International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)
ISSN: 0976-1353 Volume 12 Issue 2 –JANUARY 2015.

Cloud Computing – Service Models, Types of Clouds and their Architectures, Challenges.

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***Abstract*— Internet has changes the computing world providing abundant resources for the user, moving from cluster to Grid, Grid to Cloud. The cloud provides an environment where the requirements like computing power, data storage and memory are provided to the customer as utility computing. There are many deployment models and service models. In this paper we will discuss the service models, the different types of clouds, namely public cloud, private cloud, hybrid cloud, intercloud and their architecture and introduction to community cloud, distributed cloud and multicloud and challenges and obstacles in the cloud.**

***Index Terms*— Cloud computing; public cloud; private cloud; hybrid cloud; intercloud.**

I. INTRODUCTION

Cloud computing has emerged as a new computing paradigm which aims to provide the consumer or end-user, computing environment with QOS (Quality of service) and based on the dynamic requirements. The definition of cloud computing according to National Institute of standards and Technology is "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 application and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction[1]". Applications are delivered as services which results in the overall cost reduction. Cloud computing utilizes distributed resources by combining them to solve complex, large scale computation problems and to achieve higher throughput. There are different types of clouds namely Public clouds, Private Clouds and Hybrid clouds. Cloud computing deals with virtualization, scalability, interoperability and quality of service.

II. HISTORY

In 1960 John McCarthy stated that "Computation may someday be organized a s a public utility [2]". In the 1970s IBM released an Operating System called VM which enabled a real implementation of virtual machines. The 80's saw the biggest boom in computers with IBM putting out a range of personal computers and Microsoft pushing its Operating System in large scale. In the 90's there was sufficient bandwidth available to really make the internet available to the masses [3]. Service oriented Architecture delivered web services from applications to other programs, whereas the

Cloud is about delivering software services to end users and running code [4]. Many players in the industry like Amazon, Google, IBM, Microsoft, Salesforce.com have jumped into cloud computing and implemented it.

III. CHARACTERISTICS OF CLOUD COMPUTING

Following are some of the characteristics of Cloud Computing [4]:

- Mulititenancy enables sharing of resources and costs among a large pool of users.
- Reliability is enhanced in cloud computing environment because service providers utilize multiple redundant sites.
- Scalability and Elasticity - based on changing user demands the cloud services vary dynamically.
- Device and location independence. Cloud enables users to access system using a web browser through any device with internet and from any location.
- Pay-as-you-go-model. Infrastructure, platform and software are delivered as services by the cloud to consumers.

IV. SERVICE MODELS

The three service models defined by NIST include:

1. Cloud software as a service (SaaS): SaaS is a software delivery model providing access to applications through the internet as a web-based service [5]. Applications are built to be accessible to multiple users through a web browser. Customers need not purchase or install software in their premises. The benefits of SaaS to the customer are streamlined administration, automated update and patch management services, data compatibility across the enterprise, facilitated enterprise-wide collaboration and Global accessibility [4].The consumer can use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as a web browser. The consumer does not manage or control the underlying cloud infrastructure, including the network, servers, operating systems, storage, or even individual application capabilities. Possible exceptions are limited to user-specific application

configuration settings. Web-based email is a good example of SaaS [8]

Examples of SaaS providers are GoogleApps, Oracle on Demand, SalesForce.com and SQL Azure.

2. Cloud platform as a service (PaaS): PaaS solutions provide a development and deployment platform for running applications on the cloud. They constitute the middleware on top of which applications are built [5]. PaaS developers are concerned only with web based deployment and do not care what operating system is used. Chief characteristics of Paas include services to develop, test, deploy, host and manage applications to support the application development cycle [4].The consumer can deploy onto the cloud infrastructure consumer-created or -acquired applications created using programming languages and tools supported by the consumer. The consumer does not manage or control the underlying cloud infrastructure, including the network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations. A hosting provider that allows customers to purchase server space for web pages is an example of PaaS [7].

Examples of PaaS services are Force.com, GoGrid Cloudcenter, Google AppEngine, Windows Azure Platform [11].

