Hybrid Cloud: The New Generation of Indian Education Society

Ujas Bhadani[1]

[1]B.Eng. (Computer Engineering) Department of Computer Engineering, Silver Oak College of Engineering & Technology, Ahmedabad, Gujarat, India

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Abstract - *Nowadays, cloud computing is a booming technology. There are four types of cloud models available for use. Such as Community Cloud, Public Cloud, Private Cloud, Hybrid Cloud. Every organization is moving toward opensource and cloud computing. Then the question arises, why don't we apply this method to our Indian education society? So, this review paper has all answers, including how you can deploy a hybrid cloud model for your institute. Hybrid cloud act as a bridge between education society and learners. It delivers all the required resources to students while maintaining proper privacy. This article's flow is organized as follows: Firstly, a brief introduction of cloud computing and its model, followed by cloud computing in education society, security algorithms, and finally, deployment of a hybrid cloud.*
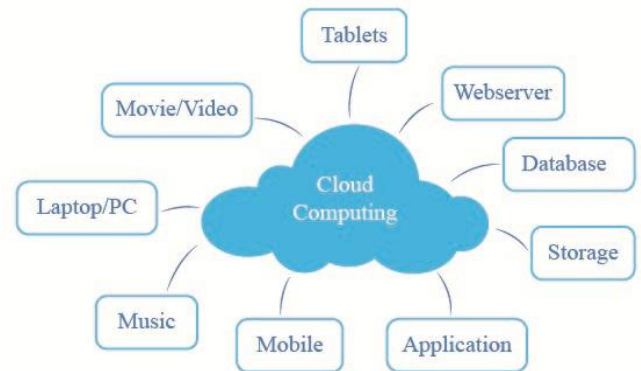
*Key Words***:** Cloud Computing, Hybrid Cloud, Private Cloud, Public Cloud, Education Society

1. INTRODUCTION

India has many schools and colleges for education, but these institutes are working on a traditional system, pen & paper-based teaching. The world is growing at the speed of light; similarly, Indian education must be improved at the same rate. This review paper contains information to improve the Indian education society, and this improvement can be done using cloud computing technology. Cloud computing means moving data and programs from local servers over the Internet to provide users with the ability to access and share information at any time from multiple devices [1].

2. WHAT IS CLOUD COMPUTINGDING

2.1 Definition

What is the Cloud? Well, the answer depends on whom you are asking. Suppose the person comes from a non-technical background. In that case, the answer will be, Cloud is a collection of water molecules, and if the person comes from the technical background, the answer will be, the Cloud is a collection of storages and networks. Cloud computing is merely delivering computing services such as servers, databases, etc. Cloud Computing is hinting at a future in which we won't compute on local computers, but centralized facilities operated by third-party compute and storage utilities [2]. Cloud computing also describes applications that are extended to be accessible through the Internet. It doesn't matter where you are, what you need is just a single

Smartphone/Laptop/Desktop with an internet connection. The users have to pay only for the services they had used [3].

Fig -1: Cloud Computing

In 1960, a seminar conducted by John McCarthy at MIT indicated that like water and electricity, computing could also be sold like a utility. And in 1999, the Salesforce company started distributing the applications to the customers through a convenient website [4]. Amazon Web Services were started by Amazon in 2002, and they were providing the services of storage and computation. In around 2009, big companies like Google, Microsoft, HP, Oracle started to provide cloud computing services [5].

2.2 Assortment

2.2.1 Service model: Cloud Computing

Each cloud provides users with services at a different level of abstraction, referred to as a service model in the NIST definition [6]. An organization's use the services as per the requirements of users. Cloud computing services are generally divided into three categories, which are:

    a. Software as a Service (SaaS)
    b. Platform as a Service (PaaS)
    c. Infrastructure as a Service (IaaS)

a. Software as a Service (SaaS): The way of carrying application as a service on the internet is known as software as a service [4]. This service reduces the user overhead of managing the hardware and software. The only thing users need is the internet connection on Smartphone/Laptop/Desktop, and they can access the application. A few famous examples of SaaS are Google mail (Gmail) and Dropbox.

b. **Platform as a Service (PaaS):** A development environment or platform is given to the consumers as a service in PaaS, upon which a user can deploy their personal software and coding. The customer has the liberty to construct applications that can run on the provider's infrastructure [4]. A few popular examples of PaaS are Google App Engine, Red Hat OpenShift, and Heroku.

c. **Infrastructure as a Service (IaaS):** Infrastructure as a service (IaaS) is a type of cloud computing model that allocates virtualized computing resources to the user through the internet. The IaaS technology helps the users to avoid the cost and complexity of purchasing and managing their physical servers. The benefits of implementing the IaaS environment includes pay-per-use, increase & decrease infrastructure, save time, and cost [7]. IaaS is one of the main components of cloud computing along with software as a service (SaaS) and platform as a service (PaaS). A few popular examples of IaaS are AWS EC2, Google Compute Engine (GCE).

