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AN OVERVIEW OF CLOUD COMPUTING AND LEADING CLOUD SERVICE PROVIDERS

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ABSTRACT

With the advent of cloud computing, we can now access our data from virtually anywhere in the world, revolutionizing the way we save and retrieve information. What makes cloud computing so special is that it provides a wide range of computer services via the Internet. Among these services are software, storage, databases, networking, servers, analytics, artificial intelligence, machine learning, and business intelligence (BI). This architecture maximizes scalability, facilitates quick invention, and provides flexible resources. The ability to scale up or down operations in response to fluctuating business needs, improve infrastructure efficiency, and cut operational expenses is all made possible by paying only for the cloud services actually used. Platforms, infrastructure, apps, migration, security, databases, storage services, AI, and ML are all offered by third-party companies known as cloud service providers. Cloud computing, similar to utility billing, enables businesses to pay for the services that are really utilized. In this research, we cover a wide range of well-known cloud service providers, including GCP, Microsoft Azure, and Amazon Web Services (AWS). Prospects and key trends in the market are also explored in the report.

Keywords: Cloud Computing, Cloud Service Providers, Cloud Architecture, AWS, Azure, And GCP

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I. INTRODUCTION

Hosting infrastructure, networks, servers, software, memory, and IT personnel to handle them can be prohibitively expensive for most firms in the modern era. Among the many advantages of cloud computing is the ease with which it can collect, utilize, and administer computer resources via an online platform [1].

The data centers that make up cloud computing are stocked with resources that are tightly linked and available to customers on demand. Businesses and people alike can now access a plethora of services thanks to this [2].

Users are able to access and utilize IT resources as needed through the internet and pay for them on an as-needed basis with computing in the cloud.

Utilize the resources of data centers and servers as needed through cloud providers such as Amazon Web Services, eliminating the need to purchase, own, and maintain physical infrastructure. The learning curve for cloud computing resource types is steep, and businesses must invest months into procurement processes to acquire physical servers and other infrastructure. To function, these devices need dedicated room space with sufficient electrical outlets, air conditioning, and other mechanical comforts. Once configured and deployed expert personnel was needed to manage them.

Have at least one public cloud offering that has been available for more than three years and has a minimum of $1 billion in revenue in the calendar year 2023 (direct from the sales of the offerings and excludes managed and professional services) with at least $250 million in revenue coming from the outside of the provider home country [10]. There is a vast pool of cloud service providers; picking the right one for long-term suitability is challenging, especially since more enterprises are turning toward cloud services. Everyday life is greatly impacted by cloud computing. The ability to use cloud services, such as Gmail, watch movies on Prime, or play games with themes hosted by cloud hosts was crucial.

From small startups to global enterprises, cloud computing has become essential in business settings. Some of its many uses include enabling remote work through ubiquitous access to data and apps, offering the computing capacity and resources needed to leverage cutting-edge technologies like quantum computing and generative AI, and optimizing omnichannel consumer engagement.

II. LEADING CLOUD SERVICE PROVIDERS

Cloud computing includes delivering resources over the web, and offering benefits like scalability, resilience, cost savings, high availability, high performance, and economies of scale. For some organizations, migrating to cloud computing is connected to modernizing their data and IT infrastructure. A supplier of cloud services is an information technology business that makes available, over the Internet, computer power, data storage, and applications that may be scaled up or down on demand. Software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS) are all part of the third group.

As a third-party provider, a cloud service company offers businesses scalable resources accessible on demand via a network, enveloping cloud-based computing, storage, platforms, and applications. Whether organizations are searching for computing power, databases, storage, content delivery, networking, analytics, machine learning, or other functionality, cloud service providers have the assistance to businesses in developing high-end apps that are more adaptable, scalable, and dependable. These providers of cloud services provide cutting-edge artificial intelligence and data solutions on a massive scale, allowing organizations to construct intelligent apps [3]. Organizations can benefit from cloud service providers' ability to address their primary challenges, regardless of where they are in the digital transformation process [10].

Many cloud service providers offer various pricing plans, including pay-as-you-go, yearly, and reserved options. Users get automatic savings based on monthly usage and lower rates for prepaid resources with a pay-as-you-go plan. Additionally, these providers offer tools to estimate costs before migrating to the cloud. With scalable and affordable cloud services, you can begin developing, deploying, and managing applications in various cloud environments, on-premises, and even at the edge.

