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A review on Cloud Computing and Cloud Service Providers

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ABSTRACT
To solve a variety of problems, a computer system employs a number of machines that are arranged in various ways. This is a computing environment in which a large number of computers work together to process and exchange data in order to solve problems. There are various types of cloud computing environments, including private, time sharing, client-server, distributed, cloud, cluster, and others. One of the important computing environments in today's era is cloud computing environment. A huge project is divided among numerous computers in grid computing to make the most of their resources. Cloud computing has the exact opposite effect. It enables the simultaneous execution of numerous smaller applications. Because of its user-friendly, virtualized, and automatically scalable utilities, clouds are more popular than grids. In comparison to grid's fixed payment scale, cloud's pay-as-you-go concept is more appealing. As a result, cloud computing is a far broader concept than grid and utility computing, and it is not limited to a single network.

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I. INTRODUCTION

1.1. Evolution of CloudComputing

Cloud computing is the practice of renting computing services. This idea was suggested for the first time in the 1950s. Cloud computing was transformed into what it is today thanks to five inventions [2]. Examples include distributed networks and their peripherals, virtualization, web 2.0, service orientation, and utilitycomputing.

1.1.1. **Distributed Systems:** It is made up of several different systems, but it appears to users as though they are just one entity[3]. The aim of distributed systems is to share resources while still making productive and efficient use of them. Scalability, concurrency, continuous availability, heterogeneity, and failure isolation are all characteristics of distributedsystems.

Problem: All the systems were required to be present at the same geographical location.

Solution: Mainframe computing

1.1.2. **Mainframe computing:** Mainframes are incredibly powerful and dependable computing machines that were originally presented in 1951. These are responsible for coping with large volumes of data, suchas massive input-output procedures [3]. These are now utilized for large-scale processing activities such as online purchases and other online transactions. These devices have nearly little downtime due to their great fault tolerance. These helped to raise the processing power than distributedsystem.

Problem: Very expensive.

Solution: Cluster computing

1.1.3. **Cluster computing:** Cluster computing emerged in the 1980s as a viable alternative to mainframe computer. Each machine in the cluster was connected to the others via a high- bandwidth network. These were far less expensive than mainframe systems[3]. These were also capable of doing complex calculations. In addition, new nodes might be readily added to the cluster if necessary. To some extent, the expense issue wasresolved.

Problem: Geographical restrictions still pertained.

Solution: Grid computing.

1.1.4. **Grid computing**: Grid computing was first presented in the 1990s. It means that several systems were installed in various geographical places and were all connected over the internet[3]. The grid was made up of heterogeneous nodes since these systems belonged to different corporations. Although it solved certain issues, as the distance between the nodes grew, other ones arose.

Problem: Low availability of high bandwidth connectivity and with it other network associated issues.

Solution: Cloud computing. It is often referred to as "Successor of gridcomputing".

1.1.5. Cloud Computing:

In grid computing, a large project is divided among multiple computers to make use of their resources. Cloud

computing does just the opposite. It allows multiple smallerapplications to run at the same time. Clouds are more popular than grids due to its user- friendly, virtualized and automatically scalable utilities. Pay-as-you-go model makes cloud more attractive as compare to the fixed payment scale of grid. So cloud is a much bigger concept than grid and utility computing and is not restricted to a specific network. Thekey technologies behind cloudare

- **Virtualization:** It was first released about 40 years ago. It's the technique of establishing a virtual layer on top of hardware that allows the user to run several instances on the same machine at the same time [4]. It's a crucial component of cloud computing. It's the foundation for key cloud computing services like Amazon EC2, VMware vCloud, and others. Hardware virtualization is still one of the most widely usedtechnologies.
- **Web 2.0**: It is the interface through which the cloud computing s ervices interact with the clients. It is because of Web 2.0 that we have interactive and dynamic web pages. It also increases flexibility among web pages[6]. Popular examples of web 2.0 include Google Maps, Facebook, Twitter, etc. Needless to say, social media is possible because of this technology only. In gained major popularity in 2004.
- **Service orientation:** It acts as areference model for cloud computing. It supportslow-cost, flexible, and evolvable applications. Two important concepts were introduced in this computing model[7]. These were Quality of Service (QoS) which also includes the SLA (Service Level Agreement) and Software as a Service (SaaS).
- **Utility computing:** It is a computing model that defines service provisioning techniques for services such as compute services along with other major services such as storage, infrastructure, etc which are provisioned on a pay-per-usebasis.

