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Service and Deployment Models for Cloud Computing Environment

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Abstract: Cloud computing is a rapidly developing information technology concept. Within a few years, cloud computing has become the fastest emerging technology. It is internet based computing software and resources are shared and information is provided to computers on demand. It is a low cost computing entity that uses the advanced business or service models such as SaaS(Software as Service), PaaS (Platform as Service), IaaS (Infrastructure as Service) and deployment models such as Public, Private , Hybrid and Community cloud to distribute the powerful computing capability to end user. This paper highlights the emergence of cloud computing from a style of computing to a on demand full fledged service model. Comparative study of various service and deployment models for cloud computing is also presented.

Keywords: cloud Computing, Cloud Technologies, Cloud Storage, Service Models, Security and Privacy.

Introduction

The name cloud computing was inspired by the cloud symbol that's often used to represent the information in flowcharts and diagrams. It is a construct that allows us to access applications that actually resides at a remote location of other internet connected device, most often, this will be a distant data centre. Cloud ccomputing is the fundamental change happening in the field of Information Technology. Cloud computing is a representation of a movement towards the intensive large scale specialization. Cloud computing allows consumers and businesses to access their personal files at any computer with internet access. For e.g. if the user want to install MS-WORD in the organization's computer then the user need to purchase the CD/DVD of it and install it or can set up a software distribution server to automatically install the application on machine. Every time Microsoft updates version and the same task need to be done again and it highlighting the cost issues. If the usage of particular application software is not very frequently then it is more reasonable to let it. If other companies host application (i.e. they handles the cost of server, they manage the software update and user pay as per utilization) [1]. Section II represents the evolution & characteristics of cloud computing. Section III contrasts the cloud computing models and finally paper is concluded in section IV.

Evolution of cloud computing

Cloud computing is accessing resources and services needed to perform functions with dynamically changing needs. The cloud is a virtualization of resources that maintains and manages itself. Similar to e-commerce, cloud computing is one of the vaguest techniques. One reason is that cloud computing can be used in many application scenarios, the other reason is that cloud computing are hyped by lots of companies for business promotion. As shpwn in Table 1 cloud computing is in the phase of fast growing technology [2].

Table 1: Cloud Computing Definitions

Source	Cloud Computing
Gartner[3]	A style of computing in which massively scalable IT-related capabilities are provided "as a service" using internet technologies to multiple external customers.
The 451 Group[4]	A service model that combines a general organizing principle for IT delivery, infrastructure components , an architectural approach and an economic model –basically , a confluence of grid computing , virtualization , utility computing , hosting and software as a service (SaaS).
Merill Lynch [5]	The idea of delivering personal(e.g. email, word processing, presentations) and business productivity applications (e.g. sales force automation , customer service , accounting) from centralized servers.
IDC[6]	An emerging IT development, deployment and delivery model, enabling real-time delivery of products, services and solutions over the Internet (i.e. enabling cloud service).
Lewis Cunningham[7]	Cloud computing is using the internet to access someone else's software running on someone else's hardware in someone else's data centre.
Ian Foster[8]	A large-scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted, virtualized, dynamically scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet .
Rajkumar Buyya[9]	A Cloud is a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements established through negotiation between the service provider and consumers .
Greg Boss et al., IBM[10]	A cloud is a pool of virtualized resources that can host a variety of different workloads, allow workloads to be deployed and scaled-out quickly, allocate resources when needed, and support redundancy.
NIST (National Institute of Standard and Technology)[11]	Cloud computing allows computer users to conveniently rent access to fully featured applications, to software development and deployment environments, and to computing infrastructure assets such as network-accessible data storage and processing. 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. This cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models.

A. Cloud Computing Features

Cloud computing reflects multiple server computers usage via a digital network, as though they were one computer. It can be referred to as a new kind of storage technology, by which user can share data or documents, software's to computers as well as other devices on demand. Cloud service provider (CSP) (e.g. Google, Amazon, Microsoft, Salesforce.com, and GoGrid) is leveraging virtualization technologies combined with self service capabilities via the internet. In these service providers' environments, virtual machines from multiple organizations have to be co-located on the same physical server in order to maximize the efficiency of virtualization. Today enterprises are looking toward cloud computing horizons to expand their own premises infrastructure, but most cannot afford the risk of security of their applications and data [12].

Following are the major features of cloud computing:

- On demand Self Service: A consumer can unilaterally provision computing capabilities, such as server time and h/w storage as needed automatically without requiring human interaction with each service provider [13].

- Resource pooling: The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model and virtualization. The customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state or Data Centre). Examples of resources include storage, processing, memory, network bandwidth, and virtual machines.

