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Cloud Computing Deployment Models: A Comparative Study

Prof. Hiral B. Patel[1], Prof. Nirali Kansara[2]

[1] Assistant Professor, Achraya Motibhai Patel Institute of Computer Studies Ganpat University, Kherva India
[2] Assistant Professor, JG College of Computer Applications, Gujarat University, India

Correspondence should be addressed to Hiral B. Patel; hiralben.patel@ganpatuniversity.ac.in

ABSTRACT -Cloud computing has become the embraced in the computer world. Cloud implementation is the process of creating a virtual computing environment. Deployment in the cloud provides organizations with flexible and scalable virtual computing resources. A cloud deployment model is the type of architecture in which a cloud system is deployed. These models differ in terms of administration, ownership, access control, and security protocols. This paper describes the different types of cloud computing service models and deployment models; it also gives us a comparative study of various clouds using many factors. The comparison is simply based on various factors such as reliability, cost, data control, workload, performance, and many other cloud parameters.

KEYWORDS-Deployment model, Service model, Public cloud, Private cloud, Hybrid cloud, Inter-Cloud, Federation cloud, Multi cloud.

I. INTRODUCTION

The demand for cloud computing has led to different types of cloud deployment models. Cloud computing is also known as the fifth utility (along with water, electricity, gas, and telephone) that is available based on user demand. Cloud computing is based on pay as per use of model. In this, a cloud computing model provides an on-demand online computing service as required by the user. [1] With all the new cloud options and the phrase "as a service" seemingly added to everything imaginable, it helps to take a step back and look at the differences between the main types of cloud deployment and the different types of services. cloud computing. Cloud deployment describes how a cloud platform is deployed, how it is hosted, and who has access to it. All cloud computing deployments operate on the same principle by virtualizing the computing power of servers into segmented, software-driven applications that provide compute and storage capabilities. [2] Like all clouds, they have different characteristics like storage capacities, billing systems, and different methods of providing the services of other clouds. The recent problem is that people do not know which cloud is suitable according to their requirements; they cannot choose the right cloud for their services among the different clouds managed by different cloud providers [3]. So, to facilitate these kinds of situations, this paper helps define the comparison of some of the most popular clouds, taking in mind. It's all the important aspects that can help a normal customer, business and academic organizations to choose the particular cloud from according to your needs. Briefly, this paper presents a comprehensive analysis of cloud computing, explaining its services and deployment models, identifying various features of interest, and comparing them with different deployment models.

II. CLOUD COMPUTING SERVICES

The cloud architecture can be divided into four layers based on their functioning which show in Fig.1.

A. IaaS (Infrastructure as service)

B. PaaS (Platform as a Service)

C. FaaS (Function as a Service

D. SaaS (Software as a Service)

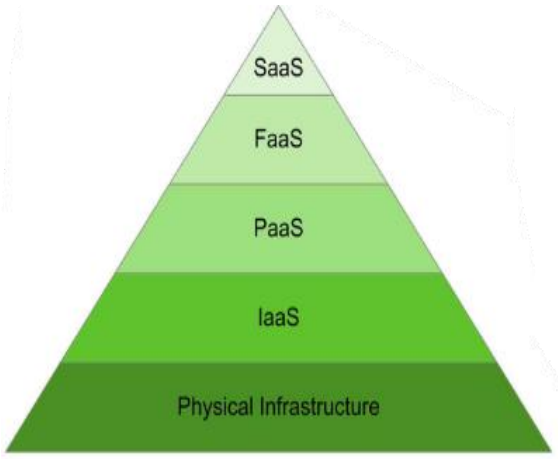

Fig 1: Classification of cloud services [4]

A. Infrastructure as a Service (IaaS)

IaaS is the most comprehensive and flexible type of cloud service. Essentially, it provides a fully virtualized computing infrastructure that is provisioned and managed over the Internet. An IaaS provider manages the physical edge of the infrastructure (servers, data storage space, etc.) in a data center, but allows customers to fully customize those virtualized resources to meet their specific needs. With IaaS, the customer can purchase, install, configure, and manage any software they need to use, including items such as operating systems, middleware, applications, business analytics, and development tools. IaaS eliminates the capital expense of building internal infrastructure.

Examples of IaaS: Microsoft Azure, Amazon Web Services (AWS), Cisco Metacloud, Google Compute Engine (GCE). [2]

B. Platform as a Service (PaaS)

PaaS provides the framework you need to create, test, deploy, manage, and update software products. It uses the same basic infrastructure as IaaS, but also includes the operating systems, middleware, development tools, and database management systems necessary to create software applications. PaaS is extremely useful for any company that develops web-based software and applications. Many of the tools required to develop for multiple platforms (computers, mobile devices, browsers, etc.) can be quite expensive. Customers can access the development tools using PaaS cloud service.