II. OVERVIEW OF CLOUD COMPUTING

This cloud model is composed of five essential characteristics, three service models and four deployment models."

2.1 Essential Characteristics - The NIST definition describes five essential characteristics of cloud computing[7].

- **Rapid Elasticity:** It is defined as the ability to scale resources both up and down asneeded.
- **Measured Service:** Cloud services are controlled and monitored by the cloud provider. This is crucial for billing, access control, resource optimization, capacity planning and othertasks.
- **On-Demand Self-Service:** It means that a consumer can use cloud services as needed without any human interaction with the cloudprovider.
- **Ubiquitous Network Access**: It means that the cloud provider's capabilities are available over the network and can be accessed through standard mechanisms by both thick and thinclients.
- **Resource Pooling:** It allows a cloud provider to serve its consumers via a multi- tenant model. Physical and virtual resources are assigned and reassigned according to consumer demand. 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, ordatacenter).

2.2 Cloud Deployment Models

There are the following 4 types of cloud that you can deploy according to the organization's needs[8]-

- PublicCloud
- PrivateCloud
- HybridCloud
- CommunityCloud

2.2.1 PublicCloud

The public cloud is a pay-per-use service that allows everyone to store and access information over the Internet. The Cloud Service Provider manages and operates computing services in the public cloud(CSP).

Example: Amazon elastic compute cloud (EC2), IBM SmartCloud Enterprise, Microsoft, Google App Engine, Windows Azure Services Platform.

2.2.2 PrivateCloud

Internal cloud or corporate cloud are other terms for a private cloud. Organizations use it to create and run their own data centers internally or with the help of a third party. Opensource applications like Openstack and Eucalyptus can be used to deploy it.The National Institute of Standards and Technology (NIST) divides

private cloud into two categories based on location andmanagement:

2.2.2.1 On-premise privatecloud
2.2.2.2 Outsourced privatecloud

2.2.3 Hybridcloud

Hybrid Cloud is a combination of the public cloud and the private cloud. We can say:

Hybrid Cloud = Public Cloud + Private Cloud

Hybrid cloud is partially secure because the services which are running on the public cloud can be accessed by anyone, while the services which are running on a private cloud can be accessed only by the organization's users.

Example: Google Application Suite (Gmail, Google Apps, and Google Drive), Office 365 (MS Office on the Web and One Drive), Amazon Web Services.

2.2.4 Community Cloud

Community cloud allows systems and services to be accessible by a group of several organizations to share the information between the organization and a specific community. It is owned, managed, and operated by one or more organizations in the community, a third party, or a combination of them.

Example: Health Care community cloud

2.2.5 Comparative analysis of deployment model

Table 1 describes the cloud deployment model.

Table 1

	Public	Private	Community	Hybrid
Ease of setup and use	Easy	Requires IT proficiency	Requires IT proficiency	Requires IT proficiency
Data security and privacy	Low	High	Comparatively high	High
Data control	Little to none	High	Comparatively high	Comparatively high
Reliability	Low	High	Comparatively high	High
Scalability and flexibility	High	High	Fixed capacity	High
Cost-effectiveness	The cheapest	Cost-intensive; the most expensive model	Cost is shared among community members	Cheaper than a private model but more costly than a public one
Demand for in-house hardware	No	Depends	Depends	Depends

2.3 Cloud ServiceModels

Cloud computing services come in three types:[6]

- SaaS (Software as aService)
- IaaS (Infrastructure as aService)
- PaaS (Platform as aService).

Each cloud model has its own collection of advantages that could be useful to a variety of businesses. Understanding these cloudmodels, assessing the specifications, and determining how the chosen model will produce your expected collection of workflows are all necessary steps in deciding between them.