Over the past two decades, numerous cloud service providers have entered the market, but only a few have consistently maintained their leadership positions. Leading providers offer over 200 cloud services across various industries and technology categories.

Some of the most well-known cloud service providers include Amazon Web Services (AWS), Microsoft Azure, Alibaba, Tencent, Google Cloud Platform (GCP), Watson, IBM, and Huawei. In 2024, the top three providers will be AWS, Google Cloud, and Microsoft Azure [7].

Amazon Web Services (AWS)

AWS initiated cloud computing back in 2006 it makes the cloud infrastructures that Let you build and innovate Faster. There are 105 availability zones spread across 33 different locations in the AWS cloud [4]. A vast, stable, and robust cloud platform, AWS's global cloud Infrastructure is second to none. AWS operates data centers all around the world and provides more than 200 fully featured services [4].

It offers an extensive range of services and features, surpassing other cloud providers in both breadth and depth. With AWS, you can access powerful capabilities across a wide range of technologies, from basic infrastructure components like databases and storage to sophisticated ones like machine learning. This breadth enables businesses to seamlessly migrate existing applications to the cloud and innovate with efficiency, speed, and cost-effectiveness, supporting a wide spectrum of creative and practical solutions.

When it comes to cloud infrastructure, AWS has the biggest worldwide footprint. When it comes to hosting enterprise applications that require high availability, Gartner recommends AWS's Region and Availability Zone model [7].

Microsoft (Azure)

Azure revolutionized cloud computing in 2010 by introducing secure, high-speed infrastructure for rapid innovation and development. Azure data centers make up a globally distributed infrastructure designed to power the Microsoft Cloud. The Azure cloud spans more than 60 Azure regions and 300 data centers [8]. Azure offers over 90 compliance offerings, representing the largest portfolio in the industry. In order to run their businesses, 95% of Fortune 500 organizations use Azure.

Microsoft Azure spends $1 billion yearly on security to protect client data from cyber attacks (9). According to Gartner's 2023 Strategic Cloud Platform Services (SCPS) Magic Quadrant, Microsoft is a Leader [7].

Google Cloud Platform (GCP)

Google Cloud data centers are available in more than 200 countries and territories around the world. Google Cloud will continue expanding into more regions [11]. Over 900 partners and software integrations contribute to our data and AI ecosystem. Translation Hub translates content into 135 languages with just a few clicks. The Google cloud platform (GCP) provides over 70% of generative AI unicorns. BigQuery customers analyze over 110 TB of data per second [11]. Google Cloud is at the top of the list for strategic cloud platform services according to Gartner's Magic Quadrant [7].

Leading the pack of strategic cloud platform services in 2023 were AWS, Azure, and GCP, according to the Gartner Magic Quadrant. The Ability to Execute scores of AWS and GCP were the highest of the top eight businesses [7].