Examples of PaaS: AWS Elastic Beanstalk, Apache Stratos, Google App Engine, Microsoft Azure. [2]

C. Function-as-a-Service (FaaS)

FaaS allows customers to react code reactively, without the need to allocate processing resources ahead of time. The cloud service provider handles the infrastructure, allowing the customer to focus strictly on the application of application codes. Functions are scaled automatically, making them excellent for adapting to dynamic workloads that vary in terms of resource consumption. Customers only pay for the resources they use, making FaaS the truest form of "pay-as-you-go" cloud computing. Most FaaS applications are quite simple and can be deployed very quickly. The cloud customer just needs to upload the complied function code and tell the platform how to provision resources when it executes.

Examples of FaaS: AWS Lambdas, Azure Functions. [2]

D. Software as a Service (SaaS)

SaaS is a fully developed software solution ready to buy and use over the Internet by subscription. The SaaS provider manages the infrastructure, operating systems, middleware, and data necessary to deliver the program, ensuring that the software is available when and where customers need it. Many SaaS applications run directly through web browsers, eliminating the need for downloads or installations.

SaaS applications allow businesses to get up and running quickly and scale operations quickly. You do not need to purchase or implement the hardware and software used to deliver your business services.

Examples of SaaS: Microsoft Office 365, Salesforce, Cisco WebEx, Google Apps. [2]

III. CLOUD COMPUTING DEPLOYMENT MODELS

There are six types of Deployment Models, from them five are main: Private Cloud, Public Cloud, Hybrid Cloud, Community Cloud, Virtual Private Cloud. Inter-Cloud is also a type of Deployment models and it has two types of clouds: Federated Clouds, Multi-clouds. In Fig. 2, it displays the uses of deployment models in Data center and its growth in present era and in future.

A. Private Cloud

The private cloud deployment model is also called as the internal or corporate model. A private cloud belongs to a specific organization. That organization controls the system and manages it centrally. While a third party (for example, a service provider) can host a private cloud server. Most companies choose to keep the hardware in their local data center. From there, an internal team can oversee and manage everything. [1]

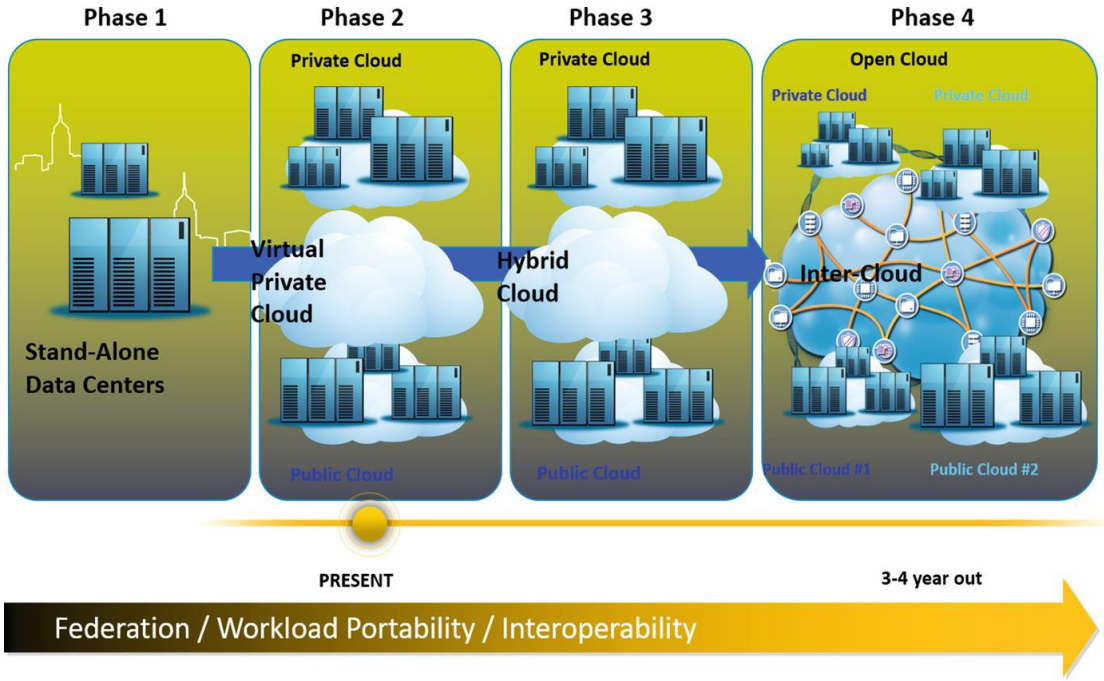

Fig 2: Growth of Cloud models [14]