On Premises	IaaS	PaaS	SaaS
Application	Application	Application	Application
Data	Data	Data	Data
Runtime	Runtime	Runtime	Runtime
Middleware	Middleware	Middleware	Middleware
O/S	O/S	O/S	O/S
Visualization	Visualization	Visualization	Visualization
Servers	Servers	Servers	Servers
Storage	Storage	Storage	Storage

Managed By Owner

Managed By Cloud Service Provider

Table 2

Table 2 describes the which are the features are managed by owner and vendor(Cloud service Provders).The following is a brief description of the three types of cloud models and theirbenefits.

2.3.1. SaaS

Software as a Service, or SaaS, is a business model that allows users to quickly access cloud-based web applications. The vendor has complete control over the computing stack, which you can access through a web browser. These programs are cloud-based, and you can either pay for a license or use them for free with restricted access.

Pros:

In your current computing infrastructure, SaaS does not need any installations or downloads.\ This removes the need to install software on each of your machines, with the provider handling maintenance and support.

Cons:

An enterprise may not be able to find several computationally specific applications via saas. Furthermore, if a customer wishes to switch his three applications to a new vendor, the current provider can refuse or charge a significant fee. The lock-in problem is a well- known term for thisissue.

Examples of SaaS : Google G Suite, Microsoft Office 365, Dropbox,etc.

2.3.2. PaaS

PaaS (Platform as a Service) is a cloud-based platform for developing, testing, and organizing various business applications. PaaS makes the task of developing enterprise applications much easier. PaaS provides a virtual runtime environment that is ideal for designing and testing applications.

Pros: PaaS is also subscription-focused, giving you a variety of pricing choices based on your businessneeds.
Cons: Platforms from various vendors are often incompatible. Customers are unable to switch vendors due to a lack of interoperability and portability among providers.
Examples: Google App Engine and AWS Elastic Beanstalk.

2.3.3. IaaS

Infrastructure as a Service, or IaaS, is a cloud- based virtualization of computing services. An IaaS cloud provider will provide you with all of your computing infrastructure needs, including storage, servers, and networking hardware, as well as maintenance and support. **Pros:**
Businesses may choose from a variety of computing tools without having to install hardware on their premises.
Examples: Amazon Web Services, Microsoft Azure, and Google Compute Engine

III. CLOUD SERVICEPROVIDERS

A cloud service provider is a third-party company that provides a cloud-based platform, infrastructure, and application or storage services. Companies normally only have to pay for the cloud services that they use, similar to how a homeowner could pay for electricity orgas.

Aside from the pay-per-use approach, cloud service providers give businesses with a number of benefits [6]. Scalability and versatility will assist businesses by avoiding the physical limits of on-premises servers, the efficiency of many data centres with multiple redundancies, customisation by customising servers to your needs, and responsive load balancing, which is simple to implement.

Businesses should, however, be aware of the security implications of keeping data in the cloud and establish and follow industry- recommended access and enforcement control configurations and practises.

There are a few well-known big public cloud providers, such as Alibaba Cloud, Amazon Web Services (AWS), Google Cloud Platform (GCP), IBM Cloud, Oracle Cloud, and Microsoft Azure, but there are hundreds of others throughout the world. Table 2 compares the features of several cloud service providers.

Table 2

	AWS	Microsoft Azure	Google	IBM
Compute	EC2	Virtual Machines	Compute Engne App Engine	Bare Metal Servers Virtualservers Power8
Storage	S3	Blob Storage Queue Storage File Storage Disk Storage	Cloud Storage Persistent Disk	Object Storage Block Storage File Storage Mass Storage Servers
Backup and Disaster Recovery		Backup Site Recovery		Backup
Database and Data Warehouse	Aurora RDS DynamoDB Redshift	Data Lake Store SQL Database DocumentDB Table Storage SQL Data Warehouse	CloudSQL Cloud BigTable Cloud Spanner Cloud DataStore	DataServices Big Data Hosting MangoDBhosting RiakHosting
In-Memory Technology	Elasticache	RedisCache		
Containers	Container Registry Container Service	Container Registry Container Service	Container Registry Container Engine Container Builder	Containers
Serverless/Faas	Lambda	Functions	Cloud Functions	Open Whisk
Analytics	Athena EMR Kinesis	HDInsight Stream Analytics	BigQuery CloudDataflow	Analytics Services Cloudera Housting
Artificial Intelligence	Lex Polly Rekognization Machine Learning	Machine Learning Cognitive Services Data Lake	Cloud Machine Learning Engine Cloud Natural Languager API	Watson
Internet of Things	IoT platform Greengrass	IoT Hub Event Hubs		Internet of Things