3. Cloud infrastructure as a service (IaaS): IaaS solutions are most popular and developed market segment of cloud computing. IaaS solutions bring all the benefits of hardware virtualization [5]. The consumer can utilize resources like processing, storage networks and often other fundamental computing resources rather than purchasing. The consumer is charged for only the resources consumed[4]. The consumer can provision processing, storage, networks, and other fundamental computing resources.The consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications, and possibly limited control of selected networking components(e.g., firewalls and load-balancers) [8].

Examples of IaaS providers include Amazon ECC, Eucalyptus, GoGrid, Flexiscale, Linode, RackSpace Cloud, Terremark [7].

V. DEPLOYMENT MODELS

The four common deployment models are as follows:

1. Public cloud: The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services. Resources are typically provisioned on a dynamic and on-demand basis over the Internet. Small and medium enterprises (SMEs) benefit from using public clouds to minimize growth of data centers. Public clouds cater to 4 basic characteristics that are as follows.

- Flexible and Elastic Environment.
- Freedom of self service.
- Pay for what you use.
- Availability and Reliability.

The architecture of public Cloud is shown in the figure [5] below.

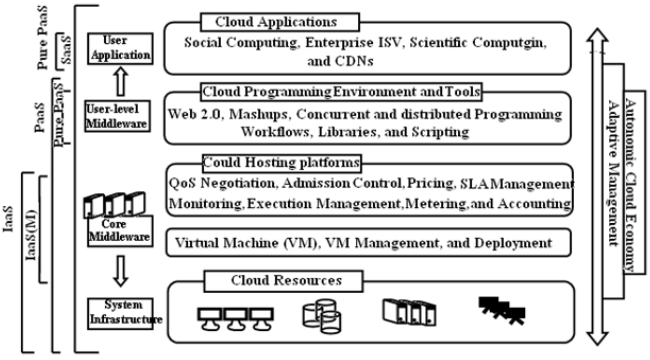

Fig. 1. Cloud-computing Architecture (Public Cloud)

2. Private cloud: This cloud infrastructure is operated solely for an organization. It can be managed by the organization or a third party and can exist on premises or off premises [8]. In short, the private cloud is an emulation of the public cloud, typically on a private network, and exists to support the goals of the organization, rather than to generically support resources for multiple organizations. The architecture of private cloud [5] is shown in figure below.

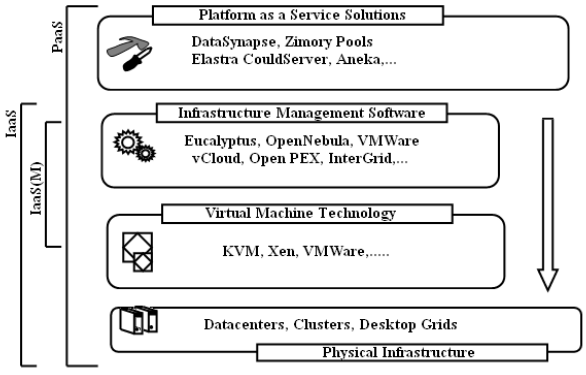

Fig.2. Private Clouds- Hardware and Softwsre Stack.

3. Hybrid cloud: This cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds) [8].

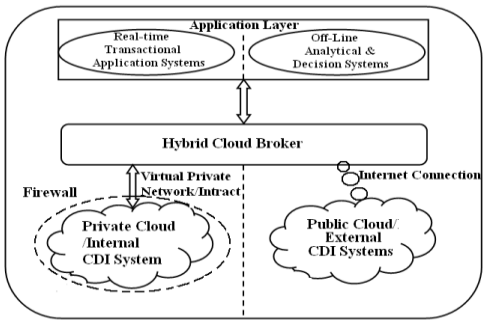

Fig 3. Hybrid Cloud.

4. Community cloud: This cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It can be managed by the organizations or a third party and can exist on premises or off premises.

VI. OTHER TYPES OF CLOUDS

- Distributed cloud: Cloud computing can also be provided by a distributed set of machines that are running at different locations, while still connected to a single network or hub service. Examples of this include distributed computing platforms such as BOINC and Folding@Home. An interesting attempt in such direction is Cloud@Home, aiming at implementing cloud computing provisioning model on top of voluntarily shared resources [2].