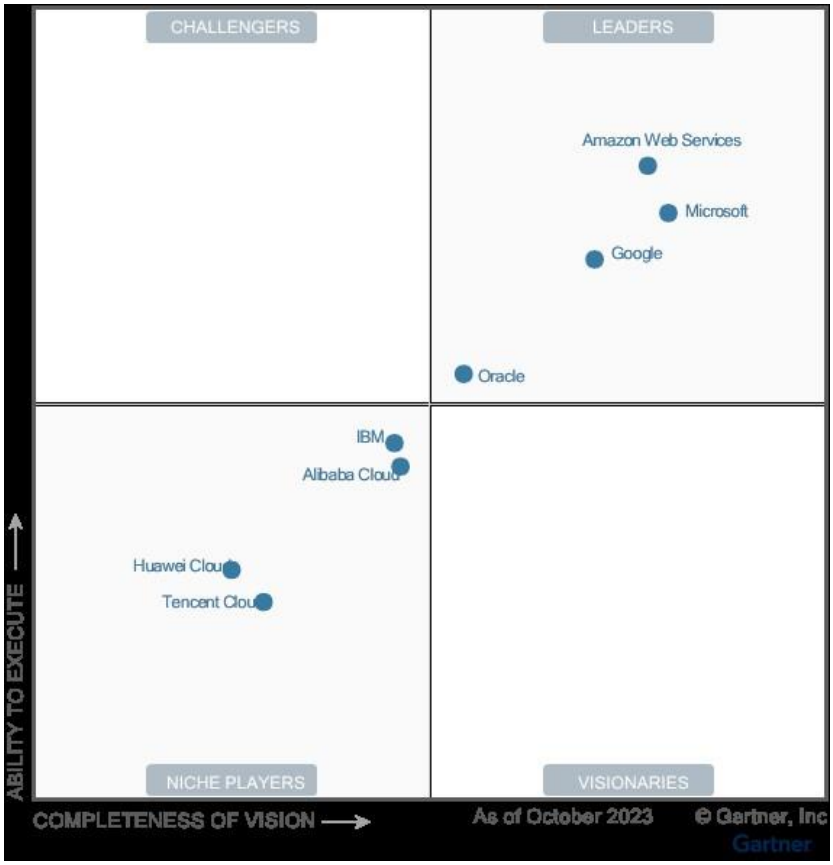

Figure 1: Assessment of Strategic Cloud Platform Services in the Fourth Quarter of 2023 [7]

It stands as leading cloud platform globally in terms of usage. Azure is putting the pressure on the competition. GCP is rapid growth fueled by innovation [7]. With 32% of the market share, AWS is followed by Azure with 23% and GCP with approximately 10%. Concurrently, the Asia-Pacific market is dominated by Alibaba Cloud and Tencent Cloud [7].

Table 1: AWS vs Azure vs GCP [3,4,10]

	AWS	**Azure**	**GCP**
Launch Year	2006	2010	2008
Market Share	32	23	10
Availability Regions	30+	60+	40+
Countries	200+	200+	200+
Services	200+	200+	120+

Table 2: Some of the most important services compared include AWS, Azure, and GCP. in [13]

Cloud Services	**Amazon Web Services (AWS)**	**Microsoft Azure**	**Google Cloud Platform (GCP)**
Life Cycle Management	CodeCommit, CodeBuild, CodeDeploy	Azure DevOps	Google Cloud Deploy
Cloud cost optimization	Cost Optimization	Cost Management	Recommender
ML platform	SageMaker	Machine Learning	Vertex AI custom training
Business intelligence (BI)	QuickSight	Microsoft Power BI	Looker

Cloud Services	**Amazon Web Services (AWS)**	**Microsoft Azure**	**Google Cloud Platform (GCP)**
Data integration / ETL	Amazon AppFlow, Amazon Data Pipeline, AWS Glue	Data Factory	Cloud Data Fusion
Data processing	Elastic MapReduce (EMR), AWS Batch, AWS Glue	Data Lake Analytics, HDInsight	Dataproc
Data warehouse	Athena, Redshift	Synapse Analytics	BigQuery
Stream data processing	Amazon Kinesis Data Firehose	Azure Stream Analytics	Dataflow
NoSQL	DynamoDB	Cosmos DB	Datastore
Relational	Amazon RDS for Oracle	Azure Oracle Database Enterprise Edition	Bare Metal Solution
IoT platform	IoT Core	IoT Hub	Cloud IoT
Cost management	Cost Explorer, Budgets	Cost Management	Cost Management
Load balancer	Elastic Load Balancing	Load Balancer	Cloud Load Balancing
Network connectivity	Direct Connect	ExpressRoute	Cloud Interconnect
Job scheduler	EventBridge	Scheduler	Cloud Scheduler
Identity and Access Management	IAM Identity Center	Active Directory	Cloud Identity
Resource monitoring	Resource Access Manager, Organizations, AWS Control Tower	Resource Manager	Resource Manager
Secret key management	AWS Secrets Manager, AWS Systems Manager Parameter Store	Key Vault	Secret Manager
Content Delivery Network	CloudFront	Content Delivery Network, Front Door	Cloud CDN
Virtual network	Virtual Private Cloud (VPC)	Virtual Network	Virtual Private Cloud
Event handling	EventBridge	Event Grid	Eventarc
Infrequent Access (IA) object storage	Amazon S3 Glacier	Azure Archive Storage	Cloud Storage Archive
Storage Service	Amazon S3	Blob Storage, ADLS	Cloud Storage
Domains and DNS	Route 53	DNS	Cloud DNS

