizing energy consumption in a cloud computing environment.

Reliability & Availability of Service: The challenge of reliability comes into the picture when a cloud provider delivers on-demand software as a service. The software needs to have a reliability quality factor so that users can access it under any network conditions (such as during slow network connections). There are a few cases identified due to the unreliability of on-demand software. One of the examples is Apple's MobileMe cloud service, which stores and synchronizes data across multiple devices.

Common Cloud Standards: Security based accreditation for Cloud Computing would cover three main areas which are technology, personnel and operations.

Technical standards are likely to be driven by organizations, such as, Jericho Forum1 before being ratified by established bodies, e.g., ISO2 (International Standard Organization).
The creation of a unified accreditation body to certify the Cloud services would also be a big challenge [11].

Platform Management: Challenges in delivering middleware capabilities for building, deploying, integrating and managing applications in a multi-tenant, elastic and scalable environments. One of the most important parts of cloud platforms provide various kind of platform for developers to write applications that run in the cloud, or use services provided from the cloud, or both. Different names are used for this kind of platform today, including on-demand platform and platform as a service (PaaS). This new way of supporting applications has great potential. When a development team creates an on-premises application (i.e., one that will run within an organization), much of what that application needs already exists. An operating system provides basic support for executing the application,

interacting with storage, and more, while other computers in the environment offer services such as remote storage.

Load Balancing [15]: Load balancing are critical challenges for researchers in cloud computing. Day by day increasing traffic on internet introduces the requirement of load balancing concept to get the most utilization of the resources available on Cloud. A load balancer acts as the "traffic cop" sitting in front of your servers and routing client requests across all servers capable of fulfilling those requests in a manner that maximizes speed and capacity utilization and ensures that no one server is overworked, which could degrade performance.

Serverless Archetecture[16]: Serverless architecture is current research topic in cloud computing. In 2014, AWS introduced a new managed service for compute called Lambda and the cloud world changed. Lambda, as its name implies, is an anonymous function which runs a snippet of code once and is triggered by an event (e.g., HTTPS request). Simply put, Lambda allows you to run code without provisioning or managing servers. Lambda is a component of a new architectural movement called Serverless (Microservice) Architecture. The abstraction of server management is effectively the removal of IaaS. This adoption of PaaS increases the level of responsibility for the cloud provider and decreases the responsibility of the customer. With PaaS, customers no longer manage and secure infrastructure. Benefits include no servers to manage, continuous scaling, less security to manage, and sub second metering. You pay only for the compute time not when services are idle.

VII. CONCLUSION AND FUTURE WORK

Cloud computing is a newly developing paradigm of parallel and distributed computing. This paper focus on basic concepts and challenges of cloud computing. This computing technique holds some strong promises such as highly scalable, highly available, dynamically allocate resources and pay only for resources that we use. The areas like serverless, security, load balancing and costs are major issues for researchers in future work.

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