B. Public Cloud

The public cloud model is well-known cloud service. This type of cloud is a popular choice for web applications, file sharing, and non-confidential data storage. Public clouds are recommended for software development and collaborative projects. The service provider owns and operates all the hardware necessary to run a public cloud. Vendors keep the devices in massive data centres. The public cloud delivery model plays an important role in development and testing. Developers frequently use public cloud infrastructure for development and testing purposes. Its virtual environment is inexpensive and can be easily configured and quickly deployed, making it perfect for test environments. [1]

C. Hybrid Cloud

Hybrid clouds combine public clouds with private clouds. They are designed so that data and applications move smoothly with each other and the two platforms interact smoothly. It is the perfect solution for a business or organization that needs a bit of both, which are generally industry and size dependent. [2] In essence, a hybrid cloud generally starts out as a private cloud which then extends the integration to use one or more public cloud services. This deployment model makes sense when companies have sensitive data that cannot be stored in the cloud or regulatory requirements that call for data protection, storage, and more. [6]

D. Community cloud

A cloud service that provides services to a community of users or organizations with shared interests or concerns. Organizations using this cloud service have shared missions, governance, security requirements, and policies. Cloud services can be hosted on the premises of the consumer organization, on the premises of the peer organization, at one provider, or a combination of these. This community cloud term is often used in marketing to explain the target consumers of the service, although the actual cloud could technically be a VPC, private or hybrid cloud model. [6]

E. Virtual private cloud (VPC)

A virtual private cloud (VPC) is a private cloud computing environment which is within a public cloud. Essentially, a VPC provisions logically isolated sections of a public cloud to provide a virtual private environment. Like all cloud environments, VPC resources are available on demand to scale as needed and are highly configurable. [8] This implementation is a compromise between a public and a private model in terms of price and features.

F. Inter-Clouds

Inter-cloud or "cloud of cloud" is a term that refers to a theoretical model for cloud computing services based on the idea of combining many different individual clouds into one seamless mass in terms of on-demand operations. Inter-cloud would simply ensure that a cloud could use resources beyond its reach, taking advantage of pre-existing contracts with other cloud providers. [9].

There are mainly two types of Inter-cloud:

- Multi Cloud
- Federated cloud (cloud federation)

- ***Multi Cloud***

Multi-cloud is the use of two or more cloud computing services from several different cloud providers. A multi-cloud environment could be completely private, completely public, or a combination of both. Businesses use a multi-cloud environment to allocate computing resources and reduce the risk of downtime and data loss. They can also increase the computing power and storage available to businesses. Cloud innovations in recent years have led to a shift from single-user private clouds to multi-tenant public clouds and hybrid clouds. [10]

- ***Federated cloud (cloud federation)***

A federated cloud is also called a cloud federation which is manage multiple internal and external cloud computing services for to meet business needs. A federation is the union of several smaller parties that perform a common action. [11]

IV. COMPARISON OF CLOUD DEPLOYMENT MODELS

Here is a comparative table that provides an overview of all six cloud deployment model based on many factors as listed below [1] [5][7] [12].

Table 1: Comparison Table among Six Types of Deployment Models.

	Public	Private	VPC	Community	Hybrid	Inter
Ease of Setup	Very easy to set up, the provider does most of the work	Very hard to set up as your team creates the system	Easy to set up, the provider does most of the work (unless the client asks otherwise)	Easy to set up because of community practices	Very hard to set up due to interconnected systems	Very easy to set up, the provider does most of the work
Ease of use	Very easy to use	Complex and requires an in-house team	Easy to use	Relatively easy to use as members help solve problems and establish protocols	Difficult to use if the system was not set up properly	Easy to use
Data control	Low, the provider has all control	Very high as yo-u own the system	Low, the provider has all control	High (if members collaborate)	Very high (with the right setup)	Very high (with the right setup)
Reliability	Prone to failures and outages	High (with the right team)	Prone to failures and outages	Depends on the community	High (with the right setup)	High(for clients)
Scalability	Low, most providers offer limited resources	Very high as there are no other system tenants	Very high as there are no other tenants in your segment of the cloud	Fixed capacity limits scalability	High (with the right setup)	High (with the right setup)
Security and privacy	Very low, not a good fit for sensitive data	Very high, ideal for corporate data	Very low, not a good fit for sensitive data	High (if members collaborate on security policies)	Very high as you keep the data on a private cloud	Very High
Setup flexibility	Little to no flexibility, service providers usually offer only predefined setups	Very flexible	Less than a private cloud, more than a public one	Little flexibility, setups are usually predefined to an extent	Very flexible	Very flexible
Cost	Very Inexpensive	Very expensive	Affordable	Members share the costs	Cheaper than a private model, pricier than a public one	Very Inexpensive
Demand for in-house hardware	No	In-house hardware is not a must but is preferable	No	No	In-house hardware is not a must but is preferable	No