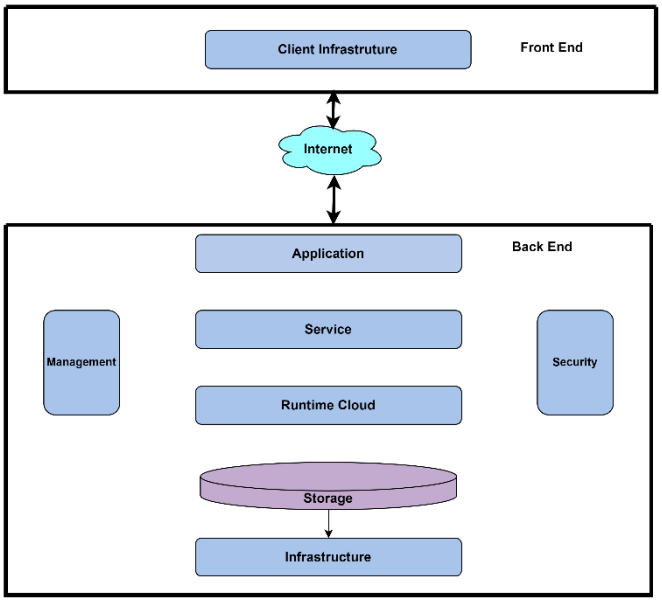

Figure 2: Cloud computing architecture

In cloud computing, frontend stages include the client infrastructure, for example, user interfaces, client-side applications, and the devices or networks accessed by the public over the public network. This includes applications like web browsers Google Chrome, Safari, and Internet Explorer. For example, utilizing a web browser on a cell phone, computer, or laptop to edit a Microsoft Word document or PDF document involves these front-end components. The gadgets, apps, and services all live on the backend. The backend is responsible for managing all the programs that power the front end applications. The backend implies the foundational parts of the actual cloud like computing resources, storage, services, security mechanisms, management tools, and more.

Applications inside cloud design refer to the backend software or services accessed by clients through the front end to manage user requests and their needs. Based on the requirement, the application provides output to the end user.

Service is the main component in the cloud architecture. Services form the core of cloud architecture, taking care of all tasks inside a cloud computing system. Service deals with the various types of services that end users can access based on their specific needs. They manage access to resources such as web applications, storage, and development environments [10].

Runtime gives virtual machines an environment to execute and run projects simultaneously. Runtime uses virtualization technologies, for example, hypervisors, to address all services, including applications, servers, storage, and networking.

Storage services are used to store and manage data in the cloud architecture. The data stored in the cloud can be accessed by multiple people at the same time. Cloud service providers offer scalable storage choices like hard drives, solid-state drives, or persistent disks, intended to manage huge volumes of data efficiently. Popular cloud storage options include Amazon Simple Storage Service (S3), Microsoft Azure Blob Storage, and Google Cloud Platform (GCP).

Another component of the backend design is the infrastructure. Included in this is the hardware that is vital for the operation of the system, such as central processing units, graphics processing units, network interface cards, and other components needed to power cloud services. It additionally incorporates the necessary software to manage and operate these components [10].

Management software, or middleware, is fundamental for correspondence among frontend and backend components of cloud architecture. While carrying out some tasks related to the cloud environment, it also specifies how the front-end and back-end will work together. It guarantees that resources are distributed dynamically in response to user needs. Additional functions include application deployment, disaster recovery, monitoring of consumption and resources, and the process of merging data from many sources.

Security efforts are important in cloud computing adoption, enveloping tools and features to protect data, applications, and platforms. Security carries out various safety efforts in the back end to secure cloud systems, applications, IP addresses, files, infrastructure, and services. These actions include data security planning, network security provisions, regular backups, debugging, and virtual firewall implementations to prevent data loss and downtime, and guarantee redundancy [10].

How does cloud architecture work?

All of the parts work together in the cloud to provide a platform where users can get resources and services whenever they need them. Everything that the cloud provider offers in terms of processing, analytics, security, data storage, and applications makes up the backend.