2.2.2 Development model: Cloud Computing

  a. Community Cloud
  b. Public Cloud
  c. Private Cloud
  d. Hybrid Cloud

a. **Community Cloud:** The Community cloud is the cloud model that shares the infrastructure between several organizations from a specific community. The community cloud systems are designed with the community's requirements of the users they are to serve to encourage contribution and participation by the community members [8]. It allows systems and services are accessible by a group of organizations. This infrastructure can be managed by the internal organization or by third-party service.

b. **Public Cloud:** The public cloud is a computing service supplied by third-party providers to the public internet. These services are available for any user who wants to use them, and they have to pay only for the services they consumed [4]. The Public Cloud has become very popular in recent few years because it reduces the pretty well cost of resources, easy and affordable way to host an application.

- **Advantages**
i. Always Data availability and continuous uptime. The world's most comprehensive and broadly adopted cloud platform, AWS has 99.99% uptime, which translates to roughly 53 minutes to 8.76 hours per year [9].
ii. Easy and inexpensive setup.

iii. 24x7 technical support provider.
iv. On-demand scalability.

- **Disadvantages**
i. Less control over data security. You never know where and under what geographic or other restrictions your data is stored.
ii. If your data size increases, then cost per hour also increases.

c. **Private Cloud:** The cloud infrastructure which is developed only for the self-uses purpose, that is the private cloud. Its organization manages this infrastructure. Enterprise private cloud solutions add capabilities like self-service, automation, and chargeback over the virtualized infrastructure [10]. Therefore, this form of cloud is more secure than the public cloud and community cloud. The cloud is hosted within the data center of an organization and used by local users only. It focuses on providing a flexible virtualized infrastructure rather than on selling the cloud resources [11].

- **Advantages**
i. Your data and applications are accessible only to your enterprise.
ii. You can deploy a server, select suitable hardware configuration by your choice and preferences.
- **Disadvantages**
i. A private server is more costly compared to community and public servers.
ii. Responsibilities may increase in operating and maintaining a data center.

d. **Hybrid Cloud:** Basically, Hybrid means combining two or more different things and create a giant structure. In terms of cloud, a hybrid cloud is a composition of at least one private cloud and at least one public cloud [12]. Hybrid clouds introduce the complexity of determining how to distribute applications across both public and private clouds [13]. Like the public & private cloud, the hybrid cloud also provides storage, servers, databases, and many more. Then why we come up with a hybrid cloud instead of using public and private clouds.

3. WHY HYBRID CLOUD?

The main reason for developing a hybrid cloud is security and cost. The hybrid cloud combines the advantages of both the cloud, such as public & private. Hybrid clouds offer the cost and scale benefits of public clouds while also offering the security and control of private clouds [12]. Hybrid cloud provides both the controls available in a private cloud deployment along with the ability to rapidly scale using public cloud [14].
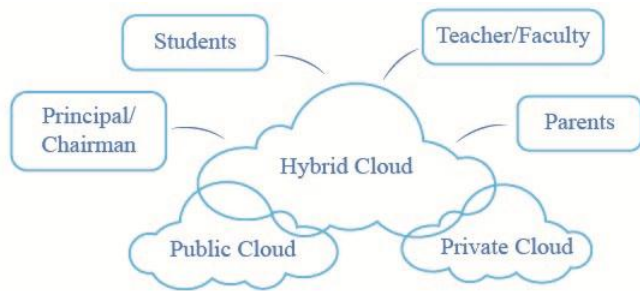
Fig -2. Hybrid Cloud

4. CLOUD COMPUTING IN EDUCATION SOCIETY

As per the report of the human resource development ministry of India, India's student population in higher education grew by 800,000 in 2018-19 as against the previous year, taking the absolute number of such students to 37.4 million [15]. With more than 1.5 million schools and about 260 million students in 2015/16, India has the world's second-largest school system after China [16]. It is an educational institution's responsibility to secure the personal data of each student. Cloud Computing is the way of providing better performance to students and teachers. The students and faculty members are the main pillars of any academic institution. By cloud computing adoption, the quality of teaching and learning can be improved by allowing students to access course materials, lecture notes, handouts, assignments, quizzes, and tests [17].