IV. BENEFITS OF CLOUD COMPUTING

Three major advantages of cloud adoption are

- **Scalable** – Cloud computing allows you to quickly scale up and down computing resources to meet your changingdemands.
- **Affordable** – A cloud service is less expensive since it eliminates the costs of hardware updates andmaintenance.
- **Secure** – When you join up for a cloud service, you're essentially entrusting your data to their industry-leading security standards.

Challanges and Opportunities forcloud computing: Each obstacle is paired with an opportunity – our thought on how to overcome theobstacle.

- **Availability of Service** – The majority of companies are anxious about whether cloudcomputing services will be available when they require them. To accomplish this, there must be no single point of failure. If a service provider has multiple data centres throughout the world, the software infrastructure and accounting systems must be shared, or the company will go out of business. As a result, big businesses are unwilling tomigrate.
- **Data Lock-in** – Device mobility from one cloud provider to another is not possible with cloud computing, and it can be prohibitivelyexpensive.
- **Security** – One of the main reasons why, despite the benefits, consumers are hesitant to shift their businesses to the cloud is because of this. Because their data is stored outside their property and they are unaware of its location, customers are unable to protect it from illegal access. It is the obligation of the cloud provider to maintain data security andintegrity.
- **Load Balancing** - The cloud computing platform must constantly balance the load among the servers to avoid hotspots and maximise resource utilisation. As a result, the researchers are faced with the task of identifying how to handle capital in a dynamic and effective manner while still meeting the needs of subscribers [18]. Virtualization technology provides an efficient technique for managing complex resources on a cloud computingnetwork.
- **Scalable Storage** – The most appealing qualities of cloud computing, as previously stated, are short-term use, no upfront expenses, and on-demand storage and processing capacity. Researchers have a chance to build a storage system that not only matches these needs, but alsoincorporates cloud computing features such as the ability to scale up and down on demand.

.□ **Bugs in Large-Scale Distributed Systems** - One of the most difficult problems in Cloud Computing is removing errors from these massively distributed systems. Because these flaws are typically impossible to recreate in smaller settings, large-scale debugging in commercial data centresis required. One possibility is the usage of virtual computers in Cloud Computing.

- **Energy Consumption** – Large-scale computing data centres are built to handle high-speed processing. Despite the introduction of energy-efficient hardware, total energy consumption is increasing as computational resource needs increase[13].

V. CONCLUSION

Cloud computing has gotten a lot of press in recent years. It literally refers to a circumstance in which a user gives a third party access to a remote equipment and programmewho's whereabouts, including their whereabouts, are unknown and uncontrollable to the user. According to the cloud provider, the development of very large datacenters at low-cost sites using commodity computing, storage, and networking revealed the possibility of selling those services on a pay-as-you-go basis for less than the cost of several medium-sized datacenters, while profiting from statistically multiplexing among a large number of customers. Customers can concentrate completely on their workinstead of devoting time and resources to the initial setup and continuing maintenance of their company's IT infrastructure. The ultimate goal of cloud computing, after water, gas, energy, and telephone, is to supply application, interface, and infrastructure as the fifth public utility. Computing models, datacenters, load balancing, security and privacy, virtualization, and other concerns remain obstacles. Improving resource usage and minimising power consumption are critical to the success of a cloud computing environment. GreenCloud architecture is designed to address these issues [12].It reduces the amount of energywasted.

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