A network connects both frontend and backend components of cloud architecture, facilitating the exchange of data between them. Whenever users interact with front ends, there are queries transmitted to backends by middleware where the service model executes a specific task or request. When users interact on the client-side interfaces, queries have been sent to a back end via middleware which service models will execute the specific tasks or requests.

Depending on the service model or cloud-based delivery model selected, the offered types of services can vary. Three service models are available in cloud computing. This paradigm is commonly referred to as SaaS, infrastructure as a service, or platform as a service.

Infrastructure as a service (IaaS):

Infrastructure as a service (IaaS) provides on-demand access to various parts of the cloud, including storage, servers, networking gear, and the virtualization layer. With IaaS, you won't have to worry about purchasing, configuring, or maintaining infrastructure on your own premises. IaaS is ideal for short-term, experimental, or dynamic workloads. Compared to buying into on-premises deployments, operating a workload is frequently simpler, quicker, and cheaper. Everyone uses their own OS and apps that they install and run. Many cloud service providers provide this type of service.

Platform as a service (PaaS):

Applications can be easily developed, deployed, and managed with the help of PaaS, which provides a computing platform together with the required programming tools and infrastructure. Platform as a service is similar to renting a vehicle. Even though you aren't putting as much thought, effort, or money into it as you would into a personal vehicle, you go behind the wheel anyway. By utilizing the software development tools, underlying infrastructure, and operating system provided by the cloud service provider, users are able to build and execute their own apps [3]. A few instances of PaaS include BigQuery, Azure App Service, Azure Functions, Azure Logic Apps, AWS Elastic Beanstalk, and AWS App Service.

Software as a service (SaaS):

Software as a service allows users to access applications hosted in the cloud, which are maintained and delivered by the provider. The requirement for end users to install software locally is removed by SaaS. SaaS permits users to access and utilize cloud-based apps over the web. Email, amazon chime, calendaring, and office 365 are a few examples of SaaS.

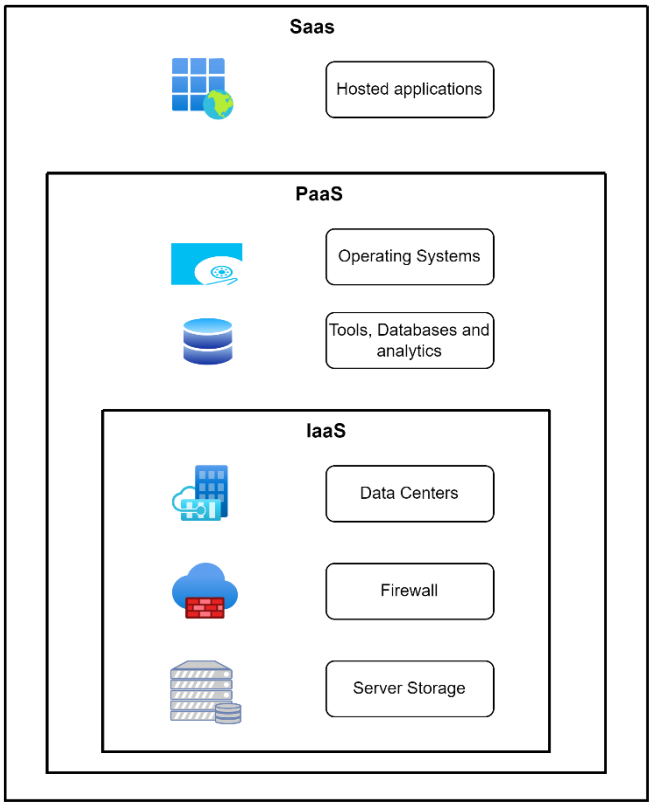

Figure 3: Difference between IaaS vs PaaS vs SaaS

Cloud architecture layers

Here is a simplified explanation of how cloud architecture functions: Consider layers stacked on top of each other to build a cloud platform.

There are three fundamental layers of cloud architecture. They are hardware, virtualization, application, and service

Hardware:

The cloud's actual components, such as servers, storage devices, network gear, and more, are known as hardware.

Virtualization:

Virtualization abstracts physical computing and storage resources into virtual representations, enabling multiple applications to share similar underlying resources efficiently.