4.1 Benefits of cloud computing

    4.1.1 24x7 data accessibilities
    4.1.2 Ameliorate competence of organization
    4.1.3 Cost scarcity

Now the question arises, which cloud deployment model should you construct and deploy the institute website? All right, the answer is the Hybrid Cloud computing model.

5. TRACK BUILDING

As a matter of fact, a hybrid cloud is a combination of public and private clouds. The Public cloud contains information about institute history, regular information, Academic curriculums, online books, magazines & journals, lectures schedule, report submission, etc. The private cloud contains information about the confidential data, fees payment gateway, staff's data, day to day work information, sensitive information about students.

Now the question arises, why we give so much importance to student's sensitive data and stored in a private cloud? Nowadays, everything is getting stored on the cloud instead of keeping hard copies of all the information. As we know, for admission process in any institute in India, it requires lots of original/duplicate copies of documents such as Birth certificate, Government-authorized identity proof, Parents Id Proof, information about parent's occupation, Electricity/water bills. Now, what if these data got leaked. What about the privacy of the students? After getting this lots of information, hackers can blackmail the victim or can-do a lot more. So, it's necessary to store these data on a private cloud.

6. DEPLOYMENT

Cloud infrastructure is a term used to describe the components needed for cloud computing, including hardware, abstracted resources, storage, and network resources [18].

6.1 Public Cloud Model

For deploying the public cloud model, you must follow the basic steps [19]:

        6.1.1 Build the infrastructure
        6.1.2 Upload your code
        6.1.3 Run your site

6.1.1 Build the infrastructure

For building the infrastructure you much select the appropriate Infrastructure as a Service (IaaS) model. Nowadays most popular IaaS are Google Cloud Platforms (GCP) and Amazon Web Service (AWS).
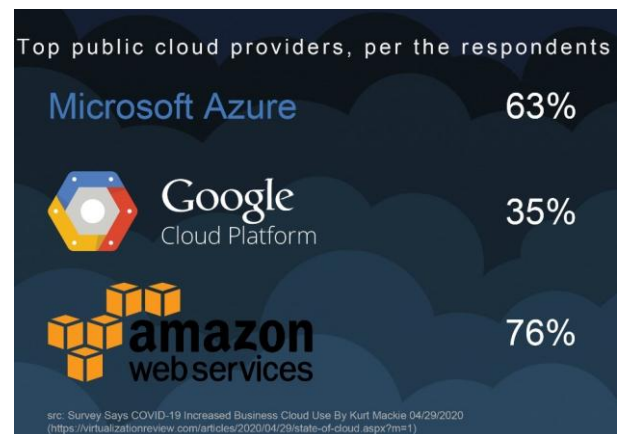

Fig -3. Survey Report

Follow the steps for creating an instance:

    Step 1: Choose an appropriate IaaS model
    Step 2: Create the instance and give appropriate name (For example, Webserver, Database)
    Step 3: Select the appropriate Operating System (OS) image.
    Step 4: Select configurations as per requirements (For example, server's central processing unit (CPU), RAM, SSD/HDD)
    Step 5: Create a cloud server and Run.

Step 6: Note the cloud servers Public IP address.

Let us consider you don't have public IP of your instance, and your web site is hosted on AWS, then you can use an elastic IP address. An Elastic IP address is a public IPv4 address, which is reachable from the internet. If your instance does not have a public IPv4 address, you can associate an Elastic IP address with your instance to enable communication with the internet [20]. Now, you can connect to a server in several ways, but the standard and the most secure method is called Secure Shell (SSH). SSH enables you to send information to and from your server in a secure fashion [19]. Secure Shell is a cryptographic network protocol that works in a client-server architecture. Both ends of the connection are authenticated using a digital certificate, and, as a protocol, it is robust enough to provide communication security over any network [21]. If you are using the Windows operating system as your primary OS, then you can connect to your cloud server using PuTTY [22], and if you are a Mac OS user, then you can use PuTTY macOS [22], and if you are Linux user then Most Linux systems come with the open-source OpenSSH preinstalled [22].

Follow the steps for installing Apache webserver:

Step 1: yum install apache2
Or
Step 1: apt-get install apache2

Now, the test, web server is successfully installed or not. Make sure your Apache server is turned on. Just put your local Ip address of the cloud server on the web browser. If it shows any output, then your server is successfully installed and running. Now you have a web server installed on your cloud server [19].