- Shared Infrastructure: Cloud environment uses an effective software model that allows sharing of physical services, storage and networking facilities among users. The cloud infrastructure is to find out most of the available infrastructure across multiple users.

- Lowering operating cost: Resources in cloud computing rapidly allocated and de-allocated on demand. Hence, a service provider no longer needs to provision capacities according to the peak load. It provides more savings since resources can be released to save on operating cost when service demand is low.

- Easy access: Services hosted in the cloud are generally web based. Therefore, they are easily accessible through a variety of devices with internet. These devices not only include laptops and desktop computers but also include cell phones, and PDAs [14].

- Highly Scalable*:* Infrastructure provides pool large amount of resources from data centres and make them easily accessible. A service provider can easily expand its services in order to handle increase demand (for e.g. flash-crowd effect). This model is sometimes called surge computing [15].
- Broad network access: Cloud services are accesses over a network from a wide range of devices such as PCs, laptops and mobile devices. Facilities are available over the network and accessed through standard mechanism that promote and use by heterogeneous thin or thick client platforms.

- Measured Service: Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported providing transparency for both the provider and consumer of the utilized service. Customers are payable for services according to how much have actually used during the billing period.

- Rapid Elasticity: Capabilities can be rapidly and elastically provisioned. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time. The resources can be released without manual intervention when no longer needed.
- No-upfront investment*:* Cloud computing uses a pay as you go pricing model. A service provider does not need to invest in the infrastructure to start gaining profit from cloud computing. Business simply rents resources from the cloud according to its own requirements and pay for the usage [16].

Cloud Computing Models

Cloud computing is a phrase used to describe a variety of computing concepts that involve a large number of computers connected through a real time communication network. Cloud computing has improved computation's efficiency while reducing its cost for users. Cloud computing models classified into two main categories as shown below:

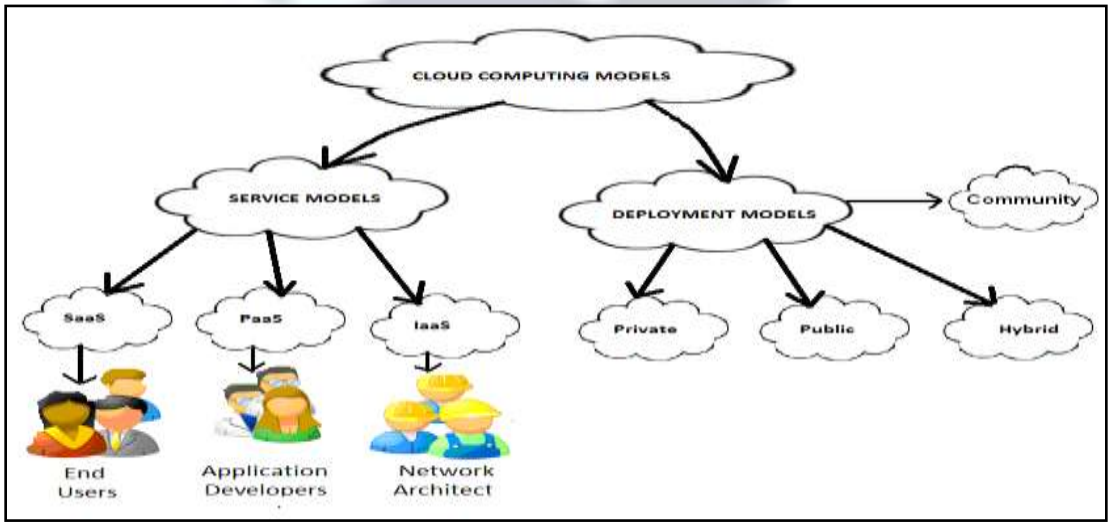

Figure1. Cloud Computing Models

A. Service Model

Three types of service models exist for providing services of cloud. These three models are referred to as SPI Model (software, Platform and Infrastructure.