Application and Services:

Application and Services are situated above the virtualization layer. This component manages and fulfills requests from the front-end user interface. It provides a range of services depending on the cloud service model chosen, from resource allocation and development tools to web-based applications [10].

III. CLOUD DEPLOYMENT MODELS

Public, private, and hybrid clouds are the three main varieties of cloud architecture.

Public Cloud:

The computing resources and infrastructure used by public cloud architecture are owned and managed by third-party cloud providers. With these shared resources, scaling up or down is a breeze, and no new hardware or software is required. In any case, public clouds operate on multi-tenant architectures, serving multiple customers simultaneously.

Private Cloud:

Private cloud architecture involves a dedicated cloud environment owned and operated by an organization. It is hosted on-premises within the organization's own data center, offering greater control over resources and improved security for data and infrastructure. While offering increased control and security, private cloud architecture is typically more expensive than public cloud and it requires a more significant level of IT expertise for maintenance.

Hybrid Cloud:

A hybrid cloud architecture allows for a versatile combination of public and private cloud services by combining elements of both models. It enables companies to easily switch between public and private environments for running their workloads, according to their unique needs. Hybrid cloud architectures are often favored by businesses seeking to maintain control over their data while leveraging the benefits of public cloud services.

IV. BENEFIT OF CLOUD COMPUTING

Cloud computing gives cost effectiveness, scalability, high availability, robust security, greater flexibility, compliance, and monitoring compared to traditional on-premises infrastructure.

Cost-effectiveness:

Substantial savings in resource, maintenance, and operational expenses are realized, along with the capability to optimize workloads for reduced operational costs. Utilizing a cloud service provider's infrastructure can be more cost-effective rather than investing upfront in servers. Organizations can focus on projects that differentiate their business and not the infrastructure. Organizations do not have to worry about the heavy lifting of racking, stacking, and powering servers [10,22].

Scalability:

Organizations can increase or decrease their resources in cloud computing based on their business needs. With cloud computing, you may easily increase or decrease the amount of available computer power based on your needs. With this function, businesses can easily handle seasonal increases in traffic or accommodate expansion.

High Availability:

A complete disaster recovery and business continuity plan with built-in security, a flexible, high-performance architecture, and high availability with cloud service providers' data centers is something that organizations can take advantage of.

Robust Security:

Protecting company resources is a top priority for many public cloud providers, which is why many of them include built-in security features and dedicated cloud security solutions. Most of the cloud service providers take care of security patching in many cases.

Greater Flexibility:

Cloud computing allows organizations to pay for the resources they actually utilize. Many cloud service providers offer pay-as-you-go plans which can help organizations pay for the resources that they utilize. Organizations do not have to pay for and keep up IT resources that they may just use incidentally [22].

Compliance:

Specialized products are available on many cloud platforms to help with compliance needs. Banking, investments, communication, healthcare, and government are unique areas that would benefit greatly from this.

Monitoring:

Using the web, organizations can manage and monitor their resources in both the cloud and their on-premises data centers. Some of the cloud monitoring tools are AWS Cloud Watch and Azure Monitor. Organizations can observe and monitor resources and applications on cloud platforms and on-premises [22].

VI. CONCLUSION

We covered the architecture of cloud computing, top cloud service providers, different kinds of services, deployment techniques, and benefits of cloud computing in this paper. Cloud computing is essential in the IT industry because it facilitates the migration and hosting of programs in the cloud, which drastically lowers the expenses for organizations.

Cloud computing offers an organization, and an individual enhanced choosing, flexibility, and cost savings Cloud computing also helps to avoid latency and reduce data redundancies. In the world of cloud computing, three of the most well-known and prominent names are Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP). With data centers spread out over the globe, they provide over 200 different services.

Cloud service providers recognize that for organizations to fully benefit from cloud computing, they must be willing to trust their cloud provider with one of their most valuable assets and their data.

VII. FUTURE WORK

However, choosing an appropriate cloud service provider requires careful evaluation of various factors. Future efforts will include expanding the comparison criteria for the leading cloud service providers and including additional providers in the assessment process. Look at ways to compare and contrast the technical differences between other cloud service providers and the top three (AWS, Azure, and GCP).

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