6.1.2 Upload your code

One might be familiar with the File Transfer Protocol (FTP) as a way to upload and download files from another computer. To enhance security, it is advisable to use both Secure Shell (SSH) access and Secure File Transfer Protocol (SFTP) in combination [24].
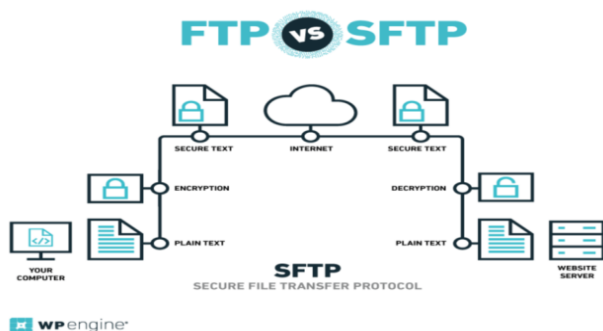For clearer view about FTP and SFTP, consider the below figure.

Fig -4. FTP vs SFTP [23]

Apache is configured to look in a specific directory for content to serve on the web. This unique directory is referred to as the DocumentRoot. The DocumentRoot is located at /var/www; therefore, individuals have to upload their site file to that directory [19]. The file must be replaced with index.html on that directory.

6.1.3 Run your site

On completion, the organization must ensure that the correct .html file is uploaded on the webserver.

6.2 Data on Public Cloud

The data, which are open for all, can be available for students, staff, parents, and visitors.
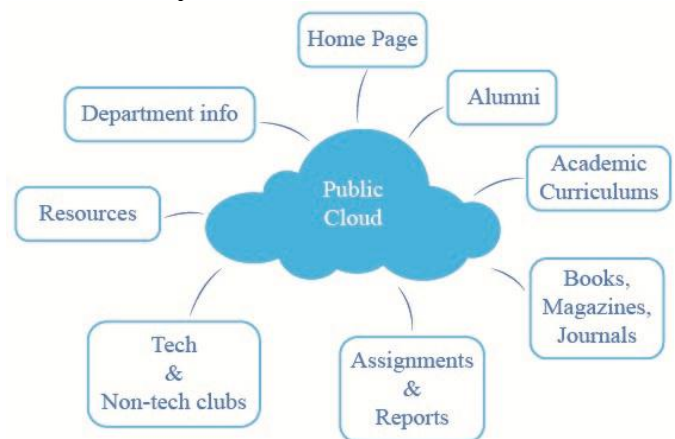

Fig -5: Content on Public Cloud

The above figure clearly shows which data should be uploaded on the public cloud. Intellectual data means course syllabus, study materials, project reports, assignments, and quizzes, while Operational data means the data that is used in the day-to-day operation of institutions [17].

6.3 Private Cloud Model

Private cloud refers to a cloud infrastructure that is internal to an organization and is usually not available to the general public. Private cloud infrastructure is normally operated and managed by the organization that owns it [25]. It can be done in two ways, Such as:

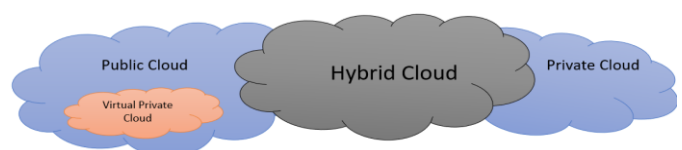**6.3.1** Virtual Private Cloud
6.3.2 Private Cloud

Fig -6: Virtual Private Cloud vs Private Cloud

6.3.1 Virtual Private Cloud

One can also construct a private cloud as a virtual private cloud. A virtual private cloud is a cloud computing infrastructure that runs on top of a public cloud that has a customized network and security settings for a particular organization. Virtual private cloud is an attractive solution for organizations that wants to use cloud computing technology without incurring the cost of building and managing its private cloud and also wants to avoid the security and data privacy risks that characterize public cloud services [25].

6.3.2 Private Cloud

Each private cloud is a model of cloud computing that is implemented within the corporate firewall, under the control of the IT department with limited resources [26]. For implementing a private cloud, you must configure a system with high throughput. For deploying the private cloud model, you must follow the basic steps:

    a.   Configure and built the system
    b.   Install the OS and software
    c.   Run your code

a. Configure and built the system

If you create a private cloud, you must create a system with high configuration. For example, you want to construct a cloud for storing your data, then the minimal configuration is as below.