A.1 Software as a Service (SaaS)

The capability provided to the consumer is to 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 (e.g., Web-based email). The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings. 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 and multiple end users are serviced. On the customer's side, there is no need for upfront investment in servers or software licenses, while for the provider, the costs are lowered, since only a single application needs to be hosted and maintained. Today SaaS is offered by companies such as Google, Sales- force, Microsoft etc. SaaS main characteristics shown below:

Figure2. Software as a Service

Table 2: Advantages and Disadvantages of SaaS

Advantages of SaaS	Disadvantages of SaaS
• Multi-tenancy and virtualization of the application • Rapid deployment • OPEX instead of CAPEX • Physical independence • No maintainance required to run the business functionalities • Pay as you go	• Selection of right provider • Lack of portability • Security and privacy issues • Longer response time • Cannot be used without access to internet • Lower integrity into existing application environment

A.2 Platform as a Service (PaaS)

Here, a layer of software, or development environment is encapsulated and offered as a service, upon which other higher levels of service can be built. The customer has the freedom to build his own applications, which run on the provider's infrastructure. To meet manageability and scalability requirements of the applications, PaaS providers offer a predefined combination of OS and application servers. Such as LAMP platform (Linux, Apache, MySql and PHP), Google's App Engine, Force.com, etc are some of the popular PaaS examples. The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or -acquired applications created using programming languages and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations. PaaS main functions are shown below:

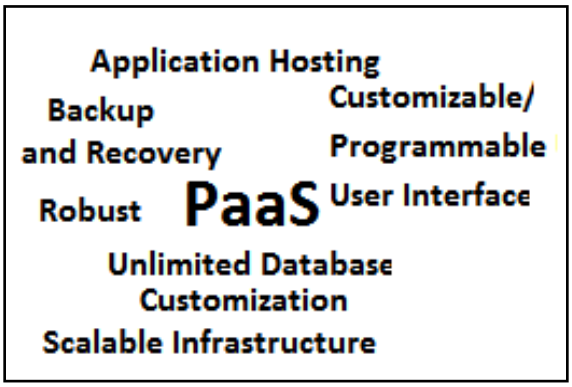

Figure 3. Platform as a Service

Table 3: Advantages and Disadvantages of PaaS

Advantages of PaaS	Disadvantages of PaaS
• Less administrative effort as there is no need to implement the infrastructure in house. • Development by geographically distributed teams possible • Single platform with minimum costs • No maintenance in setting up and running platform and its tools • Pay as you go	• Insufficient flexibility • Special requirements in case of organizations applications or development environments

A.3 Infrastructure as a Service (IaaS)

The facility provided to the customer is to lease processing, storage and other fundamental computing resources. The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where 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, deployed applications, and possibly limited control of select networking components (e.g., host firewalls) [17].

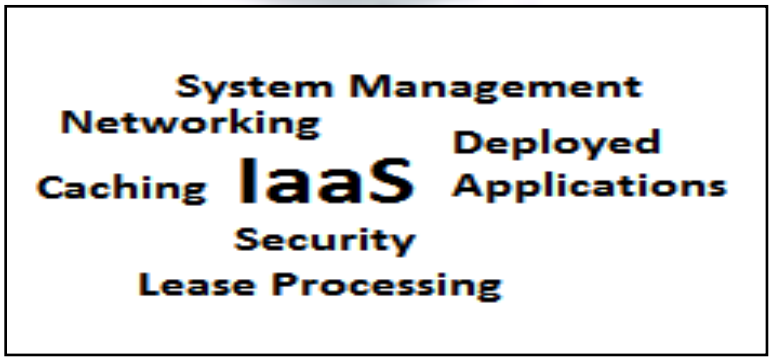

Figure4. Infrastructure as a Service

B. Deployment Model

In spite of the service models, there are three primary ways in which cloud services can also deployed and are described in figure5.

B.1 Public Cloud

A public cloud is one in which the services and infrastructure are provided off-site over the Internet. These clouds offer the greatest level of efficiency in shared resources; however, they are also more vulnerable than private clouds. The cloud infrastructure is owned by an organization selling cloud services to the general public or to a large industry group. The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise. In this cloud, users can access web applications and services over the internet. Each individual user has its own resources which are dynamically provided by third party vendors. The user has no idea about how the cloud is managed or what infrastructure is available. Users of these services are considered to be untrusted .

B.2 Private Cloud

The cloud infrastructure is owned or leased by a single organization and is operated solely by an organization. In this type of cloud user has complete control over that how data is managed and what security measures are in place while data processing in cloud. A private cloud is one in which the services and infrastructure are maintained on a private network. These clouds offer the greatest level of security and control, but they require the company to still purchase and maintain all the software and infrastructure, which reduces the cost savings. A private cloud is the obvious choice when

- User business is his data and his applications. Therefore, control and security are paramount.
- User business is part of an industry that must confirm to strict security and data privacy issues.
- User Company is large enough to run a next generation cloud data centre efficiently and effectively on its own.