- Intercloud: The Intercloud is an interconnected global "cloud of clouds" and an extension of the Internet "network of networks" on which it is based. The focus is on direct interoperability between public cloud service providers, more so than between providers and consumers (as is the case for hybrid- and multi-cloud) [2] . Intercloud [6].can be shown using the figure below.

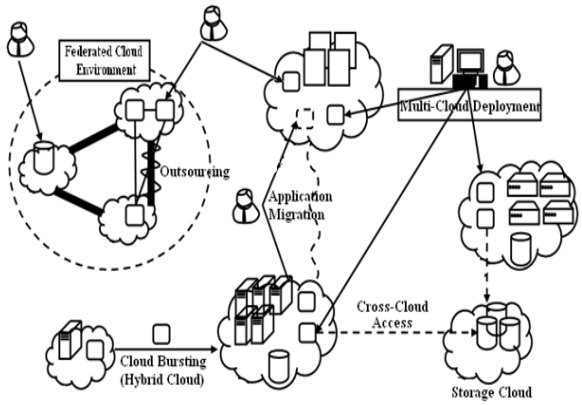

Fig 4. InterCloud

- Multicloud: Multicloud is the use of multiple cloud computing services in a single heterogeneous architecture to reduce reliance on single vendors, increase flexibility through choice, mitigate against disasters, etc. It differs from hybrid cloud in that it refers to multiple cloud services, rather than multiple deployment modes (public, private, and legacy) [2].

VII. CHALLENGES AND OBSTACLES IN CLOUDS

Table 1 summarizes the various obstacles and challenges that cloud computing faces [7].

Area in Cloud	Challenge
Accounting Management	In private systems, costs associated with operations are fixed due to licenses and must be charged back to accounts based on some formula or usage model. For cloud computing the pay-as-you-go usage model allows for costs to be applied to individual accounts directly.
Compliance	Compliance to laws and policies varies by geographical area. This requires that the cloud accommodate multiple compliance regimes.
Data Privacy	To ensure data privacy in the cloud, additional security methods such as private encryption, VLANs, firewalls, and local storage of sensitive data is necessary.
Monitoring	For private systems, any monitoring system the organization wishes to deploy can be used. Cloud computing models often have limited monitoring because it is vender-defined
Network Bottlenecks	Network bottlenecks occur when large data sets must be transferred. This is the case for staging. Replication and other operations. On-premise operations use LANs that are better able to

	accommodate transfers than the WAN connections used in cloud computing.
Reputation	The reputation for cloud computing services for the quality of those services is shared by tenants. An outage of the cloud provider impacts individuals. Clouds often have higher reliability than private systems.
Security	The different trust mechanisms require that applications be structured differently and that operations be modified to account for these differences.
Service Level Agreements (SLAs)	Cloud SLAs are standardized in order to appeal to the majority of its audience. Custom SLAs that allow for multiple data sources are difficult to obtain or enforce. Cloud SLAs do not generally offer industry standard chargeback rates, and negotiations with large cloud providers can be difficult for small users. Business risks that aren't covered by a cloud SLA must be taken into account.
Software Stack	The cloud enforces standardization and lowers the ability of a system to be customized for need
Storage	Enterprise class storage is under the control of an on-premise system and can support high speed queries. In cloud computing large data stores are possible but they have low bandwidth connection. High speed local storage in the cloud tends to be expensive.
Vendor Lock-in	Vendor lock-in is a function of the particular enterprise and application in an on-premises deployment. For cloud provider, vendor lock-in increases going from the IaaS to SaaS to PaaS model. Vendor lock-in for a cloud computing solution in a PaaS model is very high.

VIII. CONCLUSION

In this paper we have discussed the key concepts in the field of information technology - cloud computing [9]. We have also described the architecture of some deployments of cloud and introduced some new models. We have also discussed the challenges and obstacles in cloud computing in various issues. Cloud computing is the development trend for the future. Extensive research is going on in the field of Cloud.

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