Operator	CPU cores	RAM	Storage (SSD)
Worker	8 cores	16 GB	1TB
Master	16 cores	64 GB	4/5 TB

Table -1: System Configuration

b. Install the OS and software

One can choose any operating system as a base OS. The administrator must configure the hypervisor. Hypervisor, also known as a virtual machine monitor, is a process that creates and runs virtual machines (VMs) [27]. Generally, there are two types of hypervisors. Type 1 hypervisors, called "bare metal," run directly on the host's hardware. Type 2 hypervisors, called "hosted," run as a software layer on an operating system, like other computer programs [27]. Popular hypervisors are Oracle Virtual Box and VMware Workstation. You can also choose a Container Engine platform.
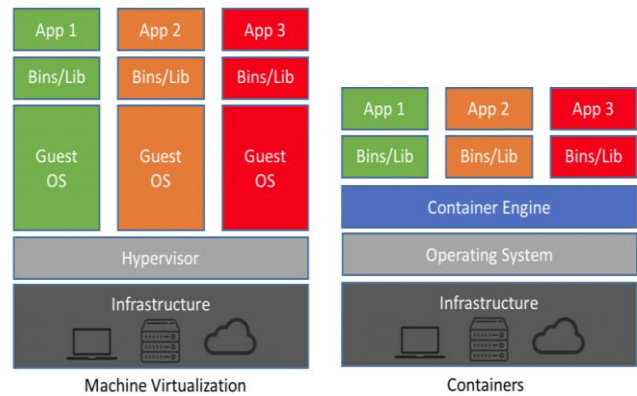

Fig -7: Hypervisor vs Container Engine [28]

Follow the steps:

Step 1: Configure any hypervisor platform
Step 2: Install OS on Virtual machine
Step 3: Buy a Public IP address from your internet provider for your machine
Step 4: Assign Public IP to your machine
Step 5: Setup server
Step 6: Setup database
Step 7: Establish the connection between your public cloud instance to your private cloud
Step 8: Update your code

One can also use OpenStack as Infrastructure as a Service (IaaS). OpenStack is an infrastructure platform managed by IT operators to enable a private cloud [29].

To establish the connection between the public and on-premises infrastructure, one can use VPN. A virtual private network (VPN) is a network that uses a public telecommunication infrastructure, such as the Internet, to provide remote offices or individual users with secure access to their organization's network [30].

c. Run your code

Once the setup is completed, the admin must check the website if it's working properly or not.

6.4 Data on Private Cloud

The data which are confidential for the institute must be stored on a private cloud.
Consider the below figure for better understanding about data on private cloud.
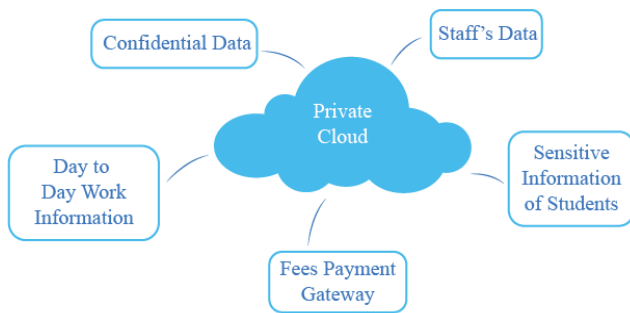
Fig -8: Content on Private Cloud

The figure shows that a private cloud contains sensitive data of students and staff members. Apart from this, it also contains the fees payment gateways and day to day work information.

7. SECURITY ALGORITHMS

Encryption is one of the principal means to grantee the security of sensitive information [31]. There are lots of Encryption Algorithms available now a day. Popular algorithms are Triple DES, RSA, AES, and MD5.

Let us focus on RSA (Rivest–Shamir–Adleman); it is an algorithm used by modern computers to encrypt and decrypt messages. The public key can be known to everyone and is used for encrypting messages. Messages encrypted with the public key can only be decrypted using the private key [32].

8. CONCLUSION & FUTURE WORK

Cloud Computing is one of those technologies whose demand is increasing day by day. This paper gives information about cloud computing and its implementation in an institute. Applying the hybrid cloud model in education society is the signal of beginning the new generation of Indian education society. The Private cloud can be constructed more conveniently. Now, we are focusing on the same.

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BIOGRAPHY

Ujas Bhadani is pursuing his Bachelor of Engineering in Computer Engineering degree from Silver Oak College of Engineering and Technology. His research fields are Cloud Computing, Ansible, Containers, and OpenStack.