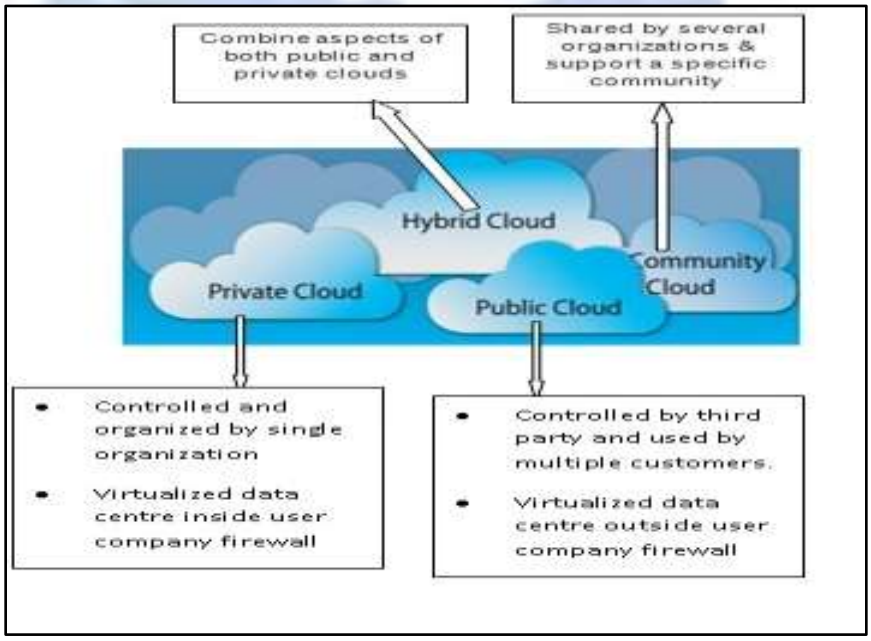

Figure5. Cloud Computing Deployment Model

B.3 Hybrid Cloud

The cloud infrastructure is a composition of two or more clouds with multiple providers. It is combination of public and private clouds within the same network. Private cloud users can store personal information over their private cloud and use the public cloud for handling large amount of processing demands. By spreading things out over a hybrid cloud, user keep each aspect at user business in the most efficient environment possible. The downside is that user has to keep track of multiple different security platforms and ensure that all aspects of user business can communicate with each other. Here are a couple of situations where a hybrid environment is best when

- User Company wants to use a SaaS application but is concerned about security. User SaaS vendor can create a private cloud just for user company inside their firewall. They provide user with a virtual private network (VPN) for additional security.

- User Company offers services that are tailored for different vertical markets. User can use a public cloud to interact with the clients but keep their data secured within a private cloud.

B.4 Community Cloud

Many organizations jointly construct and share the same cloud infrastructure as well as policies, requirements, values and concerns. The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy) as shown below [18].

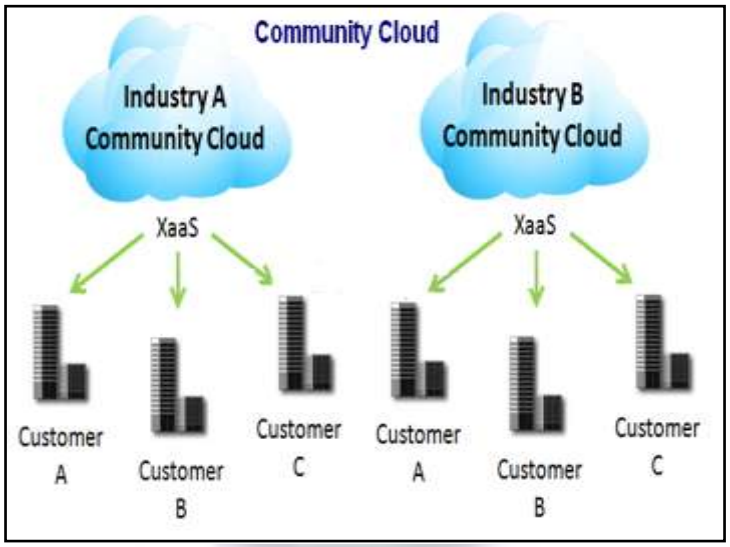

Figure 6. Community Model

Conclusion

Virtualization is the key component of cloud computing for providing computing and storage services. Both virtualization and cloud computing are response to the ever increasing need to make the most of computing resources in a cost effective manner. With the rapid development of processing and storage technologies and the success of internet, computing resources have become cheaper, more ubiquitously available than before. This technological trend has enabled the realization of a new computing model in which resources like CPU and storage devices are provided as general utilities that can be leased and released by users through internet in an on-demand fashion. Cloud computing enables a new business model that supports on-demand, pay-for-use, and scalable IT services over the Internet. Clouds provide services at different levels: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) and this paper presents the comparative study of same.

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