Ownership	CSP	Single organization	CSP	Several organization	Organization and CSP	CSP
Performance	Low to medium	Excellent	Low	Very good	good	Excellent
Location	Off premise	Off or on premise	On premise	Off or on premise	Off or on premise	On premise
Managed by	CSP	Single organization	CSP	Several organization or CSP	Organization and CSP	CSP
User's control	Limited control	Full control	Full control	High control but limited by community policies	Full control over private part and limited at public part	Full control
Workload	Normal workload with short-spikes in demand	Not suitable for handling large workload	Suitable for handling high workload	Suitable for handling large workload	Highly dynamic or changeable	Highly dynamic or changeable
Size of Data Center	Around 50,000s	Around 50,000s	50000>TO <80000	Public cloud > 15000> Private cloud	Less than private cloud	More than hybrid cloud
Used By	Anyone can access	Limited people can access	Depend on Authorization of the user	Depend upon number of cooperatives	Medium accessibility	Any client

V. CONCLUSION

Cloud computing has transformed the way businesses around the world do business in a way that many people are unaware of. Understanding the difference among various types of cloud computing and identifying which one is best suited for a growing business is tremendously important. This paper provides the knowledge of the introduction to cloud computing, its concepts, models and services. The paper also discusses the comparison of all cloud computing deployment models in table form. These clouds are compared against supported platforms, supported languages, storage capacity, services, and products. Fig. 3 shows Public cloud is the most popular general deployment option, with a usage share of over 61%. Traditional on-premises deployment, with just under half (49%) of shared use, ranks second. Hybrid cloud, which combines public cloud services with on-premises private cloud infrastructure, ranks third, with approximately 39% usage. The study encouraged respondents to choose from several of the five cloud deployment options. It shows a tenth (9%) selected all five, and almost a fifth (19%) selected four out of five. Among them two-thirds (64%) selected at least two cloud deployment options. The upshot is that while the public cloud is by far the most popular choice, most of the organizations surveyed employ a mix of cloud types. Interestingly, multi-cloud or the use of multiple cloud computing and storage services in a single homogeneous network architecture had the fewest users (24% of respondents).

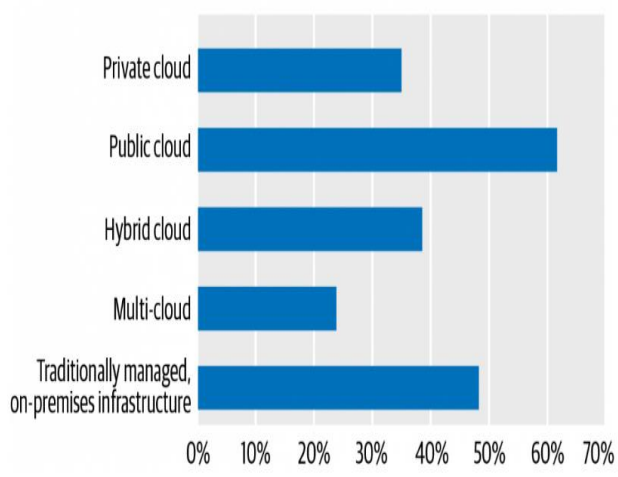

Fig 3: Cloud Computing Technology Market Analysis by Type [13]

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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ABOUT THE AUTHORS

Prof. Hiral B. Patel received her B.Sc. and M.Sc. (Computer Application & Information Technology) from Hemchandracharya North Gujarat University (HNGU), Patan, Gujarat, India. She Published many Research Paper in National Journal. She Published a Book regarding Question Bank of Computer Networking. She is an Assistant Professor at Achraya Motibhai Patel Institute of Computer Studies, Ganpat University, Gujarat, India. She has Teaching experience of 13 years in BCA. Her area of interest includes Cloud computing, Computer Network, Wireless Networking, Web Development Technology.

Prof. Nirali Kansara received her BCA and MCA from NSVKMS MCA College, Visnagar, Gujarat, India. She is an Assistant Professor at JG College of Computer Applications, Gujarat University, Gujarat, India. She has Teaching experience of 14 years in BCA. Her area of interest includes Cloud computing, Cyber Security, IOT.